CLARKSON COMMUNITY CENTRE RENEWAL – PHASE 2

2475 Truscott Drive, Mississauga, Ontario

For City of Mississauga

salter pilon architecture inc.

Project Manual

Divisions 0-33

Project Number: 22015
Date of Issue: September 22, 2023
Issued for Tender

Quasar Consulting Group
Mechanical / Electrical Consultants

Aquatic Design and Engineering
Aquatic Consultant

END OF SECTION

1 SUMMARY OF WORK

.1 The project consists of: the development of Clarkson Community Centre Renewal Phase 2 at Mississauga, Ontario.

.2 Work by Owner comprises the following:

.1 Installation of Owner equipment and furnishings.

2 WORK RESTRICTIONS

.1 Contractor's Use Of Site

.1 Use of site to the areas designated on the drawings for execution of the Work. Do not unreasonably encumber site with materials or equipment. Move stored products or equipment which interfere with operations of Owner, or other contractors. Obtain and pay for use of off-site additional storage, or work areas as required by the Work.

.2 Hours of Work

.1 Hours of work for this Contract are generally confined to regular daily business hours of 6:30am to 5:00pm, Monday to Friday. Where required by sequencing of the Work, portions of the Work may be required to be performed outside of regular daily business hours, or on weekends, but shall be performed at such times at no additional cost to the Owner.

.2 Once the building is occupied, Contractor access to the building to perform Work to Correct deficiencies or to perform warranty is restricted and work must be done after hours.

3 OFF SITE WORK

.1 All work beyond property lines, adjacent to the site, is included in Contract unless noted otherwise.

END OF SECTION

1 GENERAL

.1 Include all allowances listed below in the Bid Price.

.2 Expend Cash Allowances as directed by the Consultant.

.3 Each Cash Allowance will be adjusted to actual cost as defined hereunder and Contract Price will be amended accordingly by written order.

.4 Progress payments for work and material authorized under Cash Allowances will be made in accordance with GC 5.3 of the Contract.

.5 Where costs under a cash allowance exceed amount of allowance, Contractor will be compensated for excess incurred and substantiated plus allowance for overhead and profit as set out in Contract Documents.

.6 Include progress payments on accounts of Work authorized under cash allowances in Consultant's monthly certificate for payment.

.7 Prepare schedule jointly with Consultant and Contractor to show when items called for under cash allowances must be authorized by Consultant for ordering purposes so that progress of Work will not be delayed.

.8 Cash allowances do not include H.S.T.

2 MATERIAL ALLOWANCES (SUPPLY ONLY)

.1 Material cash allowance shall include and provide payment for:
- .1 Net cost of material.
- .2 Applicable duties and taxes.
- .3 Delivery to the Place of the Work.

.2 Include in the Bid Price, in addition to the material cash allowance, costs for the following:
- .1 Handling at the Place of the Work, including unloading, uncrating, storage and hoisting.
- .2 Protection from damage by elements or otherwise.
- .3 Labour for installation and finishing.
- .4 Other expenses required to complete installation.
- .5 Overhead and profit.

3 ASSEMBLY ALLOWANCES (SUPPLY AND INSTALL)

.1 Assembly cash allowance shall include and provide payment for:
- .1 Net cost of material.
- .2 Applicable duties and taxes.
- .3 Delivery to the Place of the Work.
- .4 Assembly contractors'/suppliers' only, expenses relating to the following:
  - .1 Handling at site, including unloading, uncrating, storage and hoisting.
  - .2 Protection from damage by elements or otherwise.
  - .3 Labour installation and finishing.
  - .4 Other expenses required to complete installation.
  - .5 Overhead and profit.

.2 Include in the Bid Price any overhead and profit or related General Contractor costs.

4 TESTING & LABORATORY SERVICES

.1 Testing & Laboratory Services allowances shall include and provide payment for:

.1 Transportation costs to and from the Place of the Work,

.2 Personnel & equipment required to perform tests or inspections,

.3 Costs of shipping & handling samples to laboratory for testing,

.4 Applicable duties and taxes.

5 ALLOWANCE AMOUNTS

.1 The Total Cash Allowance to be included in the Stipulated Price is Seventy Thosand Dollars ($40,000.00) in Canadian funds.

.2 The Cash Allowance shall cover the following (in general):

.1 Inspection & Testing – for charges from independent company(s) to provide services related to all areas of the project that require inspection and testing.

.2 Third party commissioning of mechanical systems.

.3 BAS System integration.

.4 Structural reinforcement of existing roof and openings.

END OF SECTION

1 MODIFICATIONS TO CONTRACT

.1 Supplemental Instruction: as issued by the Consultant, consistent with the intent of the Contract Documents, and will not involve an adjustment in Contract Price or Contract Time.

.2 Proposed Change: as issued by the Consultant, will notify the Contractor of an impending or proposed change to the Work, and will require submission of a quotation from the Contractor and all affected Subcontractors for each item noted. Submit quotation within the time period stipulated on the form, and indicate separate line items for labour and materials in each case. Work outlined in a Proposed Change must not proceed without the issuance of a Change Order signed by the Owner.

.3 Change Directive: will be issued by the Consultant where an immediate response is required to an on-site condition. This form will authorize the Contractor to proceed with the change, with the stipulation that accurate accounts of costs be recorded, and may contain an upset cost, as agreed upon by the Owner and the Contractor.

.4 Change Order: will be issued by the Consultant upon review and approval of quotations for a Proposed Change, or a Change Directive, and authorizes the Contractor to proceed with the change(s) proposed. A Change Order will amend the Contract Price, and/or the Contract Time.

2 FEES FOR CHANGES IN THE WORK

.1 The fees (mark-ups) permitted to be applied to the Contract Price for changes to the Work shall be in accordance with the Supplementary Conditions of the Contract (CCDC 2 - 2008) as provided.

.2 Fees (mark-ups) for Changes in the Work shall apply to all extras to the Contract Price in accordance with the Supplementary Conditions of the Contract (CCDC 2 - 2008) as provided.

.3 Fees (mark-ups) for Changes in the Work shall only apply to credits to the Contract Price in accordance with the Supplementary Conditions of the Contract (CCDC 2 - 2008) as provided.

END OF SECTION

1 APPLICATIONS FOR PAYMENT

.1 Applications for payment on account may be made monthly as the Work progresses, and shall be preceded by the submission of a Schedule of Values for review by the Consultant, in accordance with the Contract.

.2 The second and all subsequent applications for payment shall include a statement based on the Schedule of Values, a statutory declaration (CCDC 9B), and a standard Workers Compensation Certificate of Clearance.

2 SCHEDULE OF VALUES

.1 Submit Schedule of Values in spreadsheet form acceptable to the Consultant.

.2 Identify on each Schedule of Values, the following information:

.1 Date of Issue
.2 Project name
.3 Owner's name
.4 Contractor's name
.5 Payment period
.6 Payment certificate number

.3 Items of work listed shall include, but not be limited to, separate line items for the following:

.1 General Accounts
.2 Mobilization
.3 Supervision
.4 Bonds and Insurance
.5 Permits and Licenses
.6 Operations and Maintenance Manuals/As-Built Drawings
.7 All trades or portions of the Work, generally in chronological order
.8 Provision of other Products and/or services
.9 Cash Allowance expenditures
.10 Changes in the Work

.4 The total Contract amount for each trade or portion of the Work shall be listed beside each item.

.5 For the purposes of monthly payments, the following values shall be assigned for Operation and Maintenance Manuals and Contractor created Redline and/or Final electronic As-Built Drawings.

.1 Architectural Maintenance Manuals: $2500.00
.2 Architectural Redline As-Built Drawings: $2500.00
.3 Structural Redline As-Built Drawings: $2500.00
.4 Mechanical Maintenance Manuals: $2500.00
.5 Mechanical Redline and Electronic As-Built Drawings: $2500.00
.6 Electrical Maintenance Manuals: $2500.00
.7 Electrical Redline and Electronic As-Built Drawings: $2500.00
.8 Civil Redline As-Built Drawings: $2500.00

.6 The Values of the Work shall be listed as to the aggregate percentage and dollar value completed, under the following major headings:
- .1 Initial Contract Amounts for each line item,
- .2 Progress to Date,
- .3 Percent Complete,
- .4 Current Invoice,
- .5 Previous Billings,
- .6 Contract Balance

.7 Work shall be subtotaled under original Contract amounts, Cash Allowance expenditures, and Changes to the Work.

.8 Final totals shall identify:
- .1 Total amount
- .2 Holdback deducted
- .3 Holdback released
- .4 Amount invoiced to date
- .5 Net amount
- .6 HST
- .7 Amount due this Certificate

END OF SECTION

1 PROJECT MANAGEMENT & COORDINATION

.1 Project Coordination

.1 The Contractor is responsible for the overall coordination of the Work. Coordinate the work of all subcontractors, and provide such assistance as is necessary, including but not limited to;

.1 Providing site dimensions and layout,

.2 Providing temporary facilities and controls,

.3 Scheduling subcontractors work to prevent conflicts,

.4 Scheduling and administering regular subtrade scheduling and coordination meetings throughout progress of the Work.

.5 Scheduling and administering regular subtrade safety meetings throughout progress of the Work.

.6 Coordinate construction sequences an schedules including all components of the Work, including all Divisions with interdependent responsibilities.

.2 The Contractor shall facilitate production of interference drawings where necessary for coordination of the Work. Provide such interference drawings to the Consultant for review.

.2 Project Supervision

.1 The Contractor shall provide and maintain full-time supervision on site until Substantial Performance is achieved and the deficiencies have been completed or otherwise agreed with the Owner. The supervisor shall be responsible for the overall day-to-day coordination on site between subtrades.

.2 The supervisor shall coordinate the work of all subcontractors, and provide such assistance as is necessary, including but not limited to;

.1 Layout,

.2 Rough carpentry work for blocking, strapping, nailers, etc.

.3 Project Meetings

.1 Attend all regular bi-weekly project progress meetings throughout progress of work.

.2 Consultant shall chair regular bi-weekly project progress meetings and shall record and distribute same to Owner, Contractor and Subconsultants. Contractor shall forward to appropriate subcontractors.

.4 Project Site Administration

.1 Maintain at job site, one copy each of the following:

.1 Contract drawings.

.2 Project manual.

.3 Addenda and Bid Revisions.

.4 Reviewed shop drawings.

.5 Change orders and other Contract modifications.

.6 Field test and inspection reports.

.7 Approved schedules.

.8 Manufacturer's installation and application instructions.

2 SCHEDULES

.1 Construction Progress Schedule.

.1 Prepare schedule in horizontal chart form, with weekly horizontal time scale identifying first/last work day of each week. Schedule must utilize "crtical path" method.

.2 Indicate separate line for each trade or operation of the Work. Arrange trades in chronological order for commencement of that part of the Work.

.3 Identify projected major milestones in the course of the Work such as completion of foundation work, structure, closing in, major inspections by building officials, Substantial Performance, etc.

.2 Submittal Schedule

.1 Provide schedule for submittal of all Shop Drawings, Product Data and Samples.

.2 Provide complete list of all manufacturered products to be used in the course of the Work, including those amended by addenda.

.3 Submission of Schedules

.1 Submit one copy of each schedule to the Consultant for review, prior to first progress billing. Amend schedule as required.

.2 Submit 4 copies of each subsequent issue of schedules to the Consultant.

.3 Update schedule on a regular basis or as requested by the Consultant.

3 ELECTRONIC FILE AGREEMENT

.1 Electronic files for this project will not be released until the Electronic Files Transfer Agreement, appended to this Section, has been completed and returned to the Consultant.

4 ADDITIONAL DOCUMENTS

.1 Consultant may issue additional documents in the form of drawings, specifications, schedules, or written instructions to assist proper execution of the Work. These documents shall take one of the following forms as defined in the Contract;

.1 Supplemental Instruction: no adjustment in Contract Price or Contract Time.

.2 Change Order: amendment to the Contract recommended by the Consultant, and agreed upon by the Owner and the Contractor.

5 SUBMITTAL PROCEDURES

.1 Submit to Consultant, all items specified for review, with reasonable promptness and in orderly sequence so as to not cause delay in the Work. Failure to submit in ample time is not considered sufficient reason for an extension of Contract Time and no claim for extension by reason of such default will be allowed.

.2 The Contractor shall schedule a minimum of 10 working days in order for the Consultants to review each submission. This shall also apply to subsequent resubmissions.

.3 Do not proceed with work affected by the submittal until review is complete.

.4 Review all submittals prior to submission to the Consultant. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and coordinated with the requirements of the Work and the Contract Documents. Submittals not stamped, signed, and dated will be returned without review.

.5 Verify field measurements and affected adjacent work are coordinated.

.6 Contractor's responsibility for errors and omissions in submission, or deviations from requirements of Contract Documents, is not relieved by Consultant's review of submittals.

.7 Keep one reviewed copy of each submission on site.

.8 Shop Drawings

.1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by the Contractor to illustrate details of a portion of the Work.

.2 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been coordinated, regardless of the Section under which the adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.

.3 Adjustments made on shop drawings by the Consultant are not intended to change the Contract Price. If adjustments affect the value of Work, state such in writing to the Consultant prior to proceeding with the Work.

.4 Make changes in shop drawings as the Consultant may require, consistent with Contract Documents. When resubmitting, notify the Consultant in writing of any revisions other than those requested.

.5 Shop drawings shall be submitted electronically wherever possible. Files shall be in PDF format only.

.6 Shop drawings submitted by FAX, or as copies of FAX transmissions are not acceptable as shop drawings, and will not be reviewed.

.7 Reproductions of Consultants' drawings are not acceptable for the purpose of creating Shop Drawings. Any drawings submitted for review which contain drawings or any parts of drawings produced by the Consultant, will be rejected. The Consultant will not take responsibility for any resulting delays in construction as a result of the above.

.8 Shop drawings not submitted in the scale type of the contract documents (ie. metric for metric drawings) will not be reviewed.

.9 Product Data Sheets

.1 Manufacturer's standard schematics, catalogue sheets, diagrams, schedules, performance charts, illustrations and other descriptive data are acceptable in lieu of shop drawings, where specified.

.2 Product Data Sheets are acceptable provided they conform to the following:

.1 Information not applicable to project has been deleted.
.2 Supplement standard information to provide additional information applicable to project.
.3 Show dimensions and clearances required.
.4 Show performance characteristics and capacities.
.5 Show wiring diagrams, when requested, and controls.

.3 Submit product data sheets or brochures for requirements requested in specification Sections and as the Consultant may reasonably request where shop drawings will not be prepared due to standardized manufacture of product.

.4 Submit copies of all WHMIS Data Sheets.

.5 Submit 8 copies of Product Data Sheets.

.6 Product data sheets submitted by FAX, or as copies of FAX transmissions will not be accepted.

.10 Return of Submissions

.1 If upon review by the Consultant, no errors or omissions are discovered or if only minor corrections are made, the shop drawing transparency or one copy of the product data will be returned and fabrication and installation of Work may proceed.

.2 If shop drawings or data sheets are rejected, noted copy will be returned and resubmission of corrected shop drawings or data sheets through the same procedure indicated above, shall be performed before fabrication and installation of Work may proceed.

.11 Samples

.1 Submit samples for review, in duplicate, in sizes requested in respective specification sections. Label samples as to origin and intended use in the Work.

.2 Where colour, pattern or texture is criteria, submit full range of samples.

.3 Deliver samples prepaid to Consultant's office.

.4 Notify the Consultant in writing, at the time of submission of deviations in samples from requirements of Contract Documents.

.5 Adjustments made on samples by the Consultant are not intended to change the Contract Price. If adjustments affect the value of Work, state such in writing to the Consultant prior to proceeding with the work.

.6 Make changes in samples which the Consultant may require, consistent with Contract Documents.

.7 Reviewed samples or mock-ups will become standards of workmanship and material against which installed work will be checked on project.

.12 Submission Requirements

.1 Accompany submissions with transmittal letter containing:

.1 Date,
.2 Project title and number,
.3 Contractor's name and address,
.4 Drawing/page numbers of each shop drawing or data sheet,
.5 Identification (ie. "Structural Steel Shop Dwgs."), and
.6 Number of copies submitted.

.2 Submissions shall include (where applicable) :

.1 Date and revision date,
.2 Project title and number,
.3 Name of Contractor, Subcontractor(s), Supplier/Manufacturer,
.4 Identification of product or material,
.5 Relation to adjacent structure or materials,
.6 Field dimensions, clearly identified as such,
.7 Reference standards (CSA, CGSB, ASTM, etc.), and
.8 Contractor's stamp, initialled or signed, certifying review of submission, and verification of field measurements.

.13 Distribution of Submittals after Review

.1 Distribute copies of shop drawings and product data which carry Consultant's stamp as follows (where applcable):

.1 Job site file (Record documents),
.2 General Contractor’s office,
.3 Subcontractors, and
.4 Suppliers or Fabricators.

END OF SECTION

Electronic Files Transfer Agreement

Architect of Record ("The Consultant"): salter pilon architecture inc.

Contractor ("The Contractor"): _____

Re ("The Owner"): Clarkson Community Centre Renewal

The Contractor hereby acknowledges requesting from the Consultant, electronic data containing the graphic (electronic) representation of the Architectural Drawings *as per attached list of drawings*, subject to the condition that the said drawings are to be used only for information and reference in connection with the Owner's use and occupancy of the Project. The Contractor shall be responsible for checking and verifying all dimensions, details, and quantities of materials, and for the coordination of related elements as required to facilitate complete and accurate fabrication and installation. Any omissions or discrepancies shall be reported to the Consultant. The Contractor hereby warrants to the Consultant that the files will be used solely for the development of shop drawings. The drawings shall not be used for any other purpose on this project and shall not be used on any other project either by the Contractor or by others. The Contractor further warrants not to alter the electronic data or the information contained therein, in any way except for the above-noted purposes, and acknowledges that such unauthorized use or alteration of the original work is protected in accordance with the Copyright Act and subject to the penalties prescribed therein.

The Contractor hereby acknowledges that the said electronic data contain information which may be updated or altered at any time by the Consultant, and that it is the responsibility of the Contractor to make themselves aware of these changes, in a timely manner. In the event of a conflict between the drawings issued to the Contractor and the sealed contract drawings, the sealed contract drawings shall govern.

The Contractor agrees to pay the Consultant $200.00 per file, plus any and all applicable taxes. The fees are to cover the costs of preparation of the electronic data, and disbursements related to the preparation and shipment/forwarding of the electronic data only. By paying the fees, the Contractor has in no way purchased the drawings or any rights to the drawings or the information contained therein, and the Contractor may only alter the drawings for the purposes noted above.

The Contractor shall, to the fullest extent permitted by law, indemnify, defend and hold harmless the Consultant, and its sub-consultants from all claims, damages, losses, expenses, penalties and liabilities of any kind, including attorney's fees, arising out of, or resulting from the use of the electronic files by the Contractor, or by third party recipients of the electronic files from the Contractor.

The Consultant believes that no licensing or copyright fees are due to others on account of the transfer of the electronic files, but to the extent any are, the Contractor will pay the appropriate fees and hold the Consultant harmless from such claims.

Any purchase order number provided by the Contractor is for Contractor's accounting purposes only. Purchase order terms and conditions are void and are not a part of this agreement.

The laws of the Province of Ontario shall govern this agreement.

The conditions and undertakings expressed herein apply to partners, employees, agents, successors, assigns and legal or other representatives of the Contractor.

AUTHORIZED ACCEPTANCE

by Consultant

_____
Signature

_____
Print Name and Title

Date _____

by Contractor

_____
Signature

_____
Print Name and Title
(Authorized Signing Officer)

Date _____

1 GENERAL

.1 Provide construction photographs in accordance with procedures and submission requirements specified in this section.

.2 Photographs shall be taken using a digital camera.

.3 Photographs shall be named and grouped by date using the following file name format: CLARKSON_CC - YYYY_MM_DD (##).jpeg

2 PROGRESS PHOTOGRAPHS

.1 Provide 1 digital set of construction photographs, documenting progress of the Work. Submit one digital set with each monthly progress draw.

.2 Submit progress photographs with each monthly progress draw, and at the following milestones;

.1 Completion of excavation and pouring of footings,
.2 Completion of foundations prior to backfilling,
.3 Completion of structural frame,
.4 Completion of rough-in of mechanical and electrical services before concealment.
.5 Completion of each major portion of work
.6 Completion of each major finish item.

.3 Orientation of Photographs: provide photos from 4 general viewpoints, as well as specific views as required by milestones specified above, and as determined by Consultant prior to first Progress Draw.

3 FINAL PHOTOGRAPHS

.1 Submit full digital set of construction photographs taken during course of Work with Operations & Maintenance Manuals at the completion of the project.

.2 Orientation of Photographs: provide final photos as follows:

.1 General viewpoints as defined above,
.2 Views of all exterior elevations,
.3 One view from each street,
.4 Views of site showing parking areas and play surfaces,
.5 Interior views of all major spaces,
.6 One set of views of a typical room,
.7 Specific views as determined by Consultant (Max. 48 views).

END OF SECTION

1 GENERAL

1.1 SECTION INCLUDES
- .1 Requirements for quality of work.
- .2 Requirements for for material inspection and testing.
- .3 Requirements for determination of defective materials and work.

1.2 REFERENCE STANDARDS
- .1 CSA A23.1; Concrete Materials and Methods of Concrete Construction.
- .2 CSA A23.2; Methods of Test for Concrete.
- .3 CSA S16.1; Limit States Design of Steel Structures.
- .4 CSA W47.1; Certification of Companies for Fusion Welding of Steel Structures.
- .5 CSA W59; Welded Steel Construction (Metal Arc Welding).
- .6 CISC; Code of Standard Practice for Structural Steel.
- .7 OPSS; Ontario Provincial Standard Specifications.

1.3 REGULATORY REQUIREMENTS
- .1 Products and services provided to complete the Work shall meet or exceed requirements of specified standards, municipal by-laws, building codes and referenced documents.

1.4 INDEPENDENT INSPECTION AND TESTING
- .1 Independent Inspection and Testing Consultants will be engaged by the Owner for the purpose of inspecting and/or testing individual portions of the Work. The initial cost of such services will be borne by the Owner, as allocated under Section 01 21 00, Allowances.

1.5 RESPONSIBILITIES
- .1 Inspection and Testing Consultants
  - .1 Inspection and Testing Consultants shall;
    - .1 Provide inspection and testing specified,
    - .2 Inform the Contractor and Consultant immediately upon observance of materials, systems, or procedures not in compliance with the specifications, and
    - .3 Submit complete reports to the Contractor and the Consultant in a timely manner.

- .2 Contractor
  - .1 Contractor shall:
    - .1 Provide access to the Work for Inspection/Testing Consultants, and
    - .2 Inform the Inspection/Testing Consultants in advance of day and time required for inspection and tests.
  - .2 It is the responsibility of the General Contractor to ensure the quality control requirements of the Contract are implemented.

- .3 Consultant
  - .1 The Consultant will make final decisions on changes to the scope of work of inspection and testing that may affect the Contract Price.

.2 When informed of of any material procedure or test result that does not meet or exceed the specifications, the Consultant will respond in an expedient manner to resolve the issue.

1.6 ACCESS TO WORK

.1 Allow inspection & testing companies access to the Work, as well as off site manufacturing and fabrication plants.

1.7 REPORTS

.1 Submit three copies of inspection and test reports to the Consultant.

.2 Provide copies to Subcontractor of work being inspected or tested, manufacturer or fabricator of material being inspected or tested.

.3 Submit one copy of inspection and test reports to the Building Official having jurisdiction, where required by that official.

.4 The cost of tests beyond those called for in the Contract Documents or beyond those required by the law of the Place of Work shall be appraised by the Consultant and may be authorized as recoverable.

1.8 STRUCTURAL STEEL

.1 All structural steel shall be subject to inspection and testing as specified herein. Inspection and Testing shall include:

.1 Confirmation that materials supplied meet specifications.
.2 Shop inspection during fabrication of steel.
.3 Checking welders' CWB Certification.
.4 Checking fabricated members against design member shapes.
.5 Checking fabricated members against allowable sweep and camber.
.6 Checking fabricated members against specified camber.
.7 Visual inspection of all welded connections including spot checking of joint preparation and fit-up.
.8 Non-destructive testing of welding.
.9 Sample checking that tolerances are not exceeded during erection including fit-up of field welded joints.
.10 Inspection of field cutting.
.11 Inspection and testing of all field bolted connections.
.12 Visual inspection of all welds securing steel deck to structural steel.
.13 Visual inspection of all bearing plate locations.

1.9 AIR/VAPOUR BARRIERS

.1 All building envelope air/vapour barrier components shall be subject to inspection and testing as specified herein. Inspection and Testing shall include:

.1 Visual inspection of total membrane for defects.
.2 Visual inspection of all transition membranes.

1.10 ROOFING

.1 All roofing shall be subject to inspection as specified herein. Inspection and Testing shall include:

.1 Inspection of all roofing materials to verify compliance with specifications.
.2 Inspection of roofing application.

2 PRODUCTS

(RESERVED)

3 EXECUTION

3.1 INSPECTION AND TESTING - GENERAL

.1 Furnish test results and mix designs as may be requested.

.2 The cost of tests and mix designs beyond those called for in the Contract Documents or beyond those required by the law of the Place of Work shall be appraised by the Consultant and may be authorized as recoverable.

3.2 INSPECTION AND TESTING - PROCEDURES

.1 Notify the appropriate agency and Consultant in advance of the requirement for tests, in order that attendance arrangements can be made.

.2 Submit samples and/or materials required for testing, as specifically requested in specifications. Submit with reasonable promptness and in an orderly sequence so as not to cause delay in the Work.

.3 Provide labour and facilities to obtain and handle samples and materials on site. Provide sufficient space to store, cure and inspect test samples.

3.3 QUALITY OF THE WORK

.1 Quality of the Work shall be first class, executed by workers experienced and skilled in the respective duties for which they are employed. Immediately notify the Consultant if required work is such as to make it impractical to produce required results.

.2 Do not employ any unfit person or anyone unskilled in their required duties. The Consultant reserves the right to require the dismissal from the site, of workers deemed incompetent, careless, insubordinate or otherwise objectionable.

3.4 DEFECTIVE MATERIALS AND WORK

.1 Refer to GC 2.4 of CCDC 2-2008.

.2 Where evidence exists that defective work has occurred, or that work has been carried out incorporating defective products, the Consultant may have independent tests, inspections, or surveys performed in order to determine if work is defective.

.3 Tests, inspections, or surveys carried out under these circumstances will be made at the Contractor's expense in the event of defective work, or at the Owner's expense where work is in conformance. Where tests incorporate a number of samples, payment will be assessed, by the Consultant, based on the ratio of conforming to non-conforming results. This does not include re-testing of soil compaction during placement, where evidence exists of non-conformance with the Contract documents, but rather only if re-testing is called for after completion of compaction.

END OF SECTION

1 GENERAL

1 SECTION INCLUDES
- .1 Codes and Standards.
- .2 Authority Having Jurisdiction.
- .3 Permits and Fees.
- .4 Relics, Antiquities and Human Remains.

2 CODES AND STANDARDS

.1 Codes

.1 All construction shall conform to the Ontario Building Code, the National Building Code (NBC) and the National Fire Code (NFC) latest editions including all supplements and amendments.

.2 Conform to all other codes, by-laws and regulations as specified within individual sections of the specifications.

.2 Industry Standards

.1 Industry Standards are specified within individual sections as applicable to those portions of the Work. The latest editions of all industry standards shall be the standards for which quality of work shall be assessed.

.2 Comply with all relevent codes, standards and industry-accepted practices, as specified herein, or as applicable to the Work.

3 AUTHORITIES HAVING JURISDICTION

.1 The Chief Building Official of the Municipality of the Place of the Work, is the primary Authority Having Jurisdiction for compliance with all codes, by-laws and regulations as they apply to all construction.

.2 Other Authorities Having Jurisdiction may be required to review and approve certain portions of the Work. The Chief Building Official of the Municipality of the Place of the Work, will determine the requirements for such involvement.

4 PERMITS AND FEES

.1 No construction work may commence without a valid, posted Building Permit.

.2 The Owner is responsible for obtaining all necessary information and applying for the Building Permit, including payment of associated fees.

.3 The Contractor is responsible for applying for, and obtaining all necessary permits, licenses, or certificates required by the Work.

.4 Authorities Having Jurisdiction may levy fees for issuing permits, licenses, or certificates under their jurisdiction. The Contractor shall pay all such fees as required, and shall include the cost of such fees in their Contract Price.

.5 Furnish certificates and permits from other Authorities Having Jurisdiction when so requested by the Consultant.

.6 Prior to commencement of construction, post the Building Permit at the Place of the Work.

5 RELICS, ANTIQUITIES AND HUMAN REMAINS

.1 Comply with the General Conditions of the Contract with respect to relics, antiquities, and human remains.

.2 Isolate and protect human remains, relics, antiquities, items of historical, archeological or scientific interest such as cornerstones, commemorative plaques, inscribed tablets and other similar objects found during the course of the Work.

.3 If such items are discovered in the course of construction, stop work in the immediate vicinity, and give immediate notice to the Consultant as to the nature of the discovery, and await written instructions before proceeding with work in the area.

.4 Resume work only after the conclusion of any inspection and evaluation by experts engaged by the Owner, and only after being given permission to do so.

.5 Relics, antiquities and items of historical or specific interest remain the Owner's property.

END OF SECTION

Abbreviations listed, when used in the Contract Documents, shall have the following meanings:

ABBREVIATION	MEANING
AA	ALUMINUM ASSOCIATION
AAMA	ARCHITECTURAL ALUMINUM MANUFACTURERS` ASSOCIATION
AASHO	AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS
ACI	AMERICAN CONCRETE INSTITUTE
AGA	AMERICAN GAS ASSOCIATION
AIA	AMERICAN INSTITUTE OF ARCHITECTS
AIMA	ACOUSTICAL & INSULATING MATERIALS ASSOCIATION
AISC	AMERICAN INSTITUTE OF STEEL CONSTRUCTION
AISI	AMERICAN IRON AND STEEL INSTITUTE
AMCA	AIR MOVING AND CONDITIONING ASSOCIATION INC.
ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE
ASHRAE	AMERICAN SOCIETY OF HEATING, REFRIGERATING & AIR CONDITIONING ENGINEERS
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
AWI	ARCHITECTURAL WOODWORK INSTITUTE (USA)
AWMAC	ARCHITECTURAL WOODWORK MANUFACTURERS ASSOCIATION OF CANADA
AWS	AMERICAN WELDING SOCIETY
CCA	CANADIAN CONSTRUCTION ASSOCIATION
CCRC	CANADIAN CODE FOR RESIDENTIAL CONSTRUCTION
CEC	CANADIAN ELECTRICAL CODE
CFUA	CANADIAN FIRE UNDERWRITERS ASSOCIATION
CGA	CANADIAN GAS ASSOCIATION
CGSB	CANADIAN GENERAL STANDARDS BOARD
CIQS	CANADIAN INSTITUTE OF QUANTITY SURVEYORS
CISC	CANADIAN INSTITUTE OF STEEL CONSTRUCTION
CITC	CANADIAN INSTITUTE OF TIMBER CONSTRUCTION
CLA	CANADIAN LUMBERMEN`S ASSOCIATION
CMHC	CANADA MORTGAGE & HOUSING CORPORATION
COFI	COUNCIL OF FOREST INDUSTRIES OF BRITISH COLUMBIA
CPCI	CANADIAN PRESTRESSED CONCRETE INSTITUTE
CRCA	CANADIAN ROOFING CONTRACTORS ASSOCIATION
CSA	CANADIAN STANDARDS ASSOCIATION
CSC	CONSTRUCTION SPECIFICATIONS CANADA
CSI	CONSTRUCTION SPECIFICATIONS INSTITUTE (USA)
CSPI	CORRUGATED STEEL PIPE INSTITUTE
CSSBI	CANADIAN SHEET STEEL BUILDING INSTITUTE
CUA	CANADIAN UNDERWRITERS` ASSOCIATION
CWB	CANADIAN WELDING BUREAU
CWC	CANADIAN WOOD COUNCIL
DND	DEPARTMENT OF NATIONAL DEFENCE, CANADA
FM	FACTORY MUTUAL ENGINEERING CORPORATION
FS	FEDERAL SPECIFICATION (USA)
IES	ILLUMINATING ENGINEERING SOCIETY
IGMAC	INSULATED GLASS MANUFACTURERS ASSOCIATION OF CANADA
LTIC	LAMINATED TIMBER INSTITUTE OF CANADA
MIA	MARBLE INSTITUTE OF AMERICA
MPMDD	MODIFIED PROCTOR MAXIMUM DRY DENSITY
NAAMM	NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (USA)
NBFU	NATIONAL BOARD OF FIRE UNDERWRITERS
NBC	NATIONAL BUILDING CODE OF CANADA

NBS	NATIONAL BUREAU OF STANDARDS (USDC)
NEMA	NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION
NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
NHLA	NATIONAL HARDWOOD LUMBER ASSOCIATION (USA)
NLGA	NATIONAL LUMBER GRADES AUTHORITY
NRC	NATIONAL RESEARCH COUNCIL
OBC	ONTARIO BUILDING CODE
OHSA	OCCUPATIONAL HEALTH AND SAFETY ACT
OPSS	ONTARIO PROVINCIAL STANDARD SPECIFICATIONS
PCA	PORTLAND CEMENT ASSOCIATION
PCI	PRESTRESSED CONCRETE INSTITUTE
SDI	STEEL DECK INSTITUTE
SPMDD	STANDARD PROCTOR MAXIMUM DRY DENSITY
SSPC	STEEL STRUCTURES PAINTING COUNCIL
TTMAC	TERRAZZO, TILE & MARBLE ASSOCIATION OF CANADA
ULC	UNDERWRITERS LABORATORIES CANADA
UL	UNDERWRITERS LABORATORIES (USA)
USAS	UNITED STATES OF AMERICA STANDARDS INSTITUTE
WSIB	WORKPLACE SAFETY AND INSURANCE BOARD

END OF SECTION

1 REFERENCES

.1 Occupational Health and Safety Act and Regulations for Construction Projects (2000) (Ontario Regulation 213/91, amended by Reg. 631/94, & Reg. 145/00).

.2 National Fire Code of Canada (2005)

.3 Ontario Fire Code (2005)

.4 Ontario Building Code (2006)

2 INSTALLATION AND REMOVAL

.1 Provide temporary utilities, facilities and controls in order to execute the work expeditiously. Remove from site all such work after use.

3 VEHICULAR ACCESS & PARKING

.1 Provide and maintain adequate access to project site.

.2 Build and maintain temporary access roads where indicated or required, and provide snow removal during period of work.

.3 If authorized to use existing roads for access to project site, maintain such roads for duration of Contract and make good damage resulting from Contractor's use of roads. Maintenance shall include regular snow removal if not provided under separate contract, and regular power washing to remove mud and dirt.

.4 Where site access for construction vehicles necessitates use of public roads, remove mud and dirt from such roads where contaminated by construction vehicles.

.5 Traffic Control: Provide and maintain flagpersons, traffic signals, barricades and flares, lights, or lanterns as required to perform the work and protect the public.

.6 Construction Parking

.1 Parking for construction equipment vehicles will be limited to the site or immediate areas of work.

.2 Parking for Contractors' and Subcontactors' personal vehicles will be permitted on site provided it does not constitute a safety hazard nor disrupt the performance of Work. Parkinng areas will be designated by the Owner.

4 TEMPORARY UTILITIES

.1 Temporary Electricity and Lighting

.1 Arrange, pay for and maintain temporary electrical power supply in accordance with governing regulations and ordinances.

.2 Install temporary facilities for power such as pole line and underground cables to approval of local power supply authority.

.3 Electrical power and lighting systems installed under this contract can be used for construction requirements provided that guarantees are not affected thereby. Make good damage. Replace lamps which have been used more than a period of 3 months.

.4 Provide temporary lighting in all areas of construction, to the minimum requirements of the Occupational Health and Safety Act, and minimum requirements specified herein.

.2 Temporary Water Supply

.1 Arrange, pay for and maintain temporary water supply in accordance with governing regulations and ordinances.

.2 Permanent water supply system installed under this contract can be used for construction requirements provided that guarantees are not affected thereby. Make good damage.

.3 Temporary Heating and Ventilating

.1 Provide and maintain all temporary heat and ventilation necessary during construction, including cost of installation, fuel, operation, attendance and maintenance. Use of direct-fired heaters discharging waste products into work areas will not be permitted unless prior approval is given by Consultant.

.2 Provide temporary heat and ventilation in enclosed areas as required to:

.1 Facilitate progress of work.
.2 Protect work and products against dampness and cold.
.3 Prevent moisture condensation on surfaces.
.4 Provide ambient temperatures and humidity levels for storage, installation and curing of materials.
.5 Provide adequate ventilation to meet health regulations for safe working environment.

.3 Maintain minimum temperature of 10°C or higher where construction is in progress and maintain until acceptance of structure by Consultant.

.4 Ventilating

.1 Prevent hazardous accumulation of dust, fumes, mists, vapours or gases in areas occupied during construction.
.2 Provide local exhaust ventilation to prevent harmful accumulation of hazardous substances into atmosphere of occupied areas.
.3 Dispose of exhaust materials in manner that will not result in harmful exposure to persons.
.4 Ventilate storage spaces containing hazardous or volatile materials.
.5 Ventilate temporary sanitary facilities.
.6 Continue operation of ventilation and exhaust system for a time after cessation of work process, to assure removal of harmful elements.

.5 Maintain strict supervision or operation of temporary heating and ventilating equipment.
.1 Conform with applicable codes and standards.
.2 Enforce safe practices.
.3 Prevent abuse of services.
.4 Prevent damage to finishes.
.5 Vent direct-fired combustion units to outside.

.6 The permanent HVAC systems of the building, or portions thereof, may not be used during construction.

5 CONSTRUCTION FACILITIES

.1 Field Office

.1 Provide minimum 2400 x 4800mm office and furnish with desk, drawing layout table, filing cabinet, and coat hooks.

.2 Provide minimum 750 Lx lighting level.

.3 Heat to maintain 22°C inside temperature.

.4 Provide 2 operable windows for cross ventilation, or air condition.

.2 Temporary Communication

.1 Provide and pay for temporary communication systems to be installed in Field Office.

.2 Provide hard wire and wireless internet access.

.3 Cellular telephones are acceptable. Pay telephone is not acceptable.

.3 Equipment, Tools and Materials Storage

.1 Provide adequate weathertight enclosures with raised floors, for storage of materials, tools, and equipment which are subject to damage by weather.

.2 Temporary enclosures required by subtrades as workshops shall be provided by those trades.

.4 Site Storage and Overloading

.1 Confine the Work and the operations of employees to limits indicated by the Contract Documents. Do not unreasonably encumber the premises with products.

.2 Do not load or permit to be loaded any part of the Work with a weight or force that will endanger the Work.

.5 Sanitary Facilities

.1 Provide sanitary facilities for work force in accordance with governing regulations and ordinances. Post notices and take such precautions as required by local health authorities. Keep area and premises in sanitary condition. Where portable toilet facilities are provided, empty and sanitize such facilities on a weekly basis, or more frequently if required.

.2 Permanent new facilities shall not used by the Contractor.

6 CONSTRUCTION SAFETY MEASURES

.1 Observe all construction safety measures as required by the General Conditions of the Contract, the Occupational Health and Safety Act and Regulations for Construction Projects, and by all authorities having juridiction, provided that in case of conflict or discrepancy, the more stringent requirements shall apply.

.2 Provide applicable spare safety equipment such as helmets, safety glasses, and harnesses, and enforce their use by Consultants, the Owner, their representatives and any authorized visitors to the site.

.3 Provide and maintain fences, gates and locks, covered walkways, guard rails, barriers, night lights, and appropriate warning signage as required for the protection of the public, and of public and private property; as required by the General Conditions of the Contract, the Occupational Health and Safety Act and Regulations for Construction Projects, and by all authorities having jurisdiction. Erect and maintain sturdy railings around shafts, and the like, to protect workmen and the public from injury.

.4 Workplace Hazardous Materials Information System

.1 Comply with all requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials; and regarding labelling and provision of material safety data sheets.

.2 Include copies of all WHMIS data sheets in Operations and Maintenance Manuals.

7 CONSTRUCTION AIDS

.1 Falsework

.1 Design and construct falsework in accordance with CSA S269.1.

.2 Scaffolding

.1 Design, construct and maintain scaffolding in accordance with CSA S269.2.

.2 Erect scaffolding independent of walls. Remove promptly when no longer required.

.3 Hoisting

.1 Provide, operate and maintain hoists or cranes required for moving of workers, materials and equipment. Make financial arrangements with Subcontractors for use thereof.

.2 Hoists or cranes shall be operated by qualified operator.

8 TEMPORARY BARRIERS & ENCLOSURES

.1 Construction Isolation Fencing

.1 Erect isolation fencing around perimeter of construction areas to protect the public, workers, and the public from injury.

.2 Construction Isolation Fencing shall consist of:

.1 Temporary modular welded wire mesh fencing, minimum 1828 x 2440mm high, by CanFence Rentals Ltd., or equivalent.

.2 Provide lockable gates within hoarding / fencing for access to site by workers and vehicles.

.3 Provide barriers around trees and planting beds designated to remain. Protect from damage.

.4 Enclosure of Structure

.1 Provide temporary weathertight enclosures and protection for exterior openings until permanently enclosed.

.2 Erect enclosures to allow access for installation of materials and working inside enclosure.

.3 Erect enclosures to withstand wind pressure and snow loading.

.4 Close off floor areas where walls are not finished; seal off other openings; enclose building interior work area for temporary heat.

.5 Dust Control

.1 Provide dust tight screens or partitions to localize dust generating activities, and for the protection of workers, or finished areas of Work.

.2 Dust screens shall consist of, as a minimum, 0.15mm thick fire retardant polyethylene sheets secured to appropriate framing and sealed at all joints and at perimeter to prevent migration of dust

.1 Poly sheet: Polytarp, Super Six by Polytarp Products or approved alternative.

.3 Maintain and relocate protection until such work is complete.

.4 Provide dust catching walk-off matting, at all construction entrances.

9 TEMPORARY CONTROLS

.1 Drainage & Erosion Control

.1 Refer to Section 01 57 19 – Temporary Environmental Controls and Site Grading & Servicing drawings.

.2 Tree and Plant Protection

.1 Refer to Section 01 57 19 – Temporary Environmental Controls and Landscape drawings.

.3 Security Measures

.1 Where progress of construction reaches point where building exterior is fully enclosed, provide construction cylinders for doors, and secure building against intrusion. Where installation of fixtures and equipment, or storage of materials and equipment, inside the building has begun prior to installation of exterior windows and doors, provide temporary plywood enclosures for window and door openings to prevent intrusion until permanent closures are in place.

.2 Extent of security services shall be at the sole discretion of the Contractor (except as noted in item .3 below) and all costs incurred shall be paid for by the Contractor. Note that the fit, finish and new appearance of the finished building will not be compromised to accommodate temporary security provisions. Materials, products, finishes, etc. damaged due to vandalism are to be restored and/or replaced to an as-new condition.

.3 Commencing at a date which is four (4) months prior to the scheduled date for Substantial Performance, Contractor shall arrange and pay for the provision of “after hours” manned security at the project site. Security shall provide surveillance and oversite of the building and site areas, during all times when the Contractor’s construction personnel are not in attendance. Continue services until time of substantial completion.

.4 Site Signs and Notices

.1 Maintain approved signs and notices in good condition for duration of project, and dispose of off site on completion of project or earlier if directed by Consultant.

.2 No other signs or advertisements of any description except notices regarding safety and instruction, shall be put up around the building, or site, without the approval of the Consultant.

10 TEMPORARY FIELD OFFICE

.1 Provide an office for the owner which shall consist of one 3660 mm x 12190 mm Atco trailer with: two full height, moveable partitions; adequate electric heating, air conditioning and lighting; washroom and water closet with hot and cold running water and supplies; and labour for daily cleaning of washrooms and offices. Equip the trailer with the following; two offices with two executive lockable desks and two swivel chairs; one boardroom table with 10 chairs; two plan tables and 2 drafting stools; two aluminum wall mounted plan racks each with twelve are capacity and two four drawer legal size lockable fireproof file cabinets. Provide and pay for telephone services consisting of 3 business lines on five key sets for local calls. The Consultant will determine the distribution of the equipment and telephone service between the two trailers. Long distance telephone calls will be to the Owner's account. Provide an pay for internet service with Wi-Fi for mobile devices. Provide photocopier/printer/scanner with data to be installed into each office.

.2 Provide a site meeting trailer which shall consist of one 3660 mm x 18288 mm Atco trailer with: two full height, moveable partitions; adequate electric heating, air conditioning and lighting; labour for daily cleaning. Equip the trailer with the following; boardroom table and chairs to accommodate 20 individuals; two plan tables and 2 drafting stools; Provide an pay for internet service with Wi-Fi for mobile devices. Provide photocopier/printer/scanner with data to be installed into each office. Provide and pay for telephone services at the discretion of the contractors use. Long distance telephone calls will be to the Contractor's account. The Contractor is responsible for all other accessories related to their use of the trailers. This trailer cannot be used by the Contractor or Sub-Contractor for workers breaks or dining activities.

.3 Provide a dining trailer for site personnel which shall consist of one 3660 mm x 12190 mm Atco Trailer. Outfitting of the trailers is at the discretion of the Contractor within reason of necessary equipment and accessories to conduct the proper use of the facility.

.4 Provide and maintain until contract completion a temporary office as required for work, large enough to accommodate site administrative activities and site meeting, complete with lighting, heating, and air conditioning equipment to maintain 21^{o}C. Ventilation, telephone, facsimile machine on a separate line, copier (not combination fax/copier), table and chairs. Do not store materials, tools. equipment in meeting area; keep clean and tidy.

.5 For all trailers and temporary buildings, provide wood stairs, platform and boardwalk, painted and repainted as required with non-skid abrasive paint.

.6 Do not locate any buildings, structures or equipment in a manner that interferes with surveys along the control line and reference line tangents.

.7 Remove temporary buildings upon Contract Completion. Restore area(s) to match the existing surrounding area.

END OF SECTION

1 REFERENCES
- .1 National Building Code of Canada (2005)
- .2 National Fire Code of Canada (2005)
- .3 Ontario Fire Code (2007)
- .4 Guidelines for Maintaining Fire Safety during Construction in Existing Buildings, (10/31/88) Ontario Ministry of the Solicitor General, Office of the Fire Marshal.
- .5 Ontario Building Code (Regulation 350/06)

2 FIRE SAFETY

.1 Fire Fighting Equipment

.1 Provide and maintain in working order, ULC labelled, 9kg 4A 60BC type fire extinguishers, and locate in prominent positions to approval of authorities having jurisdiction.

.2 Fire Department Access

.1 Provide and maintain fire access routes as designed, as soon as construction sequence will allow. Access routes must have compacted granular subbase, and base in place before superstructure of building may proceed.

.2 Construction activities must not obstruct access routes designated for fire department equipment. If necessary that existing access be obstructed or deleted, alternative access, acceptable to the fire department, must be provided prior to commencement of construction, in accordance with Ontario Building Code location and design criteria for required access routes.

.3 Control of Combustible Materials

.1 The stockpiling of construction materials adjacent to the existing building must be carefully controlled in accordance with the Ontario Fire Code. Materials stored, and their proximity to, equipment used in construction may create a fire hazard. Control of combustibles on a construction site is regulated under the Occupational Health and Safety Act.

.4 Hot Work

.2 Conform to the requirements of the Occupational Health and Safety Act – Regulations for Construction Projects.

.3 Provide all necessary guards and barriers to protect workers, property, and the public when performing hot work such as torching, cutting or coring. Protect all adjacent combustible materials.

.4 Provide a "Fire Watch" for a minimum of 3 hours after each instance of discontinuing hot work.

END OF SECTION

1 DEFINITIONS

.1 Environmental Pollution and Damage: presence of chemical, physical, biological elements or agents which adversely affect human health and welfare; unfavourably alter ecological balances of importance to human life; affect other species of importance to humankind; or degrade environment aesthetically, culturally and/or historically.

.2 Environmental Protection: prevention/control of pollution and habitat or environment disruption during construction. Control of environmental pollution and damage requires consideration of land, water, and air; biological and cultural resources; and includes management of visual aesthetics; noise; solid, chemical, gaseous, and liquid waste; radiant energy and radioactive material as well as other pollutants.

2 SUBMITTALS

.1 Submittals: in accordance with Submittal Procedures.

.2 Prior to commencing construction activities or delivery of materials to Site, submit Environmental Protection Plan for review and approval by Consultant Environmental Protection Plan is to present comprehensive overview of known or potential environmental issues which must be addressed during construction.

.3 Address topics at level of detail commensurate with environmental issue and required construction tasks.

.4 Environmental protection plan: include:

.1 Name(s) of person(s) responsible for ensuring adherence to Environmental Protection Plan;

.2 Name(s) and qualifications of person(s) responsible for manifesting hazardous waste to be removed from Site;

.3 Name(s) and qualifications of person(s) responsible for training site personnel;

.4 Descriptions of environmental protection personnel training program;

.5 Erosion and sediment control plan which identifies type and location of erosion and sediment controls to be provided including monitoring and reporting requirements to assure that control measures are in compliance with erosion and sediment control plan, Federal, Provincial and Municipal laws and regulations;

.6 Drawings showing locations of proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities and stockpiles of excess or spoil materials including methods to control runoff and to contain materials on Site;

.7 Traffic control plans including measures to reduce erosion of temporary roadbeds by construction traffic, especially during wet weather. Plans include measures to minimize amount of mud transported onto paved public roads by vehicles or runoff;

.8 Work area plan showing proposed activity in each portion of area and identifying areas of limited use or non-use. Plan to include measures for marking limits of use areas including methods for protection of features to be preserved within authorized work areas;

.9 Spill Control Plan: including procedures, instructions, and reports to be used in event of unforeseen spill of regulated substance;

.10 Non-Hazardous solid waste disposal plan identifying methods and locations for solid waste disposal including clearing debris;

.11 Air pollution control plan detailing provisions to assure that dust, debris, materials, and trash, do not become air borne and travel off-site;

.12 Contaminant prevention plan that: identifies potentially hazardous substances to be used on Site; identifies intended actions to prevent introduction of such materials into air, water or ground; and details provisions for compliance with Federal, Provincial, and Municipal laws and regulations for storage and handling of these materials;

.13 Waste water management plan that identifies methods and procedures for management and/or discharge of waste waters which are directly derived from construction activities, such as concrete curing water, clean-up water, dewatering of ground water, disinfection water, hydrostatic test water and water used in flushing of lines;

.14 Historical, archaeological, cultural resources biological resources and wetlands plan that defines procedures for identifying and protecting historical, archaeological, cultural resources, biological resources and wetlands;

.15 Pesticide treatment plan: to be included and updated, as required.

3 FIRES

.1 Fires and burning of rubbish on Site is strictly prohibitted.

4 DISPOSAL OF WASTES

.1 Burying of rubbish and waste materials on Site is strictly prohibitted.

.2 Do not dispose of waste or volatile materials, such as mineral spirits, oil or paint thinner into waterways, storm or sanitary sewers.

5 DRAINAGE & EROSION CONTROL

.1 Provide erosion and sediment control plan that identifies type and location of erosion and sediment controls to be provided. Plan: include monitoring and reporting requirements to assure that control measures are in compliance with erosion and sediment control plan, Federal, Provincial, and Municipal laws and regulations.

.2 Storm Water Pollution Prevention Plan (SWPPP) may be substituted for erosion and sedimentations control plan.

.3 Provide temporary drainage and pumping as necessary to keep excavations and Site, free from water.

.4 Do not pump water containing suspended materials into waterways, sewer or drainage systems.

.5 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with local authority requirements.

.6 Provide and maintain temporary drainage and pumping as necessary to keep excavations and site free from excess water.

.7 Provide silt fencing at site perimeters and where required by local authorities to prevent contamination of adjoining properties from silt and water drainage.

6 TREE AND PLANT PROTECTION

.1 Protect existing trees and plants on all adjacent properties, where in close proximity to construction activities, or where construction access passes within 3m of trees or plants, whether indicated on drawings or not.

.2 Conform to all local By-Laws regarding tree preservation and protection.

.3 Protect existing trees and plants on site as indicated.

.4 Restrict tree removal to those designated by Consultant. Wrap in burlap trees and shrubs adjacent to construction work, storage areas and trucking lanes. Encase trees and shrubs with protective wood framework from grade level to height of 2134mm.

.5 Protect roots to minimum 1m beyond dripline during excavation and site grading to prevent disturbance or damage. Avoid unnecessary traffic, dumping and storage of materials over root zones of protected trees. Minimize stripping of topsoil and vegetation.

.6 The Minimum Tree Protection Zone will be the drip line. Within this tree protection zone there will also be no construction activity including but not limited to no root cutting, no alteration or disturbance to existing grades of any kind, no changes to the grade by adding fill, excavating or scraping, no storage of construction materials or equipment, no stockpiling of soil, debris or construction waste, & no movement or storage of heavy vehicles or equipment. Tree protection barriers must be included and priced as part of the project. For short term project (up to 2 months), standard T-bars and plastic safety fence can be used. For a longer term project, use 10 gauge chain link fence and standard T-bars. In all cases, standard T-bars should not be spaced more than 6 to 7 feet apart. These protection barriers must be erected before the project starts, must be maintained throughout the project, and taken down when final inspection and signoffs are completed.

7 WORK ADJACENT TO WATERWAYS/DRAINAGE DITCHES

.1 Do not operate construction equipment in waterways.

.2 Do not use waterway beds for borrow material.

.3 Do not dump excavated fill, waste material or debris in waterways.

.4 Design and construct temporary crossings to minimize erosion to waterways.

.5 Do not skid construction materials across waterways.

.6 Avoid indicated spawning beds constructing temporary crossings of waterways.

8 POLLUTION CONTROL

.1 Maintain temporary erosion and pollution control features installed under this Contract.

.2 Prevent sandblasting and other extraneous materials from contaminating air and waterways beyond application area, by providing temporary enclosures.

.3 Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary roads.

9 HISTORICAL / ARCHAEOLOGICAL ARTIFACTS

.1 In the event that buried archaeological remains are encountered on the property during construction activities, the Heritage Operations Unit of the Ministry of Tourism and Culture be notified immediately at (416) 314-714.

.2 In the event that human remains are encountered during construction, the proponent should immediately contact both the Ministry of Tourism and Culture, and the Registrar or Deputy Registrar of Cemeteries at the Cemeteries Regulation Unit, Ministry of Government Services, (416) 326-8404.

10 NOTIFICATION

.1 Consultant will notify Contractor in writing of observed non-compliance with Federal, Provincial or Municipal environmental laws or regulations, permits, and other elements of Contractor's Environmental Protection plan. Contractor shall, after receipt of such notice, inform Consultant of proposed corrective action and take such action for approval by Consultant.

.2 Consultant will issue stop order of Work until satisfactory corrective action has been taken.

.3 No time extensions granted or equitable adjustments allowed to Contractor for such suspensions.

END OF SECTION

1 PRODUCT OPTIONS

.1 Provide products specified under individual specification sections. Where Specification lists two or more products, or two or more manufacturers of the same product, the Contractor may select one of the listed products or manufacturers. Confirm selection of products and manufacturers when requested by the Consultant.

.2 When only one product or manufacturer is listed in the specifications, it is intended that only that product or manufacturer is acceptable.

2 PRODUCT SUBSTITUTION PROCEDURES

.1 Substitution Procedures During Construction

.1 Products may only be substituted during the Construction period for one or more of the following reasons:

.1 Insolvency of the product manufacturer.

.2 Inability of the manufacturer to provide the product(s) in the timeframe required to maintain the construction schedule.

.3 Product specified has been discontinued.

.4 Substitution proposed offers better performance than that specified, at no additional cost.

.5 Substitution offers equivalent performance to that specified, at a reduced cost to the Owner (reduction in Contract Price).

.2 Items 2.1.1.2, and 2.1.1.3 will require a letter from the manufacturer, confirming their inability to provide the products specified, or inability to meet the schedule.

.3 Items 2.1.1.4, and 2.1.1.5 will be at the discretion of the Owner.

3 AVAILABILITY

.1 Immediately upon signing Contract, review Product delivery requirements, and identify lead times for supply of all Products. If lead times in supply of Products may affect the Construction Schedule, notify the Consultant in order that appropriate action may be authorized in ample time to prevent delay in performance of the Work.

.2 The Contractor shall order Products and materials in a timely fashion so as to ensure that delivery of such Products and materials shall coincide with the Construction Schedule. Failure of the Contractor or their Subcontractors to order Products and materials in a timely fashion, shall not be cause for substitution in accordance with the criteria set out under Article 2 – Product Substitution Proccedures.

.3 In the event of failure to notify the Consultant of Product delivery problems at the commencement of the Work, and should it appear that the Work may be delayed for such reason, the Consultant reserves the right to substitute more readily available Products of similar character of their chosing, at no increase in Contract Price.

4 REFERENCE STANDARDS

.1 Within the specifications, reference standards are identified. Conform to these standards, in whole or part, as specifically requested.

.2 If there is question as to whether any product or system is in conformance with applicable standards, the Consultant reserves the right to have such products or systems tested to prove or disprove conformance.

.3 The cost for such testing will be born by the Owner in the event of conformance with Contract Documents or by the Contractor in the event of non-conformance.

.4 Conform to latest date of issue of referenced standards in effect on date of submission of bids, except where a specific date of issue is specifically noted.

5 PRODUCT TRANSPORTATION & DELIVERY

.1 Transportation and delivery costs of Products required in the performance of the Work, are included in the Contract Price.

.2 Transportation and delivery costs of Products supplied by the Owner will be paid for by the Owner. Unload, handle, and store such Products on site.

.3 Products must be appropriately crated, skidded, boxed, shrink-wrapped, or otherwise packaged to protect such products from damage during shipment. Products which arrive at the site in a damaged condition must be rejected and returned to the supplier/manufacturer for immediate replacement.

.4 Advise the Owner 30 days in advance of anticipated delivery dates for materials and equipment supplied by the Owner.

6 PRODUCT STORAGE, HANDLING AND PROTECTION

.1 Handle and store Products in a manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions.

.2 Store packaged or bundled Products in original and undamaged condition with manufacturer's seal and labels intact. Do not remove from packaging or bundling until required in the Work.

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

.4 Store cementitious products clear of earth or concrete floors, and away from walls.

.5 Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.

.6 Store sheet materials and lumber on flat, solid supports and keep clear of ground. Slope to shed moisture.

.7 Store paints in a heated and ventilated room. Remove oily rags and other combustible debris from site daily. Take every precaution necessary to prevent spontaneous combustion.

.8 Remove and replace damaged Products at own expense and to the satisfaction of the Consultant.

7 MANUFACTURER'S INSTRUCTIONS

.1 Unless otherwise indicated in the specifications, install or erect Products in accordance with manufacturer's printed instructions. Do not rely on labels or enclosures provided with Products. Obtain written instructions directly from manufacturers.

.2 Notify Consultant in writing, of conflicts between the specifications and manufacturer's instructions, so that Consultant may establish correct course of action.

.3 Improper installation or erection of Products, due to failure in complying with these requirements, authorizes the Consultant to require removal, replacement where necessary, and re-installation at no increase in Contract Price.

8 FASTENINGS

.1 Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials, unless indicated otherwise.

.2 Prevent electrolytic action between dissimilar metals and materials.

.3 Use non corrosive hot dip galvanized steel fasteners and anchors for securing exterior work, unless stainless steel or other material is specifically requested in the affected specification Section.

.4 Space anchors within limits of load limit or shear capacity and ensure that they provide positive permanent anchorage. Wood or any other organic material plugs are not acceptable.

.5 Keep exposed fastenings to a minimum, space evenly and install neatly.

.6 Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.

.7 Obtain Consultant's approval before using explosive actuated fastening devices.

9 QUALITY OF MATERIALS

.1 Products, materials, equipment and articles (referred to as Products throughout the specifications) incorporated in the Work shall be new, not damaged or defective, and of the best quality (compatible with specifications) for the purpose intended. If requested, furnish evidence as to type, source and quality of Products provided.

.2 Products relying on uniformity of colour and pattern for appearance, such as resilient flooring, carpeting, fabrics, and vinyl wallcovering, shall be from one dye lot for the project. All products delivered to the site must be labeled as to dye lot, or production run number, as well as production date.

.3 Defective products, whenever identified prior to the completion of Work, will be rejected, regardless of previous inspections. Inspection does not relieve responsibility, but is a precaution against oversight or error. Remove and replace defective Products at own expense and be responsible for delays and expenses caused by rejection.

.4 Should any dispute arise as to the quality or fitness of Products, the Consultant may request additional testing based upon the requirements of the Contract Documents, to confirm acceptability of products or materials. Refer to Article 10 - Defective Materials And Work, and Section 01 40 00.

.5 Unless otherwise indicated in the specifications, maintain uniformity of manufacture for any particular or like item throughout the building.

.6 Permanent labels, trademarks and nameplates on Products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms.

10 DEFECTIVE MATERIALS AND WORK

.1 Where evidence exists that defective work has occurred, or that work has been carried out incorporating defective products, the Consultant may have independent tests, inspections, or surveys performed in order to determine if work is defective.

.2 Tests, inspections, or surveys carried out under these circumstances will be made at the Contractor's expense in the event of defective work, or at the Owner's expense where work is in conformance. Where tests incorporate a number of samples, payment will be assessed, by the Consultant, based on the ratio of conforming to non-conforming results. This does not include re-testing of soil compaction during placement, where evidence exists of non-conformance with the Contract documents, but rather only if re-testing is called for after completion of compaction.

12 WARRANTIES & GUARANTEES

.1 Warrant all products and labour forming part of the Work for the period specified in the Contract, unless otherwise specified herein.

.2 Warrant products and assemblies for the specified periods of time where in excess of the Contract Warranty, as specified within their respective sections.

.3 Guarantee aspects of the Work for the specified periods of time where in excess of the Contract Warranty, as specified within their respective sections.

.4 Warranties and Guarantees shall commence at Date of Substantial Performance of the Contract as certified by the Consultant.

.5 Warranties and Guarantees shall be original copies, printed on company letterhead, or on a standard company warranty certificate, bearing the name of the company.

.6 Warranties and Guarantees shall indicate:

.1 Name of the Principal (the Manufacturer/Subcontractor),
.2 Name of the Obligee (the Owner),
.3 Name and address of Project,
.4 Commencement date (Date of Substantial Performance),
.5 Duration of warranty or guarantee,
.6 Clear statement of what is included, and what if any exclusions there are, and

.7 Signature of Principal's representative having signing authority.

END OF SECTION

1 EXAMINATION

.1 Acceptance of Conditions

.1 The General Contractor shall examine all existing or pre-determined conditions, prior to commencing work in that area, and report to the Consultant all conditions unacceptable for work to proceed. Commencement of work shall imply acceptance of conditions as is.

.2 Subcontractors shall examine all existing or pre-determined conditions affecting their portion of the Work, prior to commencing such work, and report to the Contractor all conditions unacceptable for work to proceed. Commencement of work shall imply acceptance of conditions as is.

2 PREPARATION

.1 Field Engineering

.1 Locate, confirm and protect control points prior to starting the Work. Preserve permanent reference points during construction.

.2 Establish reference lines and elevations. Locate and lay out by instrumentation.

.2 Records

.1 Maintain a complete, accurate log of control points and survey work as work progresses.

3 CUTTING AND PATCHING

.1 Submit a written request in advance, for approval of cutting or alteration which affects:

.1 Structural integrity of any element of Project.
.2 Integrity of weather-exposed or moisture-resistant elements.
.3 Efficiency, maintenance, or safety of any operational element.
.4 Visual qualities of sight-exposed elements.
.5 Work of Owner or separate contractor.

.2 Inspect existing conditions, including elements subject to damage or movement during cutting and patching.

.3 After uncovering, inspect conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

.4 Perform cutting, fitting and patching, including excavation and fill, to complete the Work. Perform work to avoid damage to other work.

.5 Employ original installer to perform cutting and patching for weather-exposed and moisture-resistant elements, and sight-exposed surfaces.

.6 Cut rigid materials using power saw or core drill. Pneumatic or impact tools not allowed.

.7 Fit work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces. At penetration of fire-rated wall, ceiling, or floor construction, completely seal voids with fire stopping material, full thickness of construction element.

.8 Refinish surfaces to match adjacent finishes; for continuous surfaces refinish to nearest intersection; for an assembly, refinish entire unit.

.9 Provide all openings greater than 200mm in non-structural elements of work for penetrations of mechanical and electrical work. Mechanical and Electrical Subcontractors shall provide all sleeves and locations for sleeves. The cost of all cutting and patching required by Mechanical and Electrical Subcontractors shall be paid for by those trades.

.10 Ensure that all cutting and patching work, including that by Mechanical and Electrical Subcontractors, is properly performed by the respective trades skilled in that line of work. Restore work with new products in accordance with Contract Documents.

4 LOCATION OF EQUIPMENT AND FIXTURES

.1 Location of mechanical and electrical equipment, fixtures and devices indicated or specified, are to be considered as approximate. Final location of such items will be determined on site, based on integration with structural and architectural elements, and as required by coordination with other trades. In the event of a conflict, final determination of location of these items rests with the Consultant.

.2 Prepare and submit for review by the Consultant, interference field drawings, to indicate relative position of various services and equipment, at the following locations as a minimum:

.1 Under all rooftop mechanical units.
.2 At locations of all major ductwork, piping, and conduit crossovers.
.3 Where ductwork passes under major structural elements.

.3 Locate equipment, fixtures and distribution systems to provide minimum interference and maximum usable space and in accordance with manufacturer's recommendations for safety, access and maintenance.

.4 Request a review of items by Consultant once rough-in is underway, prior to final installation, and obtain approval for actual locations.

5 CONCEALMENT

.1 Conceal pipes, ducts and wiring in floor, wall and ceiling construction of finished areas, except where indicated otherwise.

.2 In existing building, all pipes shall be enclosed in shafts. All conduit shall be placed in accordance with approved conduit shop drawings.

6 LIGHTING FIXTURES AT SUSPENDED CEILINGS

.1 Ensure that secure support is provided for lighting fixtures by suspended ceilings, or by separate hangers, or by both.

.2 Coordinate the ceiling system and lighting fixture installations to provide adequate support.

.3 Submit affidavits with acceptable design information confirming that the installation of the suspended ceiling system and/or separate fixture hangers will provide adequate support for the lighting fixtures without exceeding specified deflection tolerances for the ceiling system.

.4 Conform to current requirements of the Electrical Safety Authority (ESA).

7 EXISTING SERVICES

.1 Where work involves the interruption of, or connection to existing services, carry out such work as directed by governing authorities, with minimum of disturbance to pedestrian and vehicular traffic.

.2 Before commencing work, establish location and extent of service lines in area of work and notify Consultant of findings.

.3 Submit schedule to, and obtain approval from Consultant for any shutdown or closure of active service or facility. Adhere to approved schedule and provide notice to affected parties.

.4 Provide adequate bridging over trenches which cross sidewalks or roads to permit normal traffic.

.5 Where unknown services are encountered, immediately advise Consultant and confirm findings in writing.

.6 Remove abandoned service lines to distance of 1821mm from foundations. Cap or otherwise seal lines at cut-off points as directed by Consultant.

.7 Record locations of maintained, re-routed and abandoned service lines.

8 PROTECTION OF WORK IN PROGRESS

.1 Adequately protect Work completed or in progress. Work damaged or defaced due to failure in providing such protection is to be removed and replaced, or repaired, as directed by the Consultant, at no increase in Contract Price.

.2 Prevent overloading of any part of the building. Do not cut, drill or sleeve any load bearing structural member, unless specifically indicated, without written approval of Consultant.

.3 Protect finished surfaces with overlays of protective materials such as Kraft paper, cardboard, or plywood, as required for individual applications to provide adequate protection.

END OF SECTION

1 GENERAL

.1 Conduct cleaning and disposal operations to comply with local ordinances and environmental protection legislation.

.2 Store volatile wastes in covered metal containers, and remove from premises at end of each working day.

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

2 CLEANING DURING CONSTRUCTION

.1 Maintain the Work in tidy condition, free from accumulation of waste products and debris.

.2 Remove waste material and debris from the work areas and deposit in waste container at the end of each working day.

.3 Vacuum clean interior areas prior to start of finishing work. Maintain areas free of dust and other contaminants during finishing operations.

.4 Individual Subcontractors are responsible for the daily clean-up and removal of debris related to, or generated by, their own work. The overall responsibility for project cleanliness rests with the Contractor.

3 WASTE MANAGEMENT

.1 Audit, separate and dispose of construction waste generated by new construction or by demolition of existing structures in whole or in part, in accordance with Ontario Regulations 102/94 and 103/94 made under the Environmental Protection Act.

.2 Fires, and burning of rubbish or waste on site is prohibited.

.3 Burying of rubbish or waste materials, except as specified herein, is prohibited.

.4 Disposal of waste or volatile materials such as mineral spirits, oil, gasoline or paint thinner into ground, waterways, or sewer systems is prohibited.

.5 Empty waste containers on a regular basis to prevent contamination of site and adjacent properties by wind-blown dust or debris.

4 FINAL CLEANING OPERATIONS

.1 Immediately following Date of Substantial Performance, and prior to Owner occupancy of the building or portion of the building affected by the Work, conduct full and complete final cleaning operations.

.2 Final cleaning operations shall be performed by an experienced professional cleaning company, possessing equipment and personnel sufficient to perform full building cleaning operations.

.3 Remove all surplus products, tools, construction machinery and equipment not required for the performance of remaining work, and thereafter remove any remaining materials, equipment, waste and debris.

.4 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.

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

.6 Cleaning operations shall include the removal of all stains, spots, scuff marks, dirt, dust, remaining labels, adhesives or other surface imperfections.

.7 Remove all paint spots or overspray from all affected surfaces.

.8 Clean and polish all glass and mirrors. Replace broken, scratched or disfigured glazing. Remove remaining manufacturer's and safety "X" labels.

.9 Clean and polish all finished metal surfaces such as enamelled or stainless steel, chrome, aluminum, brass, and bronze.

.10 Clean and polish all vitreous surfaces such as plumbing fixtures, ceramic tile, porcelain enamel, or other such materials.

.11 Clean all ceramic tile surfaces in accordance with the manufacturer's instructions, and apply final coat of sealer where specified.

.12 Clean inside of all millwork and cabinetry.

.13 Vacuum, clean and dust behind grilles, louvres and screens.

.14 Sealing and waxing of resilient floor surfaces shall be done by Owner forces, coordinate final cleaning and scheduling of sealing and waxing.

.15 Broom clean and spray wash all exterior paved surfaces.

.16 Remove dirt and other disfiguration from exterior surfaces.

.17 Clean all roofs, gutters, downspouts, areaways, drywells, and drainage systems.

.18 Clean all equipment and fixtures to a sanitary condition, clean or replace filters of mechanical equipment.

END OF SECTION

1 INSPECTION AND DECLARATION PROCEDURES

.1 Arrange for, conduct and document final inspections, close-out and commissioning at the completion of the Work in accordance with the procedures described in the General Conditions of the Contract, and OAA/OGCA Document 100.

2 SUBSTANTIAL PERFORMANCE

.1 Contractor's Inspection

.1 Refer to OAA/OGCA Document 100 – STAGE 2.

.2 The Contractor and all Subcontractors shall conduct an inspection of the work, identify deficiencies and defects, and make corrections as required to conform with the Contract Documents. Notify Consultant in writing of satisfactory completion of Contractor's Inspection and that corrections have been made. Request a Consultant's Inspection.

.2 Contractor's Application for Substantial Performance of the Work

.1 Refer to OAA/OGCA Document 100 – STAGE 3.

.2 When the Contractor has carried out the steps in Stage 2 of OAA/OGCA Document 100, and has determined that the requirements of the Contract have been substantially performed as defined by local Lien legislation, the Contractor shall make application for Substantial Performance of the Work.

.3 In addition to the requirements of OAA/OGCA Document 100, the following items shall accompany the Contractor's application for Substantial Performance. These items must be complete in all respects, and all verification certificates and reports having been submitted and approved by the Consultants:

.1 Completed (and accepted) Maintenance Manuals for all disciplines (No. of copies as specified),
.2 As-Built Drawings for all disciplines (No. of copies as specified),
.3 Mechanical, Sprinkler, and Electrical as-built CAD drawings,
.4 Occupancy Permit (where required by Municipality),
.5 Air Balance Report (legible technicians worksheets are acceptable),
.6 Gas fired appliances inspection,
.7 Plumbing Inspection,
.8 Domestic Water Quality Test Report,
.9 Sprinkler dry test verification letter stamped and signed by sprinkler design Engineer,
.10 Mechanical start-up reports (Boilers, HVAC Units, Chillers, Water Softeners, etc.),
.11 Fire Alarm verification (include legible technicians worksheets),
.12 Emergency Lighting verification,
.13 Electrical distribution system inspection,
.14 ESA Hydro Certificate, and
.15 Systems operations have been demonstrated to Owner's personnel.

.3 Consultant's Inspection

.1 The Consultants shall perform an inspection of the Work to assess the validity of the Contractors application, and shall identify in separate lists, unfinished work and deficiencies. Contractor shall correct work accordingly.

.4 Certificate of Substantial Performance

.1 Refer to OAA/OGCA Document 100 – STAGE 4.

.2 Should the Consultant concur with the Contractor's application for Substantial Performance, the Consultant shall notify the Contractor of approval of the application for Substantial Performance and issue a Certificate of Substantial Performance.

.3 The Contractor shall publish a copy of the Certificate of Substantial Performance in a construction trade newspaper, and shall provide the Consultant with proof of the date of publication.

3 LIEN PERIOD AND RELEASE OF BASIC HOLDBACK

.1 Refer to OAA/OGCA Document 100 – STAGE 5.

.2 Commencement of Lien Periods

.1 The day following the date of publication of Certificate of Substantial Performance shall be the date of commencement of the 45 day Lien Period prior to release of basic holdback, unless required otherwise by lien statute of the Place of the Work.

.2 When the Contractor has carried out the required steps in Stages 3 and 4 of OAA/OGCA Document 100, the Contractor shall make application for Release of Basic Holdback.

.3 The Consultant shall prepare the Certificate for Payment for release of basic holdback, and promptly upon receipt of the necessary documentation, issue the Certificate for Payment to the Owner.

4 FINAL INSPECTION AND PAYMENT

.1 Refer to OAA/OGCA Document 100 – STAGE 6.

.2 Submit a signed statement stating following have been performed:

.1 Work has been reviewed for compliance with Contract Documents,
.2 All defeciencies have been corrected,
.3 All unfinished work has been completed, and
.4 Work is complete and ready for Final Inspection.

.3 When items noted above are completed, a final inspection of the Work will be performed by the Owner, the Consultants, and the Contractor.

.4 If the Work is deemed to be incomplete, complete outstanding items and request a reinspection.

.5 If the Work is deemed to be complete, the Consultant will issue a Final Certificate for Payment.

5 DEFICIENCY REVIEW

.1 Following the issuance of the Certificate of Substantial Performance and prior to the Contractor's application for Final Payment and release of any monies retained as "Finishing Holdback", the Contractor shall continue to complete unfinished work and correct deficiencies. At the request of the Contractor, the Consultants shall conduct up to two general deficiency reviews during this period.

.2 The first review will be undertaken only if the Contractor has inspected the Work, and states in writing that the unfinished work noted in their application for Substantial Performance has been completed, and at least 50% of all deficiencies have been corrected.

.3 The second review will be undertaken only if the Contractor has inspected the Work, and states in writing that 90% of the deficiencies have been corrected.

.4 Should further review by Consultants be required due to failure of the Work to comply with Contract Documents or the criteria set out herein, the Owner will deduct amount of Consultant's compensation for reinspection services from monies owed to the Contractor.

END OF SECTION

1 REFERENCES
.1 OAA/OGCA Document 100; OAA/OGCA Take-Over Procedures.

2 OPERATION AND MAINTENANCE MANUALS
.1 General
.1 Prepare Operation and Maintenance Manual during the course of construction and have completed prior to Date of Substantial Performance.

.2 Submission
.1 Maintain one copy of the Operation and Maintenance Manual volume(s) for periodic review and comment, as requested by the Consultant during the course of construction.

.2 Submit two (2) final hard copies and one (1) USB device with PDF version of all documents of the final completed volume(s) with the application for Substantial Performance in accordance with OAA/OGCA Document 100.

.3 Format
.1 Bind data in commercial quality, 219 x 279mm, "D" ring binders, having clear cover and spline pockets.

.2 Identify each binder on the cover and spline with the following:
OPERATION & MAINTENANCE MANUALS
Clarkson Community Centre Renewal - Phase 2
VOLUME ___ OF ___

.3 Provide table of contents and index tab sheets for each volume. Itemize and tabulate contents.

.4 Provide drawings with reinforced punched binder tab, or insert into clear sleeves in folded format. Group drawings as to content, and index for quick reference.

.4 Contents - Each Volume
.1 Table of Contents: provide title of Project, Date of submission and names:
.1 Addresses, and telephone numbers of Consultant and Contractor with name of responsible parties;
.2 Schedule of products and systems, indexed to content of volume.

.2 For each product or system: List names, addresses and telephone numbers of sub-contractors and suppliers, including local source of supplies and replacement parts.

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

.4 Operation and Maintenance Manuals shall contain, as a minimum, the following information:
- .1 List of Contents; cross-referenced to each Volume.
- .2 Contact information for maintenance and repairs
- .3 Warranty and guarantee certificates
- .4 Equipment start-up and troubleshooting instructions
- .5 Equipment schematics & diagrams
- .6 Catalogue of all maintenance materials and quantities
- .7 Complete list of Contractor, Subcontractors and suppliers, indicating name, address, telephone & fax numbers, email addresses, name of contact person and description of work done.
- .8 Complete list of products used in the work, indicating product name and manufacturer for each listing.
- .9 Copy of Finish Hardware List, complete with all amendments and revisions, if applicable.
- .10 Schedule of paints and coatings. Include sufficient explanation to fully identify each surface with the applicable paint or coating used. Enclose copy of Colour Schedule.
- .11 All “reviewed” shop drawings.
- .12 Maintenance instructions for all finished surfaces.
- .13 Brochures and cuts of all equipment and fixtures.
- .14 Operating and maintenance instructions for all equipment.
- .15 All Warranties and Guarantees required by the Specifications for this Work.

.5 Refer to Division 21, 22 and 23 for more specific mechanical data required beyond the description of this paragraph.

.6 Refer to Division 26 for more specific electrical data required beyond the description of this paragraph.

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

.8 Typewritten Text: as required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

3 AS-BUILT DRAWINGS

.1 Record information on a clean set of black line opaque drawings, provided by Owner.

.2 Maintain as-built drawings on site and update as construction progresses. Allow periodic review by Consultant as requested.

.3 Record information concurrently with construction progress. Do not conceal work until required information is recorded.

.4 Contract drawings and shop drawings: legibly mark each item to record actual construction, including:
- .1 Measured depths of elements of foundation in relation to finish first floor datum.
- .2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
- .3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.
- .4 Field changes of dimension and detail.
- .5 Changes made by change orders.
- .6 Details not on original Contract Drawings.
- .7 References to related shop drawings and modifications.

4 EQUIPMENT AND SYSTEMS

.1 Each Item of Equipment and Each System: include description of unit or system, and component parts. Give function, normal operation characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.

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

.3 Include installed colour coded wiring diagrams.

.4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.

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

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

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

.8 Include sequence of operation by controls manufacturer.

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

.10 Provide installed control diagrams by controls manufacturer.

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

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

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

.14 Include all test and balancing reports

.15 Additional requirements: As specified in individual specification sections.

5 MATERIALS AND FINISHES

.1 Building Products, Applied Materials, and Finishes: include product data, with catalogue number, size, composition, and colour and texture designations. Provide information for re-ordering custom manufactured products.

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

.3 Moisture-protection and Weather-exposed Products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

.4 Additional Requirements: as specified in individual specifications sections.

6 MAINTENANCE MATERIALS, SPARE PARTS & TOOLS

.1 Provide spare parts in quantities specified in individual specification sections. Provide identical items to those installed in the Work.

.2 Provide maintenance materials in quantities specified in individual specification sections. Provide identical items of same manufacturer, dye lot or production run as items in the Work.

.3 Provide special tools in quantities specified in individual specification sections, and tag items identifying their function and equipment or products to which they are associated.

.4 Receive and catalogue all items. Check inventory and include approved listings in Operations and Maintenance Manual.

.5 Obtain receipts for delivered products and submit prior to Substantial Performance.

.6 Quality

.1 Spare parts, maintenance materials and special tools provided shall be new, not damaged or defective, and of the same quality and manufacture as products provided in the Work.

.2 If requested, furnish evidence as to type, source and quality of Products provided.

.3 Defective products will be rejected, regardless of previous inspections. Replace products at own expense.

.7 Delivery, Storage, And Handling

.1 Deliver all materials required as maintenance materials, spare parts or special tools, to the site, include shipping costs, and store as directed.

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

.3 Store in original and undamaged containers with manufacturer's seals or labels intact.

.4 Store materials subject to damage from severe climatic changes in a climate-controlled, weatherproof enclosure.

.5 Store paints and freezable materials in a moderately heated and ventilated room.

7 WARRANTIES AND BONDS

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

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

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

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

.5 Verify that documents are in proper form, contain full information, and are notarized. Co-execute submittals when required.

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

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for modified bituminous roofing work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM C1177/C1177M, Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing

.2 ASTM D6162/D6162M, Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcements

.3 CSA A123.21, Standard Test Method for the Dynamic Wind Uplift Resistance of Membrane-Roofing Systems.

.4 CSA A231.1/A231.2, Precast Concrete Paving Slabs/Precast Concrete Pavers.

.5 CGSB 37-GP-9Ma, Primer, Asphalt, Unfilled, for Asphalt Roofing, Dampproofing and Waterproofing.

.6 CGSB 37-GP-15M, Application of Asphalt Primer for Asphalt Roofing, Dampproofing and Waterproofing.

.7 CAN/ULC S107, Fire Test For Roof Coverings.

.8 CAN/ULC S704, Standard for Thermal Insulation, Polyurethane and Polyisocyanurate, Boards, Faced.

.9 OIRCA, Ontario Industrial Roofing Contractors Association.

1.3 **SUBMITTALS**

.1 Product data:
  .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
    .1 Systems, materials, and methods of installation proposed for use, showing system and each component. Certify compliance of each component with applicable standards.
    .2 Submit cold weather construction procedures and methods of protection which will be initiated, installed and maintained when ambient temperature falls below 0^0C.

.2 Shop Drawings: Submit Shop Drawings in accordance with Section 01 30 00 indicating roof layout, sections, details, materials, fastener layout, flashings and membrane terminations, perimeter securement, vapour barrier terminations, insulation wrapping procedures, tapered insulation layout, membrane penetrations, control joints, roof walkway system, and roof accessories.

.3 Samples:
- .1 Submit following samples in accordance with Section 01 30 00:
  - .1 Substrate board and adhesive.
  - .2 Vapour retarder and adhesive.
  - .3 Insulation boards.
  - .4 Tapered insulation.
  - .5 Insulation protection board.
  - .6 Roofing membranes.
  - .7 Roof accessories.

.4 Reports and Certificates:
- .1 Submit copy of membership in good standing of OIRCA
- .2 Submit certification from manufacturer that roof system has a minimum Class C classification in accordance with CAN/ULC-S107.
- .3 Submit Pre-Installation Notice (PIN): Copy to show that manufacturer's required Pre-Installation Notice (PIN) has been accepted and approved by the manufacturer.
- .4 Submit project specific report, issued by certified material testing laboratory, confirming that proposed roofing assembly conforms to CSA A123.21. As a minimum report shall indicate uplift pressures for field of roof, perimeter of roof and corners of roof.
- .5 Submit written inspection reports in duplicate from manufacturer, stating that materials proposed for use on this project meet criteria specified and are compatible with each other.

.5 Project close-out submittals:
- .1 Submit close-out submittals in accordance with Section 01 78 00.
- .2 Submit membrane manufacturer's certificate that membrane has been installed in accordance with Contract Documents.

1.4 QUALITY ASSURANCE

.1 Qualification: Perform work of this Section by a company that is a member in good standing of the Ontario Industrial Roofing Contractors Association (OIRCA) and has a minimum of 5 years proven acceptable roofing experience on installations of similar complexity and scope.

.2 Testing: Provide flood testing conducted by an independent testing agency of the specified roofing products.

.3 Perform roofing work in accordance with the CRCA Roofing Specifications Manual and in accordance with membrane manufacturer's printed installation instructions.

.4 Ensure roofing system has been tested and conforms to CAN/CSA A123.21 to ensure wind uplift resistant applicable to the Place of Work.

.5 Roof system shall have a minimum Class C classification in accordance with CAN/ULC-S107.

.6 Ensure torching is performed by skilled workers who have successfully completed and passed a course of instruction by membrane manufacturer in torch-applied-membrane techniques.

.7 Ensure membrane manufacturer's representative has full access to this work for proper inspection prior to and during membrane installation. Roof inspections shall be conducted when the roof is 10%, 50%, and 100% complete minimum. Membrane manufacturer to certify that roof installation was in conformance to manufacturer's written requirements.

.8 Pre-installation meetings: Arrange meeting on Site to be attended by Consultant, Contractor, and roofing manufacturer's representative to inspect substrates, and to review installation procedures 48 hours in advance of installation.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Deliver Products in original containers and keep in protective storage until used.

.2 Indicate on containers or wrappings of Products:
- .1 Manufacturer's name and brand.
- .2 Compliance with applicable standard.
- .3 Weight of material, where applicable.

.3 Handle and store Products to prevent damage. Keep manufacturer's labels and seals intact. Store roofing rolls on end to prevent flattening. Ensure that shelf life of Products has not expired.

.4 Protect Products from inclement weather. Keep insulation, protection board, and roofing membranes absolutely dry. Remove from storage only as much Product as can be applied, made weathertight, and covered with roofing in same day. Do not install Products which are damp at time of installation or showing evidence of having been damp or exposed to moisture.

.5 Store roofing membranes for 24 hours minimum in area kept at 10^0C minimum and remove for application with minimum exposure to low temperatures. Keep membranes dry, stored off-the-ground, on end and well ventilated.

.6 Do not store more than one day's supply of Products on the roof at any time. Stack materials on pallets on roof. Cover Products with incombustible waterproof tarpaulin whenever work is interrupted, or when there is precipitation of any kind.

.7 Distribute Products stored on roof. Install bases under equipment and Products to distribute weight. Do not store Products on, or transport materials across, completed roof areas.

.8 Place 19 mm thick plywood runways over work to enable movement of Products and other traffic.

.9 Where hoisting or pumping occurs adjacent to construction, hang tarpaulins to protect walls and other surfaces. Locate kettle so smoke will not discolour adjacent building surfaces.

.10 Locate a 9 kg fire extinguisher fully charged and in operable condition at installation location, of proper type for Products being used and stored.

.11 Cover walls and adjacent work where Products are hoisted or used.

.12 Use warning signs and barriers and maintain in good order until completion of work.

.13 Clean off drips and smears of bituminous immediately.

.14 Dispose of rain water off roof and away from face of building until roof drainage system has been installed and connected.

.15 At end of each day's work or when stoppage occurs due to inclement weather, protect completed work and Products.

1.6 **SITE CONDITIONS**

.1 Install roofing on dry deck, free of snow and ice, use only dry Products and apply only during weather that will not introduce moisture into roofing system.

.2 Apply roofing only when air and surface temperatures are above 4^0C, have been so for at least 48 hours and are not likely to go below 4^0C, until work is completed.

.3 Proceed with work when temperatures are below 4^0C only with mutual documented agreement between Contractor and Consultant.

1.7 **EXTENDED WARRANTY**

.1 At completion of this work, provide a signed OIRCA warranty to the Owner covering defects of workmanship for a period of 2 years commencing from Contract Completion. Agree to make good promptly any defects which occur or become apparent within the warranty period in conjunction with the membrane manufacture's warranty. Defects shall include but not be limited to leakage, failure to stay in place, lifting, and deformation.

.2 At completion of this work, provide a signed warranty from the roofing system manufacturer to the Owner covering defects in workmanship and materials for a period of 10 years commencing from Contract Completion. Warranty shall include vapour retarder, membrane, roof insulation, sloped insulation, and all other products supplied by roofing system manufacturer. Scope of coverage: Repair and/or replace damaged roofing material caused by the ordinary wear and tear of the elements, manufacturing defect, and the workmanship used to install these materials.

2 Products

2.1 **MATERIALS**

.1 All materials under work of this Section, including but not limited to, adhesives and primers are to have low VOC content limits.

.2 Acceptable membrane manufacturers:
- .1 Henry Company Canada Inc.
- .2 Iko Industries Canada.
- .3 Soprema.
- .4 Tremco Incorporated.

.3 Roof sheathing board: ASTM C1177/C117M, 12.7 mm thick, unless otherwise indicated, ‘Dens Deck’ by G-P Products, ‘Securock Gypsum Fiber Roof Board' by CGC, or approved alternative by CertainTeed.

.4 Sheathing fasteners and plates: Conforming to manufacturers recommended layout for wind uplift and corrosion resistance, furnish fasteners of length required by sheathing thickness.

.5 Insulation and protection board adhesive (where roof deck is exposed to view from below): Single component polyurethane adhesive as recommended by roof system manufacturer.

.6 Asphalt primer: CGSB 37-GP-9Ma; Asphalt modified bitumen with thermoplastic polymers.

.7 Vapour retarder: Minimum 0.8 mm thick self adhesive membrane consisting of SBS modified bitumen adhesive bottom and tri-laminated woven polyethylene top with silicone release film. ‘Vapour Block SA' by Henry, ‘M.V.P.' by IKO, or ‘Sopravap'r by Soprema.

.8 Vapour retarder primer: ‘Blueskin Adhesive’ by Henry Company, ‘Elastocol Stick’ by Soprema, or approved alternative by Siplast

.9 Insulation:
- .1 Polyisocyanurate insulation: CAN/ULC S704, rigid, closed cell, polyisocyanurate foam insulation integrally laminated to perforated black glass reinforced felt facers, square edges, thickness as indicated on Drawings, use maximum size board possible. Insulation thickness under 50 mm use single layer board. Insulation thickness over 50 mm use two equal thickness boards.
- .2 Tapered Insulation: Factory pre-engineered tapered polyisocyanurate insulation in thickness sufficient for slopes shown on Contract Drawing; manufactured by Accu-Plane Systems Inc., Posi-Slope Manufacturing Ltd.

.10 Protection board:
.1 Bituminous Board; Multi-ply, semi-rigid asphaltic roofing substrate board composed of a mineral fortified asphaltic core formed between two asphaltic saturated fibreglass liners. 1200 x 1500 x 3.2 mm thick; 'IKO Protection Board' by IKO or 'Sopraboard' by Soprema or approved alternate.

.11 Base sheet membrane and flashing: ASTM D6162, Type 1, Grade S, Styrene-Butadiene-Styrene (SBS) elastomeric polymer, prefabricated sheet, non-woven polyester and glass fiber composite reinforcing, having the following minimum characteristics:
.1 Thickness: 2.2 mm.
.2 Reinforcing fabric weight: 200 g/m^2.
.3 Cold flex: -18 deg. C.
.4 Tensile strength: 13 kN/m.
.5 Ultimate elongation: 26%.
.6 Tensile-tear: 289 N.
.7 Bottom and top surfaces: Sanded/Polyethylene.

.12 Cap sheet membrane and flashing: ASTM D6162, Type 1, Grade S, Styrene-Butadiene-Styrene (SBS) elastomeric polymer, prefabricated sheet, non-woven polyester and glass fiber composite reinforcing, having the following minimum characteristics:
.1 Thickness: 4.0 mm.
.2 Reinforcing fabric weight: 200 g/m^2.
.3 Cold flex: -18 deg. C.
.4 Tensile strength: 13 kN/m.
.5 Ultimate elongation: 26%.
.6 Tensile-tear: 289 N.
.7 Granule loss: 2.0 g maximum.
.8 Bottom and top surfaces: Polyethylene/Granules.
.9 Top surface to providing a minimum SRI of 78.

.13 Plastic cement: Trowel grade asphalt mastic.

.14 Roofing nails: Galvanized steel, minimum 19 mm head of length to penetrate wood nailer minimum 19 mm.

.15 Roof drains: In accordance with Division 22 - Mechanical.

.16 Stack flashing units: In accordance with Division 22 - Mechanical.

.17 Stack Jacks: to CSA-B272, insulated aluminum stack jacks complete with bitumen protection dam and screw-secured cover;
.1 SJ-26/SJ-27, by Thaler Metal Industries Ltd.
.2 Flash-Tite VSC-S Series, by Lexcor.

.18 Roof Penetration Flashings: to CSA-B272, insulated aluminum, complete with bitumen protection dam and screw-secured cover. Acceptable products and manufacturers by Thaler Metal Industries Ltd. or Flash-Tite by Lexcor as follows:
.1 Rigid Conduits: MEF-AE1.

.2 Flexible Conduits: MEF-2A.
.3 Gas Pipe Protrusion: MEF-9.
.4 Mechanical Unit Supply Piping & Tubing: MEF-AE2/AE4 series.

.19 Irregular Roof Protrusion Flashings: Pre-fabricated mastic sealer pockets; 127 mm high x appropriate diameter to exceed diameter or width of protrusion by 50 mm. Pockets to be sealed with pourable self-leveling sealant;
.1 Chemlink Advanced Construction Products.
.2 Hi-Tuff TPO Molded Sealant Pockets by Lexcan Limited.

.20 Gas Line supports: PPH Portable Pipe Hangers Ltd. Model PP10 with strut and Hanger.

.21 Precast Pavers: 610 X 610 x 45 mm thick non-interlocking roof slabs, less then 5% absorption, minimum 55MPa compressive strength, standard diamond finish, chamfered edges, patio quality, conforming to CSA A231.1/A231.2. 'Diamond' concrete roof slab by armtec Brooklin or approved alternative.

.22 Pedestals: Provide pedestals at each corner of paving slabs to product a level, smooth surface for pedestrian traffic; 'Pave-el' by Envirospec Inc. or approved alternative by Bison.

.23 Roof hatch: Preassembled 915 x 762 mm single leaf metal roof scuttle. EPDM rubber gasket adhered to hollow metal cover. Insulation 25 mm thick with metal liner protector. 305 mm high curb with integral flashing and full welded corners. Lifting mechanism will be compression spring operators enclosed in telescopic tubes. Slam latch with interior and exterior turn handles and padlock hasps. 'Type S' by Bilco or approved alternative.

3 Execution

3.1 EXAMINATION

.1 Verify condition of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 PREPARATION

.1 Prior to commencement of work ensure:
.1 Environmental and Site conditions are suitable for material installation in accordance with manufacturer's recommendations.
.2 Decks are sound, straight, smooth, dry, free of oils, grease, snow, ice or frost, and swept clean of dust and debris.
.3 Curbs have been built and plywood and lumber nailer plates have been installed.

.2 Supply to trades concerned in ample time, inserts, reglets and accessories to be built into Work. Assist in setting such items.

.3 Cooperate with respective trades to determine methods and procedures to ensure watertight junctions to items passing through roof.

3.3 DECK SHEATHING

.1 Over metal deck, Install sheathing in straight parallel rows, with long dimension perpendicular to metal roof deck rib direction, and with short dimension edges centred on and supported by ribs of metal deck in both directions.

.2 Place sheathing in moderately tight contact at joints between boards and abutting surfaces with gaps between boards not exceeding 3 mm. Under no circumstances shall the roofing membrane be left unsupported over a space greater than 3 mm.

.3 Mechanically fasten sheathing to metal deck not exposed to view with in accordance with sheathing manufacturer’s written instructions.

.4 Adhere sheathing to metal deck where roof deck will be exposed to view from below in accordance with sheathing and adhesive manufacturer's written instructions

3.4 PRIMING

.1 Perform priming at rate and to surfaces recommended by the manufacturer in accordance with CGSB 37-GP-15M.

3.5 VAPOUR RETARDER

.1 Primer substrate to manufacturers recommendations.

.2 Install vapour retarder in accordance with manufacturers written instructions.

.3 Lap vapour retarder ends and edges 50 mm minimum. Roll vapour retarder and laps for continuous adhesion over entire substrate area; use manufacturer's recommended roller.

.4 Cut and fit vapour retarder as required for passage of protrusions, ensuring continuous adherence to substrate.

.5 At junction of deck to vertical surfaces and along perimeter of roof deck, extend vapour retarder, set in adhesive, beyond the point where insulation will terminate.

.6 Seal penetrations, end and side laps, and ends of vapour retarder to substrates and to wall system air/vapour retarder to maintain continuity of building air/vapour retarder system.

3.6 INSULATION

.1 Prior to installation of insulation, examine vapour retarder and make good damage.

.2 Use full size insulation boards wherever possible, and minimum half boards at abutting vertical surfaces.

.3 Install insulation promptly to avoid possibility of condensation beneath vapour retarder.

.4 Install insulation in straight parallel rows, with long dimension parallel to long dimension of roof. Stagger end joints of insulation boards in adjacent rows 50%.

.5 Place insulation boards in moderately tight contact at joints between boards and abutting surfaces with gaps between boards not exceeding 1.5 mm. Under no circumstances shall the roofing membrane be left unsupported over a space greater than 3 mm.

.6 When cutting insulation board cut completely through board thickness; do not break or tear insulation board to fit a detail. Any areas of insulation system having voids will be rejected.

.7 When installing multiple layers of insulation, all joints between layers shall be staggered at least 300 mm.

.8 Do not lay more insulation than can be completely covered as finished roofing system on the same day.

.9 Do not cut off insulation in straight lines at the end of a work period, allow stepped boards for toothing-in.

.10 Install Polyisocyanurate insulation in a minimum of two layers.

.11 Install Polyisocyanurate insulation, in adhesive, in straight parallel rows, with long dimension parallel to long dimensions of roof.

.12 Install subsequent layers of insulation, in adhesive, in straight parallel rows, with long dimension parallel to previous layer of insulation with joints offset as recommended by insulation manufacturer.

.13 Install tapered insulation in accordance with manufacturer’s details and instructions. Miter roof insulation edges at ridge, valley and other similar non-planar conditions.

.14 Install protection board over tapered insulation in straight parallel rows, with long dimension parallel to long dimensions of insulation. Stagger side joints in adjacent rows minimum 50%.

.15 Mechanically fasten protection boards to vertical surfaces of upturns and on top of parapet substrates in accordance with manufacturer's written instructions.

3.7 MEMBRANE INSTALLATION

.1 Install materials in accordance with manufacturer's instructions.

.2 Install membrane free of blisters, wrinkles and fishmouths in accordance with membrane manufacturer's instructions. Avoid asphalt seepage at seams in cap sheet greater than 5 mm.

.3 Base sheet application:

.1 Starting at low point of roof, perpendicular to slope, unroll base sheet dry over substrates, align and reroll for both ends.

.2 Unroll and install membrane in full moppings of asphalt. Extend base sheet to base of cant.
.3 Lap sheets 75 mm minimum for side and 150 mm minimum for end laps.

.4 Cap sheet application:
.1 Starting at low point on roof, perpendicular to slope, unroll cap sheet, dry over base sheet, align and reroll from both ends.
.2 Unroll and torch cap sheet onto base sheet extending to base of upturns taking care not to burn membrane or its reinforcement.
.3 Lap sheets 75 mm minimum for side laps and 150 mm minimum for end laps. Offset joints in cap sheet 300 mm minimum for those in base sheet.
.4 Embed surface granules on end laps by heating and using a round-nosed roofing trowel, prior to installation of following sheet.

3.8 FLASHING INSTALLATION

.1 Install flashing free of blisters, sags, wrinkles and fishmouths in accordance with the manufacturer's recommendations. Avoid asphalt seepage at seams greater than 5 mm.

.2 Base flashing:
.1 Lay base flashings in vertical strips 1000 mm wide to curb surfaces as shown.
.2 Extend on to flat roof surface minimum 100 mm from toe of cant.
.3 Make 75 mm side laps and 100 mm end laps from laps in base sheet of roof membrane.
.4 Install flashings in full moppings of asphalt directly to substrates, proceeding from bottom to top.
.5 Nail top leading edge to nailer at 300 mm o.c.

.3 Cap flashing:
.1 Lay cap flashing in vertical strips 1000 mm wide to curb surfaces as shown.
.2 Extend on to flat roof surface minimum 300 mm from base of upturn.
.3 Make 75 mm side laps and 100 mm end laps from cap sheet laps and base flashing laps.
.4 Embed surface granules on laps over cap sheet roofing by heating and use of round-nosed roofing trowel.
.5 Torch cap flashing directly to cap sheet roofing and to base sheet flashing proceeding from bottom to top.
.6 Soften underside of membrane by torching, without overheating, resulting in uniform adhesion over surface of base flashing.
.7 Extend cap up and over parapets and nail leading edge to face of nailers 300 mm o.c.

3.9 ROOF ACCESSORIES

.1 Prior to application of membrane set stack flashing units, roof hatch, prefabricated equipment curbs, and other roof penetration accessory units in accordance with manufacturer's Product data. Install removable cap per accessory manufacturer's Product data as applicable.

.2 Seal joints at items projecting through membrane watertight to acceptance of Consultant.

.3 Roof pavers: Install pavers on pedestals, one at each corner, in locations shown butted tightly, maximum 6 mm gap. Adjust or Shim up as required to obtain smooth surface transition from slab to slab.

3.10 FIELD QUALITY CONTROL

.1 Check completed membrane welds for continuity after cooling by use of screw driver run along welded seams and showing uninterrupted extrusion of melted asphalt material.

.2 Inspect completed membrane and flashings for punctures, tears and discontinuous weld seams. Apply additional layer of cap sheet membrane over punctures and tears, extending beyond damaged area or open seam in all directions, torch in-place.

3.11 CLEANING

.1 Clean roofing, metal, masonry, and similar items of dirt, cuttings, stains and foreign matter upon completion of the work.

END OF SECTION

1 General

1.1 SECTION INCLUDES

.1 Labour, Products, equipment and services necessary for flashing and sheet metal Work in accordance with the Contract Documents.

1.2 REFERENCES

.1 CSA A123.3-M Asphalt or Tar Saturated Roofing Felt.

.2 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.

.3 ASTM C920, Specification for Elastomeric Joint Sealants.

.4 OIRCA, Ontario Industrial Roofing Contractors Association.

1.3 DESIGN REQUIREMENTS

.1 Design flashing elements and fastenings to withstand wind loading and perimeter and corner uplift pressures for roof system in accordance with CSA A123.21.

1.4 SUBMITTALS

.1 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
  - .1 Proposed method of shaping, forming, jointing.
  - .2 Fastening, and application of flashing and sheet metal Work.

.2 Samples:
- .1 Submit following samples in accordance with Section 01 30 00:
  - .1 50 x 50 mm samples of sheet metal material, colour and finish.
  - .2 Representative sample section of prepainted metal flashing illustrating S locking jointing method, minimum 600 mm long.

1.5 EXTENDED WARRANTY

.1 Submit an extended warranty for flashing and sheet metal work in accordance with General Conditions, except that warranty period is extended to 5 years from date of Substantial Performance of the Work.
- .1 Warrant against warping, twisting, joint, finish failure and water penetration.
- .2 Coverage: Complete replacement including affected adjacent parts.

2 Products

2.1 **MATERIALS**

.1 All materials under Work of this Section, including but not limited to, sealants and paints are to have low VOC content limits.

.2 Prepainted sheet steel: ASTM A653/A653M; Classification LFQ, Grade A, Z275 zinc coating designation, 0.76 mm (22 ga.) minimum base steel thickness, commercial quality, prefinished with Perspectra Series coating system by U.S. Steel Canada, or WeatherX by Vicwest Steel. Colour: To be selected by Consultant.

.3 Plastic cement: Trowel grade asphalt mastic.

.4 Sealant: ASTM C920, Type S, Grade NS, Class 25; High-performance, medium-modulus, one-part, neutral-cure silicone sealant. 'CWS' by Dow Corning, 'Sikasil 305CN' by Sika, or 'Tremsil 400' by Tremco.

.5 Cleats and starter strips: Starter strips to be continuous, of same material as flashing used, 1.2 mm thick.

.6 Fasteners: Flat head roofing nails of length, type and thickness suitable for metal flashing application.

.7 Washers: of same material as sheet metal, 1 mm thick with rubber packings.

.8 Touch-up paint: Same colour and material as prepainted sheet steel, as recommended by prefinished coating manufacturer.

2.2 **FABRICATION**

.1 Fabricate copings, flashings, curb counter flashings, starter strips, and miscellaneous flashings in accordance with OIRCA and to details shown.

.2 Breakform prepainted sheet material at shop to shapes shown. Make end joints where adjacent lengths of metal flashing meet, in accordance with jointing method specified.

.3 Form pieces in 2400 mm maximum practical lengths. Make allowance for expansion at joints.

.4 Hem exposed edges 13 mm minimum on underside for appearance and stiffness. Mitre and seal corners with sealant.

.5 Reglets and Cap flashing: Form flashings of as detailed and in accordance with OIRCA. Provide slotted fixing holes and steel/plastic washer fasteners.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.

3.2 **INSTALLATION**

.1 Install coping flashings, curb counter flashings, starter strips, and miscellaneous flashings to details shown on the Contract Drawings and in accordance with OIRCA.

.2 Use concealed fasteners. Exposed fasteners such as pop rivets are not allowed.

.3 Install continuous starter strips to present a true, non-waving, leading edge. Anchor to back-up for a rigid, secure installation.

.4 Counterflash bituminous flashings at intersections of roof with vertical surfaces and curbs. Flash joints using S-lock forming tight fit over hook strips.

.5 Make end joints using an S lock joint. Execute by inserting end coping length in 25 mm deep S lock formed in end of adjacent length. Extend concealed portion of S lock 25 mm outwards and nail to substrate. Face nailing of joints will not be permitted.

.6 Seal where necessary to form weathertight seal between flashing and adjoining surfaces and between flashing and other Work. Sealing Work consists of bedding between members where possible. Tool sealant to concave profile where exposed.

.7 Insert metal flashing under cap flashing to form weathertight junction.

.8 Caulk flashing at cap flashing with sealant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for firestopping and smoke seals work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 ASTM C303, Standard Test Method for Dimensions and Density of Preformed Block and Board–Type Thermal Insulation.

.2 ASTM C920, Standard Specification for Elastomeric Joint Sealants.

.3 ASTM C1104, Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.

.4 ASTM E814, Test Method for Fire Tests of Through-Penetration Fire Stops.

.5 ASTM E2174, Standard Practice for On-Site Inspection of Installed Fire Stops.

.6 CAN/ULC S102, Surface Burning Characteristics of Building Materials and Assemblies.

.7 CAN/ULC S114, Standard Method of Test for Determination of Non-Combustibility in Building Materials.

.8 CAN/ULC S115, Standard Method of Fire Tests of Firestop Systems.

.9 CAN/ULC S129, Standard Method Of Test For Smoulder Resistance Of Insulation (Basket Method).

.10 CAN/ULC S702, Thermal Insulation, Mineral Fibre for Buildings.

1.3 **DEFINITIONS**

.1 Fire Separation: A construction assembly, plane or device, either vertical or horizontal, which is required to prevent the passage of fire and smoke for a prescribed period of time. Proof of compliance to required time rating shall be by ULC, Warnock Hersey (or similar approved) certification or shall be as listed in the Ontario Building Code Supplementary Standard SB-2.

.2 Smoke Separation: A construction assembly, plane or device, either vertical or horizontal, which is not required to prevent the passage of fire for a prescribed period of time but is required to prevent the passage of smoke. A "Smoke Separation" is also known as a "Fire Separation with No Rating" or a "Zero Hour Rated Separation".

.3 Non-Rated Separation: A construction assembly, plane or device, either vertical or horizontal, which is not required to prevent the passage of fire for a prescribed period of time and is not required to prevent the passage of smoke.

1.4 SYSTEM DESCRIPTION

.1 Firestopping and smoke seals: ULC or Intertek Testing Services listed Products and systems in accordance with CAN/ULC S115 suitable to actual application and installation conditions.

.2 Firestop applications that exist for which no ULC or cUL tested system is available through a manufacturer, a manufacturer's engineering judgment derived from similar ULC or cUL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineer judgment drawings must follow requirements set forth by the International Firestop Council.

.3 Firestop and smoke seal system shall achieve a fire resistance rating and smoke seal rating equal to that of assemblies into which they are installed.

.4 Provide smoke sealants over firestopping materials or combination smoke seal/firestop seal material to form air tight barriers to retard the passage of gas and smoke.

.5 Firestopping and smoke seals located at movement joints shall be designed with movement capability.

.6 Firestopping and smoke seals within mechanical and electrical assemblies shall be provided as part of the work of Divisions 21, 22, 23, 26, 27, and 28 respectively.

1.5 SUBMITTALS

.1 Product data:
- .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
  - .1 Performance criteria, compliance with appropriate cUL or ULC reference standard, characteristics, limitations.
  - .2 Product transportation, storage, handling and installation requirements.
  - .3 Submit firestop and smoke seal manufacturer's Product data for materials and prefabricated devices, including manufacturer's printed installation instructions.

.2 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
  - .1 Fire rated and smoke sealed systems for each typical application.
  - .2 Construction details, accurately reflecting actual job conditions.
  - .3 ULC or Intertek Testing assembly listing.
  - .4 Each floor and wall assembly requiring firestop system with each corresponding ULC firestop system.

.3 Certification:
- .1 Submit certified documentation from manufacturer for each worker performing work of this Section.
- .2 Submit installer's and Product manufacturer's certification verifying compliance with the Contract Documents and conformance with ASTM E814 and CAN/ULC S115.

1.6 **QUALITY ASSURANCE**

.1 Installers qualifications: Perform work of this Section by a company that has a minimum of five years proven experience in the installation of firestopping and smoke seal work of a similar size and nature and that is approved by manufacturer. Submit to Consultant, applicator's current certificate of approval by the material manufacturer as proof of compliance.

.2 Manufacturer's direct representative and/or fire protection specialist shall be on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures conforming to manufacturer's written recommendations published in their literature and drawing details.

.3 Pre-construction meetings: Arrange with manufacturer's representative, Contractor, Consultant and Field Engineer to determine responsibility for handling such issues as FT rated partitions, firestop custom details, compatibility, mixed penetrations, and to review installation procedures 48 hours in advance of installation.

1.7 **DELIVERY STORAGE AND HANDLING**

.1 Deliver materials to Place of Work in manufacturer's unopened containers, containing classification label with labels intact and legible at time of use.

.2 Do not use damaged or adulterated materials exceeding their expiry date.

1.8 **SITE CONDITIONS**

.1 Conform to manufacturer's requirements and maintain a minimum temperature of 5^0 C for a minimum period of 24 h before application, during, and until application is fully cured.

.2 Maintain sealant at a minimum 18° C for best workability.

2 Products

2.1 **ACCEPTABLE MANUFACTURERS**

.1 Acceptable manufacturers of rated systems include:
- .1 Hilti Canada Corporation.
- .2 Specified Technologies Inc.
- .3 Tremco Ltd.

2.2 **GENERAL SYSTEM REQUIREMENTS**

.1 All materials under work of this Section, including but not limited to, primers and sealants are to have low VOC content limits.

.2 Do not use Products containing asbestos.

.3 Firestopping components shall not contain volatile solvents or require special application to protect plastic pipe from firestopping compound.

.4 Provide smoke seal sealant in following colours:
.1 Grey or white in finished areas.
.2 Red in unfinished areas.

.5 Smoke sealant for overhead and vertical joints for floor to be self-levelling and non-sagging sealant.

.6 Smoke sealant at vertical through penetrations in areas with floor drains shall be waterproof type.

2.3 MATERIALS

.1 Following materials have been provided for convenience. Contractor shall provide complete system with all components and accessories as required for fire resistant and smoke seal installation.

.2 Firestop sealant: single component, low modulus, silicone rubber, moisture curing sealant to ASTM C920, ULC labelled to CAN/ULC S115.

.3 Pre-Installed firestop devices for use with non-combustible and combustible pipes, conduit and/or cable bundles penetrating concrete floors and walls.
.1 Cast-in place firestop device complete with aerator adaptor when used in conjunction with aerator system. Model CP 680-P by Hilti or approved alternative.
.2 Cast-in place firestop device for use with noncombustible penetrants. Model CP 680-M by Hilti or approved alternative.
.3 Speed sleeve for use with cable penetrations. Model CP 653 by Hilti or approved alternative.
.4 Firestop block. Model CFS-BL by Hilti or approved alternative.

.4 Re-penetrable, round cable management devices for use with new or existing cable bundles penetrating walls:
.1 Speed sleeve with integrated smoke seal fabric membrane. Model CP 653 by Hilti or approved alternative.
.2 Firestop Sleeve. Model CFS-SL SK by Hilti or approved alternative.
.3 Retrofit sleeve for use with existing cable bundles. Model CFS-SL RK by Hilti or approved alternative.
.4 Gangplate for use with multiple cable management devices. Model CFS-SL GP by Hilti or approved alternative.
.5 Gangplate Cap for use at blank openings in gangplate for future penetrations. Model CFS-SL GP CAP by Hilti or approved alternative.

.5 Firestop insulation: to CAN/ULC S702, Type 2; mineral fibre manufactured from rock or slag, suitable for manual application.
.1 Density: Minimum 64 kg/m^3 when tested to ASTM C303.
.2 Combustibility: Noncombustible to CAN/ULC S114.
.3 Melt temperature: >1175 degrees C.

.4 Surface burning characteristics: to CAN/ULC S102, maximum flame spread of 0, smoke developed of 0.
.5 Moisture Absorption: 0.04 percent when tested to ASTM C1104.
.6 Smoulder Resistance: 0.01 percent when tested to CAN/ULC S129.

.6 Damming, back-up, supports, and anchorage: In accordance with manufacturer's fire rated systems and to acceptance of authorities having jurisdiction.

.7 Primer: As recommended by firestopping sealant manufacturer.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

.2 Verify that substrates and surfaces to receive firestopping and smoke seals are clean, dry, and frost free.

3.2 **PREPARATION**

.1 Prepare, modify, and adjust void sizes, proportions, and conditions to conform to fire rated and smoke sealed assembly requirements such as assembly opening size and dimensional restrictions.

.2 Clean surfaces to remove material detrimental to bond including dust, paint, rust, oil, grease, moisture, frost and other foreign matter to manufacturers recommendations.

.3 Mask adjacent surfaces to avoid spillage and over-coating of adjacent surfaces. Remove stains from adjacent surfaces.

3.3 **INSTALLATION**

.1 Install firestopping and smoke seal systems in accordance with reviewed Shop Drawings, manufacturer's instructions and fire rated assembly to establish continuity and integrity of fire separations.

.2 Install firestop insulation in compacted thicknesses required by ULC design. Compress insulation approximately 50 percent.

.3 Install primers as recommended by firestop and smoke seal Product manufacturers.

.4 Install temporary forming, damming, back-up as required, remove after materials have achieved initial cure and will resist displacement.

.5 Install firestop and smoke seal filler in horizontal joints providing 25% compression fit.

.6 Use resilient, elastomeric firestopping and smoke seal systems in following locations:
- .1 Openings and sleeves for future use.
- .2 Penetration systems subject to vibration or thermal movement.
- .3 Penetration systems in acoustical containment enclosures.

.7 Trowel and tool exposed firestop and smoke seal. Product surfaces to uniform, smooth finish.

.8 Seal joints to ensure an air and water resistant seal capable of withstanding compressions and extensions due to thermal wind or seismic joint movement.

.9 Taped joints will not be acceptable.

.10 Repair damaged firestopped and smoke sealed surfaces to acceptance of Consultant.

.11 Identify each firestop and smoke seal penetration assembly with permanent label listing following:
- .1 Assembly and rating in hours.
- .2 Date of installation.
- .3 Installing company's name and telephone number.

.12 Do not cover materials until full cure has taken place.

3.4 INSPECTION AND TESTING

.1 Inspection of through-penetration firestopping shall be performed in accordance with ASTM E2174 to ensure that firestopping and smoke seals have been installed in accordance with Contract documents and to tested and listed firestop system.

3.5 CLEAN-UP

.1 Clean all surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.

.2 Remove excess materials and debris immediately after application.

3.6 SCHEDULE OF FIRESTOP AND SMOKE SEAL LOCATIONS

.1 Following firestop and smoke seal location schedule is included for convenience and may not be complete. Examine Contract Drawings and other specification sections and determine entire extent of work of this Section. Generally provide systems with required fire and smoke ratings at following locations:
- .1 Gaps at intersections of fire-resistance rated walls and partitions.
- .2 Control and sway joints in fire-resistance rated walls and partitions.
- .3 Gaps at top of fire-resistance rated partitions and walls.
- .4 Penetrations through fire-resistance rated walls and partitions including but not limited to mechanical and electrical services and openings and sleeves for future use.
- .5 Penetrations through fire-resistance rated floor slabs, ceilings, and roofs.
- .6 Gaps at edge of floor slabs at exterior walls.

.7 Perimeter of retaining angles on rigid ducts greater than 0.012 m^2, firestopping material between retaining angle and fire separation and between retaining angle and duct, on each side of fire separation.
.8 Where indicated on drawings.
.9 At non-rated assemblies that require a smoke seal.
.10 Where required by Ontario Building Code.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for sealant work in accordance with the Contract Documents.

.2 Work of this Section does not include sealants in firestopping and smoke sealed assemblies.

.3 Work of this Section does not include sealant work identified in individual specification sections.

1.2 **REFERENCES**

.1 ASTM C834, Specification for Latex Sealants.

.2 ASTM C920, Specification for Elastomeric Joint Sealants.

.3 ASTM C1330, Specification for Cylindrical Sealant Backing for Use with Cold Liquid Applied Sealants.

1.3 **SUBMITTALS**

.1 Product data: Submit copies of Product data in accordance with Section 01 30 00 describing type, composition and recommendations or directions for surface preparation, material preparation and material installation.

.2 Samples:
.1 Submit following samples in accordance with Section 01 30 00:
.1 Two samples of sealant/caulking, for colour selection.
.2 Two samples of back-up material and primer for physical characteristics.

.3 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

1.4 **QUALITY ASSURANCE**

.1 Qualifications: Work of this Section shall be executed by trained applicators approved by sealant manufacturer and having a minimum of 5 years proven experience.

1.5 **SITE CONDITIONS**

.1 Do not install materials when ambient air temperature is less than 5 °C, when recesses are wet or damp, or to manufacturer's recommendations.

1.6 **DELIVERY, STORAGE AND HANDLING**

.1 Arrange delivery of materials in original, unopened packages with labels intact, including batch number, and ensure that on-site storage is kept to a minimum. Do not store materials on site where there exists any danger of damage from moisture, direct sunlight, freezing and other contaminants.

1.7 **EXTENDED WARRANTY**

.1 Submit an extended warranty for Sealant work in accordance with General Conditions, except that warranty period is extended to 2 years from date of Substantial Performance of the Work.
- .1 Warrant against leakage, cracking, crumbling, melting, shrinkage, running, loss of adhesion and staining adjacent surfaces.
- .2 Coverage: Complete replacement including affected adjacent work.

2 Products

2.1 **MATERIALS**

.1 General:
- .1 All materials under work of this Section, including but not limited to, primers and sealants are to have low VOC content limits.
- .2 Use materials as received from manufacturers, without additives or adulterations. Use one manufacturer's Product for each kind of Product specified.

.2 Sealant **Type A**: ASTM C920, Type S, Grade NS, Class 25; One-part, non-sag type, silicone sealant, in standard colours selected.
- .1 ‘Dowsil CWS’ by Dow Consumer Solutions.
- .2 ‘Sikasil 305CN' by Sika.
- .3 ‘Tremsil 400' by Tremco.

.3 Sealant **Type B**: ASTM C834; Pure acrylic siliconized sealant; in standard white colour (paintable).
- .1 ‘950A Siliconized Acrylic Latex Caulk’ by Sherwin Williams.
- .2 ‘Tremflex 834 Silconized Sealant’ by Tremco Ltd.

2.2 **ACCESSORIES**

.1 Primers: Type recommended by material manufacturers for various substrates, primers to prevent staining of adjacent surfaces encountered on project.

.2 Joint backing: ASTM C1330; Round, solid section, closed cell, skinned surface, soft polyethylene foam gasket stock, compatible with primer and sealant materials, 30 to 50% oversized, Shore A hardness of 20, tensile strength 140 to 200 kPa. Bond breaker type surface.

.3 Bond breaker: Type recommended by material manufacturers.

.4 Void filler around the window frames to be one part expanding polyurethane foam.

.5 Cleaning agents: As recommended by material manufacturer, non-staining, harmless to substrates and adjacent finished surfaces.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 **PREPARATION**

.1 Protect adjacent exposed surfaces to prevent smearing, staining or other damage, by masking or other means, prior to performing work. Make good any damage caused by sealant application. Remove protection upon completion and clean adjacent, exposed surfaces of any compound deposited upon such surfaces.

.2 Prepare joints to receive sealants to manufacturer's instructions. Ensure that joints are clean and dry and ferrous surfaces are free from rust and oil.

.3 Clean recesses to receive sealant, to be free of dirt, dust, loose material, oil, grease, form release agents and other substances detrimental to sealant's performance.
- .1 Remove lacquer or other protective coatings from metal surfaces, without damaging metal finish, using oil-free solvents. Remove rust, mill scale and coatings from ferrous metals by wire brush, grinding or sand blasting.
- .2 Ensure recess is dry.
- .3 Do not apply sealants to joint surfaces treated with sealer, curing compound, water repellent, or other coatings. Remove incompatible coatings as required.

.4 Ensure that all materials in contact with sealant are compatible. Test substrate for adhesion.

.5 Depth of recess: Maintain depth to ½ joint width up to a maximum of 13 mm and not less than 6 mm at centre of joint. For greater depth, use joint backing under. Where recess is less than specified depth, cut back surface of recess to specified recess depth.

.6 Install polyethylene backing rod in joints 6 mm or more in width. Roll backing rod into joint. Do not stretch or bend backing rod. Install bond breaker to back of recess.

.7 Prime sides of recess, in accordance with sealant manufacturer's instructions.

.8 Condition products for use in accordance with manufacturer’s recommendations.

3.3 INSTALLATION

.1 Apply sealant immediately after adjoining work is in condition to receive such work. Apply sealant in continuous bead using gun with correctly sized nozzle. Use sufficient pressure to evenly fill joint.

.2 Ensure sealant has full uniform contact with, and adhesion to, side surfaces of recess. Superficial painting with skin bead is not acceptable. Tool sealant to smooth surface, free from ridges, wrinkles, sags, air pockets, embedded impurities, dirt, stains or other defects.

.1 At recesses in angular surfaces, finish sealant with flat profile, flush with face of material at each side.

.2 At recesses in flush surfaces, finish compound with concave face, flush with face of material at each side.

.3 Make sealant bead uniform in colour.

.4 Cure sealants in accordance with sealant manufacturer's instructions. Do not cover up sealants until proper curing has taken place.

.5 Immediately remove excess compound or droppings which would set up or become difficult to remove from adjacent finished surfaces, using recommended cleaners, as work progresses. Do not use scrapers, chemicals or other tools which could damage finished surfaces. Remove defective sealant.

.6 Clean recesses and re-apply sealant.

.7 Remove masking tape immediately after joints have been sealed and tooled.

3.4 INSTALLATION OF PRECAST AIRSEAL AND JOINT SEALANTS

.1 Install precast airseal sealant for a continuous interior panel to panel and perimeter seal, as indicated.

.2 Install backer rod and precast joint sealants between pre-cast architectural concrete units and between previously installed adjacent Work for a complete and continuous weather seal.

.3 Joints between wall panels shall be modified rain screen principal, airtight at interior face, vented at exterior face. If corner joints are used, they shall be a bellows joint with the use of airtight neoprene inside, vented sealed joints outside.

.4 Progressively as the work proceeds and in a manner to prevent contamination of joint surfaces, caulk horizontal and/or vertical joints between precast concrete panels and between panels and adjoining construction at exterior and interior faces. Exterior bead shall be a rain screen while interior bead shall be an air seal. Intervening space is vented to exterior.

3.5 CLEANING

.1 Clean surfaces adjacent to joints, remove sealant smears or other soiling resulting from application of sealants. At metal surfaces, remove residue. Do not mar or damage finishes on materials adjacent to joints. Repair or replace marred or damaged materials.

3.6 SCHEDULE OF LOCATIONS

.1 Following sealant location schedule is included for convenience and may not be complete. Examine Contract Drawings and other specification sections and determine entire extent of work of this Section. Generally seal following locations:
- .1 Concrete, stone, masonry and wood to metal.
- .2 Wood to masonry, stone and concrete.
- .3 Metal to metal.
- .4 All dissimilar materials.
- .5 Where ‘sealant’ or ‘caulking’ in indicated on drawings.

.2 Sealant **Type A**:
- .1 Exterior joints between steel or aluminum and concrete.
- .2 Interior and exterior control joints, except in floors.
- .3 Door frames, interior and exterior side.
- .4 Protrusions through interior and exterior walls and floors, interior and exterior side, except where fire rated seals are required.
- .5 Seal thresholds.

.3 Sealant **Type B:**
- .1 Perimeter of interior windows.

END OF SECTION

1 General

1.1 SECTION INCLUDES

.1 Fire rated and non-fire rated access doors and frame units.

1.2 RELATED REQUIREMENTS

.1 Section 20 05 00 – Common Work Results for Mechanical.

.2 Section 26 05 00 – Common Work Results for Electrical.

1.3 REFERENCES

.1 UL/ULC Fire Resistance Directory.

1.4 ACTION SUBMITTALS

.1 Submit in accordance with Section 01 30 00.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for access door components and include product characteristics, performance criteria, physical size, finish, and limitations.

.3 Shop Drawings:

.1 Submit catalogue details for each type of door illustrating profiles, dimensions, and methods of assembly.

.2 If access door is to be installed in a fire rated assembly, shop drawing to indicate the rating.

1.5 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00.

.2 Operation and Maintenance Data:

.1 Submit operation and maintenance data for cleaning and maintenance of finishes for incorporation into manual.

.2 Submit manufacturer’s ordering information for additional keys.

.3 At time of instruction of Owner’s operating staff, hand-over and obtain signed receipt for four sets of each type of key used to lock access doors in secure areas.

1.6 DELIVERY, STORAGE, AND HANDLING

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

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

.3 Store and protect access doors from nicks, scratches, and blemishes.

.4 Leave protective coatings in place until final cleaning of building.

2 Products

2.1 MANUFACTURERS

.1 Acudor Acorn.

.2 Baird – ABCO.

.3 Mifab.

.4 Stelpro - Type 700.

.5 Watts Water Technologies (Canada) Inc.

2.2 ACCESS DOORS

.1 Construction:

.1 Access doors shall be flush to edge of frame, concealed continuous hinge with screwdriver operated cam latch.

.2 Steel, prime coated, flush mounted with 180 degree opening door, round safety corners, concealed hinges, plaster lock and anchor straps.

.3 Rounded safety corners, concealed hinges, screwdriver latch, anchor straps, able to open 180 degrees.

.4 Door construction to be minimum 14 gauge with 16 gauge frame.

.5 Fire-rated door construction to be a minimum 20 gauge insulated door with 16 gauge frame. Insulation thickness to provide required rating.

.6 Provide for plaster surfaces recessed 16 gauge prime painted steel door and welded metal lath, ready to take plaster.

.7 Provide for tiled surfaces, recessed type 16 gauge primed steel doors to suit type of tile used.

.8 Provide other access doors of welded 12 gauge steel, factory prime coated, flush type.

.2 Materials:

.1 Tiled or marble surfaces: stainless steel with brushed satin finish.

.2 Other areas: prime coated steel.

.3 Constructed of stainless steel in areas finished with tile or marble surfaces

.4 Constructed of stainless steel with neoprene gasketed door in damp and high humidity areas

.5 Latching:

.6 Fitted with screwdriver operated latches.

.7 In areas subject to security risks (Public Corridors, Public Washrooms, etc.), fitted with keyed cylinder locks with similar keys.

.3 Fire Ratings:

.1 When access doors are required to be located in fire rated walls, floor and ceilings, provide ULC tested and labelled units rated in accordance with the structures being penetrated i.e. 3/4 hour, 1 hour, 2 hour.

.4 Minimum dimensions (or as indicated otherwise on drawings):

.1 600 mm by 600 mm (24 inches by 24 inches) for personnel entry.

.2 450 mm by 450 mm (18 inches by 18 inches) for hand entry.

.3 300 mm by 300 mm (12 inches by 12 inches) for viewing only.

.4 Size doors to allow adequate operating/maintenance clearance for devices.

.5 Access doors shall be, wherever possible, of a standard size for each application.

.5 Example products based on Acudor Acorn:

.1 Concealed plaster: PS-5010.

.2 Concealed drywall: DW-5015.

.3 Existing drywall: DW-5040.

.4 Fire-rated: FW-5050/FB-5060 to match assembly.

2.3 EXCLUSIONS

.1 Lay-in tile ceilings: use unobtrusive identification locators.

3 Execution

3.1 EXAMINATION

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

.2 Lay-in type ceiling tiles, properly marked, with lamacoid label on adjacent ceiling carrying channel, may serve as access panels. Where ceiling tiles are required to be clipped, provide the appropriate access clips.

.3 Confirm exact access door dimensions and locations with the Consultant prior to ordering and prior to commencing installation. Arrange work to suit.

3.2 INSTALLATION

.1 Access doors are to be installed by the trade responsible for the particular type of construction in which the doors are required.

.2 Provide access doors for new and existing concealed valves, dampers, junction boxes, equipment, etc.

.3 Provide access doors wherever equipment, valves, dampers, control devices, junction boxes, pull boxes, etc., are concealed behind walls or inaccessible ceilings.

.4 Provide access doors to give access to all valves, cleanouts, strainers, duct access doors, and other mechanical devices which may need maintenance or repair which are concealed in inaccessible construction.

.5 Access doors shall match wall and ceiling finishes.

.6 Access doors in gypsum ceiling shall be recessed type.

.7 Locate access doors within view of equipment and ensure equipment is accessible for operating, inspecting, adjusting, servicing without using special tools.

.8 Supply access doors and make arrangements and pay for installation by trade in whose work they occur.

.9 Size and locate access doors in applied tile, block, or in glazed or unglazed structural tile to suit joint patterns.

.10 Access doors in ceilings, where acoustic tile is applied to plaster or gypsum board, to be dish type designed to receive tile insert.

.11 Access doors are not required in removable ceilings. Provide coloured marking devices after completion of ceilings, at one corner of each panel below point requiring access. Colour code markers to show service or device above.

.12 Provide access doors at locations where equipment requires inspection, service, maintenance, or adjustment, including by not limited to the following:

.1 Expansion joints.

.2 Plumbing cleanouts.

.3 Dampers.

.4 Fire dampers.

.5 Air valves.

.6 Air terminal units.

.7 Valves.

.8 Heating or cooling coils.

.9 Junction and pull boxes for power wiring or control wiring.

.10 Any concealed electrical devices.

3.3 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by access door installation.

End of Section

1 General

1.1 **SECTION INCLUDES**

.1 Labour, Products, equipment and services necessary for unit skylight work in accordance with the Contract Documents.

1.2 **REFERENCES**

.1 AAMA 611, Voluntary Standards for Anodized Architectural Aluminum.

.2 AAMA/WDMA/CSA 101/I.S.2/A440, Standard Specification for Windows, Doors, and Unit Skylights.

.3 CAN/CGSB-19.13-M, Sealing Compound, One-Component, Elastomeric, Chemical Curing.

1.3 **DESIGN REQUIREMENTS**

.1 Design skylights in accordance to AAMA/WDMA/CSA -101/I.S.2/ A440, to the following performance levels:
- .1 Minimum performance grade (PG): 30.
- .2 Minimum design pressure (DP): 1440 Pa.
- .3 Minimum positive structural test pressure (STP): 2880 Pa.
- .4 Minimum negative structural test pressure (STP): - 2160 Pa.
- .5 Minimum water penetration test pressure: 220 Pa.

1.4 **SUBMITTALS**

.1 Product data:
- .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
  - .1 Performance criteria, compliance with appropriate reference standard, characteristics, and limitations.
  - .2 Product transportation, storage, handling and installation requirements.

.2 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
  - .1 Elevations, sections and details, dimensions, thicknesses, materials, fastening devices, installation details, and finishes.

.3 Closeout submittals: Submit cleaning and maintenance for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00.

2 Products

2.1 **MANUFACTURED UNITS**

.1 Curb mounted skylights: Fixed curb mounted unit skylight with extruded aluminum frame and cover. Insulated unit consisting of tempered and laminated glass panes with low E coating and argon filled air space. Internal drainage to weep to the exterior. 'Model FCM' by Velux or approved alternative.

.2 Fasteners: Stainless steel screws to manufacturers standard.

.3 Finish: Clear anodized to AAMA 611 per Aluminum Association Designation System for Aluminum Finishes AA-M12C22A31.

3 Execution

3.1 **EXAMINATION**

.1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 **PREPARATION**

.1 Verify all dimensions affecting work of this Section from site. Ensure adjacent and adjoining materials, flashings, curbs, framing, anchors, fastenings and the like, are properly set and in readiness to accept the structural supports and glazed skylight.

3.3 **INSTALLATION**

.1 Install skylights in accordance with reviewed shop drawings, manufacturer's written instructions, and authorities having jurisdiction.

.2 Install components plumb, level and in proper alignment. Secure preformed curb assembly to substrate.

.3 Metals in contact with dissimilar metals, concrete or other cementitious surface shall have the surfaces protected by a suitable inert material.

.4 Conceal all fasteners or set flush with surface unless otherwise indicated.

.5 Adjust and seal assembly with provision for expansion and contraction of components. Secure and seal frame to curb.

END OF SECTION

M&E Specifications

Issued for Tender

CITY OF MISSISSAUGA
CLARKSON COMMUNITY CENTRE RENEWAL – PHASE 2

2475 Truscott Drive
Mississauga, Ontario

Consultant:
Quasar Consulting Group

250 Rowntree Dairy Road
Woodbridge, ON, L4L 9J7
Tel: 905.507.0800
Fax: 905.507.0081
Web: www.quasarcg.com

QCG Project No. CM-22-127

22 September 2023

1 General

1.1 SECTION INCLUDES

.1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Mechanical Divisions. It is intended as a supplement to each Section and is to be read accordingly.

1.2 REFERENCES

.1 Division 00 and Division 01 apply to and are a part of each Mechanical Division:

.1 Division 20 – Common Mechanical Requirements;

.2 Division 23 – Heating, Ventilating, and Air Conditioning;

.3 Division 25 – Integrated Automation.

1.3 SUBMITTALS

.1 Submit shop drawings/product data sheets for:

.1 pressure gauges and thermometers;

.2 electric motors (submit with equipment they are associated with).

.2 Submit weight loads for selected equipment (upon request).

.3 Submit copy of architectural reflected ceiling plan drawings and elevation drawings to indicate proposed access door locations.

.4 Submit a list of equipment identification nameplates indicating proposed wording and sizes.

.5 Submit a list of pipe and duct identification colour coding and wording.

.6 Submit a proposed valve tag chart and a list of proposed valve tag numbering and identification wording.

.7 Submit drawings indicating size and location of required sleeves, recesses and formed openings in poured or precast concrete work.

.8 Submit any other submittals specified in this Section or other Sections of Mechanical Divisions.

1.4 MAINTENANCE MATERIAL SUBMITTALS

.1 As specified in Part 2 of this Section, submit a spare belt set, tagged and identified, for each belt driven piece of equipment.

2 Products

2.1 ACCESS DOORS

.1 Provide all access doors required for Mechanical work unless otherwise specified in Division 08. Coordinate consistency of look and finish of access doors on project with each Division of Work. Coordinate exact requirements with General Trades Contractor.

.2 Access doors to be rust resistant steel door panels, with concealed hinges and positive locking and self-opening screwdriver operated lock. Wall type frame to be suitable for wall installation and have integral keys for plaster walls. Doors in tile wall to be stainless steel and in ceilings to be suitable for plaster covering with only frame joint showing. Other doors to be prime painted steel.

.3 Size access doors to suit the concealed work for which they are supplied, and wherever possible they are to be of standard size for all applications, but in any case they are to be minimum 300 mm x 300 mm (12" x 12") for hand entry and 600 mm x 600 mm (24" x 24") for body entry.

.4 Lay-in type tiles, properly marked, may serve as access panels. Coordinate marking of ceiling tiles with the Consultant. Panels in glazed tile walls to be 12 gauge, 304 alloy stainless steel, No. 4 finish, with recessed frame secured with stainless steel counter-sunk flush head screws.

.5 Panels in plaster surfaces to have dish-shaped door and welded metal lath, ready to take plaster. Provide a plastic grommet for door key access.

.6 Other access doors to be welded 12 gauge steel, flush type with concealed hinges, lock and anchor straps, complete with factory prime coat. Submit to Consultant for review, details of non-standard door construction details.

.7 Access doors in fire rated ceilings, walls, partitions, structures, etc., to be ULC listed and labelled and of a rating to maintain fire separation integrity.

.8 Where access doors are located in surfaces where special finishes are required, they are to be of a recessed door type capable of accepting finish in which they are to be installed so as to maintain final building surface appearance throughout.

.9 Manufacturers:

.1 Le Hage.

.2 SMS.

.3 Pedlar.

.4 Acudor.

2.2 FLEXIBLE PIPING CONNECTORS

.1 Double wall stainless steel flexible connectors for piping connections to vibration isolated equipment, each selected by manufacturer to suit the application. Shop drawings or product data sheets must indicate construction and performance requirements that suit the application.

.2 Manufacturers:

.1 Hyspan Precision Products Inc.;

.2 Senior Flexonics Ltd.;

.3 The Metraflex Co.

3 Execution

3.1 GENERAL PIPING AND DUCTWORK INSTALLATION REQUIREMENTS

.1 Unless otherwise specified, locate and arrange horizontal pipes and ducts above or at ceiling on floors, arranged so that under consideration of all other work in area, maximum ceiling height and/or usable space is maintained. If required to maintain ceiling heights, reroute and/or resize ductwork, with Consultant’s approval.

.2 Unless otherwise specified, install work concealed in finished spaces, and concealed to degree possible in partially finished and unfinished spaces. Refer to and examine Architectural drawings and room finish schedules to determine finished, partially finished, and unfinished areas. Walls which are painted are considered finished.

.3 Install pipes and ducts parallel to building lines and to each other.

.4 Neatly group and arrange exposed work.

.5 Locate work to permit easy access for service or maintenance as required and/or applicable. Locate valves, dampers and any other equipment which will or may need maintenance or repairs and which are to be installed in accessible construction so as to be easily accessible from access doors. Where valves, dampers and similar piping or ductwork accessories occur in vertical services in shafts, pipe spaces or partitions, locate accessories at floor level.

.6 Make connections between pipes of different materials using adapters suitable for application. Provide cast brass dielectric type adapters/unions at connections between ferrous and copper pipe.

.7 Comply with equipment and material manufacturer's installation instructions unless otherwise specified herein or on drawings, and unless such instructions contradict governing codes and regulations.

.8 Carefully clean ducts, pipe and fittings prior to installation. Temporarily cap or plug ends of pipe, ducts and equipment which are open and exposed during construction.

.9 Install piping and ductwork which are to be insulated so that they have sufficient clearance to permit insulation and finish to be applied continuously and unbroken around pipe or duct, except for ductwork at fire barriers, in which case insulation will be terminated at each side of the duct fire damper.

.10 Inspect surfaces and structure prepared by other trades before performing work. Verify surfaces or structure to receive work has no defects or discrepancies which could result in poor application or cause latent defects in installation and workmanship. Report defects in writing. Installation of work will constitute acceptance of such surfaces as being satisfactory.

.11 Any ferrous piping that exhibits in excess of 5% surface rust, either inside or outside or both, is to be wire brush cleaned to bare metal and coated with suitable primer. Steel pipe, fittings and accessories are to be free of corrosion and dirt when work is complete or prior to being concealed from view. Where dirt is evident, clean piping prior to being concealed.

.12 For factory applied finishes, repaint or refinish surfaces damaged during shipment and installation. Quality of repair work is to match original finish. This requirement also applies to galvanized finishes.

.13 Where mechanical work is located in high humidity areas where ferrous metal products will be subject to corrosion and protection for such products is not specified, provide finishes on products to protect against corrosion or provide products which will not corrode in the environment, i.e. aluminium ductwork, copper or stainless steel pipe, etc.

.14 Provide screwed unions or flanges in piping connections to equipment and in regular intervals in long (in excess of 12 m (40')) piping runs to permit removal of sections of piping.

.15 Unless otherwise specified and except where space limitations do not permit, piping elbows are to be long radius. Eccentric reducers are to be installed with straight side at top of piping.

3.2 PIPE JOINT REQUIREMENTS

.1 Do not make pipe joints in walls or slabs.

.2 Ream piping ends prior to making joints.

.3 Properly cut threads in screwed steel piping and coat male threads only with Teflon tape or paste, or an equivalent thread lubricant. After pipe has been screwed into fitting, valve, union, or piping accessory, not more than 2 pipe threads are to remain exposed.

.4 Site bevel steel pipe to be welded or supply mill bevelled pipe. Remove scale and oxide from bevels and leave smooth and clean. Use factory made welding tees or welding outlet fittings for

piping branches off mains. Do not use shop or site fabricated fittings unless written approval has been obtained.

.5 Welded joints are to be made by CWB certified licensed journeyman welders qualified in accordance with CSA B51, Boiler Pressure Vessel and Pressure Piping Code, and who are in possession of a proper certificate of qualification for each procedure to be performed. Each weld is to be identified with the welder's identification symbol, and welds are not to be concealed until they have been inspected and approved. Electrodes are to be in accordance with CSA W48 Series, Electrodes, and requirements of CAN/CSA W117.2, Safety in Welding, Cutting and Allied Processes are to be followed.

.6 Unless otherwise specified, make flanged joints with Garlock 5500 or equivalent gasket materials to suit the application, and bolts and nuts. Bolts are not to be longer than length necessary to screw nut up flush to the end of bolt. Bolts used for flanged connections in piping with a working pressure of 690 kPa (100 psi) and greater are to be ASTM A-193 Grade B-7, with heavy hexagon nuts to ASTM A-194 CL-2H. Provide suitable washers between each bolt head and flange and between each nut and flange.

.7 A random check of bolted flanged connections will be made to verify flanged connections are properly mated with no shear force acting on bolts. Supply labour to disconnect and reconnect selected flanged joints. If improperly mated joints are found, remove and reinstall affected piping so flanges mate properly. If improperly mated joints are found, additional joints will be checked, and you will be responsible for the repair of any other improper joints discovered.

.8 Unless otherwise specified make soldered joints in copper piping using flux suitable for and compatible with type of solder being used. Clean the outside of pipe end and inside of fitting, valve, or similar accessory prior to soldering.

.9 Install mechanical joint fittings and couplings in accordance with manufacturer's instructions.

.10 Grooves are to be rolled. Make arrangements with coupling and fitting manufacturer for shop and/or site instructions and demonstrations as required, and adhere to manufacturer's instructions with respect to pipe grooving, support, type of gasket required, anchoring and guiding the grooved piping system.

.11 If pressure crimped couplings and fittings are used, ensure gaskets are fully compatible with piping fluid, and valves and piping accessories are suitable. Use only fitting manufacturer supplied crimping equipment. Comply with manufacturer's latest published specification, instructions, and recommendations with respect to pipe, coupling, and fitting preparation and installation, and support, anchoring and guiding of the piping system.

.12 Solvent weld PVC piping in 2 parts, primer stage and cementing stage, in accordance with manufacturer's recommendations, ASTM D2855, and CSA requirements.

.13 Install PVC piping with gasketed joints in accordance with manufacturer's current published specifications, instructions and recommendations, and CSA requirements.

3.3 DUCT OPENINGS

.1 Duct openings, air inlet and outlet openings, fire damper and similar openings will be provided in new poured concrete work, masonry, drywall and other building surfaces by trade responsible for particular construction in which opening is required.

.2 Size openings for fire dampers to suit damper arrangement with folding blade out of air stream.

.3 For duct openings except where fire dampers are required, pack and seal space between duct or duct insulation and duct opening as specified above for pipe openings in non-fire rated construction.

3.4 SLEEVE AND FORMED OPENING LOCATION DRAWINGS

.1 Prepare and submit for review, drawings indicating size and location of required sleeves, recesses and formed openings in poured or precast concrete work.

.2 Such drawings are to be completely and accurately dimensioned and relate sleeve, recesses, and formed openings to suitable grid lines and elevation datum, and are to take into account structural items such as grade beams, column caps, and column drop slabs.

.3 Begin to prepare such drawings immediately upon notification of acceptance of bid and award of Contract.

3.5 INSTALLATION OF PIPE ESCUTCHEON PLATES

.1 Provide escutcheon plates suitably secured over exposed piping passing through finished building surfaces. A finished building surface is any surface with a factory finish or that receives a site applied finish.

.2 Install plates so they are tight against building surface concerned, completely covering pipe sleeves and/or openings, except where waterproof sleeves extend above floors, in which case fit plate tightly around sleeve.

3.6 SUPPLY OF ACCESS DOORS

.1 Supply access doors to give access to mechanical work which may need maintenance or repair but which is concealed in inaccessible construction, except as otherwise specified herein or on drawings.

.2 Before commencing installation of mechanical work, coordinate with other trades and prepare on a set of reflected ceiling plans and wall elevations, complete layouts of access doors. Submit these layouts for Consultant's review and show exact sizes and locations of such access doors. Locate and arrange mechanical work to suit.

.3 Access doors will be installed by trade responsible for particular type of construction in which doors are required. Supply access doors to trade installing same at proper time.

.4 Wherever possible, access doors to be of a standard size for each application. Confirm exact dimensions and minimum size restrictions with the Consultant prior to ordering.

.5 Group piping and ductwork to ensure minimum number of access doors is required.

.6 Coordinate with Electrical Contractor and General Trades Contractor to ensure access doors on project are provided by a single manufacturer, installed as part of work of General Trades Contractor and work involving both mechanical and electrical services should, where possible, be accessible from common access door. Coordinate work to ensure common location access doors are not supplied by both Mechanical Divisions and Electrical Divisions.

3.7 INSTALLATION OF VALVES

.1 Generally, valve locations are indicated or specified on drawings or specified in Sections of the Specification where valves are specified, however, regardless of locations shown or specified, following requirements apply:

.1 provide shut-off valves to isolate systems, at base of vertical risers, in branch take-offs at mains and risers on floors, to isolate equipment, to permit work phasing as required, and wherever else required for proper system operation and maintenance;

.2 install shut-off valves with handles upright or horizontal, not inverted, and located for easy access;

.3 unless otherwise specified, provide a check valve in discharge piping of each pump;

.4 valve sizes are to be same as connecting pipe size;

.5 valves are to be permanently identified with size, manufacturer's name, valve model or figure number and pressure rating, and wherever possible, valves are to be product of same manufacturer;

.6 for valves in insulated piping, design of valve stem, handle and operating mechanism is to be such that insulation does not have to be cut or altered in any manner to permit valve operation.

3.8 FINISH PAINTING OF MECHANICAL WORK

.1 Finish paint exposed mechanical work as specified and/or scheduled in accordance with requirements of Division 09.

.2 Touch-up paint damaged factory applied finishes on mechanical work products.

3.9 PIPE LEAKAGE TESTING

.1 Before piping has been insulated or concealed, and before equipment, fixtures and fittings have been connected, test piping for leakage.

.2 Tests are to be witnessed by the Consultant and/or Owner's representative, and, where required, representatives of governing authorities. Give ample notice of tests in writing and verify attendance. Have completed test report sheets dated and signed by those present to confirm proper test results.

.3 When circumstances prevent scheduled tests from taking place, give immediate and adequate notice of cancellation to all who were scheduled to attend.

.4 Gravity Drainage and Vent Piping

.1 Test piping in accordance with local governing building code.

.2 After fixtures and fittings are set and pipes are connected to building drain or drains, turn on water into pipe, fixtures, fittings and traps in order to detect any imperfect material or workmanship. Perform a smoke test if required by local governing authorities.

.5 Pumped Drainage Piping

.1 Test piping with cold water at a pressure of 1-½ times normal working pressure and maintain pressure for a minimum of 2 hours.

.6 Domestic Water Piping

.1 Test piping with cold water at a pressure of 1-½ times normal working pressure and maintain pressure for a minimum of 2 hours.

.7 Sprinkler System Piping

.1 Test system piping in accordance with requirements of NFPA No. 13, "Installation of Sprinkler Systems", and in accordance with any additional requirements of governing authorities.

.8 Standpipe System Piping

.1 Test system piping in accordance with requirements of NFPA No. 14, "Standpipe and Hose Systems", and in accordance with any additional requirements of governing authorities.

.9 CO2 Fire Extinguishing System Piping

.1 Test system piping in accordance with requirements of NFPA No. 12, "Standard on Carbon Dioxide Extinguishing Systems", and in accordance with any additional requirements of governing authorities.

.10 Clean Agent Fire Extinguishing System Piping

.1 Test system piping in accordance with requirements of NFPA No. 2001, "Standard on Clean Agent Extinguishing Systems", and in accordance with any additional requirements of governing authorities

.11 Heat Transfer (HVAC) System Piping

.1 Test piping with cold water at a pressure of 1035 kPa (150 psi) for a minimum of 2 hours.

.12 Steam and Condensate Piping

.1 Test piping with cold water for a minimum of 2 hours at following pressures:

.1 0 kPa to 105 kPa (0 psi to 15 psi) low pressure piping – 690 kPa (100 psi);

.2 110 kPa to 690 kPa (16 psi to 100 psi) medium pressure piping – 1035 kPa (150 psi);

.3 greater than 690 kPa (100 psi) high pressure piping – 1380 kPa (200 psi).

.13 Natural Gas Piping

.1 Test piping in accordance with requirements of CAN/CSA B149.1 and any additional requirements of local governing authorities.

.2 After completion of the verification test, locate required tag stating results of the verification test at the point of entry of gas main into building, affixed to the pipe in a secure manner.

.3 Check piping joints and connections for leaks with a water/soap solution while piping is under pressure.

.14 Propane Gas Piping

.1 Test piping in accordance with requirements of CAN/CSA B149.2 and any additional requirements of local governing authorities.

.2 After completion of the verification test, locate required tag stating results of the verification test at the point of entry of gas main into building, affixed to the pipe in a secure manner.

.3 Check piping joints and connections for leaks with a water/soap solution while piping is under pressure.

.15 Compressed Air Piping

.1 Test piping with dry compressed air or nitrogen at 690 kPa (100 psi) for a minimum of 2 hours.

.2 Test piping joints with a water-soap solution while piping is under pressure to detect leaks.

.16 Fuel Oil Piping

.1 Test piping (not tanks) with dry compressed air or nitrogen for a minimum period of 2 hours at 1035 kPa (150 psi).

.2 Check piping joints and connections for leaks with a water/soap solution while piping is under pressure.

.17 Gasoline Piping

.1 Test piping (not tanks) with dry compressed air or nitrogen for a minimum period of 2 hours at 1035 kPa (150 psi) in accordance with TSSA requirements.

.2 Check piping joints and connections for leaks with a water/soap solution while piping is under pressure.

.18 Refrigerant Piping

.1 Test refrigerant piping for leakage and dehydrate in accordance with requirements of Chapter 18 of ASHRAE Handbook - Fundamentals.

.19 Control Air Piping and Tubing

.1 Test control air piping and tubing with dry compressed air or nitrogen before concealing and again before connection of instruments.

.2 Rough-in test pressure is to be 345 kPa (50 psi) maintained over 24 hours with a pressure drop not to exceed 35 kPa (5 psi).

.3 Test joints for leaks with a soap solution.

.4 Finish test is to be 205 kPa (30 psi) with a permissible loss of 7 kPa (1 psi) over a 4 hour period. Prior to connecting instruments, blow systems clean and dry, and test component connections for leaks with a water/soap solution.

.20 Pure Water Piping

.1 When piping has been properly flushed and cleaned, test at 690 kPa (100 psi) for 2 hours with only distilled water or filtered dry compressed air. If distilled water is used, drain system when testing is complete.

.21 Following requirements apply to all testing:

.1 ensure piping has been properly flushed, cleaned and is clear of foreign matter prior to pressure testing;

.2 temporarily remove or valve off piping system specialties or equipment which may be damaged by test pressures prior to pressure testing systems, and flush piping to remove foreign matter;

.3 when testing is carried out below highest level of the particular system, increase test pressure by the hydrostatic head of 7 kPa (1 psi) for every 600 mm (24") below the high point;

.4 include for temporary piping connections required to properly complete tests;

.5 piping under test pressure is to have zero pressure drop for length of test period;

.6 tighten leaks found during tests while piping is under pressure. If this is impossible, remove and refit piping and reapply test until satisfactory results are obtained;

.7 where leaks occur in threaded joints in steel piping, no caulking of these joints will be allowed under any conditions;

.8 tests are to be done in reasonably sized sections so as to minimize number of tests required;

.9 in addition to leakage tests specified above, demonstrate proper flow throughout systems including mains, connections and equipment, as well as proper venting and drainage, and include for any necessary system adjustments to achieve proper conditions.

3.10 INTERRUPTION TO AND SHUT-DOWN OF MECHANICAL SERVICES AND SYSTEMS

.1 Coordinate shut-down and interruption to existing mechanical systems with Owner. Generally, shut-downs may be performed only between the hours of 12:00 midnight Friday until 6:00 a.m. Monday morning, unless otherwise specified in Division 01. Include for costs of premium time to perform work during nights, weekends or other times outside of normal working hours, which may be necessary to comply with stipulations specified herein this Article. Services for operation of existing non-renovated areas of building are to be maintained.

.2 Upon award of a Contract, submit a list of anticipated shut-down times and their maximum duration.

.3 Prior to each shut-down or interruption, inform Owner and the Consultant in writing 5 working days in advance of proposed shut-down or interruption and obtain written consent to proceed. Do not shut-down or interrupt any system or service without such written consent. Shutdowns of some essential services may require additional advance notification time.

.4 Perform work associated with shut-downs and interruptions as continuous operations to minimize shut-down time and to reinstate systems as soon as possible, and, prior to any shut-down, ensure materials and labour required to complete the work for which shut-down is required are available at site.

.5 Pipe freezing shall be used to connect new piping to existing piping. Alternative methods may be proposed, if site conditions are evaluated and permit, and are approved by the Consultant.

.6 Where existing isolation valves do not hold, pipe freezing shall be used to connect new piping to existing piping.

3.11 MECHANICAL SERVICE REQUIREMENTS FOR FLOATING FLOOR SLABS

.1 Where mechanical services are required to be installed in or through a vibration isolated floating slab, install such services so as not to transmit any vibration to base slab on which floating floor slab is placed.

.2 Wherever possible, arrange mechanical work to avoid penetrating a floating floor slab.

3.12 EXCAVATION AND BACKFILL WORK

.1 Unless otherwise1, provide all excavation and backfill associated with the mechanical scope of work.

.2 Before commencement of excavation for work, determine in consultation with Consultant, Owner, Municipality and utilities, presence, if any, of existing underground services at site. Engage local utilities to locate and mark out such services. Ensure trades concerned are aware of their presence.

.3 Be responsible for any damage done to underground services caused by neglect to determine and mark out location of such services prior to excavation work commences.

.4 Where Work falls under jurisdiction of local governing utility, confirm requirements and comply with utility requirements.

.5 Unless otherwise specified, provide excavation, backfill and related work required for mechanical work. Obtain a copy of soil test report if available from the Consultant. Depth of excavations

must accommodate local governing requirements and local standard practices to compensate for local frost levels of Place of the Work.

.6 Inverts and locations of existing site services may have been site surveyed and approximate location may be shown on drawings. Confirm inverts and locations are correct, prior to commencing excavation and contact Utilities to accurately locate their services. Where discrepancies are found, immediately inform Consultant, and await a direction. Grade bottom of trench excavations as required.

.7 In firm, undisturbed soil, lay pipes directly on soil, unless otherwise directed.

.8 Before backfilling, arrange for inspection of work by the Consultant. Do not backfill work unless reviewed with the Consultant. Failure to do so prior to backfilling will require re-excavating work and re-backfill at no additional cost to Owner.

.9 Unless otherwise specified, backfill trenches within building with clean sharp sand in individual layers of maximum 150 mm (6”) thickness compacted to a density of 100% Standard Proctor. Hand compact first layers up to a compacted level of minimum 300 mm (12") above top of pipe. Hand or machine compact the balance up to grade.

.10 Unless otherwise specified, backfill trenches outside the building (not under roads, parking lots or traffic areas), up to a compacted level of 450 mm (18") thick above the pipe, hand compacted to a density of 95% Standard Proctor, using granular "A" gravel. Backfill the balance in 150 mm (6") layers with approved excavated material, compacted to 95% Standard Proctor density.

.11 Unless otherwise specified, backfill trenches outside building under roads, parking lots or traffic areas with crushed stone or granular "A" gravel in layers not exceeding 150 mm (6") thickness, compacted to 100% Standard Proctor density up to grade level.

.12 Provide minimum 1.37 m (4.5') of cover for underground piping subject to freezing and located outside building.

.13 Provide minimum 450 mm (18") of cover for underground piping subject to freezing and located inside building.

.14 After first lift of backfill has been compacted, mark entire path of pipe using continuous 75 mm (3") wide detectable identified marking tape equal to SMS Ltd. D-UGMT.

.15 Store and dispose of excavated materials as follows:

.1 during progress of contract, place material as directed in such a manner to minimize damage or disfigurement of ground and which in no way impedes progress of work;

.2 separately place surplus topsoil and subsoil as directed; leave site clean and unencumbered.

.16 Perform pumping as required to keep excavations free of water.

.17 Engage services of independent soils testing agency to test final backfill compaction density of each backfilled location. Compact backfill to satisfaction of testing agency and in accordance with Specification. Submit a copy of testing agency's report to the Consultant for review.

.18 Fill depressions to correct grade level with appropriate material, after an adequate period has passed to reveal any settlement. Use maximum possible compaction. Pay costs required to make good damages caused by settlement.

.19 Coordinate requirements for final surface toppings (concrete, asphalt, pavers, grass sod, etc.) with General Contractor.

3.13 CUTTING, PATCHING AND CORE DRILLING

.1 Unless otherwise provided by General Trades, perform cutting, patching, and core drilling of existing building required for installation of mechanical work. Perform cutting in a neat and true fashion, with proper tools and equipment to Consultant's approval. Patching is to exactly match existing finishes and be performed by tradesmen skilled in particular trade or application. Work is subject to review and acceptance by the Consultant.

.2 Criteria for cutting holes for additional services:

.1 cut holes through slabs only; no holes to be cut through beams;

.2 cut holes 150 mm (6") diameter or smaller only; obtain approval from Structural Consultant for larger holes;

.3 keep at least 100 mm (4") clear from beam faces;

.4 space at least 3 hole diameters on centre;

.5 for holes that are required closer than 25% of slab span from supporting beam face, use cover meter above slab to clear slab top bars;

.6 for holes that are required within 50% of slab span, use cover meter underside of slab to clear slab bottom bars;

.7 submit sleeving drawings indicating holes and their locations for Structural Consultant's review.

.3 Do not cut or drill any existing work without approval from Owner and Consultant. Be responsible for damage done to building and services caused by cutting or drilling.

.4 Where pipes pass through existing construction, core drill an opening. Size openings to leave 12 mm (½") clearance around pipes or pipe insulation.

.5 Prior to drilling or cutting an opening, determine, in consultation with Consultant and Owner, and by use of non-destructive radar scan (magnetic scan) of slab or wall, presence of any existing services and reinforcement bars concealed behind building surface to be cut and locate openings to suit. Coring is not permitted through concrete beams or girders.

.6 Where drilling is required in waterproof slabs, size opening to permit snug and tight installation of a pipe sleeve sized to leave 12 mm (½") clearance around pipe or pipe insulation. Provide a pipe sleeve, constructed of Schedule 40 galvanized steel pipe with a flange at one end and of a length to extend 100 mm (4") above slab, in opening. Secure flange to the underside of slab and caulk void between sleeve and slab opening with proper non-hardening silicone base caulking compound to produce a water-tight installation.

.7 Firestop and seal openings in fire rated construction. Do not leave openings open overnight unless approved by Owner and Consultant.

3.14 PACKING AND SEALING CORE DRILLED PIPE OPENINGS

.1 Pack and seal void between pipe opening and pipe or pipe insulation for length of opening as follows:

.1 non-fire rated interior construction – pack with mineral wool and seal both ends of opening with non-hardening silicone base caulking compound to produce a water-tight seal;

.2 exterior walls above grade – pack with mineral wool and seal both ends of sleeves water-tight with non-hardening silicone base caulking compound unless mechanical type seals have been specified;

.3 exterior walls below grade (and any other wall where water leakage may be a problem) – seal with link type mechanical seals as specified.

3.15 FLASHING FOR MECHANICAL WORK PENETRATING ROOF

.1 Unless otherwise specified in Division 07, perform required flashing work, including counter-flashing, for mechanical work penetrating and/or set in roof.

.2 Perform flashing work in accordance with requirements of drawing details and/or requirements specified in Division 07.

3.16 CLEANING MECHANICAL WORK

.1 Refer to cleaning requirements specified in Division 01.

.2 Clean mechanical work prior to application for Substantial Performance of the Work.

.3 Include for vacuum cleaning interior of air handling units and ductwork systems.

3.17 CONNECTIONS TO OTHER EQUIPMENT

.1 Carefully examine Contract Documents during bidding period and include for mechanical work piping and/or ductwork connections to equipment requiring such connections.

3.18 SEISMIC RESTRAINT ANCHOR POINTS FOR EQUIPMENT

.1 Where mechanical equipment requires seismic restraint, it is to be complete with manufacturer designed and rated seismic restraint anchor points and attachments, certified by equipment manufacturers, so equipment may be bolted down or restrained in the field.

.2 Equipment to be restrained must be designed such that the strength and anchorage of its internal components exceed force level; used to restrain and anchor the equipment to the supporting structure.

3.19 INSTALLATION OF FLEXIBLE CONNECTORS

.1 Provide flexible connectors in piping connections to seismically restrained equipment, where applicable, and wherever else shown.

.2 Provide flexible connectors in piping connections to vibration isolated equipment.

3.20 FAN NOISE LEVELS

.1 Submit sound power levels with fan shop drawings/product data, with levels measured to AMCA 300 and calculated to AMCA 301.

3.21 EQUIPMENT AND SYSTEM MANUFACTURER'S CERTIFICATION

.1 When equipment/system installation is complete, but prior to start-up procedures, arrange and pay for equipment/system manufacturer's authorized representative to visit site to examine installation, and after any required corrective measures have been made, to certify in writing to the Consultant that equipment/system installation is complete and in accordance with equipment/system manufacturer's instructions.

3.22 SYSTEM STARTUP

.1 When installation of equipment/systems is complete but prior to commissioning, perform start-up for equipment/systems as specified in mechanical work Sections in accordance with following requirements:

.1 submit a copy of each equipment/system manufacturer's start-up report sheet to the Consultant for review, and incorporate any comments made by the Consultant;

.2 under direct on-site supervision and involvement of equipment/system manufacturer's representative, start-up equipment/systems, make any required adjustments, document procedures, leave equipment/systems in proper operating condition, and submit to the Consultant complete set of start-up documentation sheets signed by manufacturer/supplier and Contractor.

End of Section

1 General

1.1 SECTION INCLUDES

.1 This Section specifies requirements, criteria, methods and execution for mechanical demolition work that are common to one or more mechanical work Sections, and it is intended as a supplement to each Section and is to be read accordingly.

2 Products – Not Used

3 Execution

3.1 DISCONNECTION AND REMOVAL OF EXISTING MECHANICAL WORK

.1 Where indicated on drawings, disconnect and remove existing mechanical work, including hangers, supports, insulation, etc. Disconnect at point of supply, remove obsolete connecting services and make system safe. Cut back obsolete piping behind finishes and cap water-tight unless otherwise specified.

.2 Scope and extent of demolition or revision work is only generally indicated on drawings. Estimate scope, extent and cost of work at site during bidding period site visit(s). Claims for extra costs for demolition work not shown or specified but clearly visible or ascertainable at site during bidding period site visits will not be allowed.

.3 If any re-design is required due to discrepancies between mechanical drawings and site conditions, notify the Consultant who will issue a Site Instruction. If, in the opinion of the Consultant, discrepancies between mechanical drawings and actual site conditions are of a minor nature, required modifications are to be done at no additional cost.

.4 Where existing mechanical services extend through, or are in an area to serve items which are to remain, maintain services in operation. Include for rerouting existing services concealed behind existing finishes and which become exposed during renovation work, so as to be concealed behind new or existing finishes.

.5 Unless otherwise specified, remove from site and dispose of existing materials which have been removed and are not to be relocated or reused.

3.2 ROOFING WORK

.1 Where roof revisions and/or replacements are part of project, include for disconnecting, lifting, or temporarily removing mechanical equipment on roof as required to permit completion of roofing work, and for re-installing equipment when roofing work is complete.

End of Section

1 General

1.1 SECTION INCLUDES

.1 This Section specifies requirements that are common to Mechanical Divisions work Sections and it is a supplement to each Section and is to be read accordingly. Where requirements of this Section contradict requirements of Division 00 or Division 01, conditions of Division 00 or Division 01 to take precedence.

.2 Be responsible for advising product vendors of requirements of this Section.

1.2 RELATED REQUIREMENTS

.1 Division 00 and Division 01 apply to and are a part of this Section.

1.3 DEFINITIONS

.1 "concealed" – means hidden from normal sight in furred spaces, shafts, ceiling spaces, walls and partitions.

.2 "exposed" – means work normally visible, including work in equipment rooms, service tunnels, and similar spaces.

.3 "finished" - means when in description of any area or part of an area or a product which receives a finish such as paint, or in case of a product may be factory finished.

.4 "provision" or "provide" (and tenses of "provide") – means supply and install complete.

.5 "install" (and tenses of "install") – means secure in position, connect complete, test, adjust, verify, and certify.

.6 "supply" – means to procure, arrange for delivery to site, inspect, accept delivery and administer supply of products; distribute to areas; and include manufacturer's supply of any special materials, standard on site testing, initial start-up, programming, basic commissioning, warranties and manufacturers' assistance to Contractor.

.7 "delete" or "remove" (and tenses of "delete" or "remove") – means to disconnect, make safe, and remove obsolete materials; patch and repair/finish surfaces to match adjoining similar construction; include for associated re-programming of systems and/or change of documentation identifications to suit deletions, and properly dispose of deleted products off site unless otherwise instructed by Owner and reviewed with the Consultant.

.8 "BAS" – means building automation system; "BMS" – means building management system; "FMS" – means facility management system; and "DDC" means direct digital controls; references to "BAS", "BMS", "FMS" and "DDC" generally mean same.

.9 "governing authority" and/or "authority having jurisdiction" and/or "regulatory authority" and/or "Municipal authority" – means government departments, agencies, standards, rules and regulations that apply to and govern work and to which work must adhere.

.10 "OSHA" and "OHSA" – stands for Occupational Safety and Health Administration and Occupational Health and Safety Act, and wherever either one is used, they are to be read to mean local governing occupational health and safety regulations that apply to and govern work and to which work must adhere, regardless if Project falls within either authority's jurisdiction.

.11 "Mechanical Divisions" – refers to Division 20, Division 23, Division 25, and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Mechanical Contractor, unless otherwise noted.

.12 "Electrical Divisions" – refers to Division 26, and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Electrical Contractor, unless otherwise noted.

.13 "Consultant" – means person, firm or corporation identified as such in Agreement or Documents, and is licensed to practice in Place of the Work, and has been appointed by Owner to act for Owner in a professional capacity in relation to the Work.

.14 Wherever words "indicated", "shown", "noted", "listed", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean product referred to is "indicated", "shown", "listed", or "noted" on Contract Documents.

.15 Wherever words "reviewed", "satisfactory", "as directed", "submit", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean that work or product referred to is "reviewed by", "to the satisfaction of", "submitted to", etc., Consultant.

1.4 DOCUMENTS

.1 Documents for bidding include but are not limited to issued Drawings, Specifications and Addenda.

.2 Specification is arranged in accordance with CSI/CSC 49 Divisions of MasterFormat.

.3 Drawings and Specifications are portions of Contract Documents and identify labour, products and services necessary for performance of work and form a basis for determining pricing. They are intended to be cooperative. Perform work that is shown, specified, or reasonably implied on the drawings but not mentioned in Specification, or vice-versa, as though fully covered by both.

.4 Review Drawings and Specifications in conjunction with documents of other Divisions and, where applicable, Code Consultant’s report.

.5 Unless otherwise specifically noted in Specifications and/or on Drawings, Sections of Mechanical Divisions are not intended to delegate functions nor to delegate work and supply of materials to any specific trade, but rather to generally designate a basic unit of work, and Sections are to be read as a whole.

.6 Drawings are performance drawings, diagrammatic, and show approximate locations of equipment and connecting services. Any information regarding accurate measurement of building is to be taken on site. Do not scale Drawings, and do not use Drawings for prefabrication work.

.7 Drawings are intended to convey the scope of work and do not show architectural and structural details. Provide, at your cost, offsets, fittings, transformations and similar products required as a result of obstructions and other architectural and/or structural details but not shown on Drawings.

.8 Locations of equipment and materials shown may be altered, when reviewed by the Consultant, to meet requirements of equipment and/or materials, other equipment or systems being installed, and of building, all at no additional cost to Contract.

.9 Specification does not generally indicate specific number of items or amounts of material required. Specification is intended to provide product data and installation requirements. Refer to schedules, Drawings (layouts, riser diagrams, schematics, details) and Specification to provide correct quantities. Singular may be read as plural and vice versa.

.10 Starter/motor control centre (MCC)/variable frequency drive (VFD) schedule drawings are both mechanical and electrical, and apply to work of Mechanical Divisions and Electrical Divisions. Be responsible for reviewing starter, MCC, VFD, and motor specification requirements prior to Bid

submission. Confirm and coordinate exact scope of work and responsibility of work between Mechanical Divisions and Electrical Divisions.

.11 Drawings and Specifications have been prepared solely for use by party with whom Consultant has entered into a contract and there are no representations of any kind made by the Consultant to any other party.

.12 In the case of discrepancies between the drawings and specifications, documents will govern in order specified in “General Conditions”, however, when scale and date of drawings are same, or where discrepancy exists within specification, most costly arrangement will take precedence.

1.5 METRIC AND IMPERIAL MEASUREMENTS

.1 Generally, both metric and imperial units of measurement are given in Sections of Specification governed by this section. Measurement conversions may be generally "soft" and rounded off. Confirm exact measurements based on application. Where measurements are related to installation and onsite applications, confirm issued document measurements with applicable local code requirements, and/or as applicable, make accurate measurements onsite. Where significant discrepancies are found, immediately notify Consultant for direction.

1.6 EXAMINATION OF DOCUMENTS AND SITE

.1 Carefully examine Documents and visit site to determine and review existing site conditions that will or may affect work, and include for such conditions in Bid Price.

.2 Report to Consultant, prior to Bid Submittal, any existing site condition that will or may affect performance of work as per Documents. Failure to do so will not be grounds for additional costs.

.3 Upon finding discrepancies in, or omissions from Documents, or having doubt as to their meaning or intent, immediately notify Consultant, in writing.

1.7 WORK STANDARDS

.1 Where any code, regulation, bylaw, standard, contract form, manual, printed instruction, and installation and application instruction is quoted it means, unless otherwise specifically noted, latest published edition at time of submission of Bids adopted by and enforced by local governing authorities having jurisdiction. Include for compliance with revisions, bulletins, supplementary standards or amendments issued by local governing authorities.

.2 Where regulatory codes, standards and regulations are at variance with Drawings and Specification, more stringent requirement will apply unless otherwise directed by Owner and reviewed with the Consultant.

.3 Supplementary mandatory specification and requirements to be used in conjunction with project include but are not limited to following:

.1 Air-Conditioning, Heating and Refrigeration Institute (AHRI);

.2 Air Movement and Control Association (AMCA);

.3 American Iron and Steel Institute (AISI);

.4 American National Standards Institute (ANSI);

.5 American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., (ASHRAE);

.6 American Society of Mechanical Engineers (ASME);

.7 American Society of Testing and Materials (ASTM);

.8 American Water Works Association (AWWA);

.9 Associated Air Balance Council (AABC);

.10 Building Industry Consulting Services, International (BICSI);

.11 Canadian Gas Association (CGA);

.12 Canadian General Standards Board (CGSB);

.13 Canadian Standards Association (CSA);

.14 Electrical and Electronic Manufacturers Association of Canada (EEMAC);

.15 Electrical Safety Authority (ESA);

.16 Electronic Industries Association (EIA);

.17 Factory Mutual Systems (FM);

.18 Illuminating Engineering Society (IES);

.19 Institute of Electrical and Electronic Engineers (IEEE);

.20 International Standards Organization (ISO);

.21 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS);

.22 National Building Code of Canada (NBC);

.23 National Electrical Manufacturers Association (NEMA);

.24 National Environmental Balancing Bureau (NEBB);

.25 National Fire Protection Association (NFPA);

.26 National Standards of Canada;

.27 NSF International;

.28 Occupational Health and Safety Act (OHSA);

.29 Ontario Building Code (OBC);

.30 Ontario Electrical Safety Code (OESC);

.31 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA);

.32 Technical Standards and Safety Authority (TSSA);

.33 Thermal Insulation Association of Canada (TIAC);

.34 Underwriters' Laboratories of Canada (ULC);

.35 Workplace Hazardous Materials Information System (WHMIS);

.36 Material Safety Data Sheets by product manufacturers;

.37 Local utility inspection permits;

.38 Codes, standards, and regulations of local governing authorities having jurisdiction;

.39 Additional codes and standards listed in Trade Sections;

.40 Owner's standards.

.4 Provide applicable requirements for barrier free access in accordance with latest edition of local governing building code.

.5 Where any governing Code, Regulation, or Standard requires preparation and submission of special details or drawings for review they are to be prepared and submitted to appropriate authorities. Be responsible for costs associated with these submittals.

.6 Unless otherwise specified, install equipment in accordance with equipment manufacturer's recommendations and instructions, and requirements of governing Codes, Standards, and Regulations. Governing Codes, Standards, and Regulations take precedence over manufacturer's instructions.

.7 Work is to be performed by journeyperson tradesmen who perform only work that their certificates permit, or by apprentice tradesmen under direct on site supervision of experienced journeyperson tradesman. Journeyperson to apprentice ratio is not to exceed ratio determined by the Board as stated in Ontario College of Trades and Apprenticeship Act or local equivalent governing body in Place of the Work.

.8 Journeyperson tradesmen are to have a copy of valid trade certificates available at site for review with the Consultant at any time.

.9 Experienced and qualified superintendent is to be on-site at times when work is being performed.

.10 Coordinate work inspection reviews and approvals with governing inspection department to ensure that construction schedule is not delayed. Be responsible for prompt notification of deficiencies to the Consultant and submission of reports and certificates to the Consultant.

.11 Properly protect equipment and materials on site from damage due to elements and work of trades, to satisfaction of Owner and reviewed with the Consultant. Equipment and materials are to be in new condition upon Substantial Performance of the Work.

.12 Mechanical piping system work, including equipment, must comply in all respects with requirements of local technical standards authorities and CSA B51, Boiler, Pressure Vessels and Pressure Piping Code. Where required, mechanical work products must bear a CRN number.

.13 Electrical items associated with mechanical equipment are to be certified and bear stamp or seal of a recognized testing agency such as CSA, UL, ULC, ETL, etc., or bear a stamp to indicate special electrical utility approval.

1.8 PERMITS, CERTIFICATES, APPROVALS, AND FEES

.1 Contact and confirm with local authorities having jurisdiction including utility providers, requirements for approvals from such authorities. Obtain and pay for permits, certificates, and approvals required to complete Work.

.2 Be responsible for ensuring that authorities having jurisdiction which require on-site inspection of work, have ample notification to perform inspection, with sufficient lead time to correct deficiencies in a manner that will not impede schedule of completion of Work. If any defect, deficiency or non-compliant is found in work by inspection, be responsible for costs of such inspection, including any related expenses, making good and return to site, until work is passed by governing authorities.

.3 Obtain and submit to Consultant, approval/inspection certificates issued by governing authorities to confirm that Work as installed is in accordance with rules and regulations of local governing authorities and are acceptable.

.4 Include in each copy of operating and maintenance instruction manuals, copies of approvals and inspection certificates issued by regulatory authorities.

1.9 REQUIREMENTS FOR CONTRACTOR RETAINED ENGINEERS

.1 Professional engineers retained to perform consulting services with regard to Project work, i.e. seismic engineer, fire protection engineer or structural engineer, are to be members in good standing with local Association of Professional Engineers, and are to carry and pay for errors and omissions professional liability insurance in compliance with requirements of governing authorities in Place of the Work.

.2 Retained engineer's professional liability insurance is to protect Contractor's consultants and their respective servants, agents, and employees against any loss or damage resulting from professional services rendered by aforementioned consultants and their respective servants, agents, and employees in regards to the Work of this Contract.

.3 Unless otherwise specified in Division 00 or Division 01, liability insurance requirements are as follows:

.1 coverage is to be a minimum of $1,000,000.00 CDN inclusive of any one occurrence;

.2 insurance policy is not to be cancelled or changed in any way without insurer giving Owner minimum thirty days written notice;

.3 liability insurance is to be obtained from an insurer registered and licensed to underwrite such insurance in the Place of the Work;

.4 retained consultants are to ascertain that sub-consultants employed by them carry insurance in the form and limits specified above;

.5 evidence of the required liability insurance in such form as may be required is to be issued to Owner, Owner's Consultant, and Municipal Authorities as required prior to commencement of aforementioned consultant's services.

1.10 WORKPLACE SAFETY

.1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage and disposal of hazardous materials. Submit WHMIS MSDS (Material Safety Data Sheets) for products where required, and maintain one copy at site in a visible and accessible location available to personnel.

.2 Comply with requirements of Occupational Health and Safety Act and other regulations pertaining to health and safety, including worker's compensation/insurance board and fall protection regulations. When working in confined spaces, comply with requirements of Occupational Health and Safety Act - Ontario Regulation 632, "Confined Spaces" and any other applicable Ministry of Labour requirements.

.3 If at any time during course of work, hazardous materials other than those identified in Documents and pertaining to Project Scope of Work, are encountered or suspected that were not identified as being present and which specific instructions in handling of such materials were not given, cease work in area in question and immediately notify Consultant. Comply with local governing regulations with regards to working in areas suspected of containing hazardous materials. Do not resume work in affected area without approval from Owner and reviewed with the Consultant.

1.11 PLANNING AND LAYOUT OF WORK

.1 Base installation layout, design, terminations, and supply of accessories, on Contract Documents with specific coordination with reviewed shop drawings.

.2 Plan, coordinate, and establish exact locations and routing of services with affected trades prior to installation such that services clear each other as well as other obstructions. Generally, order of right of way for services to be as follows:

.1 piping requiring uniform pitch;

.2 piping 100 mm (4") dia. and larger;

.3 large ducts (main runs);

.4 cable tray and bus duct;

.5 conduit 100 mm (4") dia. and larger;

.6 piping less than 100 mm (4") dia.;

.7 smaller branch ductwork;

.8 conduit less than 100 mm (4") dia.

.3 Unless otherwise shown or specified, conceal work in finished areas, and conceal work in partially finished and/or unfinished areas to extent made possible by the area construction. Install services as high as possible to conserve headroom and/or ceiling space. Notify Consultant where headroom or ceiling space appears to be inadequate prior to installation of work.

.4 Do not use Contract Drawing measurements for prefabrication and layout of piping, sheet metal work and such other work. Locations and routing are to generally be in accordance with Contract Drawings, however, prepare layout drawings for such work. Use established bench marks for both horizontal and vertical measurements. Confirm inverts, coordinate with and make allowances for work of other trades. Accurately layout work, and be entirely responsible for work installed in accordance with layout drawings. Where any invert, grade, or size is at variance with Contract Drawings, notify Consultant prior to proceeding with work.

.5 Prepare plan and interference drawings (at a minimum drawing scale of 1:50 or ¼"=1' 0") of work for coordination with each trade Contractor. Arrange for preparation of detailed section drawings of ceiling spaces of corridors and any other congested areas. Sections are to be cross referenced with plan drawings so that trades may make use of section drawings. Section drawings to indicate lateral and elevation dimensions of major services within ceiling space. Lateral dimensions are to be from grid lines and elevations from top of floor slab. Obtain from Consultant, engineering drawings for this use. Contractors' interference drawings are to be distributed among other Trade Contractors. Submit drawings to the Consultant for review. Failure of General Contractor to prepare and coordinate overall interface drawings of trades does not relieve respective Division Contractor of responsibility to ensure that work is properly planned and coordinated.

.6 Carry out alterations in arrangement of work that has been installed without proper coordination, study, and review, even if in accordance with Contract Documents, in order to conceal work behind finishes, or to allow installation of other work, without additional cost. In addition, make necessary alterations in other work required by such alterations, without additional cost.

.7 Shut-off valves, balancing devices, air vents, equipment, and similar products, particularly such products located above suspended ceilings must be located for easy access for servicing and/or removal. Products which do not meet this location requirement are to be relocated to an accessible location at no additional cost.

.8 Be responsible for making necessary changes, at no additional cost, to accommodate structural and building conditions that were missed due to lack of coordination.

1.12 SCHEDULING

.1 Include for any and all scheduling, coordination, and construction phasing to suit project, specified in Division 01 and/or as indicated on the drawings. Review exact phasing requirements with Consultant prior to start of Work.

.2 Phasing and scheduling of Work is required in order to maintain existing building operations. Include costs (including costs for "off hours" work) for scheduling, co-ordination, and construction phasing to suit this project as specified in Division 01 and on drawings. Review phasing requirements with the Consultant prior to start of Work.

.3 Protect existing areas above, below and adjacent areas of Work from any debris, noise, or interruptions to existing services to satisfaction of Owner and reviewed with the Consultant. Maintain in operation existing services to these areas to allow Owner to continue use of these areas. If services that are required to be maintained run through areas of renovations, provide necessary protection to services or reroute, in coordination with Owner and Consultant. Include for required premium time work to meet these requirements.

.4 Work being performed within occupied spaces and work affecting surfaces adjacent to occupied spaces may need to be performed after regular business hours. For areas where spaces are used by Owner on a 24 hours basis or over various hours, coordinate hours of work with Owner on a regular basis to suit Owner's schedule. Execute work at times confirmed with and agreed to by Owner and reviewed with the Consultant, so as not to inconvenience Owner's occupation or in any way hinder Owner's use of building. Include for required premium timework to meet these requirements.

.5 Project partial occupancy permits may be required throughout project. Provide for each partial permit, required local governing authority certificate and any other testing/verification certificates for systems.

1.13 COORDINATION

.1 Review Contract Documents and coordinate work with work of each trade. Coordination requirements are to include but not be limited to following:

.1 requirements for openings, sleeves, inserts and other hardware necessary for installation of work;

.2 concrete work such as housekeeping pads, sumps, bases, etc., required for work, and including required dimensions, operating weight of equipment, location, etc.;

.3 depth and routing of excavation required for work, and requirements for bedding and backfill;

.4 wiring work required for equipment and systems but not specified to be done as part of mechanical work, including termination points, wiring type and size, and any other requirements.

.2 Ensure materials and equipment are delivered to site at proper time and in such assemblies and sizes so as to enter into building and be moved into spaces where they are to be located without difficulty.

.3 Wherever possible, coordinate equipment deliveries with manufacturers and/or suppliers so equipment is delivered to site when it is required, or so it can be stored within building, subject to available space as confirmed with Owner and reviewed with Owner, and protected from elements.

.4 Ensure proper access and service clearances are maintained around equipment, and, where applicable, access space for future equipment removal or replacement is not impeded. Comply

with code requirements with regards to access space provision around equipment. Remove and replace any equipment which does not meet this requirement.

.5 Where work is to be integrated, or is to be installed in close proximity with work of other trades, coordinate work prior to and during installation.

1.14 PRODUCTS

.1 Be responsible for ordering of products (equipment and materials) in a timely manner in order to meet project-scheduling timelines. Failure to order products to allow manufacturers sufficient production/delivery time to meet project-scheduling timelines is an unacceptable reason to request for other suppliers or substitutions.

.2 Provide Canadian manufactured products wherever possible or required and when quality and performance is obtainable at a competitive price. Products are to be supplied from manufacturer's authorized Canadian representative, unless otherwise noted. Unless otherwise specified, products are to be new and are to comply with applicable respective Canadian standards. References to UL listings of products to include requirements that products are to be also Underwriters Laboratories of Canada (ULC) listed for use in Canada. Products are to meet or exceed latest ANSI/ASHRAE/IES 90.1 standards, as applicable. Do not supply any products containing asbestos materials or PCB materials.

.3 Systems and equipment of this Project are to be "State of the Art" and be most recent and up to date series/version of product that is available at time of shop drawing review process. Products that have been stored or "on shelf" for an extended period of time will not be accepted. Software is to be of latest version available and be provided with updates available at time of shop drawing review process. Systems are to be designed such that its software is backwards compatible. Future upgrades are not to require any hardware replacements or additions to utilize latest software.

.4 Products scheduled and/or specified have been selected to establish a performance and quality standard, and, in some instances, a dimensional standard. In most cases, base specified manufacturers are stated for any product specified by manufacturer's name and model number. Where manufacturers are listed, first name listed is base specified company. Bid Price may be based on products supplied by any of manufacturers' base specified or named as acceptable for particular product. If manufacturers are not stated for a particular product, base Bid Price on product supplied by base specified manufacturer.

.5 Documents have been prepared based on product available at time of Bidding. If, after award of Contract, and if successful manufacturer can no longer supply a product that meets base specifications, notify Consultant immediately. Be responsible for obtaining other manufacturers product that complies with base specified performance and criteria and meets project timelines. Proposed products are subject to review and consideration by the Consultant and are considered as substitutions subject to a credit to Contract. In addition, if such products require modifications to room spaces, mechanical systems, electrical systems, etc., include required changes. Such changes are to be submitted in detail to the Consultant for review and consideration for acceptance. There will be no increase in Contract Price for revisions. Above conditions supplement and are not to supersede any specification conditions with regards to substitutions or failure to supply product as per issued documents.

.6 Listing of a product as "acceptable" does not imply automatic acceptance by the Consultant and/or Owner. It is responsibility of Contractor to ensure that any price quotations received and submittals made are for products that meet or exceed specifications included herein.

.7 If products supplied by a manufacturer named as acceptable are used in lieu of base specified manufacturer, be responsible for ensuring that they are equivalent in performance and operating

characteristics (including energy consumption if applicable) to base specified products. It is understood that any additional costs (i.e. for larger starters, larger feeders, additional spaces, etc.), and changes to associated or adjacent work resulting from provision of product supplied by a manufacturer other than base specified manufacturer, is included in Bid Price. In addition, in equipment spaces where equipment named as acceptable is used in lieu of base specified equipment and dimensions of such equipment differs from base specified equipment, prepare, and submit for review accurately dimensioned layouts of rooms affected, identifying architectural and structural elements, systems and equipment to prove that equipment in room will fit properly meeting design intent. There will be no increase in Contract Price for revisions.

.8 In addition to manufacturer's products base specified or named as acceptable, other manufacturers of products may be proposed as substitutions to the Consultant for review and consideration for acceptance, listing in each case a corresponding credit for each substitution proposed. However, base Bid Price on products base specified or named as acceptable. Certify in writing to the Consultant that proposed substitution meets space, power, design, energy consumption, and other requirements of base specified or acceptable product. It is understood that there will be no increase in Contract Price by reason of any changes to associated equipment, mechanically, electrically, structurally, or architecturally, required by acceptance of proposed substitution. Consultant has sole discretion in accepting any such proposed substitution of product. Indicate any proposed substitutions in areas provided on Bid Form. Do not order such products until they are accepted in writing by the Consultant.

.9 Where products are listed as "or approved equal", certify in writing that product to be used in lieu of base specified product, at least meets space, power, design, energy consumption, and other requirements of base specified product and is equivalent or better than base specified product. When requested by the Consultant, provide full design detail drawings and specifications of proposed products. Acceptance of these "or approved equal" products is at sole discretion of the Consultant. It is understood that there will be no increase in Contract Price by reason of any changes to associated equipment, mechanically, electrically, structurally, or architecturally, required by acceptance of approved equal product. There must be no increase in Contract price due to Consultant's rejection of proposed equivalent product.

.10 Whenever use of product other than base specified product is being supplied, ensure corresponding certifications and product information (detailed catalogue and engineering data, fabrication information and performance characteristics) are submitted to the Consultant for review. Failure of submission of these documents to the Consultant in a timely manner to allow for review will result in base specified product to be supplied at Consultant's discretion, at no additional cost to Contract.

.11 Products supplied by a manufacturer/supplier other than a manufacturer listed as acceptable may be considered for acceptance by the Consultant if requested in writing with full product documentation submitted, a minimum of 10 working days prior to Bid closing date.

.12 Any proposed changes initiated by Contractor after award of Contract may be considered by the Consultant at the Consultant's discretion, with any additional costs for such changes if accepted by Owner and reviewed with the Consultant, and costs for review, to be borne by Contractor.

.13 Whenever use of product other than based specified products or named as acceptable is being supplied, time for process of submission of other products and Consultant's review of products will not alter contract time or delay work schedule.

1.15 SHOP DRAWINGS

.1 At start-up meeting, review with the Consultant products to be included in shop drawing submission. Prepare and submit list of products to the Consultant for review.

.2 Submit electronic copies of shop drawings unless otherwise directed by the Consultant. Coordinate exact requirements with the Consultant.

.3 Submit for review, drawings showing detail design, construction, and performance of equipment and materials as requested in Specification. Submit shop drawings to the Consultant for review prior to ordering and delivery of product to site. Include minimally for preparation and submission of following, as applicable:

.1 product literature cuts;

.2 equipment data sheets;

.3 equipment dimension drawings;

.4 system block diagrams;

.5 sequence of operation;

.6 connection wiring schematic diagrams;

.7 functionality with integrated systems.

.4 Each shop drawing or product data sheet is to be properly identified with project name and product drawing or specification reference. Shop drawing or product data sheet dimensions are to match dimension type on drawings.

.5 Where any item of equipment is required by Code or Standard or By-Law to meet a specific energy efficiency level, or any other specific requirement, ensure this requirement is clearly indicated on submission.

.6 Ensure proposed products meet each requirement of Project. Endorse each shop drawing copy "CERTIFIED TO BE IN ACCORDANCE WITH ALL REQUIREMENTS". Include company name, submittal date, and sign each copy. Shop drawings that are received and are not endorsed, dated and signed will be returned to be resubmitted.

.7 Consultant to review shop drawings and indicate review status by stamping shop drawing copies as follows:

.1 "REVIEWED" or "REVIEWED AS NOTED" (appropriately marked) – If Consultant's review of shop drawing is final, Consultant to stamp shop drawing;

.2 "RETURNED FOR CORRECTION" – If Consultant's review of shop drawing is not final, Consultant to stamp shop drawing as stated above, mark submission with comments, and return submission. Revise shop drawing in accordance with Consultant's notations and resubmit.

.8 Following is to be read in conjunction with wording on Consultant's shop drawing review stamp applied to each and every shop drawing or product data sheet submitted:

.1 "THIS REVIEW BY CONSULTANT IS FOR SOLE PURPOSE OF ASCERTAINING CONFORMANCE WITH GENERAL DESIGN CONCEPT. THIS REVIEW DOES NOT MEAN THAT CONSULTANT APPROVES DETAILED DESIGN INHERENT IN SHOP DRAWINGS, RESPONSIBILITY FOR WHICH REMAINS WITH CONTRACTOR. CONSULTANT'S REVIEW DOES NOT RELIEVE CONTRACTOR OF RESPONSIBILITY FOR ERRORS OR OMISSIONS IN SHOP DRAWINGS OR OF CONTRACTOR'S RESPONSIBILITY FOR MEETING REQUIREMENTS OF CONTRACT DOCUMENTS. BE RESPONSIBLE FOR DIMENSIONS TO BE CONFIRMED AND CORRELATED AT JOB SITE, FOR INFORMATION THAT PERTAINS SOLELY TO FABRICATION PROCESSES OR TO TECHNIQUES OF CONSTRUCTION AND INSTALLATION, AND FOR COORDINATION OF WORK OF SUB-TRADES."

.9 Submit each system and each major component as separate shop drawing submissions. Submit together, shop drawings for common devices such as devices of each system are to be submitted together.

.10 Obtain shop drawings for submission from product manufacturer's authorized representatives and supplemented with additional items specified herein.

.11 Do not order product until respective shop drawing review process has been properly reviewed with the Consultant.

.12 Where extended warranties are specified for equipment items, submit specified extended warranty with shop drawing submittal.

.13 Applicable mechanical equipment has been selected to meet energy efficiency requirements of ANSI/ASHRAE/IES 90.1, Energy Standards for Buildings, and shop drawings/product data submittals for such equipment must indicate compliance with this Standard or they will be returned for correction and re-submittal.

1.16 EQUIPMENT LOADS

.1 Supply equipment loads (self-weight, operating weight, housekeeping pad, inertia pads, etc.) to the Consultant, via shop drawing submissions, prior to construction.

.2 Where given choice of specific equipment, actual weight, location and method of support of equipment may differ from those assumed by the Consultant for base design. Back-check equipment loads, location, and supports, and include necessary accommodations.

.3 Where supporting structure consists of structural steel framing, it is imperative that equipment loads, location, and method of support be confirmed prior to fabrication of structural steel. Review locations of equipment with the Consultant prior to construction.

1.17 OPENINGS

.1 Supply opening sizes and locations to the Consultant to allow verification of their effect on design, and for inclusion on structural drawings where appropriate.

.2 No openings are permitted through completed structure without written approval from Owner and reviewed with the Consultant. Show required openings on a copy of structural drawings. Identify exact locations, elevations, and size of proposed openings and submit to the Consultant for review, well in advance of doing work.

.3 Prior to leaving site at end of each day, walk through areas of work and check for any openings, penetrations, holes, and/or voids created under scope of work of project, and ensure that any openings created under scope of work have been closed off, fire-stopped and smoke-sealed. Unless directed by Owner and reviewed with the Consultant, do not leave any openings unprotected and unfinished overnight.

1.18 SCAFFOLDING, HOISTING AND RIGGING

.1 Unless otherwise specified or directed, supply, erect and operate scaffolding, rigging, hoisting equipment and associated hardware required for work, and subject to approval from Owner and reviewed with the Consultant.

.2 Immediately remove from site scaffolding, rigging and hoisting equipment when no longer required.

.3 Do not place major scaffolding/hoisting equipment loads on any portion of structure without approval from Owner and reviewed with the Consultant.

1.19 CHANGES IN THE WORK

.1 Whenever Consultant proposes in writing to make a change or revision to design, arrangement, quantity, or type of work from that required by Contract Documents, prepare and submit to the Consultant for review, a quotation being proposed cost for executing change or revision.

.2 Quotation is to be a detailed and itemized estimate of product, labour, and equipment costs associated with change or revision, plus overhead and profit percentages and applicable taxes and duties.

.3 Unless otherwise specified in Division 00 or Division 01, allowable maximum percentages for overhead and profit are to be 7% and 5% respectively.

.4 Unless otherwise specified in Division 00 or Division 01, following additional requirements apply to all quotations submitted:

.1 when change or revision involves deleted work as well as additional work, cost of deleted work (less overhead and profit percentages but including taxes and duties) is to be subtracted from cost of additional work before overhead and profit percentages are applied to additional work;

.2 material costs are not to exceed those published in the latest edition of Allpriser price guide, less the following discounts:

Item	Discount
Steel Pipe	50%
Copper Pipe	45%
Cast Iron Soil Pipe	45%
Stainless Steel Pipe and Fittings	45%
Welded Fittings	50%
Grooved Fittings	30%
Threaded Fittings	40%
Cast Iron Screwed Fittings	40%
Copper Fittings	45%
Cast Iron MJ Fittings	35%
Valves	25%
Insulation Materials	35%

.3 mechanical material labour unit costs are to be in accordance with Mechanical Contractors Association of America Labor Estimating Manual, less 25%;

.4 electrical material labour unit costs are to be in accordance with National Electrical Contractors Association Manual of Labor Units at difficult level, less 25%;

.5 costs for journeyperson and apprentice labour must not exceed prevailing rates at time of execution of Contract and must reflect actual personnel performing work;

.6 cost for site superintendent must not exceed 10% of total hours of labour estimated for change or revision, and change or revision must be such that site superintendent's involvement is necessary;

.7 costs for rental tools and/or equipment are not to exceed local rental costs;

.8 overhead percentage will be deemed to cover quotation costs other than actual site labour and materials, and rentals;

.9 quotations, including those for deleted work, to include a figure for any required change to Contract time.

.5 Quotations submitted that are not in accordance with requirements specified above will be rejected and returned for re-submittal. Failure to submit a proper quotation to enable Consultant to expeditiously process quotation and issue a Change Order will not be grounds for any additional change to Contract time.

.6 Make requests for changes or revisions to work to Consultant in writing and, if Consultant agrees, will issue Notice of Change.

.7 Do not execute any change or revision until written authorization for the change or revision has been obtained from the Consultant.

1.20 PROGRESS PAYMENT BREAKDOWN

.1 Prior to submittal of first progress payment draw, submit a detailed breakdown of work cost to assist Consultant in reviewing and approving progress payment claims.

.2 Payment breakdown is subject to Owner's approval and Consultant's review. Progress payments will not be processed until an approved breakdown is in place. Breakdown is to include one-time claim items such as mobilization and demobilization, insurance, bonds (if applicable), shop drawings and product data sheets, commissioning including testing, adjusting and balancing, system testing and verification, and project closeout submittals.

.3 Indicate equipment, material and labour costs for site services (if applicable) and indicate work of each trade in same manner as indicated on progress draw.

1.21 NOTICE FOR REQUIRED FIELD REVIEWS

.1 Whenever there is a requirement for the Consultant to perform a field review prior to concealment of any work, to inspect/re-inspect work for deficiencies prior to Substantial Performance of the Work, for commissioning demonstrations, and any other such field review, give minimum 5 working days' notice in writing to the Consultant.

.2 If Consultant is unable to attend a field review when requested, arrange an alternative date and time.

.3 Do not conceal work until the Consultant advises that it may be concealed.

.4 When Consultant is requested to perform a field review and work is not ready to be reviewed, reimburse Consultant for time and travel expenses.

1.22 PRELIMINARY TESTING

.1 When directed by the Consultant, promptly arrange, pay for, and perform site tests on any piece of equipment or any system for such reasonable lengths of time and at such times as may be required to prove compliance with Specification and governing Codes and Regulations, prior to Substantial Performance of the Work.

.2 When, in Consultant's opinion, tests are required to be performed by a certified testing laboratory, arrange and pay for such tests.

.3 These tests are not to be construed as evidence of acceptance of work, and it is agreed and understood that no claim for delays or damage will be made for injury or breakage to any part or

parts of equipment or system due to test where such injuries or breakage were caused by faulty parts and/or workmanship of any kind.

.4 When, in Consultant's opinion, tests indicate that equipment, products, etc., are defective or deficient, immediately remove such equipment and/or products from site and replace them with acceptable equipment and/or products, at no additional cost.

1.23 PROVISIONS FOR SYSTEMS/EQUIPMENT USED DURING CONSTRUCTION

.1 Permanent building mechanical systems are not to be used for temporary heating or cooling purposes during construction.

1.24 TEMPORARY SERVICES

.1 Coordinate with Prime Contractor, requirements for temporary services including but not limited to temporary heating, cooling, and water. Unless otherwise noted, provide required services in compliance with requirements of local governing building code and local governing inspection authorities.

.2 Maintain fire protection of areas which may include fire watch during temporary shutdowns of existing systems, in accordance with requirements of local governing code and local governing authorities.

1.25 MAINTAINING EQUIPMENT PRIOR TO ACCEPTANCE

.1 Maintain equipment in accordance with the manufacturer's printed instructions prior to start-up, testing and commissioning.

.2 Employ a qualified millwright to check and align shafts, drives, and couplings on all base mounted split coupled motor driven equipment.

.3 Where equipment lubrication fittings are not easily accessible, extend the fittings to accessible locations using copper or aluminium tubing.

.4 All filters are to be new upon Substantial Performance of the Work. This is in addition to any spare filters specified.

1.26 RECORD DOCUMENTATION

.1 Drawings for this project have been prepared on a CAD system using AutoCAD software of release version reviewed with the Consultant. For purpose of producing record "as built" drawings, copies of Contract Drawings can be obtained from the Consultant.

.2 As work progresses at site, clearly mark in red in a neat and legible manner on a set of bound white prints of Contract Drawings, changes, and deviations from routing of services and locations of equipment shown on Contract Drawings, on a daily basis. Changes and deviations include those made by addenda, change orders, and site instructions. Use notes marked in red as required. Maintain white print red line as-built set at site for exclusive use of recording as-built conditions, keep set up-to-date at all times, and ensure set is always available for periodic review. As-built set is also to include the following:

.1 dimensioned location of inaccessible concealed work;

.2 locations of control devices with identification for each;

.3 for underground piping and ducts, record dimensions, invert elevations, offsets, fittings, cathodic protection and accessories if applicable, and locate dimensions from benchmarks to be preserved after construction is complete;

.4 for fire protection systems, record actual locations of equipment, sprinkler heads, and valves, drains, and test locations, and deviations of pipe routing and sizing from that shown on the drawings;

.5 location of piping system air vents;

.6 location of concealed services terminated for future extension and work concealed within building in inaccessible locations.

.3 Before applying for a Certificate of Substantial Performance of the Work, update a clean copy of Contract Drawing set in accordance with marked up set of "as-built" white prints including deviations from original Contract Drawings, thus forming an "as-built" drawing set. Submit "as-built" site drawing prints to the Consultant for review. Make necessary revisions to drawings as per Consultant's comments, to satisfaction of the Consultant.

.4 Use final reviewed "as-built" drawing set to provide CAD files of drawings thus forming true "as-built" set of Contract Drawings. Identify set as "Project Record Copy". Load digital copies of final reviewed by the Consultant as-built drawings onto USB type flash drive. Provide 2 complete sets of "as-built" drawings on separate USBs. Submit "as-built" sets of white prints and USBs to Consultant.

.5 Submitted drawings are to be of same quality as original Contract Drawings. CAD drawing files are to be compatible with AutoCAD software release version confirmed with the Consultant.

.6 Unless otherwise noted in Division 00 or Division 01, failure to maintain accurate record drawings will incur additional 5% holdback on progress claims until drawings are brought up to date to satisfaction of Owner and reviewed with the Consultant.

.7 For projects with phased turnover of project (refer to Division 01), review with the Consultant completeness of as-built drawings prior to turn over of an area. Interim as-built drawings to be made available to Owner's maintenance personnel.

.8 Where part of the Mechanical Scope of Work, retain and pay for services of a land surveyor registered in Place of the Work to measure, verify, and record size, location, invert elevation and pitch of buried piping services, and, when complete, transfer survey work to as-built drawings.

1.27 OPERATING AND MAINTENANCE DATA

.1 For each item of equipment for which a shop drawing is required (except for simple equipment), supply indexed copies of equipment manufacturers' operating and maintenance (O&M) instruction data manuals. Consolidate each copy of data as a PDF file on a USB drive. Consolidated O&M manual PDF to include:

.1 front cover: project name; wording – "Mechanical Systems Operating and Maintenance Manual"; and date;

.2 introduction sheet listing Consultant, Contractor, and Subcontractor names, street addresses, telephone and fax numbers, and e-mail addresses;

.3 equipment manufacturer's authorized contact person name, telephone number and company website;

.4 Table of Contents sheet, and corresponding index tab sheets;

.5 copy of each "REVIEWED" or clean, updated "REVIEWED AS NOTED" shop drawing or product data sheet, with manufacturer's/supplier's name, telephone and fax numbers, email address, company website address, and email address for local source of parts and service; when shop drawings are returned marked "Reviewed As Noted" with revisions marked on shop drawing copies, they are to be revised by equipment supplier

to incorporate comments marked on "Reviewed" shop drawings and a clean updated copy is to be included in operating and maintenance manuals;

.6 Operating data is to include:

.1 pressure test reports, and certificates issued by governing authorities;

.2 description of each system and its controls;

.3 control schematics for equipment/systems including building environmental controls;

.4 wiring and connection diagrams;

.5 if applicable, BAS architecture and all required operating data;

.6 description of operation of each system at various loads together with reset schedules and seasonal variances;

.7 operation instruction for each system and each component;

.8 description of actions to be taken in event of emergencies and/or equipment failure;

.9 valve tag schedule, and flow diagrams to indicate valve locations.

.7 Maintenance data is to include:

.1 operation and trouble-shooting instructions for each item of equipment and each system;

.2 schedules of tasks, frequency, tools required, and estimated task time;

.3 recommended maintenance practices and precautions;

.4 complete parts lists with numbers.

.8 Performance data is to include:

.1 equipment and system start-up data sheets;

.2 equipment performance verification test results, and final commissioning report;

.3 final testing, adjusting and balancing reports.

.9 copies of warranties;

.10 items requested specifically in Section Articles.

.2 Operating and maintenance instructions are to relate to job specific equipment supplied under this project and related to Owner’s building. Language used in manuals is to contain simple practical operating terms and language easy for in-house maintenance staff to understand how to operate and maintain each system.

.3 Before applying for a Certificate of Substantial Performance of the Work, assemble one copy of O&M Manual and submit to the Consultant for review prior to assembling remaining copies. Incorporate Consultant's comments into final submission.

1.28 COMMISSIONING

.1 After successful start-up and prior to Substantial Performance of the Work, commission the mechanical work. Commissioning work is the process of Contractor demonstrating to Owner and Consultant, for purpose of final acceptance, by means of successful and documented functional performance testing, that systems and/or subsystems are capable of being operated and maintained to perform in accordance with requirements of Contract Documents, as further described below.

.1 Retain services of a testing, adjusting, and balancing agency to perform testing and balancing of mechanical system air/fluid flows and capacities, prior to operational performance testing. Refer to Section 20 05 93 – Testing, Adjusting, and Balancing for Mechanical Systems.

.2 Test, adjust and operate equipment and systems after start-up but before functional performance testing, to confirm operations are in accordance with requirements of Contract Documents. Verify modes and sequences of control and monitoring, interlocks, and responses to emergency conditions. Complete commissioning data sheets to document successful operational performance testing.

.3 Repeat successful operational performance testing with completed commissioning data sheet documentation in the presence of Consultant and Owner to validate and verify equipment and systems are complete in all respects, function correctly, and are ready for acceptance.

.4 Submit final commissioning data sheets, TAB reports as specified in Section 20 05 93 – Testing, Adjusting, and Balancing for Mechanical Systems, project closeout documents, and other required submittals.

1.29 WARRANTY

.1 Unless otherwise specified in Division 00 and Division 01, warrant mechanical work to be in accordance with Contract Documents and free from defects for a period of 1 year from date of issue of a Certificate of Substantial Performance of the Work.

.2 Where equipment includes extended warranty period, e.g., 5 years, first year of warranty period is to be governed by terms and conditions of warranty in Contract Documents, and remaining years of warranty are to be direct from equipment manufacturer and/or supplier to Owner. Submit signed and dated copies of extended warranties to the Consultant.

.3 Warranty to include parts, labour, travel costs and living expenses incurred by manufacturer's authorized technician to provide factory authorized on-site service.

.4 Repair and/or replace any defects that appear in Work within warranty period without additional expense to Owner. Be responsible for costs incurred in making defective work good, including repair or replacement of building finishes, other materials, and damage to other equipment. Ordinary wear and tear and damage caused wilfully or due to carelessness of Owner's staff or agents is exempted.

.5 Do not include Owner deductible amounts in warranties.

.6 It is understood that warranties are to commence from time of Substantial Performance of the Work, regardless of what is noted within following Sections of Specification. Be responsible for providing whatever "bridging" or additional extended warranty period is required from time that material is purchased until this time.

.7 Visit building during warranty period with Owner representatives. Owner to organize these visits. At these meetings, Owner representatives are to review performance of systems. If performance is satisfactory, then no further action needs to be taken. If unsatisfactory, then correct deficiencies, as directed by Owner representatives, to satisfaction of Owner's representatives. These site visits to occur:

.1 once during 1st month of building operation;

.2 once during 3rd month of building operation;

.3 once between 4th and 10th month in a season opposite to 1st and 3rd month visits.

1.30 CLOSEOUT SUBMITTALS

.1 Prior to application for Substantial Performance of the Work, submit required items and documentation specified, including following as applicable to the project:

.1 Operating and Maintenance Manuals;

.2 as-built record drawings and associated data;

.3 extended warranties for equipment as specified;

.4 operating test certificates, i.e. Sprinkler Test Certificate;

.5 final commissioning report and TAB report;

.6 identified keys for equipment and/or panels for which keys are required, and other items required to be submitted;

.7 other data or products specified.

1.31 INSTRUCTIONS TO OWNER

.1 Refer to equipment and system operational and maintenance training requirements specified in Division 01.

.2 Train Owner's designated personnel in aspects of operation and maintenance of equipment and systems as specified. Demonstrations and training are to be performed by qualified technicians employed by equipment/system manufacturer/supplier. Supply hard copies of training materials to each attendee.

.3 Unless where specified otherwise in trade Sections, minimum requirements are for manufacturer/suppliers of each system and major equipment, to provide minimum two separate sessions each consisting of minimum 4 hours on site or in factory training (at Owner's choice), of Owner's designated personnel (for up to 6 people each session), on operation and maintenance procedures of system.

.4 For each item of equipment and for each system for which training is specified, prepare training modules as specified below. Use Operating and Maintenance Manuals during training sessions. Training modules include but are not limited to:

.1 Operational Requirements and Criteria – equipment function, stopping and starting, safeties, operating standards, operating characteristics, performance curves, and limitations;

.2 Troubleshooting – diagnostic instructions, test and inspection procedures;

.3 Documentation – equipment/system warranties, and manufacturer's/supplier's parts and service facilities, telephone numbers, email addresses, and the like;

.4 Maintenance – inspection instructions, types of cleaning agents to be used as well as cleaning methods, preventive maintenance procedures, and use of any special tools;

.5 Repairs – diagnostic instructions, disassembly, component removal and repair instructions, instructions for identifying parts and components, and review of any spare parts inventory.

.5 Before instructing Owner's designated personnel, submit to the Consultant for review preliminary copy of training manual and proposed schedule of demonstration and training dates and times. Incorporate Consultant's comments in final copy.

.6 Obtain in writing from the Consultant list of Owner's representatives to receive instructions. Submit to Consultant prior to application for Certificate of Substantial Performance of the Work, complete list of systems for which instructions were given, stating for each system:

.1 date instructions were given to Owner's staff;

.2 duration of instruction;

.3 names of persons instructed;

.4 other parties present (manufacturer's representative, consultants, etc.).

.7 Obtain signatures of Owner's staff to verify they properly understood system installation, operation, and maintenance requirements, and have received operating and maintenance instruction manuals and "as-built" record drawings.

.8 Submit to the Consultant copy of electronic version of training materials and include in operating and maintenance manuals submission.

1.32 FINAL INSPECTION

.1 Submit to Consultant, written request for final inspection of systems. Include written certification that:

.1 deficiencies noted during job inspections have been completed;

.2 field quality control procedures have been completed;

.3 systems have been tested and verified, balanced, and adjusted, and are ready for operation;

.4 maintenance and operating data have been completed and submitted to, reviewed with the Consultant and accepted by Owner;

.5 tags and nameplates are in place and equipment identifications have been completed;

.6 clean-up is complete;

.7 spare parts and replacement parts specified have been provided and acknowledged by the Consultant;

.8 as-built and record drawings have been completed and submitted to and reviewed with the Consultant and accepted by Owner;

.9 Owner's staff has been instructed in operation and maintenance of systems;

.10 commissioning procedures have been completed.

2 Products – Not Used

3 Execution

3.1 CLEANING

.1 During construction, keep site reasonably clear of rubbish and waste material resulting from work on a daily basis to the satisfaction of Owner and Consultant. Before applying for a Certificate of Substantial Performance of the Work, remove rubbish and debris, and be responsible for repair of any damage caused as a result of work.

.2 Clean equipment and devices installed as part of this project.

End of Section

1 General

1.1 SUBMITTALS

.1 Submit shop drawings/product data sheets for:

.1 electric motors (submit with equipment they are associated with).

.2 Submit a list of equipment identification nameplates indicating proposed wording and sizes.

2 Products

2.1 EQUIPMENT BELT DRIVES

.1 ANSI/RMA Standard V-belt type rated at minimum 1.5 times motor nameplate rating, and in accordance with following requirements:

.1 belts are to be reinforced cord and rubber, and multiple belts are to be matched sets;

.2 sheaves are to be cast iron or steel, secured to shafts with removable keys unless otherwise specified, standard adjustable pitch (± 10% range) for motors under 10 HP, fixed pitch type with split tapered bushing and keyway for motors 10 HP and larger, and, if required, replaced as part of mechanical work to suit system air/water quantity testing and balancing work;

.3 motor slide rail adjustment plates are to allow for centre line adjustment.

.2 Supply a spare belt set (tagged and identified) for each belt drive and hand to Owner upon Substantial Performance of the Work.

2.2 EQUIPMENT DRIVE GUARDS AND ACCESSORIES

.1 For V-belt drives – removable, 4-sided, fully enclosed, galvanized sheet steel guards to OHSA standards, cleaned, factory primed and painted with yellow equipment enamel, complete with a 2-piece full length hinged front panel to permit belt maintenance or replacement without removing guard, and 40 mm (1-½") diameter tachometer openings at each shaft location.

.2 For flexible couplings – removable "U" shaped galvanized steel guards to OHSA Standards with a 2.3 mm (3/32") thick frame and expanded mesh face.

.3 For unprotected fan inlets and outlets – unless otherwise specified, removable 20 mm (¾") galvanized steel wire mesh with galvanized steel frames, all to OHSA Standards.

2.3 ELECTRIC MOTORS

.1 Unless otherwise specified, motors are to conform to NEMA Standard MG1, applicable IEEE Standards, and applicable CSA C22.2 Standards, and are to meet NEMA standards for maximum sound level ratings under full load. Confirm motor voltages prior to ordering.

.2 Vertically mounted and submersible motors are to be purposely designed for mounting in this attitude.

.3 Efficiency of 1-phase motors to 1 HP is to be in accordance with CAN/CSA C747. Efficiency of 3-phase motors 1 HP and larger is to be in accordance with CAN/CSA C390 or IEEE 112B.

.4 Unless otherwise specified, 1-phase motors smaller than ½ HP are to be 115 volt, continuous duty capacitor start type with an NEMA 48 or 56 frame size, solid base, heavy-gauge steel shell with solid die-cast end shields, dynamically balanced die-cast rotor, integral automatic reset thermal overload protection, Class "B" insulation, and a 1.15 service factor at 40°C (105°F) ambient temperature.

.5 Explosion-proof 1-phase motors are to be totally enclosed, fan cooled, 115 volt continuous duty capacitor start type in accordance with CSA C22.2 No. 145, as specified for standard 1-phase motors but suitable for use in Class 1 Group D hazardous locations and complete with a rolled steel shell and a 1.0 service factor at 40°C (105°F) ambient temperature.

.6 Unless otherwise specified, motors ½ HP and larger are to be totally enclosed, fan cooled, 3-phase, T-frame, squirrel cage continuous duty induction motors suitable for voltages indicated on Drawings, NEMA Design "B" for normal starting torque or Design "C" for high starting torque as required by the application, each complete with Class "B" insulation, a 1.15 service factor at 40°C ambient temperature, grease lubricated open ball bearings with grease fittings to permit re-lubrication without dismantling motor, a cast iron frame with cast iron feet where required, cast iron end bracket and precision machined bearing fit, and balanced carbon steel shaft assembly with die-cast aluminum rotor windings.

.7 Explosion-proof 3-phase motors are to be totally enclosed fan cooled motors in accordance with CSA C22.2 No. 145, generally as specified above for standard 3-phase motors but suitable for use in Class 1 Group D hazardous locations and with a 1.0 service factor at 40°C (105°F) ambient temperature.

.8 Motor(s) for 2-speed cooling tower(s) are to be as specified above but 2-speed single winding type.

.9 Motor(s) for 2-speed fan(s) are to be as above but 2-speed double winding type.

.10 Unless otherwise indicated, motors 30 HP and larger are to be complete with a heat sensing PTC thermistor in the end turn of stator winding for each phase and connected in series inside motor with 2 marked leads brought out to motor conduit box.

.11 Motors for equipment with variable frequency drives are to be generally as specified above but inverter duty type to NEMA Standard MG-1 Part 31, quantified by CSA for operation from a variable frequency drive of type specified, and complete with Class "H" insulation. Motors are to be equipped with AEGIS, or approved equal, shaft grounding ring system to protect bearings from damage by diverting harmful shaft voltages and bearing currents to ground.

.12 Motors 150 HP and larger with "wye-delta" reduced voltage starters are to be complete with six leads for connection to motor starter.

.13 Motors for equipment which is scheduled or specified with a corrosion resistant coating or constructed from corrosion resistant materials are to be factory coated with a primer and epoxy paint finish.

.14 Manufacturers:

- .1 TECO-Westinghouse Motors (Canada) Inc.;
- .2 Canadian General Electric;
- .3 Baldor Electric Co.;
- .4 U.S. Electrical Motors;
- .5 Weg Electric Corp.;
- .6 Marathon Electric;
- .7 Toshiba Corp.;
- .8 Leeson Canada.

2.4 MOTOR STARTERS AND ACCESSORIES

.1 Motor starters must be capable of starting associated motors under the imposed loads. Confirm starter voltage matches motor prior to ordering.

.2 Unless otherwise specified, starters for 1-phase motors are to be 115 volt, thermal overload protected manual starting switches with a neon pilot light, a surface or recessed enclosure to suit the application, and, where automatic operation is required, a separate H-O-A switch in an enclosure to match starter enclosure.

.3 Unless otherwise specified, starters for 3-phase motors less than 50 HP are to be combination "quick-make" and "quick-break" fused disconnects and full voltage non-reversing across-the-line starters, each complete with and overload relay per phase, an enclosure to suit the application, and, a H-O-A switch, pilot lights, control transformer, auxiliary contacts, and other accessories as per motor starter schedule.

.4 Unless otherwise specified, starters for 3-phase motors 50 HP to 150 HP are to be reduced voltage, non-reversing, auto-transformer type starters complete with one overload relay per phase, an enclosure to suit the application, and, a H-O-A switch, pilot lights, control transformer, auxiliary contacts, and other accessories as per motor starter schedule.

.5 Unless otherwise specified, starters for 3-phase motors 150 HP and larger are to be reduced voltage, non-reversing, closed transition "wye-delta" starters complete with one overload relay per phase, an enclosure to suit the application, and, a H-O-A switch, pilot lights, control transformer, auxiliary contacts, and other accessories as per motor starter schedule.

.6 Starters for 2-speed double winding motors are to be generally as specified above but suitable for motor and equipped with a 45 second time delay to permit equipment to coast down to low speed before it is operated at low speed.

.7 Starters for 2-speed single winding motors are to be generally as specified above but suitable for motor and equipped with a 45 second time delay to permit equipment to coast down to low speed before it is operated at low speed.

.8 Starters for reversible motors for cooling towers are to be generally as specified above but suitable for motor and equipped with a 45 second time delay to allow fan(s) to coast down to a stop before being operated in reverse rotation.

.9 Unless otherwise specified, motor starter enclosures are to be in accordance with following NEMA ratings:

.1 enclosures located in sprinklered areas – Type 2;

.2 enclosures exposed to the elements – Type 3R, constructed of stainless steel;

.3 enclosures inside the building in wet areas – Type 3R, constructed of stainless steel;

.4 enclosures in explosion rated area – Type 7 with exact requirements to suit the area and application;

.5 enclosures except as noted above – Type 1;

.6 enclosures located in finished areas – as above but recess type with brushed stainless steel faceplate.

.10 Motor control centres are to be multi-unit, 2.28 m (9') high, NEMA Class 1, type "B", factory assembled, dead front, floor mounted, free-standing motor control centre with tin plated copper bus and an NEMA Type 1 or Type 2 enclosure as for loose starters specified above. Each motor

control centre is to be complete with starters as specified above, load and control wiring terminal boards, and required facilities for line and load side power wiring connections.

.11 Disconnect switches for motor control centres are to be heavy-duty, CSA certified, front operated switches as per motor starter schedule, each complete with a handle suitable for padlocking in "off" position and arranged so that door cannot be opened with handle in "on" position and an NEMA enclosure as specified for loose starters. Fusible units are to be complete with fuse clips to suit fuse types specified below.

.12 Fuses are to be, unless otherwise scheduled or specified, English Electric Ltd. HRC fuses, Form I Class "J" for constant running equipment and Form II Class "C" for equipment that cycles on and off.

.13 Manufacturers:

.1 Rockwell Automation Inc. - Allen-Bradley;

.2 Eaton Corp. – Cutler-Hammer;

.3 Eaton Corp. – Moeller Electric;

.4 Siemens Canada;

.5 Schneider Electric.

2.5 SPRINKLER PROOFING

.1 Provide drip shields for protection of surface mounted equipment enclosures from water spray and dripping of liquids. Features of shields include:

.1 factory constructed by respective equipment manufacturers;

.2 constructed from non-combustible materials (sheet steel);

.3 enamel painted to match equipment;

.4 surfaces and edges filled/sanded smooth prior to painting;

.5 supported from equipment with structural steel rods/metal framing or other method approved by Consultant;

.6 structural support finish painted to match shield.

.2 Include with equipment shop drawings, detailed dimensions of drip shields and methods of supporting.

.3 Equipment with top cable/conduit entries to include additional sealing of entries with gasketting and/or waterproof sealant to prevent water from entering enclosure.

.4 Design ventilation louvers such that live components are not exposed to water spray and dripping liquids.

.5 Above requirements are additional minimum "sprinkler proof" standards for equipment specified as NEMA 1, 2 or 12.

.6 Obtain CSA approval where required by local governing authorities.

3 Execution

3.1 INSTALLATION OF EQUIPMENT DRIVE GUARDS AND ACCESSORIES

.1 Provide OHSA guards for exposed accessible rotating parts such as belt drives, couplings, fan wheels, and shaft ends on mechanical equipment.

.2 Install belt guards to allow movement of motors for adjusting belt tension.

.3 Provide a means to permit lubrication and use of test instruments with guards in place.

.4 Secure guards to equipment or equipment base but do not bridge sound or vibration isolation.

.5 Where equipment oil level gauges, oil reservoirs, grease cups, or grease gun fittings are integral with equipment but are not easily accessible for service, extend to an accessible location using aluminium or copper tubing.

3.2 SUPPLY OF MOTOR STARTERS AND ACCESSORIES

.1 Unless otherwise shown or specified, supply a starter for each item of motorized equipment. Refer to Motor Starter Schedule.

.2 Where 3-phase starters are indicated in motor control centres, supply motor control centres with starters and bolt to a concrete housekeeping pad.

.3 Where package type equipment with integral starters, or equipment with starters integral in loose power and control panels supplied with equipment is fed from a motor control centre, provide a disconnect switch in motor control centre in lieu of a motor starter.

.4 Where 3-phase starters are indicated and/or scheduled to be mounted on a motor starter panel, starters will be mounted and connected, complete with panels and splitter trough, as part of electrical work. Hand starters to electrical trade at site when they are required.

.5 Where package type equipment with integral starters, or equipment with starters integral in loose power and control panels supplied with equipment is fed from a motor starter panel, a disconnect switch will be provided on motor starter panel as part of electrical work.

.6 Unless otherwise specified or shown on drawings, 1-phase motor starters will be mounted adjacent to equipment they serve and connected complete as part of electrical work. Hand starters to electrical trade at site at the proper time.

3.3 ELECTRICAL WIRING WORK FOR MECHANICAL WORK

.1 Unless otherwise specified or indicated, following electrical wiring work for mechanical equipment will be done as part of the electrical work:

.1 "line" side power wiring to motor starters or disconnect switches in motor control centres and starters or disconnects on motor starter panels, and "load" side wiring from starters or disconnects to equipment;

.2 "line" side power wiring to individual wall mounted starters, and "load" side wiring from starters to equipment;

.3 "line" side power wiring to pre-wired power and control panels and variable frequency drives (VFD), and "load" side power wiring from the panels and VFD's to equipment;

.4 provision of receptacles for plug-in equipment;

.5 provision of disconnect switches for motors in excess of 10 m (30') from starter location, or cannot be seen from starter location, and associated power wiring;

.6 motor starter interlocking in excess of 24 volts;

.7 wiring from motor winding thermistors in motors 30 HP and larger to motor starter contacts;

.8 120 volt power connections to electrical receptacles integral with small ceiling exhaust fans, including wiring through light switches or speed controllers;

.9 120 volt wiring connections to lighting fixture/switch combinations integral with air handling units;

.10 120 volt wiring connections to duplex receptacles integral with air handling unit control panels;

.11 120 volt wiring connections to BAS system controllers/panels and other control system or component requiring 120 volt power including, but not limited to, VAV boxes, dampers, low voltage transformers, etc.

.2 Mechanical wiring work not listed above or specified herein or on drawings to be done as part of electrical work is to be installed in conduit and is to be done as part of mechanical work in accordance with wiring requirements specified for electrical work.

End of Section

1 General

1.1 SUBMITTALS

.1 Shop Drawings/Product Data: Submit shop drawings with product data sheets for variable frequency drives (VFDs). Include:

.1 construction and performance details;

.2 wiring and control schematics;

.3 dimensions of units;

.4 calculations specific to installation showing total harmonic voltage distortion is less than 5%;

.5 certified production test results with serial numbers for harmonic mitigation performance and energy efficiency under actual variable frequency drive loading.

1.2 CLOSEOUT SUBMITTALS

.1 Certification Letter: Submit a start-up and installation certification letter from supplier of VFDs as specified in Part 3 of this Section;

.2 Parameters: Prepare list of parameters for uploading for Owner's future use as specified in Part 3 of this Section. Load on USB type flash drive and submit to the Consultant.

.3 Extended Warranty: Where extended warranty is specified to be included, include a copy of VFD extended warranty in each Operating and Maintenance Manual. Prior to Substantial Performance of Work, submit a copy of warranty to Owner.

.4 Additionally, coordinate with Prime Contractor and Electrical Contractor to ensure that shop drawings clearly identify that proposed VFDs and connected motors are 100% compatible and Mechanical Contractor to sign off on selected VFDs.

.5 Additionally, coordinate with Prime Contractor and Mechanical Contractor to ensure that shop drawings clearly identify that proposed VFDs and connected motors are 100% compatible and that Mechanical Contractor has signed off on selected VFDs.

1.3 COORDINATION WITH ELECTRICAL DIVISIONS

.1 This Section specifies VFD requirements for motors. Ensure that VFDs packaged with various system equipment, complies with specifications of this Section.

.2 VFDs are each to be approved by respective manufacturers of VFDs and connected motors, as suitable for installation on scheduled motors. VFD output current rating to match or exceed connected motor nameplate full load current rating.

.3 Coordinate and review with Electrical Divisions, responsibility requirements for supply of VFDs, harmonic filters and requirements for control and power conductors and connections.

.4 Check that motors are equipped with AEGIS or approved equal, shaft grounding ring system to protect bearings from damage in motors by diverting harmful shaft voltages and bearing currents to ground.

.5 Additionally, review and confirm responsibilities with Consultant and Prime Contractor.

1.4 COORDINATION WITH MECHANICAL DIVISIONS

.1 This Section specifies VFD requirements for Mechanical Division motors. Mechanical Divisions Contractor and trades to ensure that VFDs packaged with their equipment, complies with specifications of this Section.

.2 VFDs are each to be approved by respective manufacturers of VFDs and connected motors, as suitable for installation on scheduled motors. VFD output current rating to match or exceed connected motor nameplate full load current rating.

.3 Coordinate with Mechanical Divisions, responsibility requirements for supply of VFDs and harmonic filters. Do not supply VFDs that are pre-packaged with mechanical equipment and supplied as part of Work of Mechanical Divisions.

.4 Check that motors supplied by Mechanical Divisions and which are to be connected to VFDs, are equipped with AEGIS or approved equal, shaft grounding ring system to protect bearings from damage in motors by diverting harmful shaft voltages and bearing currents to ground. Identify in writing to Consultant any motors without such requirements.

.5 Additionally, confirm responsibilities with Consultant and Prime Contractor.

1.5 WARRANTY

.1 VFDs to be warranted free from defective labour and materials for period of 36 months from date of Substantial Performance of the Work. Include for initial one year Contract warranty and an additional 2 year extended warranty direct to Owner. Extended warranty terms and conditions are to be identical to one year Contract warranty, and extended warranty period is to commence day Contract warranty expires.

2 Products

2.1 VFD BASIC REQUIREMENTS

.1 VFDs supplied on project to be products of same manufacturer and be CSA approved, ULC listed and labelled. Base specified product is ABB ACH series units that include compliance with following standards:

.1 CSA C22.2 No.14 Industrial Control Equipment;

.2 UL 508 - Industrial Control Equipment;

.3 UL 508C – Power Conversion Equipment;

.4 NEMA ICS 7 - Adjustable-Speed Drives.

.2 Basis for limiting harmonics is to be provided generally to IEEE Standard 519 - Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems, except intended for user's electrical distribution system with point of common coupling (where harmonic limits are assessed) to be set at input terminals of harmonic mitigating equipment.

.3 Refer to Schedule of VFDs on drawings for features to include with respective VFDs.

.4 VFDs to include following basic requirements:

.1 regardless of HP rating are to be of same VFD model; I/O and control circuit boards as well as keypads are to be identical and interchangeable regardless of HP rating;

.2 to be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to set point without safety tripping or component damage (flying start);

.3 6-pulse width modulated (PWM) AC to AC converter utilizing latest isolated gate bipolar transistor (IGBT) technology; PWM switching pattern to include a motor flux optimization circuit that automatically reduces applied motor voltage to the motor to optimize energy consumption and audible motor noise;

.4 carrier frequency control circuit that reduces the carrier frequency based on actual VFD temperature that allows higher carrier frequency without derating VFD or operating at high carrier frequency only at low speeds;

.5 provisions that determine motor torque and flux every 25 microseconds (40,000 times per second);

.6 completely assembled and tested by manufacturer in their facility;

.7 designed to provide at least 250,000 hours mean time before failure (MTBF) when specified preventative maintenance is performed.

.8 bypass system completely factory wired and tested;

.9 door interlocked padlockable disconnect switch that disconnects all input power from drive and all internally mounted options;

.10 control panel keyboard and display with password protection against parameter changes.

2.2 VFD RATINGS

.1 VFDs to be rated to operate from 3 phase input voltage of 208 or 600 volts ± 10%, as scheduled, and frequency range from 48 to 63 Hz. In addition, a tolerated voltage window to allow system to operate from a line of +30% to -35% nominal voltage. System to incorporate circuitry that allows drive or bypass contactor to remain “sealed in” over this voltage tolerance at a minimum.

.2 VFDs to employ a full wave rectifier to prevent input line notching and operate at a minimum fundamental input power factor of 0.97 at all speeds and loads.

.3 VFDs efficiency to be 96% or better at full speed and load.

.4 Output voltage and current ratings to match adjustable frequency operating requirements of standard 3ph, 60Hz, NEMA design B inverter-duty motors in compliance with NEMA-MG1, Part 31 Standard. Overload current capacity for variable torque overload capacity to be 110% of rated current for 1 minute out of 10 minutes and 130% for 2 seconds. Output frequency to be adjustable between 0 and 500 Hz.

.5 Open loop static speed regulation to be 0.1% to 0.3% (10% of motor slip). Dynamic speed accuracy to be 4%-sec. or better open loop.

.6 When a suitable motor is used, drive provides breakaway torque equal to 200% of rated motor torque. Torque response time to be 5 ms or less.

.7 Enclosures:

.1 in climate controlled areas – minimum NEMA 12 with drip shield;

.2 in non-climate controlled areas – NEMA 3R.

2.3 HARMONIC FILTERS AND REACTORS

.1 VFDs to include internal 5% impedance AC line reactor (or equivalent 5% impedance dual positive and negative DC bus reactors) provided as a standard to reduce input current harmonic content and provide isolation from power line transients and to reduce RFI emissions.

.2 VFDs serving motors sized 11 kw (15 HP) or more to be provided with harmonic filters to limit harmonics distortion produced by each drive to following maximum levels as measured on input side of drive:

.1 Total harmonic distortion (voltage) – 5%;

.2 Total harmonic distortion (current) – 10%.

.3 Harmonic filter to be based on MIRUS International Inc. "LINEATOR AUHF" series, with features as follows:

.1 manufactured and tested in accordance with latest applicable standards of ULC, CSA and NEMA;

.2 treat characteristic low frequency harmonics generated by a 3-phase, diode bridge rectifier load (5th, 7th, 11th, 13th, etc.);

.3 passive inductor/capacitor network;

.4 low capacitive reactance (KVAR) of less than 20% of kVA rating, to ensure compatibility with engine generator sets;

.5 full load efficiency of harmonic mitigation equipment / VFD combination to be greater than 96%;

.6 copper wiring;

.7 220°C system insulation class and temperature rise of 130°C;

.8 anti-vibration pads between reactor or transformer core and enclosure;

.9 manufacturer's standard ventilated, NEMA-3R enclosure.

2.4 CONTROLS AND ADJUSTMENT FUNCTIONS

.1 Include for following:

.1 programmable critical frequency lockout ranges to prevent VFD from operating load continuously at an unstable speed;

.2 proportional integral derivative (PID) speed loop regulators with an auto tune function as well as manual adjustments; PID set point controllers to allow pressure or flow signals to be connected to VFD, using microprocessor in VFD for closed loop control; includes 250 ma of 24 VDC auxiliary power and capability of loop powering a transmitter supplied by others; two parameter sets for first PID that allow sets to be switched via a digital input, serial communications or from keypad for night setback, summer/winter set points, etc; independent, second PID loop that can utilize second analogue input and modulate analogue outputs to maintain set point of an independent process (ie. valves, dampers, etc.); set points, process variables, etc. to be accessible from serial communication network;

.3 programmable analogue inputs that accept current or voltage signals.

.4 programmable analogue outputs (0-20ma or 4-20 ma), that may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, and other data;

.5 programmable digital inputs;

.6 programmable digital Form-C relay contact outputs for programmable on and off delay times and adjustable hysteresis; rated for maximum switching current 8 amps at 24 VDC

and 0.4 A at 250 VAC; maximum voltage 300 VDC and 250 VAC; continuous current rating 2 amps RMS;

.7 run permissive circuit - for damper or valve control; dry contact closure that will signal damper to open (VFD motor does not operate); when damper is fully open, a normally open dry contact (end-switch) closes; closed end-switch is wired to a VFD digital input and allows motor operation; two separate safety interlock inputs, when either is opened, motor to coast to stop, and damper to close;

.8 two independently adjustable accel and decel ramps with 1 – 1800 seconds adjustable time ramps;

.9 fireman's override input - upon receipt of a contact closure from fireman's control station, VFD operates in one of two modes: operate at a programmed predetermined fixed speed or operate in a specific fireman's override PID algorithm that automatically adjusts motor speed based on override set point and feedback; mode overrides all other inputs (analogue/digital, serial communication and keypad commands), except customer defined safety run interlock, and forces motor to run in one of the two modes; "Override Mode" to be displayed on control panel; upon removal of override signal, VFD resumes normal operation.

.2 Operator Control Panel:

.1 front mounted plug-in operator control panel consisting of keypad, multi-line backlit LCD display for programming and fault diagnostics;

.2 keys (switches) for HAND, OFF, AUTO, and manual speed control INCREASE/DECREASE;

.3 menu navigation and parameter selection keys for custom programming;

.4 date and time clock - clock to have a battery backup with 10 years minimum life span; clock to be used to date and time stamp faults and record operating parameters at time of fault; if battery fails VFD l automatically reverts to hours of operation since initial power up; clock also to be programmable to control start/stop functions, constant speeds, PID parameter sets and output relays; VFD to have a digital input that allows an override to time clock (when in off mode) for a programmable time frame; four (4) separate, independent timer functions that have both weekday and weekend settings;

.5 parameter names, fault messages, warnings and other information to be displayed in complete words or standard abbreviations to allow user to understand what is being displayed without use of a manual or cross reference table, as follows:

.1 "HAND" position to start drive and modify reference frequency by use of INCREASE/DECREASE keys;

.2 "OFF" position stops drive;

.3 "AUTO" position allows drive to be started or stopped using whichever remote start/stop command configured; drive speed controlled by external speed reference input or by PID controller.

.4 applicable operating values to be capable of being displayed in engineering (user) units; operating displayed include:

.1 Output Frequency;

.2 Motor Speed (RPM, %, or Engineering units);

.3 Motor Current;

.4 Drive Temperature;

.5 DC Bus Voltage;

.6 Output Voltage.

2.5 PROTECTIVE FUNCTIONS

.1 For each programmed warning and fault protection function, keypad displays a message in complete words or standard abbreviations.

.2 VFDs include metal oxide varistors (MOV's) for phase to phase and phase to ground line voltage transient protection.

.3 Short circuit current rating of 100,000 amps to be provided per UL 508C without relying on line fuses.

.4 Ground fault protection, motor phase loss protection and phase unbalance protection to be provided. Single phase protection to be provided on input and output.

.5 VFDs to provide electronic motor overload protection qualified per UL 508C.

.6 Protection to be provided for AC line or DC bus overvoltage at 130% of maximum rated or undervoltage at 65% of minimum rated.

.7 Stall protection to be programmable to provide a warning or stop VFD after motor has operated above a programmable torque level for a programmed time limit.

.8 Underload protection to be programmable to provide a warning or stop VFD after motor has operated below a selected underload curve for a programmed time limit.

.9 Overtemperature protection to provide a warning if power module temperature is less than 5C° (9F°) below overtemperature trip level.

.10 Input terminal to be provided for connecting a motor thermistor (PTC type) to drive's protective monitoring circuitry. An input to also be programmable to monitor an external relay or switch contact.

.11 VFDs through 56 kW (75HP) to be protected from damage from input and output power miss-wiring. VFD to sense this condition and display an alarm on control panel.

.12 EMI / RFI filters to be provided as per standard EN 61800-3.

.13 dv/dt long lead filter (LRC) to protect power system network.

.14 Automatic reset feature to automatically reset selected faults and attempt to restart drive based on control parameters such as adjustable time delays, number of restart attempts and duration of restart attempts. Faults include following:

.1 Overcurrent;

.2 Overvoltage;

.3 Undervoltage;

.4 Analogue input signal reference loss;

.5 External fault.

.15 Additional built-in protection circuits include:

.1 Overcurrent trip limit;

.2 Undervoltage trip limit;

.3 Microprocessor fault;

.4 Keypad control panel loss;

.5 Serial communication loss;

.6 External fault interlock inputs;

.7 Adjustable output frequency and motor speed limits;

.8 Pass code parameter change protection;

.9 Keypad operator control lockout.

2.6 ELECTRONIC BYPASS

.1 Electronic bypass system to be a fully operational horsepower rated manual and automatic system for full speed operation without VFD, with following components and features:

.1 factory wired and tested microprocessor controlled bypass system consisting of an output contactor and bypass contactor, service (isolation) switch and VFD input fuses; (bypass designs, which have no VFD only fuses, or that incorporate fuses common to both VFD and bypass will not be accepted);

.2 bypass enclosure door and VFD enclosure to be interlocked such that input power is turned off before either enclosure can be opened;

.3 door interlocked padlockable disconnect switch that disconnects all input power from drive and all internally mounted devices;

.4 following operators:

.1 bypass Hand-Off-Auto;

.2 drive mode selector and light;

.3 bypass mode selector and light;

.4 bypass fault reset;

.5 bypass LCD display, 2 lines for programming and status / fault / warning indications.

.5 motor protection from single phase power conditions; bypass system to detect a single phase input power condition while running in bypass, disengage motor in a controlled fashion, and give a single phase input power indication;

.6 bypass system does not depend on VFD for bypass operation; bypass to be completely functional in both Hand and Automatic modes even if VFD is removed from enclosure for repair / replacement;

.7 run permissive circuit - for damper or valve control; dry contact closure that will signal damper to open (VFD motor does not operate); when damper is fully open, a normally open dry contact (end-switch) closes; closed end-switch is wired to a VFD digital input and allows motor operation; two separate safety interlock inputs, when either is opened, motor to coast to stop, and damper to close;

.8 bypass control to monitor status of VFD and bypass contactors and indicate when there is a welded contactor contact or open contactor coil; this failed contactor operation to be indicated on Bypass LCD display as well as over serial communications protocol;

.9 bypass control to include a programmable time delay for bypass start and control panel indication that this time delay is in process; this allows VAV boxes to be driven open before motor operates at full speed in bypass mode; time delay to be field programmable from 0 - 120 seconds;

.10 bypass control to be programmable for manual or automatic transfer to bypass; user to be able to select via control panel programming which drive faults will generate an automatic transfer to bypass and which faults require a manual transfer to bypass;

.11 adjustable motor current sensing circuit for bypass and VFD mode to provide proof of flow indication; condition is indicated on control panel display, transmitted over building automation protocol and on a relay output contact closure;

.12 programmable digital inputs, and programmable Form-C relay outputs;

.13 relay outputs from bypass to be programmable for any of following indications:

.1 system started;

.2 system running;

.3 bypass override enabled;

.4 drive fault;

.5 bypass fault;

.6 bypass H-O-A position;

.7 motor proof of flow (broken belt);

.8 overload;

.9 bypass selected;

.10 bypass run;

.11 system started (damper opening);

.12 bypass alarm;

.13 over temperature.

.14 digital inputs for system accept 24VAC or 24VDC; bypass incorporates internally sourced power supply and does not require an external control power source; bypass power board to supply 250 ma of 24 VDC for use by others to power external devices;

.15 interlock terminal strip: provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command; external safety interlocks to remain fully functional whether system is in VFD or bypass mode; remote start/stop contact to operate in VFD and bypass modes; terminal strip allows for independent connection of up to four (4) unique safety inputs;

.16 User is able to select text to be displayed on keypad when safety opens; example text display indications include "Firestat", "Freezestat", "Over pressure" and "Low pressure"; user is able to determine which of four (4) safety contacts is open over serial communications connection;

.17 Class 10, 20, or 30 (selectable) electronic motor overload protection is included as required for specific applications.

2.7 MANUAL BYPASS

.1 Bypass system to be a fully operational horsepower rated manual system for full speed operation without VFD, with following components:

.1 VFD and By-pass output contactors, mechanically and electrically interlocked to allow only one mode of operation at one time;

.2 service switch or contactor to isolate VFD from supply;

.3 VFD input fuses;

.4 door mounted VFD/OFF/BY-PASS selector switch;

.5 VFD ON and BY-PASS ON indicator lights;

.6 door mounted HAND/OFF/AUTO switch if Hand operation is unavailable at VFD control panel;

.7 terminals for external customer safety interlocks.

.2 Bypass designs, which have no VFD only fuses, or that incorporate fuses common to both VFD and bypass are not acceptable.

.3 Door interlocked padlockable fused disconnect switch that supplies power to VFD and bypass, and disconnects input power from drive, bypass and all internally mounted devices.

2.8 COMMUNICATIONS

.1 VFD to be complete with communications connections of integrated RS-485 port suitable to allow for VFD to be controlled, supervised, monitored and programmed from one remote control panel or PC with VFD system Windows based application software.

.2 Communications protocol to be industry standard compatible to BAS of building. Coordinate exact requirements with Mechanical Divisions controls contractor and BAS vendor to ensure that appropriate interface module is supplied for drive system to communicate with BAS being used in building with interface capability to include serial communication standard protocols as follows:

.1 ModBus;

.2 Johnson Controls Metasys N2;

.3 Siemens Building Technologies FLN;

.4 BACnet.

.3 Serial communication to be used for drive setup, diagnostic analysis, monitoring and control with capabilities to include, but not be limited to:

.1 run-stop control;

.2 speed set adjustment;

.3 proportional/integral/derivative PID control adjustments;

.4 current limit;

.5 accel/decel time adjustments;

.6 ability to lock and unlock control panel keypad;

.7 capability of allowing BAS to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature;

.8 monitoring relays output status, and digital input status and analogue output values;

.9 transmitting diagnostic warning and fault information over communications bus to BAS or other monitoring system;

.10 remote fault reset.

.4 Serial communication and Windows based software to be used for drive setup, diagnostic analysis, monitoring and control. Software to provide real time graphical displays of drive performance. VFD software communication capabilities include, but not be limited to:

.1 system ON/OFF;

.2 system status;

.3 Suitable input for speed control;

.4 run-stop control;

.5 ability to force unit to bypass;

.6 ability to lock and unlock control panel keypad;

.7 allowing BAS to monitor feedback such as, current (in amps), kilowatt hours (resettable), operating hours (resettable), and logic board temperature;

.8 monitoring relays output status, and all digital input status;

.9 transmitting diagnostic warning and fault information over communications bus to BAS or other monitoring system;

.10 remote fault reset;

.11 keypad "Hand" or "Auto" selected, and status indications and settings transmitted over serial communications bus;

.12 monitor if motor is running under load in both VFD and bypass (proof of flow) in VFD mode over serial communications or Form-C relay output;

.13 minimum of 40 field parameters to be capable of being monitored in bypass mode.

2.9 SITE SERVICES, TRAINING, AND MAINTENANCE MANUALS

.1 Provide onsite inspection, testing, start up and verification work of VFDs and filters by manufacturer’s authorized technician. Allow a minimum of 1/2 day per system. Also include for a second visit to site of one (1) day duration to train operating personnel in operation and maintenance of drives. Provide verification reports and supply soft copy of system programming parameters.

.2 Upon completion of installation, supplier of VFDs to supply minimum one hard copy of complete sets of service and maintenance manuals including wiring and connection diagrams. Include for digital copy loaded onto a USB type flash drive.

.3 Provide system training and instructions on operating and maintenance procedures. Refer to additional requirements in General Instructions section and Division 01.

.4 Include for manufacturer’s authorized technician to be in attendance to assist Commissioning Agent during commissioning process.

2.10 MANUFACTURERS

.1 Manufacturer List:

.1 ABB;

.2 Schneider Electric (Square D);

.3 Rockwell Automation;

.4 Eaton Cutler Hammer;

.5 Siemens Electric;

.6 Control Techniques.

3 Execution

3.1 INSTALLATION OF VARIABLE FREQUENCY DRIVES

.1 Provide variable frequency drives for motorized equipment in accordance with drawing requirements. Coordinate requirements for conductors and connections with Electrical Divisions Contractor.

.2 Ensure that variable speed drives supplied are products of same manufacturer.

.3 Unless otherwise noted on drawings or in Part 2 of this Section, include minimally, a manual bypass with each VFD. Supply electronic bypass with VFDs specifically noted and/or scheduled on drawings.

.4 Ensure wire length between VFD and motor is less than 15 m (50') with properly sized conductors.

.5 Install VFDs in accordance with manufacturer's instructions. Ensure that VFDs installation include upstream protection, either fuses or circuit breakers in accordance with VFD manufacturer's recommendations and local electrical code requirements. Advise Electrical Divisions Contractor of these requirements in addition to required conductors and connections. Provide required control wiring and connections.

.6 Review VFD and related connected motor installation. Provide local disconnect to VFD in accordance with local governing code requirements.

.7 Mount VFDs operating controls/display at approximately 1.5 m (5') above finished floor level, unless otherwise directed by Consultant. Provide dual back to back C-channel support system from floor to ceiling, complete with cross bracing to form a solid backing for VFD mounting at required locations.

.8 Properly support VFDs. Coordinate exact locations on site with Consultant.

.9 Where VFDs are required for custom made air handling units VFDs to be supplied, factory mounted on fan cabinets, and "load" side connected to fan motors by air handling unit manufacturer. "Line" side power wiring to these VFDs to be provided as part of Electrical Divisions work.

.10 Where VFDs are required for commercial fans, mount each VFD generally where shown but with exact location to ensure that VFD is accessible in accordance with local governing electrical code requirements. "Line" and "load" side power wiring to these VFD's to be provided as part of Electrical Divisions work.

.11 Where VFDs are required for pumps, mount each VFD generally where shown but with exact location to ensure that VFD is accessible in accordance with local governing electrical code requirements. "Line" and "load" side power wiring to these VFDs to be provided as part of Electrical Divisions work.

.12 Install harmonic mitigation filter equipment as follows:

.1 in accordance with manufacturer's recommended installation practices and to comply with applicable local governing codes;

.2 provide each VFD as specified in per Part 2, with a harmonic filter sized as per manufacturer's rating table to match rating of connected VFD;

.3 mount harmonic filters sized up to 110 kW (150 HP) typically to wall/ceiling construction using suitable brackets, metal C-channel framework and vibration isolators assemblies, ensuring full support of units acceptable to local governing authorities;

.4 mount harmonic filters sized greater than 110 kW (150 HP) typically to floor mounted concrete pads with suitable vibration isolators and seismic restraints in accordance with local governing building codes;

.5 ensure that adequate ventilation and space for access is provided;

.6 review exact locations with the Consultant prior to installation;

.7 coordinate with Electrical Division Contractor to ensure units are connected complete to line side supply feed and to VFD in accordance with VFD manufacturer's instructions for standalone VFDs and VFD system with bypass; include required control wiring and connections.

.13 Ground and bond equipment as per local governing electrical code requirements and manufacturer's instructions.

.14 Provide engraved lamacoid nameplate identifying each piece of equipment. Review exact nomenclature with the Consultant.

.15 Be responsible for ensuring that VFDs, harmonic filters and connected motors are properly installed, connected, tested in proper working order and operation verified.

3.2 INSTALLATION OF VARIABLE FREQUENCY DRIVES

.1 Provide VFDs for motorized mechanical equipment in accordance with drawing requirements and coordinated with mechanical equipment vendors and Mechanical Divisions Contractor.

.2 Ensure that VFDs supplied for project are products of same manufacturer.

.3 Unless otherwise noted on drawings or in Part 2 of this Section, include minimally, a manual bypass with each VFD. Supply electronic bypass with VFDs specifically noted and/or scheduled on drawings.

.4 Supply and install wiring and connections to VFDs and harmonic filters are to recommendations of VFD Manufacturer. Ensure wire length between VFD and motor is less than 15 m (50') with properly sized conductors. Obtain required wiring diagrams from equipment vendors. Provide required control wiring and connections.

.5 Install VFDs in accordance with manufacturer's instructions.

.6 Review VFD and related connected motor installation. Provide local disconnect (fusible switch or breaker) to VFD in accordance with local governing electrical code requirements and VFD manufacturer instructions. Confirm requirements with VFD vendor.

.7 Mount VFDs operating controls/display at approximately 1.5 m (5') above finished floor level, unless otherwise directed by the Consultant. Provide dual back to back C-channel support system from floor to ceiling, complete with cross bracing to form a solid backing for VFD mounting at required locations.

.8 Properly support VFDs. Coordinate exact locations on site with Mechanical Divisions Contractor and review with the Consultant.

.9 Coordinate installation and control of VFDs with Mechanical Division Contractor and Controls Contractor. Confirm communications protocol required for compatibility with BAS and ensure VFD system includes for proper protocol.

.10 Install harmonic mitigation filter equipment as follows:

.1 to be handled, stored and installed in accordance with manufacturer's recommended installation practices and to comply with applicable local governing codes;

.2 provide each VFD as specified in per Part 2, with a harmonic filter sized as per manufacturer's rating table to match rating of connected VFD;

.3 mount harmonic filters sized up to 110 kW (150 HP) typically to wall/ceiling construction using suitable brackets, metal C-channel framework and vibration isolators assemblies, ensuring full support of units acceptable to local governing authorities;

.4 mount harmonic filters sized greater than 110 kW (150 HP) typically to floor mounted concrete pads with suitable vibration isolators and seismic restraints in accordance with local governing building codes;

.5 ensure that adequate ventilation and space for access is provided;

.6 review exact locations with the Consultant prior to installation;

.7 provide required conductors and connections in accordance with filter manufacturer's instructions; obtain required wiring diagrams from equipment vendors;

.8 connect complete to line side supply feed and to VFD in accordance with VFD manufacturer's instructions for standalone VFDs and VFD system with bypass.

.11 Ground and bond equipment as per local governing code requirements and manufacturer's instructions. Refer also to requirements of grounding and bonding article.

.12 Provide engraved lamacoid nameplate identifying each piece of equipment. Review nomenclature with the Consultant.

.13 Be responsible for ensuring that VFDs, harmonic filters and connected motors are properly installed, connected, tested in proper working order and operation verified.

3.3 TESTING, START-UP, AND VERIFICATION

.1 When installation of VFDs are complete, arrange for VFD manufacturer/supplier to:

.1 supply factory authorized technician at site for minimum of 4 hours per system to examine installation and connection of each VFD, and to perform start-up and set-up procedures in conjunction with equipment start-up and testing procedures;

.2 supply factory authorized technician at site for minimum of one 8 hour day to train Owner's personnel on VFD operating and maintenance procedures;

.3 prepare and submit letter to certify that VFDs have been properly installed, tested and adjusted, and are in proper operating condition;

.4 submit list of start-up and testing parameters for uploading for future use by Owner.

.2 Start-up data entries to include motor nameplate power, speed, voltage, frequency and current.

.3 Inspect VFDs and accessories for verification of proper operation and installation.

.4 Inspect interface wiring to BAS for verification of proper operation and installation.

.5 Verification of wire terminations to VFDs and bypass and to operational circuitry.

.6 Installation verification of VFD, bypass and motor being driven for proper operation and reliability.

.7 Verification that connections and communications to BAS or other monitoring/remote control system are of proper operation and installation and of full communications compatibility.

.8 Measurement for verification of proper operation on each of following items:

.1 Motor voltage and frequency;

.2 Verification of proper motor operation;

.3 Control input for proper building automation system interface and control calibration.

.9 Calibration check for following set points (and adjustment as necessary):

.1 minimum speed;

.2 maximum speed;

.3 acceleration and deceleration rates.

.10 Verify harmonic compliance with onsite field measurements of both voltage and current harmonic distortion at point of common coupling-input terminals of harmonic mitigating equipment with and without equipment operating. Utilize recording type Fluke 41 or equivalent harmonics analyser displaying individual and total harmonic currents and voltages.

.11 Document testing and results in a report signed by a Professional Engineer licensed in the Place of Work and authorized by system manufacturer. Include for minimum 3 hard copies and electronic copy of report to be submitted to the Consultant for review.

.12 Additionally, refer to applicable installation, testing, coordination and verification requirements in Electrical Divisions Sections.

.13 Coordinate procedures specified above to be performed by VFD manufacturer/supplier authorized technician with system commissioning work.

End of Section

1 General

1.1 SUBMITTALS

.1 Submit shop drawings/product data sheets for:

.1 pressure gauges and thermometers;

2 Products

2.1 PRESSURE GAUGES AND THERMOMETERS

.1 Pressure gauges as follows:

.1 adjustable, glycerine filled, 100 mm or 115 mm (4" or 4-½") diameter and each accurate to within 1% of scale range;

.2 type 304 stainless steel case with relief valve and polished stainless steel bayonet;

.3 stainless steel rotary movement with stainless steel bushings and socket;

.4 clear acrylic window;

.5 dual scale white dial with a scale range such that working pressure of system is at approximate mid-point of scale;

.6 black pointer.

.2 Pressure gauge accessories and additional requirements as follows:

.1 a bronze ball type shut-off valve is to be provided in the piping to each pressure gauge;

.2 each pressure gauge for piping and equipment with normal everyday flow is to be equipped with a brass pressure snubber;

.3 each pressure gauge for steam piping or steam equipment is to be equipped with a steel coil syphon;

.4 pressure gauges in fire protection piping must be ULC listed and labelled;

.3 Thermometers as follows:

.1 round, 125 mm (5") diameter, adjustable (90°) angle bimetal dial type thermometers, each accurate to within 1% of full scale;

.2 hermetically sealed stainless steel case with stainless steel ring;

.3 dampened bimetal coil;

.4 calibration adjustment screw;

.5 white aluminum dual scale dial with black and blue markings and a range such that working temperature of system is approximate mid-point of the scale;

.6 black aluminum pointer;

.7 double strength glass window;

.8 12 mm (½") NPT connection with 6.4 mm (¼") diameter stainless steel stem;

.9 suitable thermowell.

.4 Manufacturers:

.1 H.O. Trerice Co.;

.2 Weiss Instruments;

.3 Ashcroft.

3 Execution

3.1 INSTALLATION

.1 Provide pressure gauges in following locations where applicable:

.1 in valved tubing across suction, suction strainer (if applicable), and discharge piping of each circulating pump;

.2 in supply and return piping connections to main mechanical plant equipment such as boilers, chillers, heat exchangers, main coils, etc.;

.3 in expansion tank(s);

.4 in separate domestic hot water storage tank(s);

.5 at top most outlet in each standpipe fire protection system riser;

.6 in piping at each side of a pressure reducing valve;

.7 in potable water service piping downstream of meter;

.8 wherever else shown and/or specified.

.2 Provide thermometers in following locations where applicable:

.1 in supply and return piping connections to main mechanical plant equipment such as boilers, chillers, cooling towers, heat exchangers, main coils, etc., unless temperature indication is supplied with equipment;

.2 wherever else shown and/or specified.

.3 Conform to following installation requirements where applicable:

.1 for installation of thermometers in piping wells, provide a coat of metallic base heat transfer paste or grease in piping well;

.2 for pressure gauges in piping at equipment locations, install pressure gauge between equipment and first pipe fitting;

.3 locate, mount and adjust instruments so they are easily readable;

.4 where pressure gauges and/or thermometers are located at high level or in an area where they cannot be easily seen, provide remote reading instruments.

End of Section

1 General

2 Products

2.1 PIPING HANGERS AND SUPPORTS

.1 Pipe hanger and support materials, including accessories, are to be, unless otherwise specified, in accordance with Manufacturers Standardization Society (MSS) Standard Practice Manual SP-58, Pipe hangers and Supports-Materials, Design and Manufacture, and where possible, MSS designations are indicated with each product specified below. Conform to following requirements:

.1 unless otherwise specified, ferrous hanger and support products are to be electro-galvanized;

.2 hangers and supports for insulated piping are to be sized to fit around insulation and insulation jacket.

.2 Hangers and supports for horizontal suspended piping as follows:

.1 adjustable steel clevis hanger – MSS Type 1;

.2 adjustable swivel ring band hanger – MSS Type 10;

.3 adjustable roller hanger – MSS Types 41, 43, and/or 45, with MSS Type 39 steel protection saddle.

.3 Supports for horizontal pipe on vertical surfaces as follows:

.1 steel offset pipe clamp – Anvil Fig. 103 or Myatt Fig. 170;

.2 heavy-duty steel pipe clip – MSS Type 26;

.3 single steel pipe hook – Myatt Fig. 156;

.4 epoxy coated steel pipe stays are not permitted.

.4 Floor supports for vertical risers as follows:

.1 copper tubing riser clamp – MSS Type 8;

.2 heavy-duty steel riser clamp – MSS Type 8.

.5 Supports for vertical piping on vertical surfaces as follows:

.1 steel offset pipe clamp – Anvil Fig. 103 or Myatt Fig. 170;

.2 heavy-duty steel pipe bracket or soil pipe bracket – MSS Type 26;

.3 extension split pipe clamp – MSS Type 12;

.4 epoxy coated steel pipe stays are not permitted.

.6 Base support for vertical risers in excess of 6 m (20') high extending out from base mounted equipment is to consist of a base elbow support with flange.

.7 For horizontal pipe on racks, Unistrut or equal galvanized steel pipe racks with pipe securing hardware as follows:

.1 standard galvanized steel U-bolts/clamps supplied by rack manufacturer;

.2 adjustable roller chair – MSS Type 44 with MSS Type 39 steel protection saddle.

.8 Special hangers and supports for various applications as follows:

.1 vibration isolated riser supports – black steel riser clamps as specified above, complete with neoprene–steel–neoprene sandwich type vibration isolation pads between clamp and floor;

.2 for groups of pipes having same slope – MSS Type 32 welded steel brackets, Anvil Fig. 46 universal trapeze assemblies, or Unistrut or equal support assemblies, all with U-bolts, clamps, etc., to secure pipes in place;

.3 for sections of piping connected to vibration isolated equipment – hangers and supports as specified above but complete with MSS Type 48 spring cushions;

.4 for piping on new roofs – Lexcor "Flash-Tite" or Thaler Roofing Specialties Products Inc. "MERS" Series insulated aluminum support risers with diameter, height, securement method and flashing to suit the application, channel type aluminum cross members, and galvanized steel pipe hangers and supports conforming to MSS SP-58, complete with all required accessories;

.5 for glass drain and vent piping – special padded hangers supplied by pipe supplier;

.6 for plastic piping – generally as specified above but in accordance with pipe manufacturer's recommendations;

.7 for fire protection piping – generally as above but ULC listed and/or FM approved, and in accordance with Chapter requirements of NFPA Standard applicable to piping system;

.8 for bare horizontal copper piping – generally as above but factory vinyl coated to prevent direct copper/steel contact;

.9 for bare copper vertical piping – corrosion resistant ferrous clamps with flexible rubber gasket type material (not tape) to isolate pipe from clamp;

.10 insulation protection shields to and including 40 mm (1-½") dia. – MSS Type 40 galvanized steel shields with ribs to keep shield centred on hanger.

.9 Hanger rods are to be electro-galvanized carbon steel (unless otherwise specified), round, threaded, to ASTM A36, complete with captive machine nuts with washers at hangers, sized to suit loading in accordance with Table 3 in MSS SP-58, but in any case, minimum 9.5 mm (3/8") diameter.

.10 Manufacturers:

.1 E. Myatt & Co. Inc.;

.2 Anvil International Inc.;

.3 Empire Industries Inc.;

.4 Hunt Manufacturing Ltd.;

.5 Unistrut Canada Ltd.;

.6 Nibco Inc. "Tolco";

.7 Taylor Pipe Supports.

3 Execution

3.1 INSTALLATION OF FASTENING AND SECURING HARDWARE

.1 Provide fastening and securing hardware required for mechanical work to maintain installations attached to structure or to finished floors, walls and ceilings in a secure and rigid manner capable

of withstanding dead loads, live loads, superimposed dead loads, and any vibration of installed products.

.2 Use fasteners compatible with structural requirements, finishes and types of products to be connected. Do not use materials subject to electrolytic action or corrosion where conditions are liable to cause such action.

.3 Where floor, wall or ceiling construction is not suitable to support loads, provide additional framing or special fasteners to ensure proper securement to structure that is to support the products. Provide reinforcing or connecting supports where required to distribute loading to structural components.

.4 Obtain written consent before using explosive actuated fastening devices. If consent is obtained, comply with requirements of CAN/CSA Z166.1 and CAN/CSA Z166.2.

.5 Do not attach fasteners to steel deck without written consent from Consultant.

3.2 INSTALLATION OF PIPE HANGERS AND SUPPORTS

.1 Provide required pipe hangers and supports.

.2 Provide any additional structural steel channels, angles, inserts, beam champs and similar accessories required for hanging or supporting pipe. Unless otherwise shown or specified, hang or support pipes from structure only.

.3 For insulated pipe, size hanger or support to suit diameter of insulated pipe and install hanger or support on outside of insulation and insulation finish.

.4 Support requirements for underground piping are as follows:

.1 support underground pipe, unless otherwise specified, on a well compacted bed of dry, natural, undisturbed earth free from rocks or protrusions of any kind, or on compacted material as specified;

.2 support underground service piping penetrating building exterior walls or foundations to prevent pipe damage if minor building settlement occurs;

.3 ensure bedding and supports for underground pipes are flat and true and allowances are made for pipe hubs, couplings, or other protrusions so no voids are left between pipe and bedding.

.5 Unless otherwise shown or specified, hang and/or support horizontal pipe above ground by means of hangers and/or supports specified in Part 2 of this Section. Unless otherwise shown or specified, hangers for suspended pipe less than or equal to 25 mm (1") dia. are to be clevis type or adjustable ring type, and hangers for suspended pipe greater than or equal to 40 mm (1-½") dia. are to be adjustable clevis type.

.6 Space hangers and supports in accordance with following:

.1 cast iron pipe – hang or support at every joint with maximum 2.4 m (8') spacing;

.2 plastic pipe – conform to pipe manufacturer’s recommended support spacing;

.3 glass pipe – conform to pipe manufacturer’s recommended support spacing and support requirements;

.4 copper and steel pipe – hang or support at spacing in accordance with following schedule:

Pipe dia.	Max. Spacing Steel (meters)	Max. Spacing Copper (meters)
to 25 mm (1")	2.4 m (8')	1.8 m (6')
40 mm (1-½")	2.7 m (9')	2.4 m (8')
50 mm (2")	3.0 m (10')	2.7 m (9')
65 mm (2-½")	3.6 m (12')	3.0 m (10')
75 mm (3")	3.6 m (12')	3.0 m (10')
90 mm (3-½")	3.6 m (12’)	3.6 m (12')
100 mm (4")	4.2 m (14')	3.6 m (12')
250 mm (10")	6.0 m (20')	
300 mm (12")	6.7 m (22')	

.5 flexible grooved pipe/coupling joint piping – as above but with not less than one hanger or support between joints;

.7 Where pipes change direction, either horizontally or vertically, provide a hanger or support on horizontal pipe not more than 300 mm (12") from elbow, and where pipes drop from tee branches, support tees in both directions not more than 50 mm (2") on each side of tee.

.8 When pipes with same slope are grouped and a common hanger or support is used, space hanger or support to suit spacing requirement of smallest pipe in group and secure pipes in place on common hanger or support.

.9 Provide roller hangers or supports for heat transfer piping greater than or equal to 150 mm (6") diameter and conveying a material 75°C (170°F) or greater to facilitate pipe movement due to expansion and contraction, and at each hanger or support tack weld a steel protection saddle to pipe to protect piping insulation.

.10 Unless otherwise shown or specified, support vertical piping by means of supports specified in Part 2 of this Section, spaced in accordance with following:

.1 support vertical pipes at maximum 3 m (10') intervals or at every floor, whichever is lesser;

.2 for sections of vertical piping with a length less than 3 m (10'), support pipe at least once;

.3 for vertical cast iron plain end pipe (mechanical joint type), secure riser or pipe clamp around pipe under a flange integral with pipe for vertical support purposes, or provide a length of hub and spigot pipe to facilitate proper support;

.4 for vertical steel pipe risers in excess of 3 m (10'), weld shear lugs to pipe to carry load;

.5 for vibration isolated piping risers, provide rubber-steel-rubber vibration isolation pads between riser clamps and floor.

.11 Support piping on the roof as follows:

.1 on new roof – supply manufactured roof supports as per Part 2 of this Section to accommodate piping involved and support spacing specified above, and hand supports to roofing trade on roof for installation as part of roofing work, then secure piping in place on supports.

.12 Each hanger, support or securement for horizontal bare copper tubing is to be plastic coated to prevent direct contact between pipe and ferrous hanger. Each wall or floor clamp for vertical bare copper piping is to be isolated from pipe by means of strips of flexible rubber inserts. Use of painted ferrous hangers and supports, including those painted with copper coloured paint, is not acceptable. Site application of tape or other types of isolation is not acceptable.

.13 For insulated horizontal piping less than or equal to 40 mm (1-½") diameter, provide galvanized steel insulation protection shields between insulation and hanger or support. Install shields immediately after pipe is insulated.

.14 Do not support piping from steel deck without written consent from Consultant.

3.3 EQUIPMENT BASES AND SUPPORTS

.1 Unless otherwise specified or required, set floor mounted equipment on minimum 100 mm (4") high reinforced concrete housekeeping pads 200 mm (8") clear of equipment on each side and end, or a minimum of 200 mm (8") from centreline of equipment anchor bolts to edge of the base, whichever is larger. Conform to following requirements:

.1 supply dimensioned drawings and equipment base templates, and provide anchor bolts for proper setting and securing of equipment on pads;

.2 place anchor bolts during concrete pour and be responsible for required levelling, alignment, and grouting of equipment;

.3 as a minimum, use wire mesh reinforcement, however, for pads for large heavy equipment, use reinforcement as per structural drawing details.

.2 For equipment not designed for base mounting, where required, provide welded, cleaned and prime coat painted structural steel stands or supports conforming to following requirements:

.1 provide stands and supports, except those for small equipment, designed by a structural engineer registered in jurisdiction of the work, and submit stamped and signed design drawings with calculations as shop drawings for review;

.2 flange bolt steel stands to concrete housekeeping pads;

.3 seismically restrained stands and supports in accordance with applicable requirements.

.3 Where indicated on mechanical drawings, provide welded, cleaned and prime coat painted structural steel platforms, designed by a structural engineer registered in the jurisdiction of the work, for service access to equipment. Submit stamped and signed design drawings with calculations as shop drawings for review. Conform to following requirements:

.1 platforms in accordance with OHSA requirements and adequately sized, braced, anchored, and, as required, seismically restrained;

.2 flooring equal to Fisher & Ludlow "Tru-Weld" Type 19-4, Borden type W/B (19-W-4), welded steel bar type grating;

.3 support legs constructed of welded Schedule 40 black steel pipe with welded steel cross-bracing, securely anchored and sway braced;

.4 safety guard rails, constructed from minimum 32 mm (1-¼") dia. Schedule 40 black steel pipe, for all platforms and complete with vertical stanchions at maximum 1.2 m (48") centres, top and intermediate horizontal railing, and toe plates at floor;

.5 vertical ladders constructed of Schedule 40 black steel pipe, 25 mm (1") dia. for equal height rungs, 40 mm (1-½") for stringers, anchored to floors and walls and sway braced as required;

.6 ships ladders, used wherever space conditions permit, of welded steel construction, climbing at an approximate 60º angle, and complete with channel iron stringers, open grate equal height risers approximately 165 mm (6-½") wide and factory made by grating manufacturer, handrails, and suitable anchoring and support.

End of Section

1 General

1.1 SECTION INCLUDES

.1 This Section specifies vibration isolation product requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

1.2 SUBMITTALS

.1 Submit copies of manufacturer's product data sheets for products specified in this Section. Product data sheets are to include product characteristics, limitations, dimensions, finishes, and installation recommendations.

1.3 CLOSEOUT SUBMITTALS

.1 Submit a letter from vibration isolation manufacturer to certify correct installation of products, as specified in Part 3 of this Section.

2 Products

2.1 GENERAL

.1 Vibration isolation products are to be in accordance with the most recent edition of the ASHRAE Handbook and/or as indicated on drawings, schedules, details, and as specified below.

.2 Springs are to be stable, colour coded, selected to operate at no greater than ⅔ solid load, designed in accordance with Society of Automotive Engineers Handbook Supplement 9 entitled Manual on Design and Application of Helical and Spiral Springs, and with spring diameters in accordance with manufacturer's recommendations to suit static deflection and maximum equipment load.

.3 Steel components of isolation products not exposed to the weather or moisture are to be zinc plated. Steel components of isolation products exposed to the weather or in a damp, moist environment are to be factory painted with rust inhibiting primer and 2 coats of neoprene.

.4 Where weight of isolated equipment may change significantly due to draining or filling with a liquid, vibration isolators are to be equipped with limit stops to limit spring extensions.

.5 Flexible piping connections to vibration isolated equipment are specified in the appropriate piping sections of the Specification.

2.2 ISOLATION PADS

.1 Sandwich type pads, 20 mm (¾") nominal thickness, selected for 3.2 mm (1/8") static deflection unless otherwise specified, consisting of 2 waffle type or ribbed 50 durometer neoprene pads permanently bonded to a minimum #10 gauge steel plate, and complete with rubber bushed bolt holes and equipment anchor bolts with neoprene isolation grommets.

.2 Manufacturers:

.1 Vibro-Acoustics Ltd. Type NSN;

.2 The VMC Group Vibration Mounting & Controls Inc. (Korfund-Dynamics) "SHEAR-FLEX PLATES";

.3 Kinetics Noise Control Vibron Products Group Type NGS/NGD;

.4 Mason Industries Inc. Type SW/S/SW with HG Bolt Insertion Washers;

.5 J. P. America Inc. Type JSJ.

2.3 RUBBER FLOOR ISOLATORS

.1 Captive, bridge bearing quality neoprene mount selected for a minimum 4 mm (0.15") static deflection unless otherwise specified, with an integral ductile iron housing and integral equipment anchor bolt.

.2 Manufacturers:

.1 Vibro-Acoustics Ltd. Type R;

.2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type RSM;

.3 Kinetics Noise Control Vibron Products Group Type RQ;

.4 Mason Industries Inc. Type BR;

.5 J. P. America Inc. Type TRM.

2.4 SPRING FLOOR ISOLATORS

.1 Seismically rated captive spring mount isolator complete with levelling bolts, upper and lower neoprene spring cups, neoprene cushion, ductile iron housing, neoprene sound pads, and neoprene isolation grommets for securing bolts.

.2 Manufacturers:

.1 Vibro-Acoustics Ltd. Type SFS;

.2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type AMSR;

.3 Kinetics Noise Control Vibron Products Group Type FLSS;

.4 Mason Industries Inc. Type SSLFH;

.5 J. P. America Inc. Type TSO-C-SC.

2.5 OPEN SPRING MOUNTS

.1 Base mount free-standing assemblies, each complete with a stable colour coded steel spring welded in place, drilled mild steel mounting plate bonded to a ribbed rubber or neoprene acoustical pad, and an external 16 mm (5/8") diameter level adjustment bolt.

.2 Manufacturers:

.1 Vibro-Acoustics Ltd. Type FS;

.2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) "Spring-Flex" Type A;

.3 Kinetics Noise Control Vibron Products Group Type FDS;

.4 Mason Industries Inc. Type SLFH;

.5 J. P. America Inc. Type TSO.

2.6 CLOSED SPRING MOUNTS

.1 Base mount free-standing enclosed assemblies, each complete with stable colour coded spring(s), 2 piece cast housing, non-binding rubber horizontal stabilizers, a ribbed rubber or neoprene acoustical pad bonded to base of the closed housing, and an external level adjustment bolt.

.2 Manufacturers:

.1 Vibro-Acoustics Ltd. Type CM;

.2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) "Spring-Flex" Types B and C;

.3 Kinetics Noise Control Vibron Products Group Type FLS;

.4 Mason Industries Inc. Type C;

.5 J. P. America Inc. Type TSC.

2.7 TOTALLY RETAINED SPRING MOUNTS

.1 Base mount free-standing enclosed and retained assemblies to limit both vertical and lateral movement of mounted equipment, each complete with stable colour coded spring(s), drilled welded steel housing and top plate, ribbed rubber or neoprene acoustical pad bonded to bottom of housing, vertical limit adjusting hardware, and a level adjustment bolt.

.2 Manufacturers:

.1 Vibro-Acoustics Ltd. Type CSR;

.2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) "Spring-Flex" Type MS;

.3 Kinetics Noise Control Vibron Products Group Type SM;

.4 Mason Industries Inc. Type SLRSO;

.5 J. P. America Inc. Type TSR.

2.8 SPRING HANGERS

.1 Welded steel plate housing with top and bottom rod mounting holes and spring retainer, neoprene double deflection isolation element, stable colour coded spring, and heavy-duty rubber washers.

.2 Manufacturers:

.1 Vibro-Acoustics Ltd. Type SHR-SN;

.2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) "Spring-Flex" Series HRSA;

.3 Kinetics Noise Control Vibron Products Group. Type SRH;

.4 Mason Industries Inc. Type 30N;

.5 J. P. America Inc. Type TSH.

2.9 NEOPRENE HANGER ISOLATORS

.1 Neoprene double deflection rod isolators with steel housing and hanger rod bushing, selected for a minimum 4 mm (0.15") static deflection unless otherwise specified.

.2 Manufacturers:

.1 Vibro-Acoustics Ltd. Type NH;

.2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type HR;

.3 Kinetics Noise Control Vibron Products Group Type RH;

.4 Mason Industries Inc. Type HD or WHD;

.5 J. P. America Inc. Type TRH.

2.10 CONCRETE INERTIA TYPE EQUIPMENT BASE

.1 Welded steel bases, each complete with a structural black steel channel frame, concrete reinforcing rods, and brackets for spring mounts welded to frame.

.2 Manufacturers:

.1 Vibro-Acoustics Ltd. Type CIB;

.2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type CPF;

.3 Kinetics Noise Control Vibron Products Group. Type CIB;

.4 Mason Industries Inc. Type KSL;

.5 J. P. America Inc. Type BCI.

2.11 STEEL EQUIPMENT BASE

.1 Fully welded structural steel equipment and motor support bases, each complete with a wide flange steel frame, full depth cross members, brackets for spring mounts, and adjustable motor slide rails.

.2 Manufacturers:

.1 Vibro-Acoustics Ltd. Type SB;

.2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type WFB;

.3 Kinetics Noise Control Vibron Products Group Type SFB;

.4 Mason Industries Inc. Type WFSL;

.5 J. P. America Inc. Type BWS (with motor slide rail).

2.12 COMBINATION STEEL /CONCRETE INERTIA EQUIPMENT BASE

.1 Welded steel bases with a structural black steel channel frame, concrete reinforcing rods, bottom sheet steel pan, brackets for spring mounts welded to frame and adjustable motor slide rails.

.2 Manufacturers:

.1 Vibro-Acoustics Ltd. Type CIB (with motor slide rails);

.2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type WPF (with motor slide rails);

.3 Kinetics Noise Control Vibron Products Group Type CIB (with motor slide rails);

.4 Mason Industries Inc. Type BMK or K;

.5 J. P. America Inc. Type BSI (with motor slide rail).

2.13 SLUNG STEEL BASE

.1 Slung steel bases of structural members with gusset plates welded to ends and complete with adjustable motor slide rails and vertical section size to suit equipment's motor power output.

.2 Manufacturers:

.1 Vibro-Acoustics Ltd. Type SS;

.2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type CPF;

.3 Kinetics Noise Control Vibron Products Group Type CIB-H;

.4 Mason Industries Inc. Type MSL.

2.14 CONTINUOUS RAIL TYPE ISOLATION FOR ROOF MOUNTED EQUIPMENT

.1 Continuous rooftop isolation shipped completely assembled, consisting of:

.1 galvanized steel sections formed to fit roof curb and associated equipment with a flexible air and weather seal joining upper and lower rail sections;

.2 stable springs, cadmium plated and selected to provide minimum deflection with 50% additional travel to solid;

.3 neoprene cushioned and wind restraints allowing 6 mm (¼") movement before engaging and resisting wind loads in any lateral direction.

.2 Manufacturers:

.1 Vibro-Acoustics Ltd. Vibro-Acoustics Type RTR;

.2 The VMC Group Vibration Mounting and Controls (Korfund-Dynamics) Type RTIR;

.3 Kinetics Noise Control Vibron Products Group Type KSR;

.4 Mason Industries Inc. Type RSC;

.5 J. P. America Inc. Type BRC.

3 Execution

3.1 INSTALLATION OF VIBRATION ISOLATION MATERIALS

.1 Unless otherwise stated in the drawings, schedules and/or typical details, vibration isolation is to be provided for all mechanical equipment as per the recommendations contained within in the most recent edition of the ASHRAE Handbook.

.2 Supply to vibration isolation product manufacturer or supplier a copy of a "reviewed" shop drawing or product data sheet for each piece of equipment to be isolated and dimensioned pipe layouts of associated piping to be isolated.

.3 Unless otherwise specified, vibration isolation products are to be product of one manufacturer.

.4 Ensure vibration isolation manufacturer coordinates material selections with equipment provided in order to ensure adherence to performance criteria. Allow for expansion and contraction when material is selected and installed.

.5 Unless otherwise indicated, install isolation materials for base mounted equipment on concrete housekeeping pad bases which extend at least over the full base and isolated area of the isolated equipment. Additional requirements are as follows:

.1 block and shim bases level so ductwork and piping connections can be made to a rigid system at proper operating level, before isolated adjustment is made, and ensure there is no physical contact between isolated equipment and building structure;

.2 steel bases are to clear the sub-base by 25 mm (1");

.3 concrete bases are to clear the sub-base by 50 mm (2").

.6 Isolate piping larger than 25 mm (1") dia. directly connected to motorized and/or vibration isolated equipment with 25 mm (1") static deflection spring hangers at spacing intervals in accordance with following:

.1 for pipe less than or equal to 100 mm (4") dia. – first 3 points of support;

.2 for pipe 125 mm (5") to 200 mm (8") dia. – first 4 points of support;

.3 for pipe equal to or greater than 250 mm (10") dia. – first 6 points of support;

.7 First point of isolated piping support is to have a static deflection of twice the deflection of the isolated equipment but maximum 50 mm (2").

.8 Secure top of spring hanger frame rigidly to structure, and do not install spring hangers in concealed locations.

.9 Where it is impossible to use at least 2 spring hangers, provide Senior Flexonics Ltd. Style 102 (or 102-U as required) or equal, twin sphere, moulded rubber flexible connection assemblies, selected by manufacturer and suitable in all respects for intended application, and complete with required nipples and connections to provide proper vibration isolation.

.10 Isolate designated piping risers at floor support points in accordance with drawing detail and/or where indicated on drawings.

.11 Erect roof curb vibration isolation in accordance with instructions shipped with assembly. Match vibration isolation with associated roof top unit and orient isolation as identified by manufacturer to ensure proper loading and optimum performance. Caulk top of roof curb with 2 beads of caulking provided and centre isolation assembly onto roof curb and, unless otherwise noted, screw in place with 50 mm (2") lag screws at 900 mm (36") O.C. Position gasket on top rail or alternatively, caulk with 2 beads of caulking provided and orient and lower roof top unit onto isolation rails and, unless otherwise noted, screw unit into top rail with 25 mm (1") lag screws at 900 mm (36") O.C. After roof top unit is secured in place, but before damageable work is installed, spray each isolated equipment assembly with water and correct any water leaks.

.12 For control wiring connections to vibration isolated equipment ensure flexible metallic conduit with 90° bend is used for conduit 25 mm (1") dia. and smaller, and for conduit larger than 25 mm (1") dia., use Crouse Hinds EC couplings. Connections are to be long enough so that conduit will remain intact if equipment moves 300 mm (12") laterally from its installed position, and flexible enough to transmit less vibration to structure than is transmitted through vibration isolation. Coordinate these requirements with mechanical trades involved. If electrical power connections are not made in a similar manner as part of the electrical work, report this fact to the Consultant.

.13 Arrange and pay for vibration isolation product manufacturer to visit site to inspect installation of his equipment. Perform revision work required as a result of improper installation. When vibration isolation equipment manufacturer is satisfied with the installation, obtain and submit a letter stating manufacturer has inspected the installation and equipment is properly installed.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Nameplates.

.2 Tags.

.3 Pipe Markers.

1.2 REFERENCES

.1 ASME A13.1 – Scheme for the Identification of Piping Systems.

1.3 SUBMITTALS

.1 Section 01 30 00: Submittals.

.2 Submit list of wording, symbols, letter size, and colour coding for mechanical identification.

.3 Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

.4 Product Data: Provide manufacturers catalogue literature for each product required.

.5 Samples: Submit two labels, tags samples to Consultant for approval.

.6 Manufacturer's Installation Instructions: Indicate special procedures, and installation.

1.4 CLOSEOUT SUBMITTALS

.1 Section 01 77 00: Project Closeout.

.2 Record actual locations of tagged valves.

2 Products

2.1 MECHANICAL WORK IDENTIFICATION MATERIALS

.1 Confirm with the Owner if an existing mechanical work identification system is in place and, if so, match accordingly.

.2 If an existing mechanical work identification system is not in place, the following is to be used:

.1 Equipment nameplates are to be minimum 1.6 mm (1/16") thick 2-ply laminated coloured plastic plates, minimum 12 mm x 50 mm (½" x 2") for smaller items such as damper motors and control valves, minimum 25 mm x 65 mm (1" x 2-½") for equipment, and minimum 50 mm x 100 mm (2" x 4") for control panels and similar items. Additional requirements are as follows:

.1 unless otherwise specified or required, each nameplate is to be white, complete with bevelled edges and black engraved wording to completely identify equipment and its use with no abbreviations;

.2 wording is generally to be as per drawings, i.e. Fan EF-1, and is to include equipment service and building area/zone served, but must be reviewed prior to engraving;

.3 supply stainless steel screws for securing nameplates in place;

.4 nameplates for equipment suspended above floor level or generally not within easy viewing from floor level are to be increased in size so as to be easily readable from floor level.

.2 Valve tags are to be coloured, 40 mm (1-½") square, 2-ply laminated plastic with bevelled edges, red-white, green-white, yellow-black, etc., to match piping identification colour, each complete with a 3.2 mm (1/8") diameter by 100 mm (4") long brass plated steel bead chain, and four lines of engraved maximum size identification wording, i.e.:

VALVE V12 200 mm (8") CHILL. WATER NORMALLY OPEN

.3 Standard pipe identification is to be equal to Smillie McAdams Summerlin Ltd., Brady or Primark Manufacturing Inc. vinyl plastic with indoor/outdoor type vinyl ink lettering and directional arrows, as follows:

.1 for pipe less than or equal to 150 mm (6") diameter, coiled type snap-on markers of a length to wrap completely around pipe or pipe insulation;

.2 for pipe larger than 150 mm (6") diameter, saddle type strap-on markers with 2 opposite identification locations and complete with nylon cable ties.

.4 Identification wording and colours for pipe identification materials are to be as follows:

PIPE SERVICE	IDENTIFICATION COLOUR	LEGEND
domestic cold water	green	DOM. COLD WATER
domestic hot water supply	green	DOM. HW SUPPLY
domestic hot water recirculation	green	DOM. HW RECIRC.
tempered domestic water	green	TEMP. DOM. WATER
chilled drinking water	green	CH. DRINK WTR.
storm drainage	green	STORM
sanitary drainage	green	SAN.
plumbing vent	green	SAN. VENT
acid sanitary drainage	yellow	ACID DRAIN
acid drainage vent	yellow	ACID VENT
fire protection standpipe	red	F.P. STANDPIPE
fire protection sprinklers	red	F.P. SPRINKLER
natural gas	to Code	to Code, c/w pressure
natural gas vent	to Code	to Code
propane gas	to Code	to Code, c/w pressure
propane gas vent	to Code	to Code
fuel oil supply	yellow	FUEL OIL SUPPLY
fuel oil return	yellow	FUEL OIL RETURN

PIPE SERVICE	IDENTIFICATION COLOUR	LEGEND
fuel oil vent	yellow	FUEL OIL VENT
heating water supply	yellow	HTG. WTR. SUPPLY
heating water return	yellow	HTG. WTR. RETURN
heating water drain	yellow	HTG. WTR. DRAIN
glycol heating supply	yellow	GLY. HTG. SUPPLY
glycol heating return	yellow	GLY. HTG. RETURN
glycol heating drain	yellow	GLY. HTG. DRAIN
glycol heat reclaim return	yellow	GLY. HTG. RECLAIM R.
glycol heat reclaim supply	yellow	GLY. HTG. RECLAIM S.
heat pump geothermal loop – source side supply	green	GEO. LOOP SOURCE SUPPLY
heat pump geothermal loop – source side return	green	GEO. LOOP SOURCE RETURN
heat pump geothermal loop – load side supply	green	GEO. LOOP LOAD SUPPLY
Heat pump geothermal loop – load side return	green	GEO. LOOP LOAD RETURN
condenser water supply	green	COND. WTR. SUPPLY
condenser water return	green	COND. WTR. RETURN
chilled water supply	green	CH. WTR. SUPPLY
chilled water return	green	CH. WTR. RETURN
chilled water drain	green	CH. WTR. DRAIN
low pressure steam	yellow	….kPa STEAM
medium pressure steam	yellow	….kPa STEAM
high pressure steam	yellow	….kPa STEAM
low pressure condensate	yellow	L.P. CONDENSATE
medium pressure condensate	yellow	M.P. CONDENSATE
high pressure condensate	yellow	H.P. CONDENSATE
pumped condensate	yellow	PUMPED CONDENSATE
steam vent	yellow	STEAM VENT
boiler feedwater	yellow	BLR. FEEDWATER
boiler blowdown	yellow	BLR. BLOW-OFF

PIPE SERVICE	IDENTIFICATION COLOUR	LEGEND
refrigerant suction	yellow	REFRIG. SUCTION
refrigerant liquid	yellow	REFRIG. LIQUID
refrigerant hot gas	yellow	REFRIG. HOT GAS
diesel engine exhaust	yellow	ENGINE EXHAUST
gasoline	yellow	GASOLINE
distilled water	green	DISTILL. WATER
demineralized water	green	DEMIN. WATER
compressed air (< 700 kPa)	green	….kPa COMP. AIR
compressed air (>700 kPa)	yellow	….kPa COMP. AIR
control air	green	CONTROL AIR

.5 Colours for pipe identification legends and directional arrows are to be as follows:

IDENTIFICATION COLOUR	LEGEND & ARROW COLOUR
yellow	black
green	white
red	white

.6 Duct identification is to be custom made Mylar stencils with 50 mm (2") high lettering to accurately describe duct service, i.e. "AHU-1 SUPPLY", complete with a directional arrow, and coloured ink with ink pads and roller applicators. Ink colour is generally to be black but must contrast with lettering background.

3 Execution

3.1 PREPARATION

.1 Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

.1 Identify new exposed piping and ductwork as per Part 2 of this Section in locations as follows:

.1 at every end of every piping or duct run;

.2 adjacent to each valve, strainer, damper and similar accessory;

.3 at each piece of connecting equipment;

.4 on both sides of every pipe and duct passing through a floor, wall or partition, unless otherwise specified;

.5 at 6 m (20') intervals on pipe and duct runs exceeding 6 m (20') in length;

.6 at least once in each room, and at least once on pipe and duct runs less than 6 m (20') in length.

.2 Unless otherwise specified identify new concealed piping and ductwork as per Part 2 of this Section in locations as follows:

.1 at points where pipes or ducts enter and leave rooms, shafts, pipe chases, furred spaces, and similar areas;

.2 at maximum 6 m (20') intervals on piping and ductwork above suspended accessible ceilings, and at least once in each room;

.3 at each access door location;

.4 at each piece of connected equipment, automatic valve, etc.

.3 Provide an identification nameplate for equipment provided as part of this project, including items such as control valves, motorized dampers, instruments, and similar products. Secure nameplates in place, approximately at eye level if possible, with stainless steel screws unless such a practice is prohibitive, in which case use epoxy cement applied to cleaned surfaces. Locate nameplates in the most conspicuous and readable location.

.4 Paint new natural and/or propane gas piping with primer and 2 coats of yellow paint in accordance with Code requirements. Identify piping at intervals as specified above.

.5 Provide an identification nameplate for each motor starter or disconnect switch located in a motor control centre or on a motor starter panel, and on each individually mounted starter provided as part of mechanical work, and on each disconnect switch provided as part of the electrical work for motorized equipment provided as part of mechanical work.

.6 For electrically traced mechanical work, identification wording is to include "ELECTRICALLY TRACED".

.7 Tag valves and prepare a valve tag chart in accordance with following requirements:

.1 attach a valve tag to each new valve, except for valves located immediately at equipment they control;

.2 prepare a digital valve tag chart to list tagged valves, with, for each valve, the tag number, location, valve size, piping service, and valve attitude (normally open or normally closed);

.3 if an existing valve tag chart is available at site, valve tag numbering is to be an extension of existing numbering and new valve tag chart is to incorporate existing chart;

.4 include a copy of valve tag chart in each copy of operating and maintenance instruction manuals.

.8 Where shut-off valves, control dampers, sensors, and similar items which will or may need maintenance and/or repair are located above accessible suspended ceilings, provide round coloured ceiling tacks in ceiling panel material, or stickers equal to Brady "Quick Dot" on ceiling grid material to indicate locations of items. Unless otherwise specified, ceiling tack or sticker colours are to be as follows:

.1	HVAC piping valves and equipment:	yellow
.2	fire protection valves and equipment:	red
.3	plumbing valves and equipment:	green
.4	HVAC ductwork dampers and equipment:	blue
.5	control system hardware and equipment:	orange

End of Section

1 General

1.1 SECTION INCLUDES

.1 This Section specifies mechanical system testing, adjusting, and balancing requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

1.2 DEFINITIONS

.1 "Agency" – means agency to perform testing, adjusting and balancing work.

.2 "TAB" – means testing, adjusting and balancing to determine and confirm quantitative performance of equipment and systems and to regulate specified fluid flow rate and air patterns at terminal equipment, e.g., reduce fan speed, throttling, etc.

.3 "hydronic systems" – includes heating water, chilled water, glycol-water solution, condenser water, and any similar system.

.4 "air systems" – includes outside air, supply air, return air, exhaust air, and relief air systems.

.5 "flow rate tolerance" – means allowable percentage variation, minus to plus, of actual flow rate values in Contract Documents.

.6 "report forms" – means test data sheets arranged for collecting test data in logical order for submission and review, and these forms, when reviewed and accepted, should also form permanent record to be used as basis for required future testing, adjusting and balancing.

.7 "terminal" – means point where controlled fluid enters or leaves the distribution system, and these are supply inlets on water terminals, supply outlets on air terminals, return outlets on water terminals, and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.

.8 "main" – means duct or pipe containing system's major or entire fluid flow.

.9 "submain" – means duct or pipe containing part of the systems' capacity and serving 2 or more branch mains.

.10 "branch main" – means duct or pipe servicing 2 or more terminals.

.11 "branch" – means duct or pipe serving a single terminal.

1.3 SUBMITTALS

.1 Within 30 days of work commencing at site, submit name and qualifications of proposed testing and balancing agency in accordance with requirements of article entitled Quality Assurance below.

.2 Submit sample test forms, if other than those standard forms prepared by Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB), are proposed for use.

.3 Submit a report by Agency to indicate Agency's evaluation of mechanical drawings with respect to service routing and location or lack of balancing devices. Include set of drawings used and marked-up by Agency to prepare report.

1.4 CLOSEOUT SUBMITTALS

.1 Submit a report by Agency after each site visit made by Agency during construction phase of this Project.

.2 Submit a draft report, as specified in Part 3 of this Section.

.3 Submit a final report, as specified in Part 3 of this Section.

.4 Submit a testing and balancing warranty as specified in Part 3 of this Section.

.5 Submit reports listing observations and results of post construction site visits as specified in Part 3 of this Section.

1.5 QUALITY ASSURANCE

.1 Employ services of an independent testing, adjusting, and balancing agency meeting qualifications specified below, to be single source of responsibility to test, adjust, and balance building mechanical systems to produce design objectives. Agency is to have successfully completed testing, adjusting and balancing of mechanical systems for a minimum of 5 projects similar to this Project within past 3 years, and is to be certified as an independent agency in required categories by one of following:

.1 AABC – Associated Air Balance Council;

.2 NEBB – National Environmental Balancing Bureau.

.2 NBCTA certification in lieu of the above noted organizations is not permitted.

.3 Testing, adjusting and balancing of complete mechanical systems is to be performed over entire operating range of each system in accordance with 1 of following publications:

.1 National Standards for a Total System Balance published by Associated Air Balance Council;

.2 Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems published by National Environmental Balancing Bureau;

.3 Chapter 37, Testing, Adjusting, and Balancing of ASHRAE Handbook HVAC Applications.

2 Products – Not Used

3 Execution

3.1 SCOPE OF WORK

.1 Perform total mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of fluid quantities of mechanical systems as required to meet design specifications and comfort conditions, and recording and reporting results.

.2 Mechanical systems to be tested, adjusted and balanced include:

.1 TAB of domestic water systems (all piping extended from Municipal main) is to include:

.1 domestic hot water recirculation piping;

.2 tempered water piping flows.

.2 TAB of swimming pool systems is to include all pool piping water flows.

.3 TAB of laboratory systems is to include flows through piping, fittings including bench work fittings, and associated equipment including special ventilation systems.

.4 TAB of medical gas systems is not part of TAB work and is specified in Section entitled Medical Gas Piping Systems.

.5 TAB of fuel oil system is to include supply and return oil flows as applicable, and is to be in accordance with requirements of CAN/CSA B139.

.6 TAB of heating systems is to include piping and equipment fluid temperatures, flows and control, and if TAB is not done during heating season, a follow-up site visit during heating season will be required to confirm proper flows and temperatures, and any required system "fine tuning".

.7 TAB of cooling systems is also to include piping and equipment fluid temperatures, flows and control, and if TAB is not done during cooling season, a follow-up site visit during cooling season will be required to confirm proper flows and temperatures, and any required system "fine tuning".

.8 TAB of air handling systems is to include equipment and ductwork air temperatures, capacities and flows.

3.2 TESTING, ADJUSTING, AND BALANCING

.1 Conform to following:

.1 as soon as possible after award of Contract, Agency is to carefully examine a set of mechanical drawings with respect to routing of services and location of balancing devices, and is to issue a report listing results of the evaluation;

.2 set of drawings examined by Agency is to be returned with evaluation report, with red line mark-ups to indicate locations for duct system test plugs, and required revision work such as relocation of balancing devices and locations for additional devices;

.3 after review of mechanical work drawings and specification, Agency is to visit site at frequent, regular intervals during construction of mechanical systems, to observe routing of services, locations of testing and balancing devices, workmanship, and anything else that will affect testing, adjusting and balancing;

.4 after each site visit, Agency is to report results of site visit indicating date and time of visit, and detailed recommendations for any corrective work required to ensure proper adjusting and balancing;

.5 testing, adjusting and balancing is not to begin until:

.1 building construction work is substantially complete and doors have been installed;

.2 mechanical systems are complete in all respects, and have been checked, started, adjusted, and then successfully performance tested.

.6 mechanical systems to be tested, adjusted and balanced are to be maintained in full, normal operation during each day of testing, adjusting and balancing;

.7 obtain copies of reviewed shop drawings of applicable mechanical plant equipment and terminals, and temperature control diagrams and sequences;

.8 Agency is to walk each system from system "head end" equipment to terminal units to determine variations of installation from design, and system installation trades will accompany Agency;

.9 Agency is to check valves and dampers for correct and locked position, and temperature control systems for completeness of installation before starting equipment;

.10 wherever possible, Agency is to lock balancing devices in place at proper setting, and permanently mark settings on devices;

.11 Agency is to leak test ductwork as specified in Section entitled HVAC Air Distribution in accordance with requirements of SMACNA "HVAC Air Duct Leak Test Manual",

coordinate work with work of aforementioned Sections, provide detailed sketch(es) to Sheet Metal Contractor and Consultant identifying ductwork not in accordance with acceptable leakage values specified in aforementioned Sections, and retest corrected ductwork;

.12 Agency is to balance systems with due regard to objectionable noise which is to be a factor when adjusting fan speeds and performing terminal work such as adjusting air quantities, and should objectionable noise occur at design conditions, Agency is to immediately report problem and submit data, including sound readings, to permit an accurate assessment of noise problem to be made;

.13 Agency is to check supply air handling system mixing plenums for stratification, and where variation of mixed air temperature across coils is found to be in excess of ±5% of design requirements, Agency is to report problem and issue a detail sketch of plenum baffle(s) required to eliminate stratification;

.14 Agency is to perform testing, adjusting and balancing to within ±5% of design values, and make and record measurements which are within ±2% of actual values;

.15 for air handling systems equipped with air filters, test and balance systems with simulated 50% loaded (dirty) filters by providing a false pressure drop;

.16 test, adjust and balance air conditioning systems during summer season and heating systems during winter season, including at least a period of operation at outside conditions within 2.8°C (5°F) wet bulb temperature of maximum summer design condition, and within 5.5°C (10°C) dry bulb temperature of minimum winter design condition, and take final temperature readings during seasonal operation.

.2 Prepare reports as indicated below.

.1 Upon completion of testing, adjusting, and balancing procedures, prepare draft reports on AABC or NEBB forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in same manner specified for final reports and submit for review.

.2 Upon verification and approval of draft reports, prepare final reports organized and formatted as specified below. Use units of measurement (SI or Imperial) as used on Project Documents.

.3 Report forms are to be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Report forms complete with schematic systems diagrams and other data are to be consolidated in electronic format as a PDF. PDF file to be indexed and organized into sections, as it applies to the project, as follows:

.1 General Information and Summary;

.2 Air Systems;

.3 Hydronic Systems;

.4 Temperature Control Systems;

.5 Special Systems.

.4 Agency is to provide following minimum information, forms and data in report:

.1 inside cover sheet to identify Agency, Contractor, and Project, including addresses, and contact names and telephone numbers and a listing of instrumentation used for procedures along with proof of calibration;

.2 remainder of report is to contain appropriate forms containing as a minimum, information indicated on standard AABC or NEBB report forms prepared for each respective item and system;

.3 Agency is to include for each system to be tested, adjusted and balanced, a neatly drawn, identified (system designation, plant equipment location, and area served) schematic "as-built" diagram indicating and identifying equipment, terminals, and accessories;

.4 Agency is to include report sheets indicating building comfort test readings for all rooms.

.3 After final testing and balancing report has been submitted, Agency is to visit site with Contractor and Consultant to spot check results indicated on balancing report. Agency is to supply labour, ladders, and instruments to complete spot checks. If results of spot checks do not, on a consistent basis, agree with final report, spot check procedures will stop and Agency is to then rebalance systems involved, resubmit final report, and again perform spot checks with Contractor and Consultant.

.4 When final report has been accepted, Contractor is to submit to Owner, in name of Owner, a certificate equal to AABC National Guaranty Certification or a NEBB Quality Assurance Program Bond, and in addition, Contractor is to submit a written extended warranty from Agency covering one full heating season and one full cooling season, during which time any balancing problems which occur, with exception of minor revision work done during scheduled site visits, will, at no cost, be investigated by Agency and reported on to Owner, and if it is determined that problems are a result of improper testing, adjusting and balancing, they are to be immediately corrected without additional cost to Owner.

End of Section

1 General

1.1 SECTION INCLUDES

.1 This Section specifies insulation requirements common to Mechanical Divisions work Sections and it is a supplement to each Section and is to be read accordingly.

1.2 DEFINITIONS

.1 "concealed" – means mechanical services and equipment above suspended ceilings, in non-accessible chases, in accessible pipe spaces, and furred-in spaces.

.2 "exposed" – means exposed to normal view during normal conditions and operations.

.3 "mineral fibre" – includes glass fibre, rock wool, and slag wool.

.4 "domestic water" or "potable water" – means piping extended from building Municipal supply main.

1.3 SUBMITTALS

.1 Submit a product data sheet for each insulation system product.

1.4 CLOSEOUT SUBMITTALS

.1 In accordance with Part 3 of this Section, submit a letter from fire rated duct wrap supplier to certifying duct wrap has been properly installed.

1.5 QUALITY ASSURANCE

.1 Mechanical insulation is to be applied by a licensed journeyman insulation mechanic, or by an apprentice under direct, daily, on-site supervision of a journeyman mechanic.

.2 Do not apply insulation unless leakage tests have been satisfactorily completed.

.3 Ensure surfaces to be insulated are clean and dry.

.4 Ensure ambient temperature is minimum 13°C (55°F) for at least 1 day prior to application of insulation, and for duration of insulation work, and relative humidity is and will be at a level such that mildew will not form on insulation materials.

.5 Insulation materials must be stored on site in a proper and dry storage area. Any wet insulation material is to be removed from site.

2 Products

2.1 FIRE HAZARD RATINGS

.1 Unless otherwise specified, insulation system materials inside building must have a fire hazard rating of not more than 25 for flame spread and 50 for smoke developed when tested in accordance with ULC S102, Surface Burning Characteristics of Building Materials and Assemblies.

2.2 THERMAL PERFORMANCE

.1 Unless otherwise specified, thermal performance of insulation is to meet or exceed values given in Tables entitled Minimum Piping Insulation Thickness Heating and Hot Water Systems and Minimum Piping Insulation Thickness Cooling Systems, as stated in ANSI/ASHRAE/IES Standard 90.1 version referenced in Ontario Building Code.

2.3 DUCTWORK SYSTEM INSULATION MATERIALS

.1 Flexible foam elastomeric sheet is to be sheet form, CFC free, closed cell, self-adhering elastomeric nitrile rubber insulation with a water vapour permeability rating of 0.08 in accordance with ASTM E96 Procedure A.

.1 Manufacturers:

.1 Armacell "AP/Armaflex SA";

.2 IK Insulation Group "K-Flex Duct Wrap", S2S.

.2 Extruded polystyrene tapered insulation – equal to Soprema Sopra-ISO Tapered, closed cell polyisocyanurate foam core with organic facers reinforced with glass fibres, 172 kPa compressive strength as per ASTM D1621, 32 kg/m3 density, 50 mm minimum thickness, 2% slope. Thickness shall increase if width of duct work is larger than 1200 mm to maintain 2% slope.

2.4 INSULATION FASTENINGS

.1 Wire – minimum #15 gauge galvanized annealed wire.

.2 Wire with Mesh – minimum #15 gauge galvanized annealed wire factory woven into 25 mm (1") hexagonal mesh.

.3 Aluminium Banding – equal to ITW Insulation Systems Canada "FABSTRAPS" minimum 12 mm (½") wide, 0.6 mm (1/16") thick aluminium strapping.

.4 Stainless Steel Banding – equal to ITW Insulation Systems Canada "FABSTAPS" 0.6 mm (1/16") thick, minimum 12 mm (½") wide type 304 stainless steel strapping.

.5 Duct Insulation Fasteners – weld-on 2 mm (3/32") diameter zinc coated steel spindles of suitable length, complete with minimum 40 mm (1-½") square plastic or zinc plated steel self-locking washers.

.6 Tape Sealant – equal to MACtac Canada Ltd. self-adhesive insulation tapes, types PAF, FSK, ASJ, or SWV as required to match surface being sealed.

.7 Mineral Fibre Insulation Adhesive – clear, pressure sensitive, brush consistency adhesive, suitable for a temperature range of -20°C to 82°C (-4°F to 180°F), compatible with type of material to be secured, and WHMIS classified as non-hazardous.

.8 Flexible Elastomeric Insulation Adhesive – Armacell "Armaflex" #520 air-drying contact adhesive.

.9 Closed Cell Foamed Glass Insulation Adhesive – Pittsburgh Corning PC88 multi-purpose 2-component adhesive.

.10 Lagging Adhesive – white, brush consistency, ULC listed and labelled, 25/50 fire/smoke rated lagging adhesive for canvas jacket fabric, suitable for colour tinting, complete with fungicide and washable when dry.

.11 Screws – No. 10 stainless steel sheet metal screws.

2.5 INSULATION JACKETS AND FINISHES

.1 Rigid Aluminium Jacket – equal to ITW Insulation Systems Canada "Lock-on" 0.406 mm (0.016") thick embossed aluminum jacket material to ASTM B209, factory cut to size and complete with polysurlyn moisture barrier and continuous modified Pittsburgh Z-Lock, butt straps with "Fabstraps" to weatherproof the end to end joints, and 2-piece epoxy coated pressed aluminum fittings with weather locking edges.

3 Execution

3.1 GENERAL INSULATION APPLICATION REQUIREMENTS

.1 Install insulation directly over pipes and ducts, not over hangers and supports.

.2 Install duct insulation continuous through walls, partitions, and similar surfaces except at fire dampers.

.3 Where existing insulation work is damaged as a result of mechanical work, repair damaged insulation work to Project work standards.

3.2 DUCTWORK INSULATION REQUIREMENTS – MINERAL FIBRE

.1 Insulate following ductwork systems inside building and above ground with mineral fibre insulation of thickness indicated:

.1 Outdoor air intake ductwork, casings and plenums from fresh air intakes to and including mixing plenums or sections, or, if mixing plenums or sections are not provided, to first heating coil, or if both mixing plenums or sections and heating coil sections are not provided, and fresh air is not tempered, then the fresh air ductwork system complete – minimum 40 mm (1-½") thick as required;

.2 mixed supply air or preheated supply air casings, plenums and sections to and including the fan section where not factory insulated – minimum 25 mm (1") thick rigid board or minimum 40 mm (1-½") thick flexible blanket as required;

.3 supply air ductwork outward from fans, except for supply ductwork exposed in area it serves – minimum 25 mm (1") thick rigid board or minimum 40 mm (1-½") thick flexible blanket as required;

.4 exhaust discharge ductwork for a distance of 3 m (10') downstream (back) from exhaust openings to atmosphere, including any exhaust plenums within the 3 m (10') distance – minimum 25 mm (1") thick rigid board or minimum 40 mm (1-½") thick flexible blanket as required;

.5 any other ductwork, casings, plenums or sections specified or detailed on drawings to be insulated – thickness as specified.

.2 Provide rigid board type insulation for casings, plenums, and exposed rectangular ductwork. Provide blanket type insulation for round ductwork and concealed rectangular ductwork.

.3 Liberally apply adhesive to surfaces of exposed rectangular ducts and/or casings. Accurately and neatly press insulation into adhesive with tightly fitted butt joints. Provide pin and washer insulation fasteners at 300 mm (12") centres on bottom and side surfaces. Secure and seal joints with 75 mm (3") wide tape sealant. Additional installation requirements as follows:

.1 at trapeze hanger locations, install insulation between duct and hanger;

.2 provide drywall type metal corner beads on edges of ductwork, casings and plenums in equipment rooms, service corridors, and any other area where insulation is subject to accidental damage, and secure in place with tape sealant.

.4 Liberally apply adhesive to surfaces of concealed rectangular or oval ductwork, and wrap insulation around duct with a top butt joint and tight section to section butt joints. Provide pin and washer insulation fasteners at 300 mm (12") centres on bottom surfaces. Secure and seal joints with 75 mm (3") tape sealant. At each trapeze type duct hanger, provide a 100 mm (4") wide full length piece of rigid mineral fibre board insulation between duct and hanger.

.5 Accurately cut sections of insulation to fit tightly and completely around exposed and concealed round or oval ductwork. Liberally apply adhesive to surfaces of duct, and wrap insulation around duct with a top butt joint and tight section to section butt joints. Seal joints with tape sealant. At duct hanger locations install insulation between duct and hanger. At each hanger location for concealed ductwork where flexible blanket insulation is used, provide a 100 mm (4") wide full circumference strip of semi-rigid board type duct insulation between duct and hanger.

.6 Insulation application requirements common to all types of rigid ductwork are as follows:

.1 at duct connection flanges, insulate flanges with neatly cut strips of rigid insulation material secured with adhesive to side surfaces of flange with a top strip to cover exposed edges of the side strips, then butt the flat surface duct insulation up tight to flange insulation, or, alternatively, increase insulation thickness to depth of flange and cover top of flanges with tape sealant;

.2 installation of fastener pins and washers is to be concurrent with duct insulation application;

.3 cut insulation fastener pins almost flush to washer and cover with neatly cut pieces of tape sealant;

.4 accurately and neatly cut and fit insulation at duct accessories such as damper operators (with standoff mounting) and pitot tube access covers;

.5 prior to concealment of insulation by either construction finishes or canvas jacket material, patch vapour barrier damage by means of tape sealant.

3.3 DUCTWORK INSULATION REQUIREMENTS – FLEXIBLE ELASTOMERIC

.1 Insulate exposed exterior ductwork (except outdoor air intake ductwork) and associated plenums and/or casings outside building with minimum 75 mm (3”) thick flexible elastomeric sheet insulation as required, applied in 2 minimum 40 mm (1 ½”) thick layers with staggered tightly butted joints.

.2 Install with adhesive in strict accordance with manufacturer’s instructions to produce a weather-proof installation. Ensure sheet metal work joints are sealed watertight prior to applying insulation.

.3 Provide Calcium Silicate insulation between ductwork and duct supports. Tightly butt flexible elastomeric insulation to Calcium Silicate insulation. Cover Calcium Silicate insulation with a continuous sheet of self-adhesive multilayer jacketing which overlaps 75 mm past the Calcium Silicate insulation to the adjacent flexible elastomeric insulation.

.4 Provide extruded polystyrene tapered insulation between flexible elastomeric insulation and jacketing to allow for water runoff on all exterior duct work.

3.4 APPLICATION OF INSULATING COATINGS

.1 Apply, in accordance with manufacturer’s instruction, insulating coatings to following bare metal surfaces:

.1 paint bare metal surfaces clear of "cold" piping and/or equipment insulation for a distance of from 300 mm (12") to 600 mm (24") clear of pipe or equipment insulation, with "No Sweat-FX" anti-condensation coating;

.2 paint bare metal surfaces associated with mechanical systems with an operating temperature 60°C (140°F) with "ThermaLite" insulating coating.

.2 Apply coatings with a brush. Remove any splatter or excess coating from adjacent surfaces.

3.5 INSULATION FINISH REQUIREMENTS

.1 Install rigid aluminum jacket material tightly in place with overlapped circumferential joints positioned to shed water and covered with butt straps supplied with the jacket. Provide aluminum jacket for following insulation:

.1 Outdoor Ductwork;

.2 Apply 2 heavy coats of "PITTCOTE 300e" coating with 24 hr. between coats to foamed glass insulation exposed above grade.

.3 Apply 2 coats (with 24 hr. between coats) of specified coating to flexible elastomeric insulation outside building.

.4 Install 3M Ventureclad jacketing on ductwork and ensure ductwork supports are installed on the outside of the jacketing. Jacketing shall be 1577CW. Provide necessary insulation and jacketing materials at the time of duct work installation. Do not penetrate jacketing or install jacketing around duct supports. Provide 24GA G90 38 mm x 38 mm steel angle to protect all corners of rectangular ductwork and install between insulation and jacketing. Steel angle shall be continuous on entire duct work run. Provide additional steel angle between jacketing and duct support. Ensure jacketing is continuous with minimum 75 mm (or as required by manufacturer) overlapping on all joints. Provide jacketing on the following duct work:

.1 Exposed exterior duct work including outdoor air intake duct work, plenums and casings installed outside;

.2 Exposed interior insulated duct work;

.3 Interior outdoor air intake duct work, plenums, and casings;

.4 Single wall plenum casings (intake or exhaust) field insulated;

.5 Wherever indicated on drawings;

End of Section

1 General

1.1 SECTION INCLUDES

.1 This Section specifies commissioning requirements that are common to Mechanical Divisions work Sections and it is a supplement to each Section and is to be read accordingly. When requirements of this Section contradict requirements of Division 00 or Division 01, conditions of Division 00 or Division 01 to take precedence.

1.2 REFERENCES

.1 Refer to commissioning requirements specified in Division 01.

1.3 COMMISSIONING AGENT INVOLVEMENT VERSUS WARRANTY OBLIGATIONS

.1 Involvement of Commissioning Agent performing duties as described in this Section is not in any way to void or alter any Contractual warranty obligations.

1.4 SUBMITTALS

.1 Submit to Commissioning Agent, at same time as submittal to the Consultant, one copy of each shop drawing or product data sheet associated with equipment or systems to be commissioned.

.2 Submit for review, a Commissioning Plan with schedule, commissioning procedures for commissioning events, and a copy of Commissioning Agent's commissioning data sheets for equipment/systems to be commissioned.

.3 Submit a list of commissioning instruments and for each instrument, indicate purpose of instrument and include a recent calibration certificate.

.4 Submit equipment and system manufacturer's start-up and test report sheets for review a minimum of 1 month prior to equipment and system start-up procedures.

1.5 CLOSEOUT SUBMITTALS

.1 After start-up and successful pre-functional performance testing and submittal of completed forms, submit, for each system or subsystem, a letter confirming pre-functional performance testing has been successfully completed and system or subsystem is ready for functional performance testing and commissioning process to commence.

1.6 DEFINITIONS

.1 Commissioning: process of demonstrating to Owner and Consultant, for purpose of final acceptance, by means of successful and documented functional performance testing, that systems and/or subsystems are capable of being operated and maintained to perform in accordance with requirements of Contract Documents, all as further described below.

.2 Commissioning Agent: commissioning authority who will supervise commissioning process, and who will recommend final acceptance of commissioned mechanical work.

.3 Start-Up and Adjusting: process of equipment manufacturer's/supplier's technical personnel, with Contractor, starting and operating equipment and systems, making any required adjustments, documenting process, and submitting manufacturer's/supplier's start-up reports to confirm equipment has been properly installed and is operational as intended.

.4 Pre-Functional Performance Testing: testing, adjusting and operating of components, equipment, systems and/or subsystems, by Contractor, after start-up but before functional performance testing, to confirm components, equipment, systems and/or subsystems operate in accordance with requirements of Contract Documents, including modes and sequences of control and monitoring, interlocks, and responses to emergency conditions, and including submittal of pre-functional performance testing documentation sheets.

.5 Functional Performance Testing: a repeat of successful pre-functional performance testing by Contractor, in presence of Commissioning Agent and the Consultant with completed Commissioning Agent's commissioning documentation sheets to document, validate and verify equipment, systems and subsystems are complete in all respects, function correctly, and are ready for acceptance.

.6 Commissioning Documentation Sheets: prepared sheets for pre-functional performance testing and for functional performance testing supplied by Commissioning Agent for each piece of equipment/system to be commissioned, each sheet or set of sheets complete with Project name and number, date of commissioning, equipment/system involved, equipment/system name and model number, equipment tag in accordance with drawings, and, for each commissioning procedure listed, a column giving expected data in accordance with Contract Documents, a column to fill in observed data during commissioning, and space for signatures of Contractor and Commissioning Agent.

.7 Systems Operating Manual: a manual prepared by Commissioning Agent to present an overview of building mechanical systems and equipment to be used by building maintenance personnel to assist them in daily operation of systems.

.8 Validate: to confirm by examination and witnessing tests correctness of equipment and system operation.

1.7 QUALITY ASSURANCE

.1 Commissioning work is to be in accordance with requirements of following:

.1 CSA Z320, Building Commissioning Standard and Check Sheets;

.2 CSA Z8001, Commissioning of Health Care Facilities;

.3 ASHRAE Guideline 0, The Commissioning Process;

.4 ASHRAE Guideline 1.1, The HVAC Commissioning Process;

.5 ASHRAE Guideline 1.2, The Commissioning Process for Existing HVAC&R Systems;

.6 ASHRAE Guideline 1.5, Commissioning Smoke Control Systems;

.7 Owner designated Commissioning Agent.

1.8 COMMISSIONING OBJECTIVES

.1 Objectives of commissioning process:

.1 to support quality management by means of monitoring and checking installation;

.2 to verify equipment/system performance by means of commissioning of completed installation;

.3 to move completed equipment/systems from "static completion" state to "dynamic" operating state so as to transfer a complete and properly operating installation from Contractor to Owner.

1.9 TESTING EQUIPMENT

.1 Supply instruments and test equipment required to conduct start-up, testing and commissioning procedures.

2 Products – Not Used

3 Execution

3.1 COMMISSIONING

.1 Commission work in accordance with requirements of this Section and as required by Commissioning Agent.

.2 Prerequisites to successful completion of commissioning:

.1 submittal of signed start-up and test reports;

.2 completion of system testing, adjusting and balancing (TAB), and acceptance of TAB reports;

.3 permanent electrical and control connections of equipment;

.4 successful completion and documentation of pre-functional performance testing;

.5 submittal of letters to the Consultant certifying systems and subsystems have been started, tested, adjusted, successfully pre-functional performance tested, are ready for functional performance testing, and are in accordance with requirements of Contract Documents.

3.2 PHASING OF COMMISSIONING

.1 If Project will be constructed in phases, phase commissioning accordingly to suit progress and phases of Work.

3.3 DEFICIENCIES LISTED DURING COMMISSIONING

.1 Correct deficiencies listed by the Consultant and Commissioning Agent during commissioning process within 15 calendar days of notification unless agreed otherwise with the Consultant, and when deficiencies have been corrected, notify the Consultant and Commissioning Agent immediately.

3.4 SYSTEMS TO BE COMMISSIONED

.1 Mechanical systems to be commissioned include, but are not to be limited to, systems described below. Specific commissioning procedures are to be as directed by Commissioning Agent.

.2 Commissioning of drainage systems includes:

.1 commissioning of drainage pumps and controls by means of tests recommended by manufacturer to confirm proper operation and performance;

.2 commissioning of equipment such as interceptors and backflow preventers.

.3 Commissioning of fire protection systems will be considered complete upon preparation and submittal by Contractor of completion certificates required by applicable NFPA Standards, demonstration of proper system operation to local Fire Chief and any other authorities, including Owner's insurance underwriter as required, and coordination and cooperation with fire alarm system commissioning procedures, in particular smoke control systems and other such fan system control sequences.

.4 Commissioning of water systems (all piping extended from Municipal main) includes:

.1 commissioning of pumps and controls;

.2 commissioning of water heaters;

.3 commissioning of piping specialties such as backflow preventers, mixing valves, and similar components;

.4 commissioning of trap seal primer units, including adjustment of water flows and confirmation of water flow at each connected trap;

.5 commissioning of plumbing fixtures.

.5 Commissioning of swimming pool systems includes pool piping and fittings, pumping equipment and controls, filtering equipment, and chemical treatment equipment, as well as any specialized equipment for pool area such as dehumidifiers.

.6 Commissioning of laboratory systems includes piping, fittings including bench work fittings, and associated equipment including special ventilation systems.

.7 Commissioning of compressed air system includes "head end" compressor equipment, pressure reducing equipment, and outlets.

.8 Commissioning of natural gas system includes pressure regulating equipment. Perform commissioning in accordance with requirements of CAN/CSA B149.1, and any supplemental requirements of governing authorities.

.9 Commissioning of propane gas system includes pressure regulating equipment. Perform commissioning in accordance with requirements of CAN/CSA B149.2, and any supplemental requirements of governing authorities.

.10 Perform commissioning of fuel oil system in accordance with requirements of CAN/CSA B139.

.11 Commissioning of heating systems includes piping, piping specialties, equipment, and control, as well as checking and validating temperature and flow documentation contained in TAB reports. If TAB is not done during heating season, a follow-up site visit during heating season will be required to confirm proper flows and temperatures, and any required system "fine tuning".

.12 Commissioning of cooling systems includes piping, piping specialties, equipment, and control, as well as checking and validating temperature and flow documentation contained in TAB reports. If TAB is not done during cooling season, a follow-up site visit during cooling season will be required to confirm proper flows and temperatures, and any required system "fine tuning".

.13 Commissioning of HVAC chemical treatment systems includes feed and monitoring equipment, and testing of system fluids to confirm proper concentration of chemical.

.14 Commissioning of air handling systems includes equipment, ductwork, ductwork specialties, controls, interlocks, and checking and validating air capacities and flows in accordance with TAB reports.

.15 Control work commissioning includes confirmation of proper operation of individual control components, and overall operation of controls in conjunction with operation of connected building systems, including heating season/cooling season testing requirements specified above.

.16 Commissioning of BAS includes confirmation of proper operation of components, input/output points, hardware and software, and demonstration of system performing required procedures.

.17 Commissioning of special usage room controls includes confirmation of proper operation of individual components, and proper operation of overall control system, all in accordance with governing Codes and Standards.

.18 Commissioning of noise and vibration control equipment includes noise and vibration measurements to confirm proper operation of equipment.

3.5 COMMISSIONING PROCESS

.1 Perform commissioning process in stages and include, but not be limited to, following:

.1 Stage 1: Commissioning of equipment/systems as listed in this Section, which is a prerequisite to an application for Substantial Performance of the Work and includes supervising and validating results of functional performance testing, and submittal of reviewed Systems Operating Manual.

.2 Stage 2: Commissioning work performed 12 months after issue of a Certificate of Substantial Performance and which includes supervision of Contractor's "fine tuning" of equipment/systems through seasonal occupancy, and any other such work to achieve optimal comfort and performance conditions.

.3 Stage 3: Successful completion of satisfactory equipment/system operation during 1st month after issue of a Certificate of Total Performance of the Work.

.4 Stage 4: Successful completion of satisfactory equipment/system operation during 3rd month after issue of a Certificate of Total Performance of the Work.

.5 Stage 5: Successful seasonal commissioning of building.

3.6 RESPONSIBILITIES OF CONTRACTOR

.1 During construction phase, Contractor is to:

.1 prepare and submit an installation schedule which includes a time schedule for each activity with lead and lag time allowed and indicated, shop drawing and working detail drawing submissions, and major equipment factory testing and delivery dates;

.2 prepare and submit a commissioning schedule which is to include a time schedule coordinated with installation schedule referred to above and Commissioning Agent, and allowances for additional time for re-tests as may be required, and update schedule on a monthly basis as required;

.3 when requested by Commissioning Agent, arrange site commissioning meetings with Owner, the Consultant, and applicable subcontractors present, to be chaired by Commissioning Agent who will also prepare and distribute meeting minutes;

.4 promptly correct reported deficient work, and report when corrective work is complete;

.5 where required by Codes and/or Specification, retain equipment manufacturers/suppliers or independent 3rd parties to certify correct installation of equipment/systems;

.6 under supervision of equipment manufacturers/suppliers, start-up and adjust equipment to design requirements, and submit start-up sheets which include equipment data such as manufacturer and model number, serial number where applicable, and performance parameters, all signed by equipment manufacturer/supplier and Contractor;

.7 complete Commissioning Agent's commissioning data sheets for multiple items of smaller equipment such as air terminal boxes, fan coil units, backflow preventers, etc., submit sheets to Commissioning Agent, accompany Commissioning Agent for an on-site check of 30% of data sheet information for each type of equipment, and perform any corrective action required as a result of site checks;

.8 perform system testing, adjusting and balancing and, when complete, issue a copy of final report to Commissioning Agent for review and a site check of results, and perform any corrective work required as a result of site checks by Commissioning Agent;

.9 in accordance with updated commissioning schedule and actual progress at site, certify in writing to the Consultant and Commissioning Agent that equipment and/or systems are complete, have been checked, started and adjusted, successfully pre-functional performance tested and documented, and are ready for functional performance testing and commissioning procedures, giving the Consultant and Commissioning Agent a minimum of 5 working days' notice;

.10 perform system and subsystem functional performance testing under supervision of Commissioning Agent, and submit to the Consultant and Commissioning Agent, completed and signed functional performance testing and commissioning data sheets (issued by Commissioning Agent) and also signed by Commissioning Agent.

.2 During post construction phase, Contractor is to:

.1 optimize system operation in accordance with building occupant's needs and comments using System Operation Manual prepared by Commissioning Agent as reference;

.2 complete commissioning procedures, activities, and performance verification procedures that were delayed or not concluded during construction phase;

.3 accompanied by Commissioning Agent, complete system checks and "fine tuning" with signed documentation as follows:

.1 once during 1st month of building operation;

.2 once during 3rd month of building operation;

.3 once between 4th and 10th months in a season opposite to 1st and 3rd month visits.

.4 correct deficiencies revealed by system checks described above, and, where required, involve equipment manufacturers/suppliers during corrective actions, and report completion of corrective work;

.5 3 months after Substantial Completion conduct a question and answer session(s) at building with Owner's operating and maintenance personnel, with duration of session(s) dictated by number of questions and concerns that have to be addressed.

End of Section

1 General

1.1 SUBMITTALS

.1 Submit shop drawings/product data for all products specified in Part 2 of this section except for pipe, fittings, and unions. Indicate performance criteria, conformance to appropriate reference standards, and limitations.

.2 For each gas pressure regulating station, submit:

.1 a selection sheet for each PRV, indicating connected equipment, heating loads, design allowance, meter model, body size, spring range and orifice size;

.2 a selection sheet for each relief valve(s) serving a PRV.

1.2 REFERENCES

.1 CSA B149.1:20, Natural Gas and Propane Installation Code.

.2 TSSA FS-255-21, Gaseous Fuels Code Adoption Document Amendment: Ontario requirements effective May 1, 2021.

1.3 QUALITY ASSURANCE

.1 All gas system work is to be in accordance with requirements of CSA B149.1, Natural Gas and Propane Installation Code, as amended by local Gas Codes.

.2 All gas system work is to be performed only by licensed gas pipe fitters (holding Gas Technician 1 Certificate) authorized under the TSSA Act.

.3 Apply for, on TSSA forms, approval of the gas system design by the TSSA prior to work beginning at the site and prior to ordering any equipment. Submit the completed TSSA Form and copies of shop drawings/product data sheets as required to the TSSA and obtain an approval certificate. Pay all costs for the TSSA review and approval process. If the TSSA requires revisions to the system and the revisions result in an extra cost, a Notice of Change will be issued by the Consultant for the revision.

2 Products

2.1 PIPE, FITTINGS, AND JOINTS

.1 Coated Black Steel - Welded Joints: "Yellow Jacket" Schedule 40 mild black carbon steel, ASTM A53, Grade B, factory coated with yellow plastic, mill or site bevelled, and complete with forged steel butt welding fittings and welded joints. All bare metal surfaces are to be cleaned and corrosion protected with a suitable Denso primer and tape corrosion protection system.

.2 Polyethylene: Safety yellow coloured polyethylene pipe, fittings, and joints to CSA-B137.4.

.3 Coated Copper: Type "K" soft temper copper with a factory applied external yellow plastic coating and flare fittings with forged brass nuts to CAN/CSA-B149.1. Nuts are to be stamped with the designation C37700 to indicate that they are forged brass.

.4 Uncoated Black Steel - Screwed Joints: Schedule 40 mild black carbon steel, ASTM A53, Grade B, complete with malleable cast iron screwed fittings to ANSI B2.1, and screwed joints.

.5 Uncoated Black Steel - Welded Joints: Schedule 40 mild black carbon steel, ASTM A53, Grade B, mill or site bevelled, complete with factory made forged steel butt welding fittings and welded joints.

.6 Copper-Uncoated: Type "G" seamless copper tubing to ASTM B837, hard temper with wrought copper capillary brazed joint type fittings to ASTM B.61, and brazed joints made with "Sil-Fos" or "Sil-Fos 5" brazing alloy, or, soft temper with flared brass fittings of a single 45º flare type, forged

or with a machined long nut and copper to copper threaded connectors, and, where required, flared brass copper to NPS adapters.

.7 Flexible Stainless Steel: Flexible, CSA certified, 860 kPa (125 psi) rated, gas-tight, convoluted stainless steel tubing factory jacketed with a bright yellow PVC coating which is continuously identified. The tubing is to be supplied in coils and is to be complete with factory attached stainless steel end fittings, and adapter unions, protective plates, and steel clamps.

.1 Manufacturers:

.1 Tru-Flex Metal Hose LLC. "Pro-Flex";

.2 Titeflex Corp. "Gastite";

.3 Omega Flex Canada "TracPipe".

2.2 PIPING UNIONS

.1 Screwed Piping: Malleable iron, ground joint, bronze or brass to iron or bronze to bronze seat screwed unions and union elbows with a minimum pressure rating of 1725 kPa (250 psi) steam at 260°C (500°F).

.2 Flanged Piping: Forged carbon steel slip-on type raised faced welding flange unions to ASTM A105, 150 lb. Class for steel pipe, and slip-on type 150 lb. Class bronze flanges for copper pipe.

.3 Copper to Steel: Equal to Kamco Products "Copper Stopper".

2.3 EARTHQUAKE ACTIVATED AUTOMATIC SHUT-OFF VALVES

.1 Equal to KAS International or Nihon Koso Model 315 HPF earthquake activated, flanged, high pressure automatic shut-off valve suitable for both natural gas and propane, ULC listed and in accordance with ANSI Z21.70, Earthquake Actuated Automatic Gas Shutoff Valves.

2.4 SHUT-OFF VALVES

.1 Ball Type: CSA certified, minimum 3100 kPa (450 psi) WOG rated, 1/4 turn, full port non-lubricated brass ball valves, each complete with a Teflon PTFE seat, chrome plated solid ball, removable lever handle, and screwed ends.

.1 Manufacturers:

.1 Neo Valves Inc. #425;

.2 Kitz Corp. Code 58;

.3 Toyo Valve Co. Fig. 5044A.

.2 Plug or Ball Type: CSA certified, plain face flanged, Class 125, 1380 kPa (200 psi) rated, 1/4 turn, cast iron lubricated plug valves, each wrench operated and complete with cylindrical plug with lubricant grooves, lubricant screw, and lubricant receptacle, or full port carbon steel ball valves with flanged ends.

.1 Manufacturers:

.1 Neo Valves Inc. #1AS40114 plug valve;

.2 Newman Hattersley #171M plug valve;

.3 Kitz Corp. Code No. 150 SCTAM-FS-CGA ball valve.

2.5 NATURAL GAS CONVENIENCE OUTLET

.1 Neo Valves Model 3/375 quick-connect type CSA certified outlet with interlocking safety cam to prevent release of the appliance connector until the valve is off, integral thermal protection to prevent gas flow if the outlet is exposed to temperatures exceeding 90°C (195°F), and a wall enclosure box.

.2 Manufacturers:

.1 Neo Valves Inc.;

.2 Fairview Fittings & Mfg. Ltd.

2.6 PRESSURE REGULATORS

.1 CSA certified pressure regulators as follows:

.1 non-vented type: lever action, dead end lockup type, each complete with a vent limiter, self-aligning valve, die-cast aluminium housing, and synthetic rubber compound diaphragm;

.2 vented type: spring-loaded self-operated design, tight closing, selected for the facility gas pressure and piping pressure loss, and connected equipment load at full firing rate plus 20% spare, and complete with:

.1 1035 kPa (150 psi) rated cast iron body finished with corrosive resistant epoxy enamel;

.2 aluminum diaphragm and spring case with Nitrile diaphragm, disc, and body o-ring;

.3 throttling type, high flow rate, tight shut-off relief valve selected to protect equipment downstream of the regulator in coordination with regulator capacity.

.2 Manufacturers:

.1 Maxitrol Co.;

.2 Fisher Controls;

.3 Leslie Controls Inc.;

.4 Lakeside Process Controls.

3 Execution

3.1 DEMOLITION

.1 Do all required gas system demolition work. Refer to demolition requirements specified in Section 20 05 05 – Selective Demolition for Mechanical.

3.2 NATURAL GAS SERVICE

.1 Make all required arrangement with the natural gas supply utility on behalf of the Owner for installation of natural gas service piping with gas pressure regulator and meter assembly.

.2 Provide an earthquake activated automatic shut-off valve in gas service piping outside the building in accordance with the valve manufacturer's installation instructions. Provide an angle iron framed wire mesh enclosure around the valve and bolted to the wall.

.3 Provide 2 m (7') high minimum 200 mm (8") diameter Schedule 80 galvanized steel concrete filled bollards at the meter-regulator location in a pattern to protect the meter-regulator. Install the pipe straight and plumb a 1.2 m (4') below grade in a continuous 600 mm (2') diameter reinforced concrete footing. Smoothly crown the top of the concrete above the top of the pipe.

3.3 NATURAL GAS PIPING INSTALLATION REQUIREMENTS

.1 Provide all required natural gas distribution piping and connect gas fired or operated equipment, and provide all required vent piping to atmosphere, including vent piping from pressure

regulators. Do all piping work in accordance with requirements of CAN/CSA-B149.1, Natural Gas and Propane Installation Code, as amended by local Gas Codes.

.2 Piping is to be as follows:

.1 for underground piping, coated Schedule 40 black steel, coated soft copper, or polyethylene;

.2 for above ground piping, uncoated Schedule 40 black steel, hard temper or soft copper, or, if permitted, flexible stainless steel.

.3 Install flexible stainless steel pipe in strict accordance with the pipe manufacturer's printed instructions.

.4 Slope gas piping in the direction of flow to low points.

.5 Ensure that supports for roof mounted piping are sized (height) to accommodate the roof slope and the required piping slope, and to permit the installation of low point dirt pockets.

.6 Provide full pipe diameter 150 mm (6") long drip pockets at the bottom of all vertical risers, at all piping low points, and wherever else shown and/or required.

.7 Identify all natural gas piping above ground with two coats of safety yellow enamel applied over primer and coil type vinyl identification makers with arrows. SMS Ltd. or equal can be used for identification markers.

.8 For all underground gas piping, provide continuous 75 mm (3") wide yellow PVC warning tape with "CAUTION - GAS LINE BURIED BELOW" wording at 750 mm (30") intervals located above the pipe approximately 250 mm (10") below grade.

.9 Rough-in all required natural gas piping for kitchen and laundry equipment in accordance with drawing plans and schedules. Obtain accurately dimensioned rough-in drawings for the equipment and confirm exact locations prior to roughing-in. When the equipment has been installed, connect the equipment from the roughed-in Work. Provide shut-off valves in all piping connections to the equipment.

.10 Include for mounting only of a solenoid valve in the gas piping to kitchen cooking equipment.

3.4 INSTALLATION OF SHUT-OFF VALVES

.1 Provide CSA approved ball type or lubricated plug type shut-off valves to isolate equipment, and wherever else shown.

.2 Ensure that valves are located for easy accessibility and maintenance.

3.5 INSTALLATION OF NATURAL GAS CONVENIENCE OUTLETS

.1 Provide natural gas convenience outlets and wall mount.

.2 Provide a shut-off valve in connecting piping, confirm exact location prior to roughing-in, and ensure that the outlet is rigidly secured in place.

3.6 INSTALLATION OF PRESSURE REGULATORS

.1 Provide pressure regulators in gas distribution piping where indicated and/or required.

.2 For indoor appliances, use lever acting design vent limiter type, sized as shown and mounted in a horizontal upright position in strict accordance with the manufacturer's instructions. Note that these pressure regulators do not require vent piping.

.3 Use vented type pressure regulators for all other applications.

.4 Install regulating stations in accordance with requirements of CAN/CSA-B149.1.

.5 Provide 6 mm (¼") diameter test ports upstream and downstream of each regulator assembly.

.6 Locate outdoor regulating stations a minimum of 300 mm (12") away from walkways, and 3 m (10') away from equipment air intakes and building openings. Provide all required vent piping and terminate vents in a turn-down elbow fitting with bronze bug screen secured in place.

.7 Locate indoor regulating stations in locations accessible without the use of ladders or lifts. Combine vents where permitted and increase vent pipe size accordingly. Extend vent piping up through the roof 3 m (10') away from equipment air intakes and building openings and terminated in a turn-down elbow fitting with bronze bug screen secured in place.

.8 Indicate operating set-points, relief settings and vent arrangements for each regulating station on as-built record drawings.

End of Section

1 General

1.1 SUBMITTALS

.1 Submit shop drawings/product data sheets for all make-up air units. Include following:

.1 certified fan performance curves;

.2 certified sound power data;

.3 hardware for section-to-section site connections;

.4 dimensioned layouts, including dimensioned curb layouts as applicable;

.5 product data for fan motors.

1.2 CLOSEOUT SUBMITTALS

.1 Submit with delivery of each furnace a copy of the factory inspection and fire test report as specified in Part 2 of this section, and include a copy of each report with O&M Manual project close-out data.

.2 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this section.

.3 Training attendance records.

1.3 MAINTENANCE MATERIAL SUBMITTALS

.1 Submit spare air filters as specified in Part 2 of this section.

1.4 QUALITY ASSURANCE

.1 Make-up air units and installation are to be in accordance with requirements of following:

.1 all applicable Provincial Codes and Standards;

.2 CAN/CSA B149, Natural Gas and Propane Installation Codes;

.3 CSA or cETL listed and labelled electrical components.

.2 Make-up air unit installation tradesmen are to be journeyman and licensed gas fitters.

.3 Warranty: The manufacturer shall provide 24-month parts and labour warranty. Defective parts shall be repaired or replaced during the warranty period at no charge. The warranty period shall commence at start up or six months after shipment, whichever occurs first.

.4 Manufacturer to provide separate price to maintain the unit for the first 5 years including parts and labour.

.5 The manufacturer shall provide 60-month parts and labour from the date of start up.

2 Products

2.1 MANUFACTURERS

.1 Daikin

.2 Trane Canada Corp.;

.3 Carrier

2.2 CASING

.1 Panel construction shall be double-wall construction for all panels. All floor panels shall have a solid galvanized steel inner liner on the air stream side of the unit to protect insulation during

service and maintenance. Insulation shall be a minimum of 1" thick with an R-value of 7.0, and shall be 2 part injected foam. Panel design shall include no exposed insulation edges. Unit cabinet shall be designed to operate at total static pressures up to 5.0 inches w.g.

.2 Exterior surfaces shall be constructed of pre-painted galvanized steel for aesthetics and long term durability. Paint finish to include a base primer with a high quality, polyester resin topcoat of a neutral beige color. Finished panel surfaces to withstand a minimum 1000-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance.

.3 Service doors shall be provided on the fan section, filter section, control panel section, and heating vestibule in order to provide user access to unit components. All service access doors shall be mounted on multiple, stainless steel hinges and shall be secured by a latch system. Removable service panels secured by multiple mechanical fasteners are not acceptable.

.4 The unit base shall overhang the roof curb for positive water runoff and shall seat on the roof curb gasket to provide a positive, weathertight seal. Lifting brackets shall be provided on the unit base to accept cable or chain hooks for rigging the equipment.

2.3 FILTERS

.1 The filter section shall be provided with a 2 inch (50mm) prefilter rack and a 4 inch (100mm) final filter rack. A set of 2 inch (50mm) construction filters shall ship with the unit.

.2 Supply a spare set of 2 inch Merv 8-30% and 4 inch Merv 14-95% efficient filers for field installation by others.

2.4 OUTDOOR / RETURN AIR SECTION

.1 Unit shall be provided with an outdoor air economizer section. The economizer section shall include outdoor, return, and exhaust air dampers. The economizer operation shall be fully integral to the mechanical cooling and allow up to 100% of mechanical cooling if needed to maintain the cooling discharge air temperature. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include moisture eliminator filters to drain water away from the entering air stream. The outside and return air dampers shall be sized to handle 100% of the supply air volume. The dampers shall be parallel blade design. Damper blades shall be gasketed with side seals to provide an air leakage rate of 1.5 cfm / square foot of damper area at 1" differential pressure in according with testing defined in AMCA 500. A barometric exhaust damper shall be provided to exhaust air out of the back of the unit. A bird screen shall be provided to prevent infiltration of rain and foreign materials. Exhaust damper blades shall be lined with vinyl gasketing on contact edges.

.2 Control of the dampers shall be by a factory installed direct coupled actuator. Damper actuator shall be of the modulating, spring return type. A comparative enthalpy control shall be provided to sense and compare enthalpy in both the outdoor and return air streams to determine if outdoor air is suitable for "free" cooling. If outdoor air is suitable for "free" cooling, the outdoor air dampers shall modulate in response to the unit's temperature control system.

2.5 SUPPLY FAN

.1 Supply fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with fan blades that are continuously welded to the hub plate and end rim. The supply fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additonal maintenance.

.2 All fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance, prior to shipment.

.3 Supply fan and motor assembly combinations larger than 8 hp or 22" diameter shall be internally isolated on 1" deflection, spring isolators and include removable shipping tie downs.

.4 The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.

.5 The supply fan shall be capable of airflow modulation from 30% to 100% of the scheduled designed airflow. The fan shall not operate in a state of surge at any point within the modulation range.

2.6 EXHAUST FAN

.1 Exhaust fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with aluminum fan blades that are continuously welded to the hub plate and end rim. The exhaust fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.

.2 The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.

.3 The unit DDC controller shall provide building static pressure control. The unit controller shall provide proportional control of the exhaust fans from 25% to 100% of the supply air fan designed airflow to maintain the adjustable building pressure setpoint. The field shall mount the required sensing tubing from the building to the factory mounted building static pressure sensor.

2.7 COOLING COIL

.1 The indoor coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with a factory piped cooling coil and an ASHRAE 62.1 compliant double sloped drain pan.

.2 The direct expansion (DX) cooling coils shall be fabricated of seamless high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row, staggered tube design with a minimum of 3 rows. All cooling coils shall have an interlaced coil circuiting that keeps the full coil face active at all load conditions. All coils shall be factory leak tested with high pressure air under water.

.3 The cooling coil shall have an electronic controlled expansion valve. The unit controller shall control the expansion valve to maintain liquid subcooling and the superheat of the refrigerant system.

.4 The refrigerant suction lines shall be fully insulated from the expansion valve to the compressors.

.5 The drain pan shall be stainless steel and positively sloped. The slope of the drain pan shall be in two directions and comply with ASHRAE Standard 62.1. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall extend beyond the leaving side of the coil. The drain pan shall have a threaded drain connection extending through the unit base.

2.8 CONDENSING SECTION

.1 Outdoor coils shall be cast aluminum, micro-channel coils. Plate fins shall be protected and brazed between adjoining flat tubes such that they shall not extend outside the tubes. A sub-

cooling coil shall be an integral part of the main outdoor air coil. Each outdoor air coil shall be factory leak tested with high- pressure air under water.

.2 Fan motors shall be an ECM type motor for proportional control. The unit controller shall proportionally control the speed of the condenser fan motors to maintain the head pressure of the refrigerant circuit from ambient condition of 0-120°F. Mechanical cooling shall be provided to 0º F. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.

.3 The condenser fan shall be low noise blade design. Fan blade design shall be a dynamic profile for low tip speed. Fan blade shall be of a composite material

.4 The unit shall have scroll compressors. One of the compressors shall be an inverter compressor providing proportional control. The unit controller shall control the speed of the compressor to maintain the discharge air temperature. The inverter compressor shall have a separate oil pump and low oil safety protection.

.5 Pressure transducers shall be provided for the suction pressure and head pressure. Temperature sensor shall be provided for the suction temperature and the refrigerant discharge temperature of the compressors. All of the above devices shall be an input to the unit controller and the values be displayed at the unit controller.

.6 Each circuit shall be dehydrated and factory charged with R-410A Refrigerant and oi

2.9 AUXILIARY GAS HEATING SECTION

.1 The rooftop unit shall include a natural gas heating section. The gas furnace design shall be one natural gas fired heating module factory installed downstream of the supply air fan in the heat section. The heating module shall be a tubular design with in-shot gas burners.

.2 The gas burner shall have 10:1 modulating heating control.

.3 The heat exchanger tubes shall be constructed of stainless steel.

.4 The module shall have an induced draft fan that will maintain a negative pressure in the heat exchanger tubes for the removal of the flue gases.

.5 Each burner module shall have two flame roll-out safety protection switches and a high temperature limit switch that will shut the gas valve off upon detection of improper burner manifold operation. The induced draft fan shall have an airflow safety switch that will prevent the heating module from turning on in the event of no airflow in the flue chamber.

.6 The factory-installed DDC unit control system shall control the gas heat module. Field installed heating modules shall require a field ETL certification. The manufacturer’s rooftop unit ETL certification shall cover the complete unit including the gas heating modules.

2.10 HEAT PUMP HEATING

.1 The evaporator coil, condenser coil, compressors and refrigerant circuit shall be designed for heat pump operation. The refrigerant circuit shall contain a 4 way reversing valve for the heat pump operation. The outdoor coil shall have an electronic expansion valve to control the refrigerant flow. The unit controller shall modulate the expansion valve to maintain compressor operation within the compressor operational envelope.

.2 The refrigerant system shall have a pump-down cycle.

2.11 ENERGY RECOVERY WHEEL SECTION

.1 The rooftop unit shall be provided with an AHRI certified rotary wheel air-to-air heat exchanger in a cassette frame complete with seals, drive motor and drive belt. The energy recovery wheel shall be an integral part of the rooftop unit with unitary construction and does not require field assembly. Bolt-on energy recovery units that require field assembly and section to section gasketing and sealing are not acceptable.

.2 The wheel capacity, air pressure drop and effectiveness shall be AHRI certified per AHRI Standard 1060. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Heat Exchangers For Energy Recovery Ventilation Equipment.

.3 The rooftop unit shall be designed with a track so the entire energy recovery wheel cassette can slide out from the rooftop unit to facilitate cleaning.

.4 The unit shall have 2" Merv 7 filters for the outdoor air before the wheel to help keep the wheel clean and reduce maintenance. Filter access shall be by a hinged access door with ¼ turn latches.

.5 The matrix design shall have channels to reduce cross contamination between the outdoor air and the exhaust air. The layers shall be effectively captured in aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belt(s) of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.

.6 The total energy recovery wheel shall be coated with silica gel desiccant permanently bonded without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.

.7 Wheels shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning.

.8 Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel. Wheels shall be connected to the shaft by means of taper lock hubs.

.9 The control of the energy recovery wheel shall be an integral part of the rooftop unit's DDC controller. The DDC controller shall have visibility of the outdoor air temperature, leaving wheel temperature, return air temperature, and exhaust air temperature. These temperatures shall be displayed at the rooftop units DDC controller LCD display. All of these temperatures shall be made available through the BACnet interface.

.10 The rooftop unit DDC controller shall provide frost control for the energy recovery wheel. When a frost condition is encountered the unit controller shall slow down the wheel.

2.12 ELECTRICAL

.1 Each unit shall be wired and tested at the factory before shipment. Wiring shall comply with CSA standards. All wiring shall be number coded per the electrical wiring diagrams. All electrical components shall be labeled according to the electrical diagram and be CSA recognized.

.2 A terminal block shall be provided for the main power connection and a terminal board shall be provided for the low voltage control wiring. Knockouts shall be provided in the bottom of the main control panel for field wiring entrance. Branch short circuit protection, 115-volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit.

.3 Each compressor and condenser fan motor shall be furnished with contactors and internal thermal overload protection. Supply fan motors shall be supplied with external overload protection.

.4 A single non-fused disconnect switch shall be provided for disconnecting electrical power at the unit. Disconnect switches shall be mounted internally to the control panel and operated by an externally mounted handle

2.13 REFRIGERATION ONLY CONTROLS

.1 Provide a microprocessor based system to control all refrigeration functions including compressor speed, condenser fan function, unit safety protection, including compressor minimum run and minimum off times, and diagnostics. This system shall operate the unit at peak efficiency utilizing variable head pressure control and electronic expansion valve while maintaining the cooling, or heating in heat pump operation, call per third party control. The microprocessor control shall consist of only direct expansion required temperature sensors, pressure sensors, controller and keypad/display operator interface. Refrigeration sensors and controller shall be factory mounted, wired and tested.

.2 The microprocessor controls shall be solely dependent on communications with a 3rd party DDC rooftop controller supplied by the BAS contractor for proper unit operation. The microprocessor memory shall be protected from voltage fluctuations as well as any extended power failures. No commissioning settings shall be lost, even during extended power shutdowns

.3 The microprocessor controls shall be dependent on starting and stopping and modulation of the unit via terminal strip control and logic. The control system shall be capable of providing a remote alarm indication. The microprocessor shall provide compressor capacity & status, defrost status (heat pump only), condensate overflow alarm, and dirty filter alarm.

.4 All digital and analog inputs and outputs shall be protected against damage from transients or incorrect voltages. All field wiring shall be terminated at a separate, clearly marked terminal strip

.5 The keypad interface shall allow convenient navigation and access to the commissioning functions. The unit keypad/display character format shall be 4 lines x 20 characters. All control settings shall be password protected against unauthorized changes. For ease of service, the display format shall be English language readout. Coded formats with look-up tables will not be accepted. The user interaction with the display shall provide the following information as a minimum:

.1 Supply and exhaust fan speed control limits.

.2 Refrigeration alarm details.

.6 Unit to be provided with the following terminals for remote control by 3rd party DDC controller (BAS supplied):

.1 Compressor capacity command/status (Ao/Ai)

.2 Compressor capacity status (Bi)

.3 Supply fan S/S (Bo)

.4	Supply fan capacity	(Ao)
.5	Exhaust fan S/S	(Bo)
.6	Exhaust fan capacity	(Ao)
.7	Outdoor air damper	(Ao)
.8	Mode select (heat/cool)	(Bo)
.9	Heating Modulation/Enable	(Ao/Bo)
.10	Heat S/S	(Bo)
.11	Alarm Status	(Bi)
.12	Alarm Reset (120V)	(Bo)
.13	Airflow Measuring Station	(Ai)
.14	Outdoor Enthalpy Sensor	(Bi)
.15	Dirty Filter	(Bi)
.16	Energy Recovery Wheel S/S	(Bo)
.17	Energy Recovery Wheel Speed	(Ao)
.18	ERW Bypass Damper Position	(Bo)

.7 BAS contractor shall be responsible for supply and install of the following loose sensors as required to meet the specified sequences:

.1 Discharge air temperature

.2 Outdoor air temperature/humidity

.3 Return air temperature

.4 Entering/Leaving wheel temperature

.5 Duct static pressure

.6 Space temperature/humidity

.7 Space/building pressure

.8 Duct high limit

.9 CO2 measuring

.10 Airflow proving

.11 Condensate overflow

2.14 ROOF CURB

.1 A prefabricated heavy gauge galvanized steel, mounting curb shall be provided for field assembly on the roof decking prior to unit shipment. The roof curb shall be a full perimeter type with complete perimeter support of the roof top unit section and condensing section. The curb shall be a minimum of 36" high for side discharge for RTU-9A/9B and Curb adapter not higher than 14" for RTU-10,11 and 12 to suit the existing roof curb. Gasket shall be provided for field mounting between the unit base and roof curb. The roof curb shall be approved by the National Roofing Contractors Association.

3 Execution

3.1 INSTALLATION OF ROOF TOP UNIT

.1 Provide a Electric cooling-Heat pump with Auxiliary gas fired air unit on roof.

.2 Unless otherwise specified or required, provide required rigging and hoisting/moving equipment required to move units to required location. Perform rigging/hoisting/moving in accordance with unit manufacturer's directions and details.

.3 Supply a curb for each unit, assemble curb, and hand curb to roofing trade on roof for installation and flashing into roof construction. Provide continuous gasketing around perimeter of curb between curb and unit mounting frame. Insulate curb with rigid weather-proof board type insulation in accordance with curb manufacturer's details.

.4 Install components shipped loose with units. Install a discharge air temperature sensor in supply ductwork approximately 2 m (6-½') downstream of unit and in accordance with manufacturer's recommendations.

.5 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.

.6 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.

3.2 CLOSEOUT ACTIVITIES

.1 Include for a 1/2 day on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

End of Section

Refer to enclosed Appendix B - CoM Master Specifications for Energy Management Control Systems (EMCS) Rev 01 - April 5 2021.

AMERESCO
Green • Clean • Sustainable

City of Mississauga

Master Specifications for Energy Management Control Systems (EMCS)

MISSISSAUGA

Revised: 2021-04-05
Rev. 1

Abstract of Revisions

Rev. #	Issue Date	Description of Revision	Impacted Section/Para/Line	Prepared by:	
D1	July 29, 2020	First Draft	All	G. McCuaig	Ameresco
0	October 26, 2020	First Issue	All	G.McCuaig	Ameresco
1	April 5, 2021	Revision 1	20 05 01, Part 1.5, 1.5.2.8	G. McCuaig	Ameresco
1	April 5, 2021	Revision 1	20 05 01, Part 1.5, 1.6.2.3	G. McCuaig	Ameresco
1	April 5, 2021	Revision 1	Appendix B6 – Sample Project Specification EMCS Section	G.McCuaig	Ameresco

TABLE OF CONTENTS

END OF SECTION

EMCS DESIGN GUIDELINES

EMCS DESIGN GUIDELINES

Part 1 General Overview

1.1 General Overview of the CoM BAS Initiative (2020)

1.1.1 The City of Mississauga (CoM) is a progressive and leading-edge community in the GTA. Directed by the City's Climate Change Plan and Corporate Green Building Standard, energy management and sustainability are of high importance for the future city development. Recognizing this direction, the strategy of development and architecture of Building Automation Systems (BAS), as a crucial tool in controlling building HVAC, lighting, ice-making and other systems, is of the utmost importance. This document serves to provide a clear and concise strategy on the design of new BAS systems and their related inter-operability with other city-wide systems.

1.1.2 The CoM operates more than 350 buildings of various types including offices, ice rinks, pools, community centres, fire stations, libraries, parks, etc In 2020 the CoM set out to create a new BAS/EMCS standards for the purposes of insuring consistency in the design, installation and operation of BAS controls within those facilities with the intent of modernization and upgrading to meet the standards of the next generation of Smart Buildings and Internet of Things (IOT).

1.1.3 A pre-qualification of BAS/EMCS products and vendors to install and service them has been carried out and a CoM Master EMCS Upgrade Specifications has been created to outline the standards for both product an installation. All CoM Pre-Qualified BAS Vendors should be familiar with these CoM Master EMCS Upgrade Specifications and the Standards outlined within.

1.2 Basis of Design

1.2.1 The basis of design for CoM EMCS Upgrades incorporates a dedicated CoM Enterprise server (or virtual server) complete with operating system, all necessary software tools, and an EMCS Enterprise Server Software (ESS) package that has a fully open and accessible licensing structure. The design also includes a second back-up server for storage of all system database parameters including back-up of all BAS Vendor specific field controller programming, trend data, and color graphics. Both servers are located in a CoM designated server room and be connected to the CoM wide area network ("WAN") for communication to multiple sites and multiple EMCS products.

1.2.2 The new system architecture utilizes Tridium Niagara Framework N4 as the pre-selected EMCS ESS package. Vendors shall coordinate with the CoM prior to the start of any project to determine the current Revision of Software in use and to be applied to SRPDC.

1.2.3 The anticipated EMCS upgrade work involved at each facility including new construction projects shall comprise the supply and installation of a new supervisory remote digital controller ("SRPDC"), BAS Sub-Network Controllers (SNC), remote programable digital controllers ("RPDC"), terminal equipment controllers ("TEC") and connection to other original equipment manufacturer application specific controllers ("OEMASC") over EMCS vendor supplied communication network(s).

1.2.4 The EMCS vendor supplied SRPDC shall be a Tridium Niagara JACE 8000 Series controllers. EMCS vendor supplied SNC shall be Tridium Niagara Edge controller(s) connected to EMCS/BAS vendor specific RPDC, TEC, and OEMASC over a field network

EMCS DESIGN GUIDELINES

utilizing BAC-net communication protocol in an open, able to exchange information system. (Where direction has been provided from CoM to connect to existing LON based controllers, LON Communication may be used).

1.2.5 Refer to Part 1.8 of this section for System Architecture and Communication Protocols.

1.2.6 All SRPDC, RPDC, TEC, EMCS Routers/Switches, etc. to be in lockable NEMA rated enclosures (except where otherwise indicated – i.e. VAV Box TEC may be mounted directly on the VAV Box). If in doubt, seek clarification from CoM before submitting a quotation on any project.

1.2.7 All graphics, EMCS programming, trend data, security settings, access level priorities, etc. shall be uploaded by the EMCS vendor(s) and stored on the Server for each project (without need for the involvement of others). This shall be repeated at the start of commissioning and again upon completion of deficiency clean-up and as-builts. Remote access will be provided in accordance with current City of Mississauga IT policies, procedures, and processes.

1.3 Original Equipment Manufacturer Application Specific Controllers (OEMASC).

1.3.1 The use of dedicated equipment controls supplied by others shall be pre-approved by the City of Mississauga Facilities Management prior to design and specification.

1.3.2 All equipment of this nature shall come with a BAC-net compliant communications interface communicating via BAC-net IP (or approved equivalent that is supported by the Pre-Qualified DDC Vendor Hardware interface modules – i.e. LON/Modbus/etc.). The use of Non-BAC-net communication protocols shall only be considered if Bac-Net IP is not available.

1.3.3 Design consultant shall fully identify and indicate the relationship between the EMCS and the dedicated controls for specific HVAC equipment as supplied by others, spelling out the points to be monitored, points to be modified, how and where to display on the graphics, responsibility of HVAC equipment representative and EMCS vendor for programming, graphics and interface, etc.

1.3.4 Connection to the OEM supplied controls shall be via a dedicated Sub-Net communication BUS running from the SNC to the OEMASC's. Please refer to the City of Mississauga System Architecture Diagrams (Appendix A4)

1.3.5 The OEMASC are mentioned in the CoM Master EMCS Upgrade Specifications, Section 253001-EMCS: Building Controllers, are to be stand-alone microprocessor-based controllers that handle the staging, sequencing, control and coordination of specific HVAC equipment and related systems components (Example Chillers/Boilers AHU's/ Other) or a dedicated application specific control system (example, Lighting Control, Power Monitoring, etc). This provides a sole source of responsibility for the equipment's performance to avoid damage to the equipment, to increase safety, and to increase vendor and manufacturer responsiveness during problem solving.

1.3.6 All OEMASC shall be a fully BAC-net compliant devices in order to facilitate interoperability between OEM electrical/mechanical sub-systems and BAC-net EMCS. The use of a gateway/protocol translator shall not be allowed.

EMCS DESIGN GUIDELINES

1.3.7 The OEM shall provide any software or hardware required to access or modify any electrical/mechanical subsystems *i.e. RTUs, VSD's, Chillers, Lighting controls and /or Electrical Monitoring & metering.

1.3.8 All submittals for both EMCS and OEM supplied equipment shall identify the interface between EMCS and OEM supplied controller including available points to read/write between systems.

1.3.9 Set up, testing and commissioning of the interface between OEMASC and the EMCS control system shall be carried out with both parties (OEM Programmer and EMCS Programmer) present on site to ensure the proper communication set up and establishing control priority levels and parameters. The cost of these services shall be included in the price from both vendors.

1.3.10 Specifying Consultant shall ensure to include for provision of any necessary OEM Configuration Tools and Licenses as required to connect and setup the OEM controllers and the interface to base EMCS system.

1.4 Purpose of the Guideline

1.4.1 The purpose of this Guideline is to provide the Project Manager, Specifying Design Engineer/Consultant, and other CoM staff involved with evaluation of BAS related projects, with an overview of the CoM EMCS design philosophy.

1.4.2 The Guideline outlines the design requirements for; point naming conventions, typical points and standard sequences of operation, alarming, alarm routing, training needs, commissioning, and the project turn-over process. It also details the CoM approval process (to be followed by Consultant and Contractor) from concept design through to final commissioning and turn-over.

1.5 Role of Consultant and the Use of the CoM Master EMCS Upgrade Specifications

1.5.1 The Master EMCS Upgrade Specifications shall be used as the basis of all EMCS design work for the City of Mississauga facilities.

1.5.2 Design Engineers/Consultants working for the CoM shall create their own project specific EMCS specifications to the extent necessary to meet the needs of the specific project and incorporating the elements and design principals of these Master Specifications. The project specifications shall make clear reference to the sections of these **City of Mississauga Master EMCS Upgrade Specifications** (Current Revision) within their own design document (in Division 25) .

1.5.3 Project based EMCS specifications issued by Design Engineers/Consultants for the design and specification of HVAC controls shall not deviate from the basic concepts and requirements set forth in the **CoM Master EMCS Upgrade Specifications**. The Master specifications provide details of the CoM expectations an requirements for:

- Removal of Existing
- Hardware/Devices Standards
- Wiring/Network Standards

EMCS DESIGN GUIDELINES

- Installation Standards
- Alarms and Alarm Routing
- Trend setup
- Active Directory and User Access Levels

1.5.4 The Design Engineer/Consultant should also clearly identify that it is the **City of Mississauga Pre-Qualified EMCS Vendor's** responsibility to make note of any deviations between the Project Specific Specifications and **City of Mississauga Master Specifications for EMCS Upgrades (Current Revision)**. Such deviations shall be brought to the attention of the City of Mississauga project manager prior to tender closing.

1.5.5 The Design Engineer/Consultant's primary input for new EMCS installations and modifications will be as follows;

- Summary Point Matrix including an indication of points/equipment to be controlled, and locations on the drawings.
- The Sequence of Operation for Equipment to be controlled
- Control System Schematic Drawings
- EMCS Design Consultant shall make use of the material provided in the **Appendices** of the Master Specifications and attached to this Guideline including:
    - A1- CoM Point Naming Convention
    - A2- CoM Building ID and Type List
    - A3- CoM EMCS Cabinet Installation Standard
    - A4- CoM System Architectures
    - A5- CoM Graphical Standard
    - A6- CoM Points List and Typical Sequences of Operation
    - B1 – CoM Points List Template
    - B2 – CoM Sample Points List
    - B3 – CoM Pre-Commissioning Checklist Form
    - B4 – CoM Project Acceptance Form
    - B5 – CoM Training Sign-Off Form
    - B6 – CoM Sample Project Specification EMCS Section
- Electronic versions will be made available to the Consultant and shall be modified/completed to meet the particular project needs of individual projects.

1.5.6 **Note to Contractors:** The **CoM Master EMCS Upgrade Specifications** document should be read in conjunction with the Project Specific Design and Specifications for any New and/or Replacement Energy Management Control System (EMCS), and EMCS upgrade projects designed for the City of Mississauga, Ontario.

1.5.7 Because the **CoM Master EMCS Upgrade Specifications** are periodically updated, the current and most recent version of this document should be obtained directly from the City of Mississauga, Ontario Project Manager at the start of each project.

EMCS DESIGN GUIDELINES

1.6 Creation of Points List and Point Naming Convention

1.6.1 Consultants must adhere to CoM Standards for points list and point naming convention, please refer to attached **Appendices A1 and A6**.

1.7 Application of Building ID and Type

1.7.1 Each CoM has a unique **Building ID** tag which shall form a part of the point name and is to be used in the integration of other software applications (Room Booking, Asset Planning, etc) with the EMCS. The application of sequences applies different operational modes and control settings based on **Building Type**. Refer to Appendix A2 for a list of Building ID tags and Type of facility. Refer to Appendix A6 for the application of different control modes.

1.8 System Architecture and Communication Protocols

1.8.1 The System Architecture is dependent on the size of facility, type of project, and the availability of CoM IT infrastructure **refer to Appendix A4**. Design Engineer/Consultant should discuss the different system topologies and obtain approvals for the final selection of appropriate System Architecture design.

1.8.2 The intended design of all specified system Architectures requires an SRPDC, set-up and programmed to manage and monitor communication between SNC and/or all field level controllers (RPDC, TEC, OEMASC). All EMCS field level controllers shall be capable of standalone operation on loss of communication with the SRPDC and/or SNC. No physical control points shall reside on the either the SRPDC or SNC.

1.8.3 All system graphics, EMCS programming, trend data, security settings, access level priorities, etc shall be uploaded by the EMCS/BAS vendor(s) and stored on the Server (without need for the involvement of the other contractors).

1.9 Application of Typical System Points List and Standard Sequences

1.9.1 In order to maintain consistency in both the design and operation of BAS control systems, the CoM has developed a list of Typical Points and Standard Sequence of Operation to be applied to each typical system.

1.9.2 The standard sequences are generic in nature and are meant to form the basis of design for all CoM BAS control projects. The sequences shall be used as the initial starting point for each project, customized by the specifying Design Engineer/Consultant and tailored for the specifics of individual project and system requirements. Refer to **Appendix A6** for typical points and standard sequences.

1.9.3 All project specific sequences are to be submitted to the CoM for review and approval prior to Tenders (refer to Guideline Part 1.13 **BAS Design and Construction Approval Process).**

1.9.4 Final schedules, set-points, limits, dead bands, etc shall be determined during commissioning and then documented in the as-built drawings and final project close out documentation.

EMCS DESIGN GUIDELINES

1.9.5 Where new HVAC systems/design concepts are not listed in the Appendices, the Design Engineer/Consultant shall follow the same naming convention format and broader BAS design principles as outlined in the **CoM Master EMCS Upgrade Specifications** to create a new Points List and Typical Sequence of Operation for integration and use in the subsequent revisions of **CoM Master EMCS Upgrade Specifications**. Once created by Design Engineer/Consultant, the points list and sequences will be presented to the CoM Project Manager for distribution to Stakeholders, review and approval.

1.10 CoM Graphical Standards

1.10.1 The CoM uses a common graphical interface for all sites, set-up and designed specifically to the CoM organizational structure and user access requirements. Each project shall conform to the Graphical Standard and shall seek approval of system graphics before deploying them on site.

1.10.2 Each project will require the full development of **NEW** site-specific customized graphics in accordance with the CoM Graphical Standard as outlined **Appendix A5**. The contractor shall utilize the CoM Graphical Standard in conjunction with existing completed graphical workstation(s) as the starting point of development of new graphics. BAS Vendor shall work closely with the CoM assigned approver and Design Engineer/Consultant to create project/site specific custom graphics.

1.10.3 To accomplish the above, the BAS Vendor shall meet with the Owner and Design Engineer/Consultant within 2 weeks of the Project Start-Up meeting to specifically discuss the requirements for new system graphics and associated plan of execution.

1.10.4 The BAS Vendor and Design Engineer/Consultant shall anticipate a reiterative process whereby the graphics will be submitted multiple times for review and comment, followed by revision(s) until both the Owner is satisfied with the end result (and graphics approval is granted).

1.11 CoM Alarming & Guideline

1.11.1 Refer to **Appendix A6, Part 1.4 Alarm Management** and subsequent Typical Sequence of operation.

1.12 CoM Commissioning Standards

1.12.1 The commissioning agent (Cx) may be a third party service, design consultant, or CoM employee as designated and outline in the Consultant's project specifications.

1.12.2 Anticipated commissioning process and the role of the EMCS vendor are referenced in these Master Specifications Section 01 91 13 and Section 25 01 11

1.13 BAS Design and Construction Approval Process

1.13.1 All new EMCS designs shall be submitted to the City of Mississauga Facilities Management for review prior to tendering of any projects

1.13.2 Preliminary Design Review:

- Assigned CoM Approver to review:
- The use of Correct Point Naming convention

EMCS DESIGN GUIDELINES

- The specification of required points and application of correct sequences (Refer **to Appendix A1 and A6** for Point Naming Convention, Points Lists and Standard Sequence of Operation)

1.13.3 Final Design Review (prior to tender):

- Assigned CoM Approver to review:
- Specification uses correct references to **CoM Master EMCS Upgrade Specifications for EMCS Upgrade** (of latest revision)
- Correct use of (or reference to) CoM BAS Forms and Standards (Refer to **Appendix A and B**)
- Proper description of system Architecture and the Pre-Approved Products/ Pre-Qualified Vendors (Refer to **Appendix A4** and **CoM List of Pre-Approved Vendors/Products**)
- Proper reference to additional CoM Submittal and Close-Out Documentation approval process
- Inclusion of CoM Forms for Commissioning/Closeout/Training Approval (Refer to **Appendix B3, B4 and B5)**

1.13.4 Pre-Construction /Submittal Review

- Following the Design/Tender phase the next review by CoM Assigned Approver shall occur during the Pre-Construction Phase. Specifying project Design Engineer/Consultant shall also be responsible to conduct their OWN engineering review concurrently with the CoM review, and shall incorporate the CoM Assigned Approver's comments on the returned shop drawings.
- Assigned CoM Approver to review submittals to confirm:
- Conformance to the specified products and installation standards detailed in the CoM Master EMCS Upgrade Specifications (Refer to **CoM Master EMCS Upgrade Specifications Section 25 30 01 EMCS Building Controllers Family of Controllers, and Section 25 30 02 EMCS Field Control Devices**)
- Shop drawing submittal package has all necessary information (Refer to CoM Master EMCS Upgrade Specifications Section 25 05 02 EMCS Submittals and Review Process)
- Design has correct System Architecture and the Use of Pre-Qualified Products
- Application of Correct Sequences and Points/System
- Use of proper point naming convention

1.13.5 Construction Phase Review:

- Assigned CoM Approver to review close-out submittals to confirm:
- System graphics have been reviewed by CoM Facility Operations to ensure conformance with CoM Graphical Standard (Refer to **Appendix A5**)
- Graphics have been tested by CoM Facility Operations and/or Commissioning Agent to confirm that:
- Links are operational and correct,

EMCS DESIGN GUIDELINES

- PDF of As-Builts and written sequences are properly linked to the graphics and are up to date with final settings,
- active directory and user access levels are correct and functional
- specified database integration (ie room booking software) is functional and correctly linked to proper systems
- Activity Modes have been set-up and programmed including display of active operational mode on system graphics,
- All alarms (Environmental, Maintenance, Critical, Energy) are set up and alarm routing is correct.
- All systems graphics have an associated settings page with all adjustable control variables, alarm settings and time delays.
- Verification of Trend Data Set-Up, Auto Back-up of Files & software
- Site Verification that CoM Demolition & Installation standards have been met.
- Review of Closeout Data (CoM Forms – Provisional Acceptance, Commissioning Reports, Final Acceptance, Training Acknowledgement, etc). Refer to **Appendix B**

END OF SECTION

SUBMITTAL PROCEDURES

SUBMITTAL PROCEDURES

Part 1 General

1.1 RELATED REQUIREMENTS

1.1.1 Section 25 05 01 EMCS General Requirements.

1.1.2 Section 25 05 02 EMCS Submittals and Review Process

1.2 REFERENCES

1.2.1 None

1.3 ADMINISTRATIVE

1.3.1 Submit to Consultant submittals listed for review. Submit promptly and in orderly sequence to not cause delay in Work. Failure to submit in ample time is not considered a sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.

1.3.2 Do not proceed with Work affected by submittal until review is complete.

1.3.3 Present shop drawings, product data, samples and mock-ups in SI Metric units.

1.3.4 Where items or information is not produced in SI Metric units converted values are acceptable.

1.3.5 Review submittals prior to submission to Consultant. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and co-ordinated with requirements of Work and Contract Documents. Submittals not stamped, signed, dated and identified as to specific project will be returned without being examined and considered rejected.

1.3.6 Notify Consultant, in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.

1.3.7 Verify field measurements and affected adjacent Work are co-ordinated.

1.3.8 Contractor's responsibility for errors and omissions in submission is not relieved by Consultant's review of submittals.

1.3.9 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved Consultant review.

1.3.10 Keep one reviewed copy of each submission on site.

1.4 SHOP DRAWINGS AND PRODUCT DATA

1.4.1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.

1.4.2 Where applicable as indicated elsewhere, submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

1.4.3 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for

completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.

1.4.4 Allow 10 days for Consultant's review of each submission.

1.4.5 Adjustments made on shop drawings by Consultant are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Consultant prior to proceeding with Work.

1.4.6 Make changes in shop drawings as Consultant may require, consistent with Contract Documents. When resubmitting, notify Consultant in writing of revisions other than those requested.

1.4.7 Accompany submissions with transmittal letter containing:

- 1.4.7.1 Date
- 1.4.7.2 Project title and number
- 1.4.7.3 Contractor's name and address
- 1.4.7.4 Identification and quantity of each shop drawing, product data and sample
- 1.4.7.5 Other pertinent data

1.4.8 Submissions include:

- 1.4.8.1 Date and revision dates
- 1.4.8.2 Project title and number
- 1.4.8.3 Name and address of:
  - 1.4.8.3.1 Subcontractor
  - 1.4.8.3.2 Supplier
  - 1.4.8.3.3 Manufacturer
- 1.4.8.4 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.
- 1.4.8.5 Details of appropriate portions of Work as applicable:
  - 1.4.8.5.1 Fabrication.
  - 1.4.8.5.2 Layout, showing dimensions, including identified field dimensions, and clearances.
  - 1.4.8.5.3 Setting or erection details.
  - 1.4.8.5.4 Capacities.
  - 1.4.8.5.5 Performance characteristics.
  - 1.4.8.5.6 Standards.
  - 1.4.8.5.7 Operating weight.
  - 1.4.8.5.8 Wiring diagrams.
  - 1.4.8.5.9 Single line and schematic diagrams.
  - 1.4.8.5.10 Relationship to adjacent work.

SUBMITTAL PROCEDURES

1.4.9 After Consultant's review, distribute copies.

1.4.10 Submit electronic copy of shop drawings for each requirement requested in specification Sections and as Consultant may reasonably request.

1.4.11 Submit electronic copies of product data sheets or brochures for requirements requested in specification Sections and as requested by Consultant where shop drawings will not be prepared due to standardized manufacture of product.

1.4.12 Submit electronic copies of test reports for requirements requested in specification Sections and as requested by Consultant.

1.4.12.1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.

1.4.12.2 Testing must have been within 3 years of date of contract award for project.

1.4.13 Submit electronic copies of certificates for requirements requested in specification Sections and as requested by Consultant.

1.4.13.1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.

1.4.13.2 Certificates must be dated after award of project contract complete with project name.

1.4.14 Submit electronic copies of manufacturer’s instructions for requirements requested in specification Sections and as requested by Consultant.

1.4.14.1 Pre-printed material describing installation of product, system or material, including special notices and Material Safety Data Sheets concerning impedances, hazards and safety precautions.

1.4.15 Submit electronic copies of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by Consultant.

1.4.16 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.

1.4.17 Submit electronic copies of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Consultant.

1.4.18 Delete information not applicable to project.

1.4.19 Supplement standard information to provide details applicable to project.

1.4.20 If upon review by Consultant, no errors or omissions are discovered or if only minor corrections are made, copies will be returned, and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.

SUBMITTAL PROCEDURES

1.5 SAMPLES

1.5.1 Submit for review samples in duplicate as requested in respective specification Sections. Label samples with origin and intended use.

1.5.2 Deliver samples prepaid to Consultant's business address.

1.5.3 Notify Consultant in writing, at time of submission of deviations in samples from requirements of Contract Documents.

1.5.4 Where colour, pattern or texture is criterion, submit full range of samples.

1.5.5 Adjustments made on samples by Consultant are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Consultant prior to proceeding with Work.

1.5.6 Make changes in samples which Consultant may require, consistent with Contract Documents.

1.5.7 Reviewed and accepted samples will become standard of workmanship and material against which installed Work will be verified.

1.6 MOCK-UPS

1.6.1 N/A

1.7 CERTIFICATES AND TRANSCRIPTS

1.7.1 Immediately after award of Contract, submit Workers' Compensation Board status.

1.7.2 Submit transcription of insurance immediately after award of Contract.

Part 2 Products

2.1 NOT USED

2.1.1 Not Used.

Part 3 Execution

3.1 NOT USED

3.1.1 Not Used.

END OF SECTION 01 33 00

REGULATORY REQUIREMENTS

REGULATORY REQUIREMENTS

Part 1 General

1.1 REFERENCES

1.1.1 Ontario Building Code (Latest Edition)

1.2 RELATED SECTIONS

1.2.1 All

1.3 CODES, BY-LAWS, REGULATIONS, ORDINANCES

1.3.1 Carry out work in accordance with requirements of the latest edition of the applicable provincial building code, including all amendments and revisions.

1.3.2 Comply with requirements, regulations and ordinances of other authorities having jurisdiction.

1.3.3 Where it is necessary to carry out work outside property lines, such as sidewalks, paving, concrete curbs, service connections, comply with applicable requirements of municipal authorities having jurisdiction. Any permits and fees associated with this work shall be included in the Contract price.

1.3.4 Codes, by-laws, regulations, ordinances referred to in these Contract Documents are the latest published edition including published revisions and amendment, at time of Tender Submission.

1.3.5 In case of conflict between codes, by-laws, regulations, ordinances, specifications, follow most stringent requirements.

1.4 FIRE PROTECTION REQUIREMENTS

1.4.1 Refer to technical section of specifications and drawings for specific fire protection requirements.

1.4.2 Test methods used to determine fire hazard classification and fire endurance rating shall be as required by The Building Code.

1.4.3 Upon request, furnish the Owner with evidence of compliance with project fire protection requirements.

1.4.4 Materials and components used to construct fire rated assemblies and materials requiring fire hazard classification shall be listed and labelled, or otherwise approved, by fire rating authority. Labelled materials and their packaging shall bear fire rating authorities label showing product classification.

1.4.5 Materials having a fire hazard classification shall be applied/installed in accordance with manufacturer’s directions.

1.4.6 Fire rated assemblies shall be constructed in strict accordance with applicable assembly design report. Deviation will not be allowed.

1.4.7 Construct fire rated assemblies as continuous, uninterrupted elements except for permitted openings. Extend fire rated walls and partitions from floor to underside of structural deck above.

1.4.8 Fill and patch voids and gaps around opening and penetrations in and at perimeter of fire rated assemblies to maintain continuity and integrity of fire separation and smoke seal to the requirements of jurisdictional authorities.

REGULATORY REQUIREMENTS

Part 2 Products

2.1 NOT USED

2.1.1 Not Used.

Part 3 Execution

3.1 NOT USED

3.1.1 Not Used.

END OF SECTION 01 41 00

QUALITY CONTROL

QUALITY CONTROL

Part 1 General

1.1 RELATED SECTION

1.1.1 All

1.2 REFERENCES

1.2.1 Canadian Construction Association

1.2.1.1 CCA-1 Stipulated Price Subcontract

1.3 INSPECTION OF WORK

1.3.1 The Owner, Consultant, and Commissioning Agent are to have access to the work for inspection purposes. Co-operate and provide such access.

1.3.2 Give timely notice requesting inspection if work is designated for special tests, inspections or approvals or if work is to be covered up.

1.3.3 Any work which is covered or permitted to be covered that is subject to inspection or before any special tests and approvals are completed is to be uncovered and have the inspections satisfactorily completed. Pay costs of such remedial work.

1.3.4 Arrange for and be responsible for all required inspections of the Work including mechanical and electrical inspections.

1.3.5 Make all payments required for inspection permits.

1.3.6 Inform all inspection agencies of need for inspections.

1.3.7 Request that Consultant conduct all inspections concerning changes in the Work and requests for payment.

1.4 REJECTED WORK

1.4.1 Defective work, whether the result of poor workmanship, use of defective materials or damage through carelessness or other act, and whether incorporated in the work or not, which has been rejected by the owner as failing to conform to the Contract documents, is to be removed promptly and replaced in accordance with the Contract documents at the Contractor's expense.

1.4.2 If in the opinion of Consultant, it is not expedient to correct defective work, or work not done in accordance with the Contract documents, Consultant may deduct from the Contract price the difference in value between the work done and that called for in the Contract documents, the amount of which is to be determined by Consultant.

1.5 STANDARDS

1.5.1 Within the text of these specifications, reference is made to the following standards:

1.5.1.1 ASTM - American Society for Testing and Materials

1.5.1.2 CAN/CGSB - Canadian General Standards Board

1.5.1.3 CSA - Canadian Standards Association

1.5.1.4 FM - Factory Mutual Engineering Corporation

1.5.1.5 ULC - Underwriters' Laboratories of Canada

1.5.1.6 CGA - Canadian Gas Association

QUALITY CONTROL

1.5.2 The testing of materials not elsewhere specified, or normally carried out as a matter of standard construction practice, may be requested by Consultant to prove conformance with Standards, and will be paid for by Consultant. Materials that fail are to be replaced and re-tested at the Contractor's expense and costs incurred by the Owner for the original test(s) shall be deducted from the Contract value.

1.5.3 The referenced standards and any amendments on the day of receipt of tenders shall be applicable to the work during the duration of the Contract, unless otherwise specified.

1.6 CONTRACTOR'S RESPONSIBILITIES *(IF TESTING IS REQUIRED)*

1.6.1 Contractor shall be responsible for all of the following:

1.6.1.1 Notify the Owner and testing agency minimum 48 hours in advance of operations to allow for assignment of personnel and scheduling of tests without causing delay in work.

1.6.1.2 Provide testing agency with access to work at all time.

1.6.1.3 Supply casual labour and other incidental services required by testing agency.

1.6.2 When initial inspection and testing indicates non-compliance with Contract documents, any subsequent re-inspection and re-testing occasioned by non-compliance shall be performed by same testing agency at the Contractor's cost.

1.6.3 When initial inspection and testing indicates non-compliance with Contract documents, costs of that initial inspection and testing shall be charged to the Contractor.

1.7 TOLERANCES FOR INSTALLATION OF WORK

1.7.1.1 Unless acceptable tolerances are otherwise specified in a Section or are otherwise required for proper functioning of equipment, tolerances for site services, and mechanical and electrical systems are defined as follows:

1.7.1.2 "Plumb and Level" shall mean plumb or level within 1 mm in 1 metre.

1.7.1.3 "Square" shall mean not in excess of 10 seconds lesser or greater than 90 degrees.

1.7.1.4 "Straight" shall mean within 1 mm under or over a 1 Metre long straightedge

1.7.2 All work must be installed in accordance with the tolerances specified in Paragraph 1.7 above.

Part 2 Products

2.1 Not Used

Part 3 Execution

3.1 Not Used

END OF SECTION 01 45 00

CLOSEOUT PROCEDURES

CLOSEOUT PROCEDURES

Part 1 General

1.1 RELATED REQUIREMENTS

1.1.1 01 33 00 Submittal Procedures

1.1.2 01 78 00 Closeout Submittals

1.1.3 25 01 11 EMCS Start-Up, Verification and Commissioning.

1.2 REFERENCES

1.2.1 None

1.3 DEFINITIONS OF ACCEPTANCE TERMS

1.3.1 Real End of the Work

1.3.1.1 The work shall be considered finished when the deficiencies are completed in accordance to Consultant's evaluation.

1.3.2 Contractor's Inspection

1.3.2.1 The Contractor and his subcontractors shall conduct an initial inspection of the work prior to Pre-Commissioning Activities (functional testing, performance testing, etc.) and shall attempt to correct all noted deficiencies. Contractor is to provide a written list of deficiencies to the Owner and Consultant using the City of Mississauga Project Close Out Provisional Acceptance Forms.

1.3.3 Provisional Acceptance

1.3.3.1 The provisional acceptance shall follow the end of work on site as necessary to obtain substantial completion and shall signal the start of the warranty.

1.3.3.2 The Contractor shall make a request for the provisional acceptance by completing City of Mississauga ***Project Close Out Provisional Acceptance Form*** and related functional testing. This shall occur only when the system has been completely installed, calibrated, tested and is operational

1.3.3.3 Provisional Acceptance forms must be signed off by Contractor/Owner/Consultant, marking the mutual agreement of Substantial Completion of the system.

1.3.3.4 If Consultant judges that the tests are not adequately done by the Contractor prior to his request for provisional acceptance, the charges incurred by the Consultant and/or commissioning agent for an additional visit shall be charged to the Contractor.

1.3.4 Final Inspection:

1.3.4.1 Consultant, Contractor, and Owner to inspect Work and identify defects and deficiencies.

1.3.4.2 Contractor to correct Work as directed prior to Commissioning.

1.3.5 Commissioning

1.3.5.1 Commissioning shall be carried out by the contractor and Owner's designate commissioning agent only after Provisional acceptance has been granted.

1.3.5.2 As a part of the new control system installation, the contractor shall first fully test and commission the entire system. All pre-commissioning activities and testing shall be fully documented and submitted with the Provisional Acceptance Forms. This includes a full point-to point check-out (functional test) of the system, provide completed Pre-commissioning (Functional Test) Check List to Owner's designate Commissioning Agent.

1.3.5.3 Contractor shall assistance, staff and materials to support the Owner's designate Commissioning Agent activities.

1.3.5.4 Contractor's designate programmer/control technician to carry out the operator commands and adjustments to software parameters as directed by the Owners designated Commissioning Agent.

1.3.5.5 Owners designate commissioning agent to prepare commissioning report outlining results of functional and performance testing including a list of any outstanding deficiencies to be completed by the contractor to obtain Final Acceptance.

1.3.6 Final Acceptance

1.3.6.1 Application for final acceptance shall follow within a maximum of ten (10) working days from receipt of Commissioning report. Contractor shall complete all outstanding deficiencies, submitted as built and O&M documentation and completed training to receive Final Acceptance.

1.3.6.2 Final Acceptance forms must be signed off by Contractor/Owner/Consultant, marking the mutual agreement of acceptance of the system.

1.4 TAKE OVER PROCEDURE

1.4.1 Substantial Completion

1.4.1.1 Refer to Part 1 above for definition of terms for acceptance. All Forms must be completed by the Contractor, Submitted and Signed by all parties (Contractor/Consultant/Owner) for a stage to be considered Complete

1.4.1.2 Substantial Completion cannot be granted without completed and signed City of Mississauga ***Project Close Out Provisional Acceptance Forms***.

1.4.1.3 When the Contractor is satisfied that all deficiencies have been corrected, the Contractor shall request, in writing, a Substantial Completion Inspection along with the submission of the ***Project Close Out Provisional Acceptance Form***. Once forms are submitted there will be a Final Inspection to confirm completion, the inspection team shall consist of the Owner, Consultant and Contractor.

1.4.1.4 **Final Inspection**: Contractor to complete the ***Project Close Out Provisional Acceptance Forms*** and Submit to the Owner and Consultant indicating satisfactory completion of the "Contractor's Inspection" and signifying readiness for Final Inspection. Commissioning shall be scheduled but cannot take place until the Final Inspection is complete. Inspection Team shall conduct a final inspection of the system installation and create a list of any noted additional deficiencies.

CLOSEOUT PROCEDURES

1.4.1.5 **Deficiencies**: Following final inspection, a list of all noted deficiencies to date shall be drawn up and include with the deficiencies previously listed on the back pages of ***Project Close Out Provisional Acceptance Form***. The Contractor shall correct all deficiencies in a satisfactory manner and within agreed upon timelines.

1.4.1.6 **Declaration of Completion:** (Signed Project Close Out Provisional Acceptance Form): When it is mutually agreed upon by the inspection team that the work needed for Provisional Acceptance is complete, and the value of outstanding work is less than the contractual obligations required for Substantial Completion (per contract documents) all parities shall sign the "***Project Close Out Provisional Acceptance Form***" and shall agree upon the date to be noted for Substantial Completion.

1.4.1.7 **Certificate of Substantial Completion**: The Owner or Payment Certifier will state in writing, upon agreement with the above declaration, their approval of the inspected work, as "Substantially Complete." The Contractor shall publish this Certificate of Substantial Completion in a recognized industry trade journal (e.g. Daily Commercial News) to establish the date for commencement of the lien period.

1.4.1.8 **Commencement of Lien and Guarantee Period**: The date of publication of the Owner's certificate of substantial completion, as above, shall mean immediate commencement of the lien period as specified by Provincial lien laws, and commencement periods. Neither the Contractor, the subcontractors nor any supplier shall carry out any work except for repairs or replacements under guarantee on the project during the lien period.

1.5 TOTAL PERFORMANCE

1.5.1 Final Acceptance

1.5.1.1 Prior to requesting a final acceptance do the following:

1.5.1.1.1 Complete commissioning with Owner's designate Commissioning Agent.

1.5.1.1.2 Schedule and completed all outstanding deficiencies

1.5.1.1.3 Submit As-Built Documentation and where EMCS has been upgraded, update System Graphics to include Links to updated PDF's of As-Builts

1.5.1.1.4 Submit all Project Close-Out Documentation

1.5.1.1.5 Complete all Training

1.5.1.1.6 Submit a final request for payment in accordance with Contract requirements and incorporating all approved changes to the Contract price.

1.5.1.1.7 Submit completed and signed City of Mississauga ***Project Close Out Final Acceptance Forms*** to the Owner and Consultant signifying a request for a Final Acceptance. Final Acceptance Form to include a copy of all previous deficiencies noting dates corrected and indicating that the work is totally performed, and the project is ready for Final Acceptance. A final inspection will be required to verify completion and shall be carried out by the same parties involved in the Provisional Acceptance Stage.

CLOSEOUT PROCEDURES

1.5.1.2 If all deficiencies have not been corrected, in the opinion of the Owner and/or Consultant a final deficiency list shall be prepared and sent to the Contractor in the same manner as specified herein for the Substantial Completion and the inspection procedure repeated until all items have been completed to the satisfaction of the Owner and/or Consultant.

1.5.1.3 The Owner and Consultant will conduct one Total Performance inspection and maximum one follow-up inspection. Subsequent inspections due to the Contractor's failure to complete work as required shall be paid for by the Contractor.

1.5.1.4 Failure of the Contractor to correct the listed deficiencies within the 40-day lien period will result in direct action being taken by the Owner to correct the deficiencies outside of the Contract.

1.5.1.5 On the 40th day of the lien period final inspection shall be made to ascertain that Contractor progresses with deficiencies and to invoke the above clause should it be required.

1.5.1.6 Once all deficiencies are complete and all parties are satisfied that the conditions are met for "Final Acceptance". The Owner, Contractor, and Consultant will all sign the ***Project Close Out Final Acceptance Form***.

1.6 DEMONSTRATION AND TRAINING

1.6.1 The Owner's facility staff, shall receive orientation and training on features, systems and equipment in each facility requisite with the complexity and criticality of the system and the OWNER's needs.

1.6.2 Additional training requirements may be found in specific sections of Division 25.

1.7 FINAL CLEANING

1.7.1 Clean all workspace in accordance in anticipation of final turn-over

1.7.2 Remove surplus materials, excess materials, rubbish, tools and equipment.

1.7.3 Waste Management: separate waste materials for recycling

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION 01 77 00

CLOSEOUT SUBMITTALS

CLOSEOUT SUBMITTALS

Part 1 General

1.1 RELATED REQUIREMENTS

1.1.1 Section 01 33 00 - Submittal Procedures

1.1.2 Section 01 77 00 - Close-Out Procedures

1.1.3 Section 01 79 00 - Demonstration and Training.

1.2 REFERENCES

1.2.1 None

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Pre-warranty Meeting:

1.3.1.1 Convene meeting one week prior to contract completion with contractor's representative and Owner's Authorized Representative to:

1.3.1.1.1 Verify Project requirements.

1.3.1.1.2 Review manufacturer's O&M instructions and warranty requirements.

1.3.1.2 Owner's Authorized Representative to establish communication procedures for:

1.3.1.2.1 Notifying of any construction warranty defects.

1.3.1.2.2 Determine priorities for type of defects.

1.3.1.2.3 Determine reasonable response time.

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

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

1.4 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4.2 Two weeks prior to Substantial Performance of the Work, submit to the Consultant, four (4) final copies of operating and maintenance manuals in English.

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

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

1.5 FORMAT

1.5.1 Organize data as instructional manual.

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

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

1.5.3.1 Identify contents of each binder on spine.

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

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

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

1.5.7 Text: manufacturer's printed data, or typewritten data.

1.5.8 Drawings: provide with reinforced punched binder tab.

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

1.5.9 Provide scaled CAD files in dwg format on CD.

1.6 CONTENTS - PROJECT RECORD DOCUMENTS

1.6.1 Table of Contents for Each Volume: provide title of project;

1.6.1.1 Date of submission; List names and Date.

1.6.1.2 Addresses, and telephone numbers of Consultant and Contractor with name of responsible parties.

1.6.1.3 Schedule of products and systems indexed to content of volume.

1.6.2 For each product or system:

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

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

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

1.6.5 Typewritten Text: as required to supplement product data.

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

1.6.6 Training: refer to Section 01 79 00 - Demonstration and Training.

1.7 AS -BUILT DOCUMENTS AND SAMPLES

1.7.1 Maintain, at site for Consultant and Owner one record copy of:

1.7.1.1 Contract Drawings.

1.7.1.2 Specifications.

1.7.1.3 Addenda.

1.7.1.4 Change Orders and other modifications to Contract.

1.7.1.5 Reviewed shop drawings, product data, and samples.

1.7.1.6 Field test records.

1.7.1.7 Inspection certificates.

1.7.1.8 Manufacturer's certificates.

1.7.2 Store record documents and samples in field office apart from documents used for construction.

1.7.2.1 Provide files, racks, and secure storage.

CLOSEOUT SUBMITTALS

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

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

1.7.4 Maintain record documents in clean, dry and legible condition.

1.7.4.1 Do not use record documents for construction purposes.

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

1.8 RECORDING INFORMATION ON PROJECT RECORD DOCUMENTS

1.8.1 Record information on set black line opaque drawings, and in copy of Project Manual, provided by Consultant.

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

1.8.3 Record information concurrently with construction progress.

1.8.3.1 Do not conceal Work until required information is recorded.

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

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

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

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

1.8.4.4 Field changes of dimension and detail.

1.8.4.5 Changes made by change orders.

1.8.4.6 Details not on original Contract Drawings.

1.8.4.7 References to related shop drawings and modifications.

1.8.5 Specifications: mark each item to record actual construction, including:

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

1.8.5.2 Changes made by Addenda and change orders.

1.8.6 Other Documents: maintain manufacturer's certifications, inspection certifications, field test records, required by individual specifications sections.

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

1.9 EQUIPMENT AND SYSTEMS

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

1.9.1.1 Give function, normal operation characteristics and limiting conditions.

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

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

1.9.3 Include installed colour coded wiring diagrams.

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

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

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

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

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

1.9.7 Include manufacturer's printed operation and maintenance instructions.

1.9.8 Include sequence of operation by controls manufacturer.

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

1.9.10 Provide installed control diagrams by controls manufacturer.

1.9.11 Provide Contractor's co-ordination drawings, with installed colour coded piping diagrams.

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

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

1.9.14 Additional requirements: as specified in individual specification sections.

1.10 MATERIALS AND FINISHES

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

1.10.1.1 Provide information for re-ordering custom manufactured products.

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

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

1.10.4 Additional requirements: as specified in individual specifications sections.

1.11 MAINTENANCE MATERIALS

1.11.1 Spare Parts:

1.11.1.1 Provide spare parts, in quantities specified in individual specification sections.

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

1.11.1.3 Deliver to site; place and store.

1.11.1.4 Receive and catalogue items.

1.11.1.5 Submit inventory listing to Owner's Authorized Representative.

1.11.1.6 Include approved listings in Maintenance Manual.

1.11.1.7 Obtain receipt for delivered products and submit prior to final payment.

1.11.2 Extra Stock Materials:

1.11.2.1 Provide maintenance and extra materials, in quantities specified in individual specification sections.

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

1.11.2.3 Deliver to site; place and store.

1.11.2.4 Receive and catalogue items.

1.11.2.5 Submit inventory listing to Owner's Authorized Representative.

1.11.2.6 Include approved listings in Maintenance Manual.

1.11.2.7 Obtain receipt for delivered products and submit prior to final payment.

1.11.3 Special Tools:

1.11.3.1 Provide special tools, in quantities specified in individual specification section.

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

1.11.3.3 Deliver to site; place and store.

1.11.3.4 Receive and catalogue items.

1.11.3.5 Submit inventory listing to Owner's Authorized Representative.

1.11.3.6 Include approved listings in Maintenance Manual.

1.12 DELIVERY, STORAGE AND HANDLING

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

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

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

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

1.12.5 Remove and replace damaged products at own expense and for review by Consultant.

1.13 WARRANTIES AND BONDS

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

1.13.2 Submit warranty management plan, 30 days before planned pre-warranty conference, to Owner's Authorized Representative approval.

1.13.3 Warranty management plan to include required actions and documents to assure that Owner's Authorized Representative receives warranties to which it is entitled.

1.13.4 Provide plan in narrative form and contain sufficient detail to make it suitable for use by future maintenance and repair personnel.

1.13.5 Submit, warranty information made available during construction phase, to Owner's Authorized Representative for approval prior to each monthly pay estimate.

CLOSEOUT SUBMITTALS

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

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

1.13.6.2 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principals.

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

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

1.13.6.5 Co-execute submittals when required.

1.13.6.6 Retain warranties and bonds until time specified for submittal.

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

1.13.8 Conduct joint 4 month and 9-month warranty inspection, measured from time of acceptance, by Owner’s Authorized Representative.

1.13.9 Include information contained in warranty management plan as follows:

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

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

1.13.9.2.1 Name of item.

1.13.9.2.2 Model and serial numbers.

1.13.9.2.3 Location where installed.

1.13.9.2.4 Name and phone numbers of manufacturers or suppliers.

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

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

1.13.9.2.7 Cross-reference to warranty certificates as applicable.

1.13.9.2.8 Starting point and duration of warranty period.

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

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

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

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

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

CLOSEOUT SUBMITTALS

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

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

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

1.13.11 Written verification to follow oral instructions.

1.13.11.1 Failure to respond will be cause for the Owner's Authorized Representative to proceed with action against Contractor.

1.14 WARRANTY TAGS

1.14.1 Tag, at time of installation, each warranted item. Provide durable, oil and water-resistant tag approved by Owner's Authorized Representative.

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

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

1.14.4 Indicate following information on tag:

1.14.4.1 Type of product/material.

1.14.4.2 Model number.

1.14.4.3 Serial number.

1.14.4.4 Contract number.

1.14.4.5 Warranty period.

1.14.4.6 Inspector's signature.

1.14.4.7 Construction Contractor.

Part 2 Products

2.1 NOT USED

2.1.1 Not Used.

Part 3 Execution

3.1 NOT USED

3.1.1 Not Used.

END OF SECTION 01 78 00

DEMONSTRATION AND TRAINING

DEMONSTRATION AND TRAINING

Part 1 General

1.1 RELATED REQUIREMENTS

1.1.1 25 01 11 EMCS Start-Up, Verification and Commissioning

1.1.2 25 01 12 EMCS Training.

1.2 ADMINISTRATIVE REQUIREMENTS

1.2.1 Demonstrate the operation and maintenance of equipment and systems to Owner's personnel in accordance with sections 25 01 11 and 25 01 12.

1.2.2 Owner: provide list of personnel to receive instructions, and co-ordinate their attendance at agreed-upon times.

1.2.3 Preparation:

1.2.3.1 Verify conditions for demonstration and instructions comply with requirements.

1.2.3.2 Verify designated personnel are present.

1.2.3.3 Ensure equipment has been inspected and put into operation in accordance with Section 25 01 11.

1.2.3.4 Ensure testing, adjusting, and balancing has been performed and equipment and systems are fully operational.

1.2.4 Demonstration and Instructions:

1.2.4.1 Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, and maintenance of each item of equipment at agreed upon times, at the designated location.

1.2.4.2 Instruct personnel in phases of operation and maintenance using operation and maintenance manuals as basis of instruction.

1.2.4.3 Review contents of manual in detail to explain aspects of operation and maintenance.

1.2.4.4 Prepare and insert additional data in operations and maintenance manuals when needed during instructions.

1.2.5 Time Allocated for Instructions: ensure amount of time required for instruction of each item of equipment or system as follows:

1.2.5.1 Section 25 01 12 - EMCS Training: refer to part 1.4 of Section 25 01 12 for details.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.3.2 Submit schedule of time and date for demonstration of each item of equipment and each system two weeks prior to designated dates, for Owner’s approval.

1.3.3 Submit reports within one week after completion of demonstration, that demonstration and instructions have been satisfactorily completed.

1.3.4 Give time and date of each demonstration, with list of persons present.

1.3.5 Provide copies of completed operation and maintenance manuals for use in demonstrations and instructions.

DEMONSTRATION AND TRAINING

1.4 QUALITY ASSURANCE

1.4.1 When specified in individual Sections requiring manufacturer to provide authorized representative to demonstrate operation of equipment and systems:

1.4.1.1 Instruct Owner's personnel.

1.4.1.2 Provide written report that demonstration and instructions have been completed.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION 01 79 00

GENERAL COMMISSIONING REQUIREMENTS

GENERAL COMMISSIONING REQUIREMENTS

Part 1 General

1.1 SUMMARY

1.1.1 Section Includes:

1.1.2 General requirements relating to commissioning of project's components and systems, specifying general requirements to PV of components, equipment, sub-systems, systems, and integrated systems.

1.2 ACRONYMS:

1.2.1 BMM - Building Management Manual.

1.2.2 Cx - Commissioning.

1.2.3 EMCS - Energy Monitoring and Control Systems.

1.2.4 O&M - Operation and Maintenance.

1.2.5 PI - Product Information.

1.2.6 PV - Performance Verification.

1.2.7 TAB - Testing, Adjusting and Balancing.

1.3 RELATED SECTION

1.3.1 Section 25 01 11 EMCS Start-Up, Verification and Commissioning

1.3.2 Section 25 01 12 EMCS Training

1.3.3 Section 25 90 01 EMCS Site Requirements Applications and System Sequences of Operation

1.4 GENERAL

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

1.4.2 Objectives:

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

1.4.2.2 Ensure appropriate documentation is compiled into the BMM.

1.4.2.3 Effectively train O&M staff.

1.4.3 Contractor assists in Cx process, operating equipment, and systems, troubleshooting and adjusting as required.

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

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

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

1.5 SCOPE OF WORK

1.5.1 Provide all material, tools, labour, and supervision necessary to assist the commissioning agent in the verification of commissioning of the equipment and systems as outlined in the drawings, specifications, and final commissioning plan.

1.5.2 Contractors and Manufacturer Representative are to participate in the commissioning process and cooperate fully with the Commissioning Agent.

1.5.3 Once the contractor’s commissioning is completed as outlined in the project specific Contract Documents, provide material, tools, labour and supervision to verify in detail with the CxA that the equipment and systems have been commissioned in accordance with this and related Sections.

1.6 OBJECTIVES

1.6.1 Verify installed equipment, systems and integrated systems operate in accordance with the owner`s project requirements, the contract documents and design criteria and intent.

1.6.2 A third-party commissioning agent will perform commissioning verification of the new equipment and control sequences. This will include functional performance testing activities as outlined in the Final Commissioning Plan.

1.6.3 Contractor participates in the commissioning process, operating equipment and systems, troubleshooting and making adjustments as required.

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

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

1.6.6 A Final Commissioning Plan, including functional performance test forms, will be provided by the commissioning agent for completion by the contractor. The functional performance test forms will be based on the sequence of operations outlined in Section 25 90 01 EMCS Site Requirements Applications and System Sequences of Operation.

1.7 COMMISSIONING (CX) OVERVIEW

1.7.1 Complete commissioning scope to be defined by consultant/BAS Designer in project specific specifications (refer to Section 01 91 13.13 Commissioning Plan of project specifications).

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

1.7.3 Refer to drawings and specifications for overview of the equipment and systems to be commissioned. Final equipment and systems list will be provided in Final Commissioning Plan.

1.7.4 Cx activities supplement field quality and testing procedures described in relevant technical sections of the Contract Documents. Cx activities do not relieve the Contractor from the contractual requirements outlined in other specification sections of the Contract Documents. Cx activities do not circumvent or relieve the Contractor from warranty requirements, responsibilities, or obligations.

1.7.5 Ensure all systems have been started, adjusted to design criteria, and are functionally operational, ready for independent testing. The CxA will not begin Functional Performance Testing until satisfied that all requirements have been met. The CxA reserves right to request inspection reports and sign-off from Contractor or Consultant that equipment and systems are ready for Functional Performance Testing.

1.7.6 Employ experienced personnel for equipment start up and commissioning, who are able to interpret results of readings and tests and report the system status in a clear and concise manner.

1.7.7 Provide all equipment required to perform testing, balancing, and commissioning of systems. Calibrate instruments used in start-up; provide calibration certificates if requested by the CxA.

1.7.8 Utilize equipment check certificates and other commissioning documents required by the CxA.

1.7.9 Verify that equipment is installed in accordance with Contract Documents, and reviewed shop drawings.

1.7.10 Commissioning will be considered complete once:

1.7.10.1 Require start-up documentation and checklists, as outlined in Contract Documents, have been submitted for review by the CxA.

1.7.10.2 Completed Cx documentation has been received, reviewed for suitability and approved by the CxA and the Owner.

1.7.10.3 Equipment, components, and systems have been commissioned and all issues have been addressed to the satisfaction of the Owner.

1.8 NON-CONFORMANCE TO PERFORMANCE VERIFICATION REQUIREMENTS

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

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

1.9 PRE-CX REVIEW

1.9.1 Before Construction:

1.9.1.1 Review contract documents confirm by writing to Consultant.

1.9.1.1.1 Adequacy of provisions for Cx.

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

1.9.2 During Construction:

GENERAL COMMISSIONING REQUIREMENTS

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

1.9.3 Before start of Cx:

1.9.3.1 Have completed Cx Plan up to date.

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

1.9.3.3 Fully understand Cx requirements and procedures.

1.9.3.4 Understand completely design criteria and intent and special features.

1.9.3.5 All related equipment has been started up and start-up reports and pre-functional checklists are submitted and approved ready for functional testing.

1.9.3.6 All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules with debugging, loop tuning, and sensor calibrations completed.

1.9.3.7 Piping system flushing complete, water treatment system complete and operational.

1.9.3.8 Vibration control report approved (if required).

1.9.3.9 Test and balance (TAB) complete and approved for the air and hydronic systems.

1.9.3.10 All A/E deficiency list items for the equipment specified are corrected.

1.9.3.11 Functional test procedures have been reviewed and approved by installing contractor.

1.9.3.12 Safeties and operating ranges reviewed by the CxA and the Contractor.

1.9.3.13 Test requirements and sequences of operation provided.

1.9.3.14 Schedules and setpoints provided.

1.9.3.15 False loading equipment, system, and procedures ready.

1.9.3.16 Crankcase heaters have been on long enough for start-up.

1.9.3.17 Sufficient clearance around equipment for servicing.

1.9.3.18 Record of all values for pre-test setpoints changed to accommodate testing has been made and a check box provided to verify return to original values (control parameters, limits, delays, lockouts, schedules, etc.)

1.9.3.19 Other miscellaneous checks of the pre-functional checklist and start-up reports completed successfully.

1.9.3.20 Points verification report from Control Contractor has been provided.

1.9.4 Inform Consultant in writing of discrepancies and deficiencies on finished works.

Part 2 Products

2.1 Not Used

Part 3 Execution

3.1 Not Used

END OF SECTION 01 45 00

DEMOLITION FOR MINOR WORKS

DEMOLITION FOR MINOR WORKS

Part 1 General

1.1 RELATED REQUIREMENTS

1.1.1 N/A

1.2 REFERENCES

1.2.1 CSA International

1.2.1.1 CSA S350, Code of Practice for Safety in Demolition of Structures.

1.2.2 U.S. Environmental Protection Agency (EPA)/Office of Water

1.2.2.1 EPA 832/R-92-005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

1.3.1 N/A

1.4 SITE CONDITIONS

1.4.1 Review "Designated Substance Report" and take precautions to protect environment.

1.4.2 If material resembling spray or trowel-applied asbestos or other designated substance listed as hazardous be encountered, stop work, take preventative measures, and notify Owner & Consultant immediately.

1.4.2.1 Proceed only after receipt of written instructions have been received from Consultant.

1.4.3 Notify Owner and Consultant before disrupting building access or services including Power, Water, Life Safety, and Environmental Controls.

Part 2 Products

2.1 NOT USED

2.1.1 Not used.

Part 3 Execution

3.1 EXAMINATION

3.1.1 Inspect building with Owner’s Authorized Representative (OAR) and verify extent and location of items designated for removal, disposal, alternative disposal, recycling, salvage and items to remain.

3.1.2 Locate and protect utilities. Preserve active utilities traversing site in operating condition.

3.1.3 Notify and obtain approval of utility companies before starting demolition.

3.1.4 Disconnect, cap, plug or divert, as required, existing public utilities within the property where they interfere with the execution of the work, in conformity with the

requirements of the authorities having jurisdiction. Mark the location of these and previously capped or plugged services on the site and indicate location (horizontal and vertical) on the record drawings. Support, shore up, and maintain pipes and conduits encountered.

3.1.4.1 Immediately notify OAR, Consultant and utility company concerned in case of damage to any utility or service, designated to remain in place.

3.1.4.2 Immediately notify the OAR and Consultant should uncharted utility or service be encountered and await instruction in writing regarding remedial action.

3.2 PREPARATION

3.2.1 Protection of In-Place Conditions:

3.2.1.1 Keep noise, dust, and inconvenience to occupants to minimum.

3.2.1.2 Protect building systems, services and equipment.

3.2.1.3 Provide temporary dust screens, covers, railings, supports and other protection as required.

3.2.2 Demolition/Removal:

3.2.2.1 Remove all existing redundant controls and control devices and other items as indicated. Where specifically identified in specifications or points list, return to owner. If not specified, dispose of in environmentally friendly manner.

3.2.2.2 Remove/relocate existing services as required to permit new construction.

3.3 CLEANING

3.3.1 Progress Cleaning:

3.3.1.1 Leave Work area clean at end of each day.

3.3.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment from site.

3.3.3 Refer to demolition drawings and project specifications for items to be salvaged for reuse.

END OF SECTION 02 41 99

FIRE STOPPING

FIRE STOPPING

Part 1 General

1.1 RELATED SECTIONS

1.1.1 Section 25 05 01 EMCS General Requirements

1.1.2 Section 25 30 02 EMCS Field Control Devices

1.1.3 Section 26 05 00 Common Work Results Electrical.

1.2 REFERENCES

1.2.1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

1.2.2 Material Safety Data Sheets (MSDS).

1.2.3 Underwriter's Laboratories of Canada (ULC)

1.2.4 ULC-S115, Fire Tests of Fire stop Systems.

1.3 DEFINITIONS

1.3.1 Fire Stop Material: device intended to close off opening or penetration during fire or materials that fill openings in wall or floor assembly where penetration is by cables, cable trays, conduits, ducts and pipes and poke-through termination devices, including electrical outlet boxes along with their means of support through wall or floor openings.

1.3.2 Single Component Fire Stop System: fire stop material that has Listed Systems Design and is used individually without use of high temperature insulation or other materials to create fire stop system.

1.3.3 Multiple Component Fire Stop System: exact group of fire stop materials that are identified within Listed Systems Design to create on site fire stop system.

1.3.4 Tightly Fitted; (ref: NBC Part 3.1.9.1.1 and 9.10.9.6.1): penetrating items that are cast in place in buildings of non-combustible construction or have "0" annular space in buildings of combustible construction.

1.3.4.1 Words "tightly fitted" should ensure that integrity of fire separation is such that it prevents passage of smoke and hot gases to unexposed side of fire separation.

1.4 SUBMITTALS

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

1.4.2 Product Data:

1.4.2.1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

1.4.2.2 Submit two copies of WHMIS MSDS - Material Safety Data Sheets.

1.4.3 Shop Drawings:

1.4.3.1 Submit shop drawings to show proposed material, reinforcement, anchorage, fastenings and method of installation.

1.4.3.2 Construction details should accurately reflect actual job conditions.

FIRE STOPPING

1.4.4 Samples:

1.4.4.1 Submit duplicate 300 x 300 mm samples showing actual fire stop material proposed for project.

1.4.5 Quality assurance submittals: submit following in accordance with Section 01 45 00 - Quality Control.

1.4.5.1 Test reports: in accordance with CAN-ULC-S101 for fire endurance and CAN-ULC-S102 for surface burning characteristics.

1.4.5.1.1 Submit certified test reports from approved independent testing laboratories, indicating compliance of applied fire stopping with specifications for specified performance characteristics and physical properties.

1.4.5.2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.4.5.3 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, and cleaning procedures.

1.4.5.4 Manufacturer's Field Reports: Where requested by consultant, submit to manufacturer's written reports within 3 days of review, verifying compliance of Work, as described in PART 3 - FIELD QUALITY CONTROL.

1.5 QUALITY ASSURANCE

1.5.1 Qualifications:

1.5.1.1 Installer: person specializing in fire stopping installations with [2] years documented experience or approved by manufacturer (in writing).

1.5.2 Pre-Installation Meetings: convene pre-installation meeting prior to beginning work of this Section, with EMCS contractor's representative to:

1.5.2.1 Verify project requirements.

1.5.2.2 Review installation and substrate conditions.

1.5.2.3 Co-ordination with other building subtrades.

1.5.2.4 Review manufacturer's installation instructions and warranty requirements.

1.5.3 Site Meetings: as part of Manufacturer's Services described in PART 3 - FIELD QUALITY CONTROL, schedule site visits, to review Work, at stages listed.

1.5.3.1 After delivery and storage of products, and when preparatory Work is complete, but before installation begins.

1.5.3.2 Once during progress of Work at 25%.

1.5.3.3 Upon completion of Work, after cleaning is carried out.

1.6 DELIVERY, STORAGE AND HANDLING

1.6.1 Packing, shipping, handling and unloading:

1.6.1.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

1.6.1.2 Deliver materials to the site in undamaged condition and in original unopened containers, marked to indicate brand name, manufacturer, ULC markings.

1.6.2 Storage and Protection:

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

1.6.2.2 Replace defective or damaged materials with new.

1.6.3 Waste Management and Disposal:

1.6.3.1 Separate waste materials for recycling where applicable.

Part 2 Products

2.1 MATERIALS

2.1.1 Fire stopping and smoke seal systems: in accordance with CAN-ULC-S115.

2.1.1.1 Asbestos-free materials and systems capable of maintaining effective barrier against flame, smoke and gases in compliance with requirements of CAN-ULC-S115 and not to exceed opening sizes for which they are intended [and conforming to specified special requirements described in PART 3.

2.1.1.2 Fire stop system rating: Min 1 hr (or match existing where greater).

2.1.2 Service penetration assemblies: systems tested to CAN-ULC-S115.

2.1.3 Service penetration fire stop components: certified by test laboratory to CAN-ULC-S115.

2.1.4 Fire-resistance rating of installed fire stopping assembly in accordance with NBC.

2.1.5 Fire stopping and smoke seals at openings intended for ease of re-entry such as cables: elastomeric seal.

2.1.6 Fire stopping and smoke seals at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control: elastomeric seal.

2.1.7 Primers: to manufacturer's recommendation for specific material, substrate, and end use.

2.1.8 Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.

2.1.9 Damming and backup materials, supports and anchoring devices: to manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.

2.1.10 Sealants for vertical joints: non-sagging.

FIRE STOPPING

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PREPARATION

3.2.1 Examine sizes and conditions of voids to be filled to establish correct thicknesses and installation of materials.

3.2.1.1 Ensure that substrates and surfaces are clean, dry and frost free.

3.2.2 Prepare surfaces in contact with fire stopping materials and smoke seals to manufacturer's instructions.

3.2.3 Maintain insulation around pipes and ducts penetrating fire separation [without interruption to vapour barrier.

3.2.4 Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.

3.3 INSTALLATION

3.3.1 Install fire stopping and smoke seal material and components in accordance with manufacturer's certified tested system listing.

3.3.2 Seal holes or voids made by through penetrations, poke-through termination devices, and unpenetrated openings or joints to ensure continuity and integrity of fire separation are maintained.

3.3.3 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.

3.3.4 Tool or trowel exposed surfaces to neat finish.

3.3.5 Remove excess compound promptly as work progresses and upon completion.

3.4 SEQUENCES OF OPERATION

3.4.1 Proceed with installation only when submittals have been reviewed and approved by Consultant.

3.4.2 Install floor fire stopping before interior partition erections.

3.4.3 Metal deck bonding: fire stopping to precede spray applied fireproofing to ensure required bonding.

3.4.4 Mechanical pipe insulation: certified fire stop system component.

3.4.4.1 Ensure pipe insulation installation precedes fire stopping.

3.5 FIELD QUALITY CONTROL

3.5.1 Inspections: notify Authority of Jurisdiction and Consultant when ready for inspection and prior to concealing or enclosing fire stopping materials and service penetration assemblies.

3.5.2 Manufacturer's Field Services:

3.5.2.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.

3.5.2.2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

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

3.6 CLEANING

3.6.1 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.6.2 Remove temporary dams after initial set of fire stopping and smoke seal materials.

3.7 SCHEDULE

3.7.1 Fire stop and smoke seal at:

3.7.1.1 Penetrations through fire-resistance rated masonry, concrete, and gypsum board partitions and walls.

3.7.1.2 Edge of floor slabs at curtain wall and precast concrete panels.

3.7.1.3 Top of fire-resistance rated masonry and gypsum board partitions.

3.7.1.4 Intersection of fire-resistance rated masonry and gypsum board partitions.

3.7.1.5 Control and sway joints in fire-resistance rated masonry and gypsum board partitions and walls.

3.7.1.6 Penetrations through fire-resistance rated floor slabs, ceilings and roofs.

3.7.1.7 Openings and sleeves installed for future use through fire separations.

3.7.1.8 Around mechanical and electrical assemblies penetrating fire separations.

3.7.1.9 Rigid ducts: greater than 129 cm^2: fire stopping to consist of bead of fire stopping material between retaining angle and fire separation and between retaining angle and duct, on each side of fire separation.

END OF SECTION 07 84 00

EMCS: START-UP, VERIFICATION AND COMMISSIONING

EMCS: START-UP, VERIFICATION AND COMMISSIONING

Part 1 General

1.1 SUMMARY

1.1.1 Section Includes.

1.1.1.1 Methods and procedures for start-up, verification and commissioning, for building Energy Management Control System (EMCS) and includes:

1.1.1.1.1 Start-up testing and verification of systems.

1.1.1.1.2 Check out demonstration or proper operation of components.

1.1.1.1.3 On-site operational tests.

1.1.2 Related Sections.

1.1.2.1 Section 01 33 00 - Submittal Procedures.

1.1.2.2 Section 01 78 00 - Closeout Submittals.

1.1.2.3 Section 01 91 12 – General Commissioning Requirements

1.1.2.4 Section 01 79 00 – Demonstration and Training

1.1.2.5 Section 25 01 12 - EMCS: Training.

1.1.2.6 Section 25 05 01 - EMCS: General Requirements.

1.2 DEFINITIONS

1.2.1 For additional acronyms and definitions refer to Section 25 05 01 - General Requirements.

1.2.2 **AEL**: ratio between total test period less any system downtime accumulated within that period and test period.

1.2.3 **Downtime**: results whenever EMCS is unable to fulfill required functions due to malfunction of equipment defined under responsibility of EMCS vendor. Downtime is measured by duration, in time, between time that Vendor is notified of failure and time system is restored to proper operating condition. Downtime not to include following:

1.2.3.1 Outage of main power supply in excess of back-up power sources provided that:

1.2.3.1.1 Automatic initiation of back-up was accomplished.

1.2.3.1.2 Automatic shut-down and re-start of components was as specified.

1.2.3.2 Failure of communications link, provided that:

1.2.3.2.1 Controller automatically and correctly operated in stand-alone mode.

1.2.3.2.2 Failure was not due to failure of any specified EMCS equipment.

1.2.3.3 Functional failure resulting from individual sensor inputs or output devices provided that:

1.2.3.3.1 System recorded said fault.

1.2.3.3.2 Equipment defaulted to fail-safe mode.

1.2.3.3.3 AEL of total of all input sensors and output devices is at least 99% during test period.

EMCS: START-UP, VERIFICATION AND COMMISSIONING

1.3 SUBMITTALS

1.3.1 Functional Testing Check List (refer to Appendix B): Complete and submit to Commissioning Agent (CA), Consultant and Owner. See 1.6.2.

1.3.1.1 Include measurements, final settings and certified test results.

1.3.1.2 Bear signature of control technician responsible for completing verification

1.3.1.3 Revise shop drawings to reflect changes, adjustments, and modifications to EMCS as set during construction and submit preliminary "as-built" to CA, Consultant and/or Owner in accordance with Section 01 78 00 - Closeout Submittals and Section 25 05 02 EMCS Submittals and Review Process.

1.3.1.4 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.

1.4 CLOSEOUT SUBMITTALS

1.4.1 Provide documentation, O&M Manuals, and training of O&M personnel for review of Consultant and Owner before interim acceptance in accordance with Section 01 78 00 Closeout Submittals.

1.4.2 Revise preliminary "as-built" documentation to final AS-BUILT documentation. Final AS-BUILT to reflect changes made during commissioning including but not limited to sequences, set-point and limit adjustments, and alarm settings.

1.5 DESIGN REQUIREMENTS(CA)

1.5.1 The CA shall Confirm with Consultant and/or Owners Authorized Representative that Design Criteria and Design Intents are still applicable.

1.5.2 CA to be fully aware of, and qualified to interpret Design Criteria and Design Intents.

1.6 PRE-COMMISSIONING

1.6.1 As a part of the EMCS installation, the vendor shall fully test and pre-commission the entire EMCS. All pre-commissioning activates shall be fully documented on the Functional Testing Check List (refer to Appendix B) and shall be submitted with the City of Mississauga **Project Close Out Provisional Acceptance Forms** ***prior*** to Demonstration and acceptance testing.

1.6.2 Pre- Commissioning shall include a point-to point verification of the following at the minimum:

1.6.2.1 Verify that all Panel Enclosures, EMCS equipment, building and field controllers, end devices and sensors, are installed and operational according to the specifications, submittals and manufacturer's installation and application instructions.

1.6.2.2 Test, calibrate and bring on-line every control device.

1.6.2.3 Calibrate all inputs by comparing the actual site condition with the Graphical Interface point display.

1.6.2.4 Verify all outputs from Graphical Interface command to observed response of controlled device.

1.6.2.5 Verify failure response and fail-safe conditions of all devices and safeties.

1.6.2.6 Each control program shall be fully commissioned and tested for complete design intent compliance and functionality.

1.6.2.7 Verify overall network performance of EMCS for complete design intent compliance and functionality with all devices on-line, communicating and fully operational.

1.6.2.8 Subsystems not directly controlled by the EMCS but associated with the OEM Application Specific Controllers (OEMASC) shall also be fully tested and commissioned as to design intent compliance and functionality.

1.6.3 Refer to 3.6 for additional details.

1.7 COMMISSIONING

1.7.1 Upon completion of the Pre-Commissioning, EMCS vendor shall provide fall assistance, staff, and materials to support the commissioning activities. This includes:

1.7.1.1 Provision of all testing apparatus in use by the vendor to test and calibrate or verify calibration of control system and all other apparatus for which the vendor has control or calibration responsibility.

1.7.1.2 Assistance includes but is not limited to reviewing test procedures and providing software enhancements to accommodate testing methods.

1.7.1.3 On-site programmer/control technician to carry out the operator commands and adjustments to software parameters as directed by the Owners designated Commissioning Agent (CA). This may include but is not limited to; physical inspection of all hardware installed, point-to point functional testing (also referred to as Owner-Witnessed Testing), and system Performance Verification Testing.

1.8 COMPLETION OF COMMISSIONING

1.8.1 Commissioning to be considered as satisfactorily completed when objectives of commissioning have been achieved and reviewed by CA, Consultant, and Owner's Project Manager or Designated Representative.

1.8.2 Vendor shall fill out the City of Mississauga **Project Closeout Provisional Acceptance Form** (refer to Appendix B) and submit for approval.

1.9 ISSUANCE OF FINAL CERTIFICATE OF COMPLETION

1.9.1 When Commissioning is complete the CA will issue a Commissioning Report documenting the results of the Functional and Performance Based Testing that occurred and identifying any system or installation deficiencies. This list of deficiencies will be added to the list previously attached to the Project Close Out Provisional Acceptance Form and then addressed by the contractor. The contractor will then work to complete all outstanding deficiencies in a timely manor and then submit with a signed copy of the **Project Closeout Final Acceptance Form** (refer to Appendix B). Once Accepted, the Consultant will issue Final Certificate of Completion. Refer to Part 3.11 for Acceptance Procedures.

EMCS: START-UP, VERIFICATION AND COMMISSIONING

Part 2 Products

2.1 EQUIPMENT

2.1.1 Not applicable

Part 3 Execution

3.1 PROCEDURES

3.1.1 Test each system independently and then in unison with other related systems.

3.1.2 Commission integrated systems using procedures prescribed by Consultant and or as specified within. It is the EMCS vendor's responsibility to coordinate with others to ensure a Control representative familiar with the programming and set-up of the integrated system being present to ensure all BACnet communication points are properly configured and visible to the EMCS including Read/Write privileges and that the specified sequence and integration is operating as intended.

3.1.3 Debug system software.

3.1.4 Optimize operation and performance of systems by fine-tuning PID values and modifying CDLs as required.

3.2 START-UP TRIALS

3.2.1 The Consultant may at any time be able to either, on his own, or demand from the Vendor a check of all the apparatus, system or installation.

3.2.2 This test does not constitute in any manner an acceptance and may not give way to any claim for compensation due to accident, damage or rupture as a result of any deficiency in the apparatus, equipment or installation.

3.3 FACTORY TESTING

3.3.1 All computers and controls shall have passed a verification test in the factory before delivery to the site.

3.3.2 Every circuit in the SRPDC RPDC & DDC shall have been tested and operated for a minimum period of at least 96 hours.

3.4 COMMISSIONING (OWNER-WITNESSED TESTING)

3.4.1 Testing the actual system installed on site shall be done in order to demonstrate the full functionality of the EMCS to the Owner's, Consultant's and/or Owner's Commissioning Agent's satisfaction. The Vendor shall supply the instruments, specialized tools and labour for the necessary adjustments in order to obtain the specified system performance.

3.4.2 Commissioning shall include both point-to-point (**Functional**) testing and control sequence verification (**Performance Testing**).

3.4.3 A local operator workstation (LOWS), including all necessary software shall be made available and utilized to support the point-to point **Functional Testing** and **Performance Testing** activities. As the installed system is intended to be accessible from any Owner designated workstation, the location of the LOWS will be defined by the Owner and/or Owner's Authorized Representative prior to the start of commissioning activities.

3.4.3.1 Any LOWS connected upstream of the City of Mississauga demarcation point must meet all City of Mississauga ITS requirements and be approved for use by ITS.

3.4.4 After receipt of all system documentation (as supplied by this vendor) by the Owner and/or Owner's Authorized Representative, notify the Owner 10 working days before testing begins.

3.4.5 Testing shall be performed by the vendor, witnessed by the Owner or his appointed representative.

3.4.6 The vendor must fill out and complete the formatted **Functional Testing Check List** documentation (refer to Appendix B) for witnessing the results, comments, vendor repair activity, vendor's initials, and re-test witnessing. Vendor shall submit these **Functional Testing Check List** with one line for each physical point on the system, and columns to record the results, dates, and initials witnesses for both pre-tests and witness tests.

3.4.7 The Vendor shall perform pre-commissioning point-to-point verification (Functional Testing) before the witnessed tests and shall fill in the **Functional Testing Check List** to demonstrate successful performance prior to witness tests (refer to Appendix B for a sample copy of **Functional Testing Check List**). Electronic version of the check list shall be provided to the vendor at the start of the project with all intended/specified points listed by others during the design phase. The vendor shall complete remaining fields including point names, device ID, etc. as job progresses.

3.5 FUNCTIONAL TESTING

3.5.1 All items listed within this Section 3.5 shall be considered the minimum standard for functional testing to be completed.

3.5.2 Verify operation, location and proper identification of all power sources, including circuit breakers and control equipment power transformers.

3.5.3 Start/stop points:

3.5.3.1 Issue start and stop commands from the local operator workstation (LOWS). Verify that controlled equipment responds appropriately and that the stat/stop status is accurately reflected at the (LOWS).

3.5.4 Analog points:

3.5.4.1 Analog inputs and outputs shall be verified at both extremes of their ranges and at the midpoint. Verify tight shutoff and full opening of the dampers and valves.

3.5.5 Digital points:

3.5.5.1 Verify that both commanded conditions (on/off, open/closed, etc.) and device status are accurately reflected at the LOWS.

3.5.6 Fan and pump failure alarms:

3.5.6.1 Test by turning off the motor at the Hand/Off/Auto (HOA) switch and observing the run-state indication at the operator station.

3.5.7 Temperature points:

3.5.7.1 Verify accuracy of sensors by comparing temperature values with the reading of an independent measuring device located in the same space or flow. Test liquid temperature sensors as installed in piping thermo wells to verify effectiveness of heat conducting compound.

3.5.8 Pressure points:

3.5.8.1 Verify accuracy of sensors by comparing displayed pressure with the reading of an independent measuring device located in the same flow stream. Retain the services of the balancer as required to confirm reading.

3.5.9 Control valves:

3.5.9.1 Verify tight shutoff by comparing water or air temperature entering and leaving the heat transfer device.

3.5.10 Operator response and sequencing:

3.5.10.1 Demonstrate that sequenced or modulated valves and dampers position accurately in response to changed conditions. Ensure that the positioned response accurately follows anticipated and specified control behavior. Ensure that the petition of multiple operators provides simultaneous modulation of damper or valve assemblies.

3.5.11 Control signal stability (general):

3.5.11.1 Demonstrate the control loops are tuned so that the output does not change until the controlled system has time to respond to the last output signal.

3.5.12 Control signal stability (response to step input):

3.5.12.1 Demonstrate that control loops are tuned so that they are stable without excessive hunting following a step input of not less than 20% of the operating/reset range of the controlled variable.

3.5.13 Control signal stability (floating point devices):

3.5.13.1 Verify that minimum pulse output duration is no less than the value required to assure repositioning to the controlled device.

3.5.14 Demonstrate the capability of the controls system to execute the complete sequence of operation as given in the mechanical controls design documents.

3.5.15 Verify tight shut-off of all actuated control valves (for 3-way valves, demonstrate capacity for 100% by-pass of coil).

3.5.16 Failure modes

3.5.16.1 Verify all stand-alone operation by disconnecting communication lines between stand-alone control units and verifying continued operation.

3.5.16.2 Disconnect and reapply 120 VAC Local Operation Station (LOWS) power to confirm proper power recovery from power failure.

3.5.16.3 Disconnect and reconnect DDC controller power to confirm proper power recovery from power failure.

3.6 PERFORMANCE TESTING

3.6.1 Using the graphical interface at Local operator workstation (LOWS), and in conjunction with CA, verify the operation and functionality of the following:

3.6.2 Override test: Verify manual override capability for start/stop and modulated points types.

3.6.3 Control logic

3.6.3.1 Exercise all control logic packages.

3.6.3.2 Check response to change in set-point and/or key control parameters.

3.6.4 Supervisory functions

3.6.4.1 Verify content of time clock schedules.

3.6.4.2 Verify alarm's reporting capabilities including; establishing alarm limits, alarm priorities (i.e. – Critical, Maintenance, Energy, Out of Range, etc.), routing priorities .

3.6.4.3 Demonstrate alarm routing functionality by triggering each different type of alarm and verifying that the system properly routed the alarm to the appropriate email and recorded in historical files, etc.

3.6.4.4 Set-up and demonstrate trending and verify the location of data storage for historical trending.

3.6.4.5 Verify Global commands.

3.7 CONTROLLER / CONTROLLER SYSTEM FAILURE MODE TESTING

3.7.1 Verify all stand-alone operation by disconnecting communication lines between stand-alone control units and verifying continued operation.

3.7.2 Disconnect and reapply 120 VAC Local Operation Station (LOWS) power to confirm proper power recovery from power failure.

3.7.3 Disconnect and reconnect controller power (to each controller) to confirm proper power recovery from power failure.

3.8 PARTIAL START-UP

3.8.1 The Vendor shall be ready for a partial start-up. The system may be started-up and functioning even though all the components are not yet installed. For example, the system may be started-up with only one SRPDC and one point and subsequently the rest of the points and other SRPDC can be added to the system and started-up.

3.9 SWITCH OVER OF EXISTING TO NEW SYSTEM (Control System Replacements and Upgrades)

3.9.1 Once the immediate work is completed, the new system shall operate and replace the old control system. The Vendor shall remove all pneumatic and electric controllers, relays, piping, switches, and panels etc. that are no longer required and shall hand

them to the Owner. The pneumatic tubing connected to the existing pneumatic actuators may be reused if it is clean and not pierced.

3.9.2 The Vendor shall clean the site of all equipment that the Owner does not desire to keep. Equipment that the Owner wishes to keep will be identified and a list turned over to the vendor prior to the start of any demolition.

3.9.3 The existing equipment that allows starting and stopping the system locally with a key shall be conserved for added safety measures during maintenance work. These locks shall be transferred to the new panels if necessary. The whole shall be kept in good working order.

3.9.4 The existing local analog gauges shall not be retained, except for the differential static pressure gauge (D.S.P.G) inside the mechanical system that shall remain functional. These gauges (D.S.P.G.) shall be installed properly.

3.9.5 The sequences of operation for the fire alarm shall be respected and the vendor shall transfer to the new system all the necessary information from the existing panel. All transfers shall be done in parallel with the implementation of the system. The switchover from the old to the new system shall be done in a minimum downtime, subject to the Owner's approval. A temporary control system shall be provided by the Vendor during the power transfer.

3.10 DEMONSTRATION

3.10.1 Demonstration is not a part of Start-Up/Commissioning or training and shall be done independently and only after completion of both tasks.

3.10.2 Demonstrate to Consultant and Owner the operation of systems including a thorough review of the sequence of operations in regular and emergency modes, under normal and emergency conditions, start-up, shut-down interlocks and lockouts in accordance with Section 01 79 00 - Demonstration and Training.

3.11 ACCEPTANCE OF WORK

3.11.1 Real End of the Work

3.11.1.1 The real end of work shall occur when all demolition, installations, programming and graphics are complete, and the Contractor has completed (their own) initial Functional and Performance Based testing and made arrangements with the Commissioning Agent to establish a date for commissioning. Any know deficiencies to that point of the project shall be documented by the contractor (on Provisional Acceptance Form) and then scheduled for completion prior to the start of Commissioning. To mark the real end of work, the contractor shall complete (and submit) a signed copy of the City of Mississauga **Project Close Out Provisional Acceptance Form** (and all closeout documentation) to signify that they are ready for a final inspection (and commissioning)

3.11.2 Provisional Acceptance

3.11.2.1 The provisional acceptance shall follow the real end of the work and shall signal the contractor's readiness for the start of Commissioning.

3.11.2.2 The Vendor shall complete and submit a signed copy of the **Project Close Out Provisional Acceptance Form** as their request for the provisional acceptance.

This shall occur only when the system is completely installed, calibrated, tested and operational. The Owner's representative and Consultant will then conduct a final inspection of the installation and review all submitted close-out documentation, pre-commissioning forms, and provisional acceptance form. If the Consultant and/or Owner judges that the installation is not complete, or tests are not adequately done by the contractor – the Provisional Acceptance Forms will not be signed back and the contractor shall return to site to complete the work before re-submission. Any charges incurred by the Consultant and or CA for additional visits shall be charged back to the Vendor.

3.11.2.3 If the at the end of the final inspection, the City representative and Consultant deem the project ready for commissioning, they will sign back the Provisional Acceptance Form indicating the project is ready to be commissioned and the job will be considered **Substantially Complete.**

3.11.2.4 The Consultant shall add any noted deficiencies add to the list of previously identified deficiencies within the **Project Close Out Provisional Acceptance Form**

3.11.3 Commissioning

3.11.3.1 A commissioning request shall be made by the contractor after the Real End of Work and shall take place only once the Provisional Acceptance Forms have been signed back by the Owner and Consultant.

3.11.3.2 Refer to Section 3.4 above

3.11.4 Final Acceptance

3.11.4.1 The final acceptance shall follow within forty (40) working days from the start of the warranty.

3.11.5 Reference to the Specifications

3.11.5.1 All inspections, meetings, tests, etc. associated with the work acceptance shall be done by comparing the work with the specifications and the concordance and discordance documents. If there is ambiguity in the specifications or in the concordance and discordance document, the provisions in the specifications and the Consultant's opinion shall prevail. It is the Vendor's responsibility to detect any difference between the specification and the system to be supplied.

3.12 ACCEPTANCE PROCEDURES

3.12.1 General Clauses

3.12.1.1 Notwithstanding the brief definitions of acceptance mentioned in the previous sub-sections, the definitions given in the general clauses are more detailed and these shall prevail in case of any interpretation.

3.12.2 Required Interpretation

3.12.2.1 The Vendor shall supply the Consultant with all the information concerning the identification of points, the functions, the limits, the sequence of operations, the locking devices, the boot-up of the system after a power failure, the readings, the programs, the parameters and all the information associated to the system and the control points.

EMCS: START-UP, VERIFICATION AND COMMISSIONING

3.12.3 Software

3.12.3.1 The Vendor shall download to the central server all software and graphics for the installation and shall activate the system. In addition, he shall be responsible for updating and verifying the database. A computer demonstration, in real time, of the monitoring capacities and commands of the system shall be presented to the Owner before the start-up of the definitive operation of the system. If this demonstration is in conformity with the specifications requirements and Consultant's representative, he shall authorize the start-up of the system.

3.12.4 Start-Up

3.12.4.1 Once the start-up is finalized, the Owner's representative shall inspect and verify the good functioning of the system, the sub-system and its accessories. He shall establish a deficiency list for correction, if necessary.

3.12.5 Repair

3.12.5.1 After receiving the deficiency list, the Vendor shall clear all identified deficiencies and then submit a City of Mississauga **Project Closeout Provisional Acceptance Form** indicating that each component on the deficiency list has been corrected and is functional (refer to Appendix B).

3.12.5.2 When all components detailed in this report have been verified and adjusted to the Owner's satisfaction, a second request for the system acceptance shall be submitted to the Owner. The Owner shall proceed with the provisional acceptance if he finds that the whole is in conformity with the requirements of the specifications.

3.12.5.3 If the Vendor must isolate some system components for verification and/or correction, and for this reason must modify, change, add or remove some hardware, software or accessories to enable the system to function partially out of service, the Vendor shall do the necessary verification for the execution of the changes until the Consultant determines that the system may function normally.

3.12.5.4 All hardware or software defects shall be covered by the warranty and the Vendor shall repair all the deficiencies within reasonable delays (as agreed upon with the Owner when deficiency and/or repair item is first noted). The loggings of the work schedules and deficiency correction reports shall be submitted to the Owner for identifying the defects and repairs being made.

END OF SECTION 25 01 11

EMCS: TRAINING

EMCS: TRAINING

Part 1 General

1.1 SUMMARY

.1 Section Includes.

.1 Requirements and procedures for training program, instructors and training materials, for building Energy Management Control System (EMCS) Work.

.2 Related Sections.

.1	Section 01 33 00	Submittal Procedures.
.2	Section 01 78 00	Closeout Submittals.
.3	Section 01 79 00	Demonstration and Training
.4	Section 25 05 01	EMCS: General Requirements.

1.2 DEFINITIONS

.1 CDL - Control Description Logic.

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

1.3 SUBMITTALS

.1 Not Applicable

1.4 TRAINING

.1 General

.1 The supplier shall offer training in the factory and on the site. This training shall be given by the Vendor, during the start-up of the new control system and before the provisional acceptance.

.2 Quality Assurance

.1 Provide a list of the proposed trainer. Trainer must be a competent instructor thoroughly familiar with specific aspects of EMCS installed in facility.

.2 Consultant and/or Owner reserves right to approve instructors.

.3 Instructions

.1 Provide instruction to designated personnel in adjustment, operation, maintenance and pertinent safety requirements of EMCS installed.

.2 Training to be project-specific.

.4 Training Documentation

.1 Submit training documentation for review 30 days minimum before training. Documentation shall include an agenda for each training day, objectives, a synopsis of each lesson, and instructor's background and project specific qualifications (see 1.4.6).

.2 The training documentation can be submitted at the same time as the project's Controls System Operators Manual.

.5 Training in the Factory

.1 Upon request, provide a list of the courses available and the associated costs.

.6 Training on Site (Operator Training)

.1 TRAINING ON SITE shall be based on instruction for 3 different user groups, with 2 sessions per group and 4 hours of training per session. Each user groups will require a custom user-group specific level of training based on their designated user access level and functional interaction with the EMCS.

.2 Training to be provided for each EMCS installation (unless otherwise noted in the tender documents).

.3 Training shall be delivered by a qualified representative of the supplier who was directly involved in the installation of the system for which the operators are being trained.

.4 Prior to the start of training the Vendor shall ensure the manuals are submitted, approved, and available to hand out to the trainees before the start of the first training session.

.5 Commissioning and demonstration of the system are an independent task and ***shall not*** be considered as part of the TRAINING ON SITE.

.6 Upon completion of the training, each trainee should fully understand the project's DDC system fundamentals. The TRAINING ON SITE shall be given in two (2) parts, but not limited, as follows:

.1 PART ONE: System Overview and Fundamentals

- *Review of As-Built documentation including:*
    - *Overview of systems controlled and related components.*
    - *Overview of project's list of points and objects.*
    - *Overview of project's device network communication architecture.*
    - *Overview or project's specified sequence of control for each system.*
    - *Overview of Alarms Types, Alarm Limits, and Routing.*
    - *Overview Trending Capabilities and Data Storage*

.2 PART TWO: System Access and Operation

- *The second session of training shall be conducted at the Local Operators Workstation Connected to the EMCS in the field via the Enterprise Server. Upon completion of the session, each trainee should fully understand the project's EMCS site specific installed operation.*
- *The training session shall include the following:*
- *A walk-through tour of the mechanical systems and the installed BAS components.*
- *A discussion of the components and functions at each BAS panel.*
- *Logging-in and navigating at operator interface type.*
- *Modifying set-points.*

- *Creating, editing, and viewing trends.*
- *Creating, editing, and viewing alarms.*
- *Creating, editing, and viewing operating schedules and events.*
- *Trouble shooting hardware errors.*

1.5 CONTINUOUS TRAINING

.1 Concerning the training, the dominant role of the Vendor is to supply Consultant with all the information regarding the changes, the modifications, and the upgrading of the system or its components. In particular, the Vendor shall immediately advise Consultant of all the changes in the methods of operation of the system.

1.6 ADDITIONAL TRAINING

.1 Upon request, list courses offered by name, duration and approximate cost per person per week. Note courses recommended for training supervisory personnel.

1.7 MONITORING OF TRAINING

.1 Submit preliminary training schedule for review by Owner and consultant. Owner and/or Owner may modify the training schedule and content to conform to site specific requirements.

.2 Owner may choose to video tape the training session for future use.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION 25 01 12

EMCS: GENERAL REQUIREMENTS

EMCS: GENERAL REQUIREMENTS

Part 1 General

1.1 SUMMARY

1.1.1 Section Includes:

1.1.1.1 General requirements and General Profile of the Work for building Energy Monitoring and Control System (EMCS) that are common to Master Specification for Direct Digital Control System Installations City of Mississauga, Ontario.

1.1.2 Related Sections:

1.1.2.1 Section 01 33 00 - Submittal Procedures.

1.1.2.2 Section 01 77 00 – Closeout Procedures

1.1.2.3 Section 01 78 00 – Closeout Submittals

1.1.2.4 Section 01 79 00 – Demonstration and Training

1.1.2.5 Section 25 01 11 – EMCS: Start-up, Verification and Commissioning

1.1.2.6 Section 25 01 12 – EMCS: Training

1.1.2.7 Section 25 05 02 - EMCS: Submittals and Review Process.

1.1.2.8 Section 25 05 54 - EMCS: Identification.

1.1.2.9 Section 25 08 20 – EMCS: Warranty and Maintenance

1.1.2.10 Section 25 30 01 – EMCS: Location Area Network

1.1.2.11 Section 25 30 02 – EMCS: Building Family of Controllers

1.1.2.12 Section 25 30 02 – EMCS: Field Control Devices

1.1.2.13 Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation.

1.1.2.14 Appendix A: City of Mississauga Standards and Guidelines

1.1.2.15 Appendix B: City of Mississauga Forms and Templates

1.1.2.16 Appendix C: City of Mississauga IT Services Cabling Specifications

1.2 REFERENCES

1.2.1 American National Standards Institute (ANSI)/ Institute of Electrical and Electronics Engineers (IEEE).

1.2.1.1 ANSI/ISA 5.5 1985, Graphic Symbols for Process Display

1.2.1.2 ANSI/IEEE 260.1-1993, American National Standard Letter Symbols Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).

1.2.2 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).

1.2.2.1 ASHRAE STD 135, BACNET - Data Communication Protocol for Building Automation and Control Network.

1.2.3 Canadian Standards Association (CSA International).

1.2.3.1 CAN/CSA-Z234.1, Canadian Metric Practice Guide.

1.2.4 Consumer Electronics Association (CEA).

1.2.4.1 CEA-709.1, Control Network Protocol Specification.

1.2.5 Department of Justice Canada (Jus).

1.2.5.1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.

1.2.5.2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.

1.2.6 Electrical and Electronic Manufacturers Association (EEMAC).

1.2.6.1 EEMAC 2Y 1, Light Gray Colour for Indoor Switch Gear.

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

1.2.7.1 Material Safety Data Sheets (MSDS).

1.3 DEFINITIONS

1.3.1 ACRONYMS AND ABBREVIATIONS used in EMCS

- AEL - Average Effectiveness Level.
- AIT - Agreement on International Trade.
- AO - Analog Output.
- BAC-net - Building Automation and Control Network.
- CDL - Control Description Logic.
- CoM – City of Mississauga
- CDS - Control Design Schematic.
- COSV - Change of State or Value.
- CPU - Central Processing Unit.
- DI - Digital Input.
- DO - Digital Output.
- DP - Differential Pressure.
- EMCS - Energy Management Control System.
- GUI – Graphical User Interface
- HVAC - Heating, Ventilation, Air Conditioning.
- IDE - Interface Device Equipment.
- I/O - Input/Output.
- ISA - Industry Standard Architecture.
- LAN - Local Area Network.
- LON - Local Operating Network
- NC - Normally Closed.
- NO - Normally Open.
- OEMASC – Original Equipment Manufacturer Application Specific Controllers
- OWS – Operator’s Workstation.
- PCMCIA - Personal Computer Micro-Card Interface Adapter.

- PID - Proportional, Integral and Derivative.
- RAM - Random Access Memory.
- RPDC – Remote Programable Digital Controllers
- SRPDC – Supervisory Remote Programable Digital Controllers
- SP - Static Pressure.
- ROM - Read Only Memory.
- TEC - Terminal Equipment Controller.
- USB - Universal Serial Bus.
- UPS - Uninterruptible Power Supply.
- VAV - Variable Air Volume.

1.3.2 Point: may be logical or physical.

1.3.2.1 Logical points: values calculated by system such as set points, totals, counts, derived corrections and may include, but not limited to result of and statements in CDL's.

1.3.2.2 Physical points: inputs or outputs which have hardware wired to controllers which are measuring physical properties or providing status conditions of contacts or relays which provide interaction with related equipment (stop, start) and valve or damper actuators.

1.3.3 Point Name: All points shall be named in accordance with the **City of Mississauga, Point Naming Convention** – Refer to Appendix A and Section 25 05 54 EMCS: Identification

1.4 SUBMITTALS

1.4.1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures and 25 05 02 - EMCS: Submittals and Review Process.

1.5 DESIGN REQUIREMENT

1.5.1 This document should be read in conjunction with the design and specification of any New and/or Replacement Energy Management Control System (EMCS), and EMCS upgrade projects designed for the City of Mississauga, Ontario. Because these Master specifications are periodically updated, the current and most recent version of this document should be obtained directly from the City of Mississauga, Ontario Project Manager for each project.

1.5.2 The basis of design for all EMCS Upgrades incorporates the following system architecture:

1.5.2.1 A dedicated EMCS Enterprise server (complete with operating system, software tools, licenses, etc.) and Tridium Niagara 4 EMCS Enterprise Server Software (ESS) package that has a fully open and accessible licensing structure.

1.5.2.2 The EMCS Server and Tridium Niagara 4 ESS is already in place. It shall be the responsibility of the contractor to communicate with CoM Facilities Department to determine the current reversion Niagara 4 Supervisor

operating and required revision of JACE to be used at the start of each project.

1.5.2.3 Databases shall be Microsoft SQL-based in accordance with the City of Mississauga ITS standard.

1.5.2.4 Secondary back-up server(s) with database software as required for all storage of all system database parameters including; back-up of all field panel programming, trend data, and site-specific color graphics

1.5.2.5 Both servers are existing and reside in a CoM designated server room, connected to the CoM local area network (LAN) and wide area network ("WAN") for communication to multiple sites and multiple pre-qualified EMCS products.

1.5.2.6 EMCS upgrades and installation for each facility shall comprise the supply and installation of a new supervisory remote digital controller ("SRPDC") connected to remote programable digital controllers ("RPDC"), terminal equipment controllers ("TEC") and original equipment manufacturer application specific controllers ("OEMASC") over a EMCS vendor supplied BACNet communication network(s).

1.5.2.7 The EMCS vendor supplied SRPDC shall be a Tridium Niagara JACE 8000 Series controller(s) of sufficient number and capacity to manage the number of field controllers and points as specified for the specific installation.

1.5.2.8 All JACE panels shall come with Open NiCS statements and shall be installed with the most recent version of Niagara 4 at the time of purchase (ie – v4.8). EMCS Vendor shall confirm the version with CoM before ordering.

1.5.2.9 The SRPDC shall communicate to the EMCS server over the COM WAN using TCP/IP communications protocol. Only one (1) network drop and IP address shall be provided by COM at a given site. EMCS and SRPDC solutions must support LAN-, WAN-, and cellular-connected facility installations based on network availability that will be specified for each location.

1.5.2.10 The EMCS Vendor shall be responsible to supply and install all necessary routers, switches, cabling, conduits and enclosures to create any necessary sub-networks for extension of TCP/IP Communication network to accommodate multiple SRPDC on one site (or IP based controllers where approved by City of Mississauga). Ethernet communication cabling for EMCS sub-networks shall be in EMT conduit (both exposed and concealed). Refer to Appendix C for City of Mississauga cabling specifications and requirements.

1.5.2.11 All SRPDC, RPDC, TEC, switches, routers, etc. to be in lockable NEMA rated enclosures (except where otherwise – i.e. VAV Box TEC may be mounted directly on the VAV Box). If in doubt, seek clarification from COM before submitting a quotation on any project.

1.5.2.12 The system architecture requires that the SRPDC be set-up and programmed to manage and monitor communication between all field level controllers (RPDC, TEC, OEMASC), and communicate all EMCS

activity to the ESS over the City's Ethernet based WAN using TCP/IP communication protocol. All EMCS field controllers shall be capable of standalone operation on loss of communication with the SRPDC. ***No physical control points shall reside on the SRPDC.***

1.5.2.13 All graphics, EMCS programming, trend data, security settings, access level priorities, etc. shall be uploaded by the EMCS vendor(s) and stored on the Server for each project (without need for the involvement of others). This shall be repeated at the start of commissioning and again upon completion of deficiency clean-up and as-built. Remote access will be provided in accordance with current City of Mississauga ITS policies, procedures and processes.

1.5.3 Coordinate with Original Equipment Manufacturer (OEM) regarding dedicated application specific controllers as supplied by Others (OEMASC**).**

1.5.3.1 The use of dedicated equipment controls supplied by others shall be pre-approved by the City of Mississauga, Ontario Facilities Management prior to design and specification.

1.5.3.2 These shall include but not be limited to the following:

- Chillers,
- Heat pumps,
- Gas fired furnaces,
- Boilers
- VFD's
- Rooftop Units
- VRF's
- Refrigeration Systems
- Generators
- Utility Meters/Sub Meters
- Lighting Controls
- Other equipment that come with OEM Installed On-board micro-processor controls.

1.5.3.3 All equipment of this nature shall come with a BACNet compliant communications interface communicating via BACNet IP or MS/TP (as indicated in the specified project specific system architecture) or approved equivalent communication protocol that is supported by the Pre-Qualified BAS Vendor Hardware interface modules – i.e. LON/Modbus/etc.). **The use of Non-BACNet communication protocols must be PREAPPROVED by CoM and shall only be considered if Bac-Net is not available.**

1.5.3.4 Design consultant shall fully identify and indicate the relationship between the EMCS and the dedicated controls for specific HVAC equipment as supplied by others, spelling out the points to be monitored, points to be modified, how and where to display on the graphics, responsibility of

HVAC equipment representative and EMCS vendor for programming, graphics and interface, etc.

1.5.3.5 Connection to the OEM supplied controls shall be via a dedicated Sub-Net communication BUS running from the Supervisory Remote Programmable Digital Controller (SRPDC) to the OEMASC's. The SRPDC should communicate to OEMASC using BAC-net (IP) communication protocol. Please refer to the City of Mississauga System Architecture Diagram

1.5.3.6 The OEMASC as mentioned in Section 253001-EMCS: Building Controllers, are to be stand-alone microprocessor-based controllers that handle the staging, sequencing, control and coordination of specific HVAC equipment and related systems components (Example Chillers/Boilers AHU's/ Other). This provides a sole source of responsibility for the equipment's performance to avoid damage to the equipment, to increase safety, and to increase vendor and manufacturer responsiveness during problem solving.

1.5.3.7 OEMASC shall be a fully BAC-net compliant device to facilitate interoperability between OEM electrical/mechanical sub-systems and BAC-net EMCS or provide the necessary gateway to integrate into the web-based BAC-net EMCS using the BAC-net communication protocol.

1.5.3.8 The OEM shall provide any software or hardware required to access or modify any electrical/mechanical subsystems *i.e. RTUs, VSD's, Chillers, Lighting controls and /or Electrical Monitoring & metering.

1.5.3.9 Typical gateway requirements for projects include but not be limited: A BAC-net interface to the chillers' manufacturers, a BAC-net interface to the VSD manufacturers' product(s), a BAC-net interface to the electrical monitoring manufacturers product(s).

1.5.3.10 A Modbus interface may be used only when a BAC-net interface is not available from the equipment OEM. If the equipment manufacturer does not have this capability, they shall contact the authorized representative of Construction Specification of Canada (CSC) for assistance and shall include in their equipment price any necessary hardware and/or software obtained from the CSC to comply with this section. Cost alone is not an acceptable reason for not providing a BAC-net interface.

1.5.3.11 OEM Configuration Tools and licences required to configure all OEMASC installed on this project, shall be provided by the equipment EMCS Vendor.

1.5.3.12 All submittals for both EMCS and OEM supplied equipment shall identify the interface between EMCS and OEM supplied controller including available points to read/write between systems.

1.5.3.13 Set up, testing and commissioning of the interface between OEMASC and the EMCS control system shall be carried out with both parties (OEM Programmer and EMCS Programmer) present on site to ensure the proper communication set up and establishing control priority levels and parameters. The cost of these services shall be included in the price from both vendors.

1.5.3.14 Specifying Consultant shall ensure to include for provision of any necessary OEM Configuration Tools and Licenses as required to connect and setup the OEM controllers and the interface to base EMCS system.

1.5.4 Fire and Emergency Power

1.5.4.1 Only the Dedicated Fire Alarm system should control life safety equipment such as smoke evacuation and make-up air fans serving; atriums, elevator shafts, stairwells, etc. Likewise, only the Dedicated Fire Alarm system should control the smoke control dampers and related systems.

1.5.4.2 Fire and smoke damper position may be monitored by the EMCS but shall not be used for the purposes of control. The Dedicated Fire Alarm system alone should provide the functional control of these dampers and necessary fan commands during alarm conditions.

1.5.4.3 The Dedicated Fire Alarm system should directly shut down all air handling units as required by Code through a hardwired signal. That shut down authority should be effective for all positions of the local Hand-Off-Auto (H-O-A) selector switch and/or variable speed drive (VSD) controls.

1.5.4.4 The EMCS system shall not control air handling units after activation of shutdown sequence by the fire alarm panel. The EMCS shall resume control only after confirmed reset of the fire alarm system.

1.5.4.5 The EMCS system shall monitor the Dedicated Fire Alarm panel to determine when the building is under a fire alarm condition. In cases where the EMCS system is interfaced to the Alarm Panel through a direct communications interface (i.e. BACNet), the EMCS functions shall be distinct and separate from the Fire Alarm.

1.5.4.6 Smoke/fire dampers and smoke/fire damper actuators are to be specified under the air distribution system, not under Master EMCS specifications.

1.5.4.7 In buildings where mechanical systems operate under EMCS control during *emergency power conditions*, the EMCS system shall monitor the appropriate emergency power transfer switch to determine when there is loss of normal power and also the restoration of normal power.

1.5.4.8 The EMCS shall follow specified sequences for Emergency Power Operation during a power failure including but not limited to the restart of equipment based on specified equipment start-up priority.

1.5.5 Use of Colour Graphics & Graphical User Interface

1.5.5.1 The use of dynamic colour graphics to their maximum extent, are required to improve the presentation and the interpretation of data.

1.5.5.2 The Graphic displays shall have full-screen resolution when viewed on user interfaces (i.e. laptop or PC) through the Owner's Enterprise server. Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh".

1.5.5.3 The Graphical User Interface shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing, of, and access to, the hierarchical structure of the database. In addition, menu pull-downs, and toolbars shall employ

buttons, commands and navigation to permit the operator to perform tasks with minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line that displays the location and the selected object identification.

1.5.5.4 The contractor shall provide all software necessary to permit the owner's designate super user to create, modify, delete, file and recall all graphics. The software package shall encompass graphical presentation of the geographical territory of the site, floor plans and equipment locations, c/w all graphics required, and sufficient expansion for the ultimate system.

1.5.5.5 The system shall be capable of generating any graphic in conjunction with any alarm of change-of-state reported.

1.5.5.6 Command software shall be provided to:

- Create a new graphic picture
- Modify a portion of a graphic picture
- Delete a graphic picture
- Call up and cancel the display of a graphic picture

1.5.5.7 The graphic package shall contain a library of HVAC related standard graphics and graphic symbols.

1.5.5.8 In the development of a graphic picture, the graphic software shall support all operator actions necessary to:

- Define the background
- Establish colours
- Define and locate symbols
- Position and edit alpha-numeric descriptors of any height
- Establish sources of real-time data and the location of their readouts

1.5.5.9 The graphics operating values and data, such as set-points, process values, alarms and parameters should be dynamically updated.

1.5.5.10 Creation of graphics must be possible using a mouse or equivalent screen point's device.

1.5.5.11 The package should be equipped with point trend graphical presentation of historical logged data, time schedule editor and alarms. The operator should read alarms from the graphics and acknowledge.

1.5.5.12 Vendors shall provide new graphics and programming both on site and in a vendor specific dedicated server (customer supplied) Located on the City Control and monitoring Centre.

1.5.5.13 The graphics generated for each site and project shall be consistent in nature from building to building, and system to system, etc. All Graphics shall conform to the ***City of Mississauga Graphical User Interface Standard.*** The Standard is to under development by the City, Consultant, and the successful bidder of an initial pilot project that will include an implemented live **Template Workstation**.

EMCS: GENERAL REQUIREMENTS

1.5.5.14 Access to the template workstation shall be granted to all vendors at the start of each new project for purposes of determining the basis and layout of COM system graphics, along with specific objectives/instruction on graphical needs of the project from COM. EMCS vendor shall use the Template Station graphics as starting point to create NEW customized, site specific project graphics. The new graphics are to match the outlined template look, layout, and colour scheme while displaying the building and system specific information for that site and the direction of COM.

1.5.5.15 Graphics shall be submitted for review and approval by COM before acceptance and their application on site. Contractor shall make all necessary changes to satisfy the City and should anticipate a reiterative process with multiple submissions before the Graphics are finalized. **NO WORK ON SITE SHALL BEGIN** until the graphics have been submitted, reviewed and approved.

1.5.5.16 Graphical Interface shall be programmed to have multiple levels of user access (as defined with City of Mississauga Facilities Planning) via Active Directory. EMCS Vendor shall work with City of Mississauga ITS to establish levels of access and appropriate user groups.

1.5.5.17 The Graphical Interface shall include a minimum of the following features/pages:

- Main Access Page: Shall display a picture of the building exterior and shall be the entry point into the system with pop-up requesting username and password. Once access is granted and user level is defined, the graphic shall populate with site related information and links to floor plans, etc.
- Floor Plans (Minimum 1 per floor): Shall display available space temperatures, controller locations, areas served by each system (i.e. (HVAC) systems, RTU1, RTU2, etc.). There shall be graphical interface buttons for each system/area to provide timed overrides and event mode buttons for all areas served. This graphic will be accessible by all levels of users and shall have links to the individual system graphics for all equipment. The areas served by each piece of equipment shall be colour coded in a convention as identified in the ***City of Mississauga Graphical Standard*** (refer to Appendix A)
- System Graphics: (Minimum 1 per system) – Shall be accessed through floor plans and the main menu page. Shall display all set points, damper commands/positions, valve commands/positions, calculated set points, etc. This page shall be viewable by all users. Low level user shall only be able to view information, mid-level access shall have capability for temporary override of all command points for valves, dampers etc. Hi level access shall be able to override all points, set points, schedules, etc. All overrides shall be monitored, alarmed and tracked in reports accessed by the super user. Links from this graphic shall be provided to show description of sequence of operation and PDF files showing hardware diagrams

with “as-built” points data indicating what points are terminated to the panel, source of power, controller model, etc.

- Settings page (1 per system) – this page would include all access to Schedules, set points, reset values, alarm settings, time delays, deadbands, etc. – essentially all points identified as “Adjustable” in the sequence of operations.
- All points shall be named according to new naming convention to be supplied by City of Mississauga and detailed in **Appendix A** Naming convention to include numeric building identification, alpha numeric system identification and alpha numeric point descriptor.
- Terminal Equipment Controllers (TEC) Quick Reference Pages – in addition to accessing individual terminal equipment though thermostat and controller links on each floor plan Graphic, the Vendor shall provide a link to Terminal Equipment Controller (TEC) Quick Reference Pages via Navigation Bar(s) in the System Menu. The Quick Reference Page will provide a Tabular summary of data for multiple Terminal Equipment Controllers including but not limited to; VAV Boxes, Unit Ventilators, Induction Terminals, Convector/Radiation Terminals, Heat Pumps, Fan Coils, etc.
- These tables shall summarize all TEC in a given area offering a quick view of the state of all units on each particular floor area providing information on; the status of unit operation, temperatures, set-points, and commands modes, i.e. occupied/unoccupied, overrides and dampers, valves control statuses.
- The operator with proper access level shall be able to utilize the links in these tables to control and command set-point changes and trouble shoot the systems.

1.5.6 Equipment Standardization

1.5.6.1 Whenever possible, the system shall use standard and readily available components and installation techniques to minimize the risks that may arise for “specialized” equipment and devices. Proven materials, software, techniques, etc. are preferred.

1.5.7 Training

1.5.7.1 The EMCS Vendor shall be responsible to provide training. (Refer to Section 25 01 12 EMCS Training).

1.5.8 Communications

1.5.8.1 The Communication Network from the SRPDC to the Server shall utilize the Owner’s existing ETHERNET TCP/IP network protocol. Communication between SRPDC and RPDC panels and field controllers and devices shall be via BAC-net Communication Network in accordance with **ANSI/ASHRAE 135 2004**. The Contactor shall provide a peer-to-peer networked, fully distributed control system for the buildings electrical and mechanical systems.

1.5.9 Reliability/Security

1.5.9.1 The system shall include protective measures in order to minimize the interruption risks and non-authorized operation of the system. These measures include but not limited to the following:

- Equipment/device address duplication
- Protection against atmospheric conditions
- High power electrical protection
- Distributed intelligence
- Analogue and digital control
- Limited access to the system
- Proven software
- Spare parts
- Remote software down and up loading
- Maintained Memory and Programming on power failure
- Physical spacing between components
- Locking panels
- "Fail safe" programming
- Protection from radio wave interference (ex: use of walkie-talkies near the DDC.)
- TLS Encryption and Security Certificates

1.5.9.2 Provide and maintain independent validation by a reputable application security assessor of implementation of OWASP ASVS v3.0.x Level 2 application security controls. Any exceptions to Level 2 controls, or acceptance of an alternative control framework (and exceptions thereto), must be managed and approved through standard City of Mississauga Information Technology Services (information security risk management) and Records Management (privacy management) processes.

1.5.9.3 Ensure that re-validation is performed on an annual basis at a minimum, or upon any significant changes to website/application functionality

1.5.10 Back-up Databases

1.5.10.1 Back-up copies of all SRPDC,RPDC & TEC system controller databases shall be stored in the Owner's dedicated EMCS Server. In addition, the vendor shall store a copy of all back-up programming for each controller and site and shall furnish to the owner upon request at no additional charge.

1.5.10.2 Continuous supervision of the integrity of all SRPDS,RPDC & TEC system controller databases shall be provided. In the event that any SRPDC,RPDC & TEC system controller on the network experiences a loss of its database for any reason, the system shall automatically download a new copy of the respective database to restore proper operation.

1.5.10.3 Database back-up/download shall occur over the local area network without operator intervention and again over the COM WAN at a

frequency set-up by the installing contractor in coordination with CoM Facilities department. Users shall also have the ability to manually execute downloads of any or all portions of a SRPDC, RPDC & TEC system controller database.

1.6 OBJECTIVES

1.6.1 General Objectives

1.6.1.1 The Controls Contractor shall supply and install a complete new BAC-net based (DDC) direct digital control Energy Management Control System (EMCS) system as required to achieve the Sequences of control for HVAC systems, heating & cooling plants, etc. and/or to replace the existing control systems used by the Owner.

1.6.1.2 No Gateways, communication bridges, protocol Translators or any other electronic devices that translate other communication protocols to the BAC-net communication protocol shall be permitted for the EMCS installation. Gateways may only be used as required for interfacing to major HVAC equipment and other building systems as specified elsewhere (i.e. – Chillers, Boilers, Power Meters, lighting, etc.)

1.6.1.3 The new EMCS control system shall consist of a high-speed Ethernet, peer-to-peer (through a BAC-net) network using TCP/IP protocol and DDC controllers interfacing with the Owner's dedicated EMCS enterprise server through the **SPRDC**. The EMCS server shall allow facility operators and other City of Mississauga Staff to interface with the control network via dynamic color graphics.

1.6.1.4 The new EMCS shall be provided with a complete Web enabled graphical user interface (GUI). The Web enabled GUI shall operate on industry standard PC hardware. The new EMCS system graphics shall be HTML 5 based vector scalable graphics and must be able to be viewed from any computer or hand held device (i.e. smart phone, tablet, etc.) on the owner supplied network or any computer on the internet (via a VPN) using no special software other than browsers (Microsoft internet explorer, Safari, or equivalent). Any black boxes or proprietary server hardware will not be acceptable.

1.6.1.5 The new EMCS shall be flexible in nature and shall permit expansion of both capacity and functionality through the addition of EMCS controllers, sensors, actuators and operator devices.

1.6.1.6 The new system Architecture design shall eliminate dependence upon any single device for alarm, event reporting and control functionality. Each EMCS controller shall operate independently by performing its own specified control programs and routines, operator I/O, Alarm management, data collection and sequences of operations. The failure of any single device, component or network connection shall not interrupt the execution of any control strategy, routines, reporting, or any operator interface device. Refer to Appendix A for System Architecture Diagram.

1.6.1.7 The EMCS Controllers shall be able to access data from, or send control commands and alarm reports directly to, any other controller or

combination of controllers on the local area network without dependence upon a central processing device. EMCS controllers shall also be able to send alarm reports to unlimited email devices such as cell phones, pagers, or standard alarm terminals via Supervisory Remote Digital Controller (**SRPDC)** and the Owner's EMCS Server using remote alarm software.

1.6.1.8 All products used in the project installation shall be new and currently under manufacturer warranty and shall have been applied in similar installations of a minimum of two years. Spare parts shall be available for at least five years after completion of this contract. Security certifications must be maintained throughout the expected life of any/all components

1.6.1.9 All controllers supplied for control of HVAC equipment shall be of One Manufacturer throughout.

1.6.1.10 For replacement of existing systems, contractor to remove existing direct digital control panel(s) and ***return to Owner upon request or dispose of if not required by owner***. Existing sensors (pneumatic/digital/electronic) made redundant or unnecessary by this work shall be removed.

1.6.1.11 Unless otherwise noted, all existing pneumatically operated control valves shall be replaced with new electronically actuated control valves. Where indicated to remain, pneumatically actuated devices shall be interfaced with new electro-pneumatic transducers. Contractor shall run new main air pneumatic tubing from the air compressor system to transducers and again to devices.

1.6.1.12 Where noted on drawings and/or points list, existing control valves shall be replaced with new electronic control valves operating on a 0-10Vdc or 4-20 mA signal. Contractor shall be responsible for complete supply and installation (mechanical/electrical/controls) of valves and actuators.

1.6.1.13 Remove all existing pneumatic damper actuators. Supply and install replacement electronic actuators operating on a 0-10Vdc or 4-20mA signal

1.6.2 Global Scope

1.6.2.1 The City of Mississauga owns, operates, and maintains facilities across the greater area and is comprised of several buildings of different size and use (Museum, libraries, Administrative, Community Center, Fire Halls Nursing Home etc.). The City is in the process of upgrading and standardizing the controls to achieve energy efficiency goals and improved thermal comfort. As part of the process the City will be tendering a number of requests to solicit stipulated price contract Bids for the installation of the New EMCS including connection of these installations to the City's Host EMCS Enterprise Server

1.6.2.2 The scope of work shall include remote programmable BACNet Certified Supervisory Remote Digital Controllers (SRPDC) and associated controllers c/w control and sensor devices, installed in each building and connected to a host server in another building on campus.

1.6.2.3 City of Mississauga Pre-Qualified EMCS Vendors and Products are:

EMCS: GENERAL REQUIREMENTS

Company Name	Branch Location	Contact Person	EMCS Family of Products
Facio Corporation	145 West Beaver Creek Rd, Richmond Hill, ON L4B 1C6	Gary MacMillan gmacmillan@facio.ca	Honeywell Spyder BacNet IP series (programmable via Niagara Workbench) and Ciper series controller. Distech Eclypse BacNet IP series controllers
Automated Controls and Energy Solutions Group Inc.	5285 Solar Dr Unit 103, Mississauga, ON L4W 5B8	Murat Kinaci estimates@acesolutionsgroup.ca	Honeywell Spyder BacNet IP series (programmable via Niagara Workbench) and Ciper series controller
Airon HVAC and Control Ltd.	5150 Fairview St, Burlington, ON L7L 6B7	Tanya Meade ***tanyam@airongroup.ca***	Honeywell Spyder BacNet IP series (programmable via Niagara Workbench) and Ciper series controller
Ainsworth Inc.	131 Bermondsey Rd, North York, ON M4A 1X4	Julian Rogochevsky ***Julian.Rogochevsky @ainsworth.com***	Schneider Smart X BacNet IP series, with Niagara module (programmable via Niagara Workbench)
Accu-Temp Systems Inc.	226 St Leger St, Kitchener, ON N2H 4M5	Scott Ward ***Scottw@accutempsystems.com***	Honeywell Spyder BacNet IP series (programmable via Niagara Workbench) and

EMCS: GENERAL REQUIREMENTS

			Ciper series controller
Modern Niagara Toronto Inc	8125 Hwy 50 Vaughan, Ontario L4L 1A5	Sam Boyajian ***Sboyajian@modernniagara.com***	Distech – Eclypse – Bacnet IP series controllers

1.6.3 Owner's Needs and Rights

1.6.3.1 The Owner demands equipment using Direct Digital Control (DDC) and distributed intelligence that is proven and shall be currently under manufacturer warranty. The operator interfaces, Building Controllers, System Controllers, and Application Specific Controllers shall be connected directly through a BAC-net communication internetwork. It is essential that all proposed systems strictly meet the Owner's needs.

1.6.3.2 The Owner has a full ownership of all products including hardware, software, graphic files, dominations, etc.

1.6.4 General Prescriptions and Concerns

1.6.4.1 Conform to all general sections of these specifications (General Conditions, General Requirements, etc.) The present section is an integral part of the Pre-Approved Direct Digital Control Vendor's scope of work and deliverables under contract with the Owner, as well as the specific scope of work for detailed for individual installations within each facility.

1.6.5 Description of Work

1.6.5.1 Supply, install and render operational an Energy Management Control system, including communications interfaces, to the Owner's proprietary communication network. The connections to the proprietary communications network shall be provided by the Owner. ***Contractor shall be responsible for communicating and coordinating IP drop locations with Owner's designated IT representative)***

1.6.5.2 The new EMCS system shall incorporate a ***Supervisory Remote Programmable Digital Controller*** (SRPDC). The SRPDC to is be located in the owner's designate main mechanical room or other owner designated location, complete with necessary interface hardware/software to allow communication over the City of Mississauga intranet using TCP/IP BAC-net standard protocol. ***A UPS shall be provided by the EMCS Vendor*** for the SRPDC to condition power and provide 20 minutes of uninterrupted power to avoid loss of communication during temporary power outage.

1.6.5.3 The SRPDC shall communicate to third party OEM controllers through separate vendor supplied dedicated Sub-Network. Sub-Network shall also be BAC-net based Local Area Network (LAN).

1.6.5.4 The City of Mississauga intends to install Wi-Fi communications throughout each of its facilities including coverage in mechanical rooms. Vendor shall set up HTML 5 scalable graphics that can be viewed and operated via mobile devices (i.e. Smart Phone and/or tablets) accessible through the Public or Owner's Wi-Fi network. The purpose of these

graphics is to facilitate the service and maintenance of the systems by the Owner's technicians. Access to the Graphics via this method shall be through the EMCS Enterprise Server Software. Also, at each site the graphics shall reside on the SRPDC and shall be accessible by a laptop or operator's workstation. Security Access Levels as outlined in these specifications shall be consistent and maintained when accessing controls through any or all PC/Laptop/Handheld Devices.

1.6.5.5 The installation of all the necessary equipment, complete with programming, should be in accordance with the control plans, system sequences of operation, the specific scope of work for each building and any other information in these and/or other specifications associated with the specific project. The specific scope of work is an integral part of these and other specifications, where other specifications are in contradiction to these specifications it is the contractor's responsibility to bring it to the attention of the Owner prior to submitting a bid.

1.6.5.6 The contractor shall install an adequate quantity of controls in order to respond to the requirements of each facility.

1.6.5.7 Furnish and install all necessary elements in order to execute the described sequences of operations.

1.6.5.8 The Control contractor shall be responsible for having the required electrical work executed by a qualified electrician and include the associated costs in his tender.

1.6.5.9 All electrical installation shall be made in conformity with the Electrician Safety Authority (ESA) and according to the applicable codes and regulations in force.

1.6.5.10 Provide all necessary power supplies from dedicated circuits in new/existing power panels.

1.6.5.11 Provide all the necessary wiring for the remote start/stop of equipment.

1.6.5.12 Install all conduits for power, control, and communication wiring in accordance with these specifications

1.6.5.13 Install a BACNet based communication bus between SRPDC, RPDC and the field communication devices of the building.

Part 2 Products

2.1 EQUIPMENT

2.1.1 Control Network Protocol and Data Communication Protocol: to ASHRAE STD 135.

2.1.2 Complete list of equipment and materials to be used on project and forming part of tender documents by adding manufacturer's name, model number and details of materials, and submit for approval.

Part 3 Execution

3.1 INSTALLATION

3.1.1 The EMCS Vendor shall furnish and install all apparatus, accessories, wires and instrumentation piping necessary to the completion and good functioning of the system.

3.1.2 The system shall be installed by electricians, technicians and mechanics trained and qualified for this type of work.

3.1.3 The supervision and start-up of the automation system shall be done on the dates stipulated by the Owner.

3.1.4 The system shall be installed in accordance with these specifications.

3.1.5 Electrical Wiring

- Submit shop drawings and product data in accordance with the requirements as detailed in these specifications.
- All wiring shall comply with local and national electrical codes and the requirements of Division 16.
- All control and sensor wiring shall be colour coded in compliance with Section 25 05 54.
- All wiring shall be plenum rated Beldon or equivalent, #18, #20 or #22-gauge, non-shielded wiring when in conduit, shielded where exposed. Lengths for specific gauge and applications shall comply with the controls' manufacturer's guidelines. Exposed low voltage wiring shall be in EMT conduit, plenum rated cable above ceilings (neatly secured with Tie-Wraps to building elements), and wire mould in finished areas where noted. All power wiring (120V) shall be in EMT conduit. The final 18" of wiring into mechanical equipment shall be in liquid tight, mounted to ensure vibration is not transmitted from equipment to conduit.
- Size 24 VAC wiring according to length refer to manufacturer's voltage drop table and size wire to achieve a minimum of 22 VAC at the control being powered.
- The use of wire-nuts for connections on communication bus is prohibited. Use "Scothlok" 3M terminals or other similar terminal block type product.
- All new controls shall have an independent power supply with dedicated breaker. The contractor shall be responsible for finding available power and labelling panel(s) for new control circuits.
- All controllers and field devices shall be identified in accordance with Section 25 05 54

3.2 NEW SYSTEMS

3.2.1 Supply and install a BAC-net based Supervisory remote programmable digital control panel (SRPDC) in the designated main Mechanical room or other location as indicated on the drawings or designated by the Owner.

3.2.2 The SRPDC shall be powered by a dedicated circuit from the nearest power panel and conditioned through a UPS before powering the panel. This UPS will also serve to back-up power for the SRPDC so that it may maintain communication with the Owner's designated Enterprise Server during power failure at individual buildings and ensure systematic re-start of equipment upon restoration of commercial power (through Restart Programming).

3.2.3 Install all necessary equipment (sensors, wiring, relays, etc.) and complete programming of the installation (alarm messages, graphics, communications, application programs, etc.) in accordance with the sequences of operations and the control plans as specified.

3.2.4 The running status of equipment such as fans, pumps, compressors, etc. shall be detected by a current sensing relay. These relays shall be calibrated consequently on site. Auxiliary contacts or airflow switches are not accepted as a proof of run unless specified elsewhere.

3.2.5 The power supply (120V) to the control devices, which controls the mechanical systems should be from a dedicated power circuit and connected to the nearest electrical panel with the circuit identified at the power panel, on the drawings and at the control device.

3.2.6 The control equipment locations shown on the plans is approximate only and final locations shall be coordinated with the Owner and/or Consultant during the work execution. The plans are not to scale, and they indicate approximate location only.

3.2.7 All the new wiring and piping of the new control system shall be the contractor's responsibility, including the power and control wiring, electrical conduit, control devices, etc. Communication wiring between the SRPDC and the Owner's Ethernet Switch shall be done by others but coordinated by this contractor.

3.2.8 The Contractor shall coordinate the test of the fire alarm system with the Owner's fire alarm company to verify that the interlocks with the ventilation system have been properly maintained and are functional.

3.2.9 The Contractor shall coordinate a power failure test run done with the Owner in order to verify the SRPDC reactions to this test. This test shall take place after the switchover and start-up of the SRPDC, RPDC and TEC controllers.

3.2.10 The Contractor shall acquire, at his own expense, all information on manufacturer's equipment such as: boilers, rooftop HVAC systems, chillers, fire panels, VSD's etc. in order to identify the necessary electric wiring required for the proper functioning of the new system. Any relays and/or interface modules for the control panel shall be supplied by the Contractor at his own expense.

3.2.11 All controllers including but not limited to SRPD, RPDC, TEC and OEMASC shall comply with all aforementioned EMCS system requirements and shall comply with the BACNet Protocol in accordance with the latest version of **ANSI/ASHRAE Standard 135**.-**2004.** All controllers (other than OEMASC) shall be of one manufacturer.

3.2.12 Remote Programmable Digital Controllers (RPDC) shall be furnished by the EMCS vendor as necessary to control large point count of major mechanical equipment, and the implementation of EMCS global control strategies.

3.2.13 Every mechanical system and/or large piece of mechanical equipment (i.e., Heating Plant, Chiller Water Plant, Large AHU, etc.) shall have one (1) dedicated RPDC with sufficient point capacity and memory such that it shall be connected to ALL field devices and terminal components (devices & sensors) associated with that system and/or piece of equipment. Distributed control of one (1) single piece of large equipment shall not be performed by multiple controllers.

3.2.14 The SRPDC shall be microprocessor based and shall execute many functions completely without the help of the central system. For example, they shall:

- Interrogate inputs and outputs
- Calculate by using real time data and other parameters
- Execute the Enterprise Server Software instructions
- Report information to the Enterprise Server Software
- Facilitate communicate between other field controllers (RPDC, TEC, and OEMASC) allowing interrogation and operation modification without the need to connect to the Server.

3.2.15 Function of the New System

3.2.15.1 Collection of Data Base

- The system shall collect different data from the mechanical and electrical systems of the automated buildings.

3.2.15.2 Control Capacity

- The system shall permit the automatic and manual control of the data and the equipment.

3.2.15.3 Programmability

- The system shall be fully programmable in order to perform basic operations automatically and certain calculations frequently used (i.e. reset schedules and calculated system set points, etc.).

3.2.15.4 Report Printing and Generation

- The system shall produce certain reports and/or graphics as detailed in these specifications through the use of external devices such as a printer.

3.2.15.5 Database Management

- It shall be possible for the operator to view and/or print out any portion of the database including, as a minimum:
  - Point configuration
  - Alarm limits
  - Schedules (Note: The system shall permit different schedules: weekly, Holiday, Alternate schedule and Temporary schedule for special events and work orders)
  - Report configuration
  - Graphic configuration
  - Global program configuration
  - SRPDC & DDC software

3.3 REPLACEMENT OF EXISTING SYSTEMS:

3.3.1 Where the specified EMCS is intended for the replacement of existing control systems, remove **all components** of the existing control system which are not required including but not limited to:

3.3.1.1 Electric and/or pneumatic controllers

3.3.1.2 Instrumentation supports and instrument panels

3.3.1.3 Existing control panel enclosures

3.3.1.4 Pneumatic Thermostats and all pneumatic tubing (in their entirety)

3.3.1.5 All existing control transformers, relays, wiring, timers, conduits, switches, thermostats, humidistats, control piping, etc. made redundant as a result of this scope of work. Where existing control and/or power wiring is unmarked and un-know, vendor shall trace and remove.

3.3.2 It is preferable that all new control panel(s) be installed where existing control panels have been removed or in close proximity.

3.3.3 If the contractor wished to re-use any existing control components (conduit, wires, cabinets) this shall be clearly communicated to the owner and submitted for approval prior to closing. It shall also be clearly identified in the bid submission as an Optional Price Deduction and the contractor shall warranty any re-used control components for a period of one (1) year from date of final acceptance

3.3.4 It is preferable that all new control panel(s) be installed where existing control panel have been removed.

3.3.5 Where approval is given for equipment is to be re-used, contractor shall carry out all necessary tests to ensure that the equipment will perform satisfactorily in its final duty as specified. All Testing shall be carried out prior to re-use. If after testing any items cannot perform as specified, the contractor shall be responsible for providing new to make the system perform as specified. The Owner takes no responsibility for the suitability and operation of existing equipment.

3.3.6 Supply and install all necessary accessories for the remote start-up of a pump or a fan, etc. These shall include relays, H.O.A. selectors, magnetic conductors interlock wiring, etc. All safety interlocks of the existing starters shall remain functional in both hand and auto positions. Where existing starters do not have H.O.A. selectors, contractor shall be responsible to retrofit/replace the starters and provide new.

3.3.7 Supply, install and render operational, primary control panel (SRPDC) and communications interface first. This shall be done to maintain the control and communication of the existing systems during the transfer from the existing DDC to the new control system.

3.3.8 All modifications to starters wiring are to be rewired while keeping only necessary interlocks. All redundant interlocks or relays shall be removed in their entirety (i.e. pneumatic fire heads where replaced with electrical/mechanical high limits controls, etc.).

3.3.9 Pneumatic Devices

3.3.9.1 The owner does not intend to use any pneumatic devices within mechanical rooms (i.e. Damper and Valve Actuators). In some cases (where identified) field devices such as Thermostats/Valves in other areas of the building may remain as designated by the Owner/Consultant**.**

3.3.9.2 In cases where the Owner/Consultant has designated to re-use pneumatic actuators and control devices, a pressure gauge (0-30 psi) shall be installed

in the pneumatic line at the output of each electro-pneumatic transducer (EPT) and in the main compressed air line to the controller(s).

3.3.9.3 An in-line oil filter shall be installed in the main airline to each controller**.**

3.3.10 For replacement systems, the contractor shall provide a priority list at the start of the project indicating systems that are to be transferred first (from the old to the new control system) so that the building controls can be updated in a systematic and organized fashion. Consultant/Owner will review the list and provide any necessary input/changes.

3.3.11 The EMCS Contractor shall have all necessary thermo-wells for piping installed by a qualified mechanical contractor. Where existing thermometers are installed, the existing thermometer wells shall not be reused for DDC sensors. Strap-On sensors shall not be acceptable except where previously identified by the Consultant and/or Owner's representative. When new thermo-wells are to be installed in existing piping that is insulated, a length of one (1) foot of insulation shall be removed and redone adequately with new insulation of the same thickness and finish.

3.3.12 The Contractor shall be responsible for all the necessary patching and painting to make good the existing finish due to the removal of the existing equipment or the new installation.

3.3.13 Sequences of Operations

3.3.13.1 The sequences of operations for all systems furnished in these specifications are generic in nature and are the expected sequence end results. (Refer **25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation**)

3.3.13.2 The Contractor shall make sure that the programming of the sequences of operations for the systems shall be such to prevent cycling at system start-up as well as cycling of the control actuators for the mixing dampers, cooling valves, heating valves, or other devices, etc.

3.3.13.3 The Contractor shall foresee and include in his programming all necessary control loops, control modes, proportional bands, integration time, time delays for start-up, ramping, control loop reset and all other necessary details for the proper functioning of the system and in order to produce a stable control of the equipment.

3.4 QUALITY ASSURANCE

3.4.1 Ensure qualified supervisory personnel continuously direct and monitor Work and attend site meetings.

3.4.2 Health and Safety:

3.4.2.1 Do construction occupational health and safety in accordance with Province of Ontario Occupation Health and Safety Act and city of Mississauga Health and Safety Requirements as a minimum.

3.4.3 Quality Control:

3.4.3.1 Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.

3.4.3.2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.

3.4.3.3 Submit proof of compliance to specified standards with shop drawings and product data. Label or listing of specified organization is acceptable evidence.

3.4.3.4 In lieu of such evidence, submit certificate from testing organization, approved by Engineer/ Consultant and/or Owner, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.

3.4.3.5 For materials whose compliance with organizational standards/codes/specifications is not regulated by organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.

3.4.3.6 Permits and fees: in accordance with general conditions of contract.

3.4.3.7 Submit certificate of acceptance from authority having jurisdiction to Engineer/ Consultant and/or Owner.

3.4.3.8 Existing devices intended for re-use (where specified): submit test report.

3.5 DELIVERY, STORAGE AND HANDLING

3.5.1 Material Delivery Schedule: provide schedule to Owner and/or Consultant/Engineer within 2 weeks after award of Contract.

3.5.2 Waste Management and Disposal:

3.5.2.1 Separate waste materials for recycling in accordance with Specifications.

3.5.2.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

3.5.2.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material for recycling in accordance with Waste Management Plan.

3.5.2.4 Separate for recycling and place in designated containers; Steel, Metal, Plastic, Paper waste in accordance with Waste Management Plan.

3.5.2.5 Place materials defined as hazardous or toxic in designated containers.

3.5.2.6 Handle and dispose of hazardous materials in accordance with Regional and Municipal, regulations.

3.5.2.7 Label location of salvaged material's storage areas and provide barriers and security devices.

3.5.2.8 Ensure emptied containers are sealed and stored safely.

3.5.2.9 Divert unused materials from landfill to appropriate recycling facility as approved by Owner and/or Consulting/Engineer.

3.5.2.10 Fold up metal and plastic banding, flatten and place in designated area for recycling.

3.6 MANUFACTURER'S RECOMMENDATIONS

3.6.1 Installation: to manufacturer's recommendations.

3.7 PAINTING

3.7.1 Clean and touch up marred or scratched surfaces of factory finished equipment to match original finish.

3.7.2 Restore to new condition, finished surfaces too extensively damaged to be primed and touched up to make good.

3.7.3 Clean and prime exposed hangers, racks, fastenings, and other support components.

END OF SECTION 25 01 11

EMCS: SUBMITTALS AND REVIEW PROCESS

EMCS: SUBMITTALS AND REVIEW PROCESS

Part 1 General

1.1 SUMMARY

.1 Section Includes.

.1 Methods and procedures for shop drawings submittals, preliminary and detailed review process including review meetings, for building Energy Management Control System (EMCS).

.2 Related Sections.

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 25 05 01 - EMCS: General Requirements

.3 Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

1.2 DEFINITIONS

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

1.3 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures and coordinate with requirements of this Section.

.2 Shop Drawings to consist of 3 hard copies and 1 soft copy of design documents, shop drawings, product data and software.

.3 Hard copy to be completely indexed and coordinated package to assure compliance with contract requirements and arranged in same sequence as specification and cross-referenced to specification section and paragraph number.

.4 Soft copy to be in PDF and/or EXEL format in accordance with owner's request, structured using menu format for easy loading and retrieval.

.5 Receive from Owner and/or Consultant the job specific electronic version of the **City of Mississauga Points Matrix Form** as provided during project Tender. Vendor to populate all relevant columns and fields with necessary data including but not limited to; Point Names (in accordance with city of Mississauga Point Naming Convention), Point Type, Device Type, Controller Location and Power Source, etc.

1.4 SHOP DRAWING REVIEW

.1 Submit shop drawings within 15 working days of award of contract and include, but not limited, following:

.1 Specification sheets for each item. To include manufacturer's descriptive literature, manufacturer's installation recommendations, specifications, drawings, diagrams, performance and characteristic curves, catalogue cuts, manufacturer's name, trade name, catalogue or model number, nameplate data, size, layout, dimensions, capacity, other data to establish compliance.

.2 Detailed system architecture showing all points associated with each controller including, signal levels, pressures where new EMCS ties into existing control equipment (where applicable)

EMCS: SUBMITTALS AND REVIEW PROCESS

.3 Spare point capacity of each controller by number and type.

.4 Controller locations.

.5 Location of Power supply including Panel Name, Location, Circuit Numbers, etc.

.6 Auxiliary control cabinet locations.

.7 Single line diagrams showing cable routings, conduit sizes, spare conduit capacity between control centre, field controllers and systems being controlled.

.8 Valves: complete schedule listing including following information: designation, service, manufacturer, model, point ID, design flow rate, design pressure drop, required Cv, Valve size, actual Cv, spring range, pilot range, required torque, actual torque and close off pressure (required and actual).

.9 Dampers: sketches showing module assembly, interconnecting hardware, operator locations, operator spring range, pilot range, required torque, actual torque.

.10 Flow measuring stations: complete schedule listing designation, service, point ID, manufacturer, model, size, velocity at design flow rate, manufacturer, model and range of velocity transmitter.

.11 Wiring diagrams

.12 Piping diagrams and hook-ups

.13 Interface wiring diagrams showing termination connections and signal levels for equipment to be supplied by others

.14 Shop drawings for each input/output point, sensors, transmitters, showing information associated with each particular point including

- Sensing element type and location.
- Transmitter type and range.
- Associated field wiring schematics, schedules and terminations.
- Completed **City of Mississauga Points Matrix Form**
- Setpoints, curves or graphs and alarm limits (high and low, 3 types critical, cautionary and maintenance), signal range.
- Software and programming details associated with each point.
- Manufacturer's recommended installation instructions and procedures.
- Input and output signal levels or pressures where new system ties into existing control equipment.
- Control schematics, narrative description, CDL's fully showing and describing automatic and manual procedure required to achieve proper operation of project, including under complete failure of EMCS.
- Graphic system schematic displays of all pages including Main Page, System Pages, Floor Plans, Terminal Equipment Quick Reference Pages, etc. including display Common elements, critical elements, all Navigation Links and menus as specified. (refer to Appendix A)
- Complete system CDL's including companion English language explanations on same sheet but with different font and italics. CDL's to contain specified energy optimization programs (in Accordance with City of Mississauga format).

EMCS: SUBMITTALS AND REVIEW PROCESS

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION 25 05 02

EMCS PROJECT RECORD DOCUMENTS

EMCS PROJECT RECORD DOCUMENTS

Part 1 General

1.1 SUMMARY

.1 Section Includes.

.1 Requirements and procedures for final control diagrams and operation and maintenance (O&M) manual, for building Energy Management Control System (EMCS) Work.

.2 Related Sections.

.1 Section 01 78 00 - Closeout Submittals.

.2 Section 25 05 01 - EMCS: General Requirements.

.3 Section 25 05 02 - EMCS: Submittals and Review Process.

.4 Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

.5 Appendix A – City of Mississauga Forms and BAS Installation Guidelines

1.2 DEFINITIONS

.1 OWS - Operator Workstation.

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

1.3 SUBMITTALS

.1 Submittals in accordance with Section 01 78 00 - Closeout Procedures, supplemented and modified by requirements of this Section.

.2 Submit Acceptance Forms, Record Documents, As-built drawings, and Operation and Maintenance Manuals to Engineer and Owner in English.

.3 Provide soft copies and hard copies in hard-back, 50 mm 3 ring, D-ring binders.

.1 Binders to be 2/3 maximum full.

.2 Provide index to full volume in each binder.

.3 Identify contents of each manual on cover and spine.

.4 Provide Table of Contents in each manual.

.5 Assemble each manual to conform to Table of Contents with tab sheets placed before instructions covering subject.

1.4 AS-BUILTS

.1 Provide 1 copy of detailed shop drawings generated in Section 25 05 02 - EMCS: Submittals and Review Process and include:

.1 Changes to contract documents as well as addenda and contract extras.

.2 Changes to interface wiring.

.3 Routing of conduit, wiring and EMCS Subnetworks, control panel locations, power panel, and powers supply locations associated with EMCS installation.

.4 Locations of obscure devices to be indicated on drawings.

.5 Printed verification copy of received Critical alarm messages.

EMCS PROJECT RECORD DOCUMENTS

.6 Panel/circuit breaker number for sources of normal/emergency power.

.7 Names, addresses, telephone numbers of each sub-contractor having installed equipment, local representative for each item of equipment, each system.

.8 Test procedures and reports: provide records of start-up procedures, test procedures, checkout tests and final commissioning reports as specified in Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

.9 Basic system design and full documentation on system configuration.

.2 Submit for final review by Engineer and Owner.

.3 Provide before acceptance 3 Hard and 1 soft copy incorporating changes made during final review.

1.5 O&M MANUALS

.1 Custom design O&M Manuals (both hard and soft copy) to contain material pertinent to this project only, and to provide full and complete coverage of subjects referred to in this Section.

.2 Provide 3 complete sets of hard and soft copies prior to system or equipment tests

.3 Include complete coverage in concise language, readily understood by operating personnel using common terminology of functional and operational requirements of system. Do not presume knowledge of computers, electronics or in-depth control theory.

.4 Functional description to include:

.1 Functional description of theory of operation.

.2 Design philosophy.

.3 Specific functions of design philosophy and system.

.4 Full details of data communications, including IP port and protocols required/in use, data types and formats, data processing and disposition data link components, interfaces and operator tests or self-test of data link integrity.

.5 Explicit description of hardware and software functions, interfaces and requirements for components in functions and operating modes.

.6 Description of person-machine interactions required to supplement system description, known or established constraints on system operation, operating procedures currently implemented for implementation in automatic mode.

.5 System operation to include:

.1 Complete step-by-step procedures for operation of system including required actions at OWS.

.2 Operation of computer peripherals, input and output formats.

.3 Emergency, alarm and failure recovery.

.4 Step-by-step instructions for start-up, back-up equipment operation, execution of systems functions and operating modes, including keystrokes for each command so that operator need only refer to these pages for keystroke entries required to call up display or to input command.

.6 Software to include:

EMCS PROJECT RECORD DOCUMENTS

.1 Documentation of theory, design, interface requirements, functions, including test and verification procedures.

.2 Detailed descriptions of program requirements and capabilities.

.3 Data necessary to permit modification, relocation, reprogramming and to permit new and existing software modules to respond to changing system functional requirements without disrupting normal operation.

.4 Software modules, fully annotated source code listings, error free object code files ready for loading via peripheral device

.5 Complete program cross reference plus linking requirements, data exchange requirements, necessary subroutine lists, data file requirements, other information necessary for proper loading, integration, interfacing, program execution.

.6 Software for each Controller and single section referencing Controller common parameters and functions.

.7 Up-to-date security certifications.

.7 Maintenance: document maintenance procedures including inspection, periodic preventive maintenance, fault diagnosis, repair or replacement of defective components, including calibration, maintenance, repair of sensors, transmitters, transducers, controller and interface firmware's, plus diagnostics and repair/replacement of system hardware.

.8 System configuration document:

.1 Information regarding IP port and protocols required/in use

.2 Provisions and procedures for planning, implementing and recording hardware and software modifications required during operating lifetime of system.

.3 Information to ensure co-ordination of hardware and software changes, data link or message format/content changes, sensor or control changes in event that system modifications are required.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION 25 05 03

EMCS IDENTIFICATION

EMCS IDENTIFICATION

Part 1 General

1.1 SUMMARY

.1 Section Includes.

.1 Requirements and procedures for identification of devices, sensors, wiring tubing, conduit and equipment, for building Energy Monitoring and Control System (EMCS) Work and nameplates materials, colours and lettering sizes.

.2 Related Sections.

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 25 05 01 - EMCS: General Requirements.

.3 Appendix A - City of Mississauga Standards and Guidelines

.4 Appendix B – City of Mississauga Forms and Templates

.3 References

.1 Canadian Standards Association (CSA International).
CSA C22.1, The Canadian Electrical Code, Part I (19th Edition), Safety Standard for Electrical Installations.

1.2 DEFINITIONS

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

1.3 SUBMITTALS

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

.2 Submit to Consultant for approval samples of nameplates, identification tags and list of proposed wording in accordance with City of Mississauga format (refer to Appendix A1).

.3 All point names and point descriptors shall follow the **City of Mississauga Point Naming Convention** (refer to Appendix A1)

Part 2 Products

2.1 NAMEPLATES FOR CONTROL PANELS

.1 Identify by Plastic laminate, 3 mm thick Melamine, matt white finish, black core, square corners, lettering accurately aligned and engraved into core.

.2 Sizes: 25 x 67 mm minimum.

.3 Lettering: minimum 7 mm high, black.

.4 Inscriptions: machine engraved to identify function.

- Example: RTU0102 (RPDC2903)

2.2 NAMEPLATES FOR FIELD DEVICES

.1 Identify by plastic encased cards attached by plastic tie.

.2 Sizes: 50 x 100 mm minimum.

.3 Lettering: minimum 5 mm high in Black.

EMCS IDENTIFICATION

.4 Data to include full point name and point address in accordance with **the City of Mississauga Point Naming Convention** (refer to Appendix A1).
- Example: AHU0201_SF_SAT(RPDC5410)

.5 Companion cabinet: identify interior components using plastic enclosed cards with point name and point address.

2.3 NAMEPLATES FOR ROOM SENSORS

.1 Identify by stick-on labels using full point name identifier.
- Example: AHU0201_RM205_T (TEC5411)

.2 Location: On bottom portion of Room Sensor (as directed by Consultant and/or Owner).

.3 Letter size: to suit, clearly legible.

2.4 WARNING SIGNS

.1 Equipment including motors, starters under remote automatic control: supply and install orange coloured signs warning of automatic starting under control of EMCS.

.2 Sign to read: "Caution: This equipment is under automatic remote control of EMCS".

2.5 WIRING

.1 Supply and install markings on wiring at panels, junction boxes, splitters, cabinets, field devices and outlet boxes.

.2 Identify all control wiring and communication trunks at both extremities using plastic, numbered clip-on wire markers and provide a legend at each controller (including terminal unit controllers) that identifies wires by number and full point descriptor (Per **City of Mississauga Point Naming Convention** – Appendix A1).

.3 Colour coding: Use colour coded wiring throughout. Communications cables shall be of one color throughout system.

.4 Power wiring: identify circuit breaker panel/circuit breaker number inside each EMCS panel.
Example: 120V Power – Fed from Panel LP-1, CCT - 10

2.6 CONDUIT

.1 Colour code EMCS conduit.

.2 Mark all EMCS junction box covers and conduit fittings.

.3 Coding: use fluorescent orange paint and/or Owner approved Coding system.

.4 Mark conduit at 1.5m intervals with Fluorescent tape. Also mark at point of entry and exit of each wall/partition.

2.7 PANEL ENCLOSURES

.1 A professional printed/typed input/output layout sheet shall be mounted within each controller. This sheet shall be laminated and shall include:

.1 A panel layout diagram showing termination points of each controller and all devices within the panel (i.e. relays, expansion panels, transformers, etc.)

.2 The descriptor name of the points connected to each controller channel together with the revision number and date.

.3 Designation of power source panel location and circuit number

.2 All controllers and associated devices shall be identified with symbols relating directly to the control diagram.

2.8 CONCEALED CONTROL DEVICES

.1 Label all control devices (i.e. Heat Pumps, VAV Boxes, Fan Coils, room thermostats, relays, transformers, panels, etc.) in the field with proper descriptors and where concealed above ceilings, etc. - identify on the ceiling grid below where the devices are located with Lamacoid Label

Part 3 Execution

3.1 NAMEPLATES AND LABELS

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

3.2 EXISTING PANELS

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

END OF SECTION 25 05 54

EMCS WARRANTY AND MAINTENANCE

EMCS WARRANTY AND MAINTENANCE

Part 1 General

1.1 SUMMARY

.1 Section Includes.

.1 Requirements and procedures for warranty and activities during warranty period and service contracts, for building Energy Management Control System (EMCS).

.2 Related Sections.

.1 Section 01 33 00 - Submittal Procedures.
.2 Section 01 78 00 - Closeout Submittals.
.3 Section 25 05 01 - EMCS: General Requirements.
.4 Appendix A – City of Mississauga Forms and BAS Guidelines

.3 References.

.1 Canada Labour Code (R.S. 1985, c. L-2)/Part I - Industrial Relations.
.2 Canadian Standards Association (CSA International).
.1 CSA Z204-Latest Addition, Guidelines for Managing Indoor Air Quality in Office Buildings.

1.2 DEFINITIONS

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

1.3 SUBMITTALS

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

.2 Submit detailed preventative maintenance schedule for system components to Owner's Representative.

.3 Submit detailed EMCS inspection reports to Owner's Representative.

.4 Submit dated, maintenance task lists to Owner's Representative and include the following sensor and output point detail, as proof of system verification:

.1 Point name and location.
.2 Device type and range.
.3 Measured value.
.4 System displayed value.
.5 Calibration detail
.6 Indication if adjustment required,
.7 Other action taken or recommended

.5 Complete and submit a full network analysis report. Report shall identify results of analysis with detailed recommendations to correct any problems found.

.6 Records and logs

EMCS WARRANTY AND MAINTENANCE

.1 Maintain records and logs of each maintenance task on site.

.2 Organize cumulative records for each major component and for entire EMCS chronologically.

.3 Submit records to Owner's Representative, after inspection indicating that planned and systematic maintenance have been accomplished

.4 Revise and submit to Owner's Representative in accordance with Section 01 78 00 - Closeout Submittals "As-built drawings" documentation and commissioning reports to reflect changes, adjustments and modifications to EMCS made during warranty period

1.4 MAINTENANCE SERVICE DURING WARRANTY PERIOD

.1 Provide services, materials, and equipment to maintain EMCS for specified warranty period.

.2 Emergency Service Calls:

.1 Initiate service calls when EMCS is not functioning correctly.

.2 Qualified control personnel to be available during warranty period to provide service to "CRITICAL" components whenever required at no extra cost.

.3 Furnish Owner with telephone number where service personnel may be reached at any time.

.4 Service personnel to be on site ready to service EMCS within 2 hours after receiving request for service (refer to 1.5.1 of this Section)

.5 Perform Work continuously until EMCS restored to reliable operating condition.

.3 Operation: foregoing and other servicing to provide proper sequencing of equipment and satisfactory operation of EMCS based on original design conditions and as recommended by manufacturer.

.4 Work requests: record each service call request, when received separately on City of Mississauga approved form and include:

.1 Serial number identifying component involved.

.2 Location, date and time call received.

.3 Nature of trouble.

.4 Names of personnel assigned.

.5 Instructions of work to be done.

.6 Amount and nature of materials used.

.7 Time and date work started.

.8 Time and date of completion.

.5 Provide system modifications in writing.

.6 No system permanent modification, including operating parameters and control settings, to be made without approval of Engineer/Consultant and/or Owner.

1.5 WARRANTY

.1 **Scope of Warranty**: The Contractor shall guarantee the proper functioning of all the work and the installation regarding his contract for a period of one year, effective as the provisional acceptance of the work of the Owner. The Contractor shall replace or repair, at his discretion,

both immediately and free of charge and all the devices, pieces of equipment or material found defective during this period. This warranty covers material and labour including but not limited to:

.1 All expenses generated from the imperfect execution of the work, poor maintenance, repair or replacement.

.2 Emergency service calls during the warranty period (available 24 hours/day, 7 days/week, and 52 weeks/year) within a 2-hour response time.

.3 Replacement of all defective pieces and components.

.4 Correction to any and all programming where the performances are not in conformity with the rules of the trades.

.2 Warranty of Perfect Execution of the Work

.1 Owner shall hold an equivalent amount of 5% of the cost of the work without interest for a period of six (6) months following the provisional acceptance date of the work, as a warranty of perfect execution of the work.

.2 Neither the holdback nor its payment shall free the Contractor from the legal responsibilities he is incumbent upon. Consultant shall use this amount of money to execute the repair that the Contractor neglects or refuses to do within five (5) days following a written notice from the Owner to this concern.

.3 Intermittent Defects

.1 If during the warranty period, intermittent defects or abnormal phenomena are detected, that fail under the Contractor's responsibility, the period of the warranty shall be extended for a period equivalent to the time loss of system functionality caused by these defects or phenomena.

.4 The Contractor's Responsibility

.1 Any operational defect which may appear in any of the work and occurring during the period and according to the judgement of Council is not due to a misuse of the Owner and/or an ordinary wear and tear but a deficiency in the material or in the installation work and /or programming shall be repaired by the Contractor without any additional expenses to Owner or Consultant. The Contractor shall also assume any costs to compensate for any injuries or other work that the defect may have caused. All repairs done by the Contractor, during the warranty period, shall be done after peak working hours in the concerned areas and causing minimum inconveniences to the Owner.

.2 Inspection and acceptance of the work and materials, the payments made and the use of equipment by the users shall not diminish the Contractors' responsibilities. The general warranty shall not exempt, in any case, any particular warranty, otherwise stipulated and shall not affect any warranty provided in terms of the established laws.

.5 Renewal of Software

.1 If the Contractor makes any upgrade to their represented EMCS system and/or the EMCS software, it shall be made available to Owner and installed on the server and/or system controllers. The new editions of software updates which can be incorporated to the existing installed equipment shall be supplied and installed **free of charge** to the Owner for a period of five (5) years from date of initial installation. Contractor shall notify owner in writing 12 months prior to the end of the five (5) year software service

period and offer a re-subscription with a stipulated price. (This applies to both JACE and Field Controllers)

.2 Maintenance of security certifications is required during both the original and extended warranty periods as described above.

.6 Preventive Maintenance

.1 Preventive maintenance is not considered as part of the warranty.

.2 Preventive maintenance forms part of Service Contracts which is an optional decision by the Owner.

1.6 WARRANTY EXTENSION

.1 The Contractor may be asked during individual tender to submit a separate price for an additional warranty contract (for services, pieces, repair/replacement offered to the Owner), for a period of twelve (12) months, effective at the end of the warranty of the present contract.

.1 Maintenance of security certifications is required during any extended warranty periods

1.7 SERVICE CONTRACTS

.1 Provide in-depth technical expertise and assistance to Owner's Representative and Commissioning Agent in preparation and implementation of service contracts and in-house preventive maintenance procedures. Service contracts duration is for the warranty period.

.2 Service Contracts to include:

.1 Annual verification of field points for operation and calibration.

.2 Four (4) service visits per year.

.3 Two (2) hour response to all daytime emergency calls.

.4 Two (2) hour response to all emergency calls during silent hours.

.5 Silent hours defined as 1630 h – 0800 h and on weekends and statutory holidays.

.6 Complete inventory of installed system.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 FIELD QUALITY CONTROL

.1 Work must be approved by a City of Mississauga staff and receive a proper work order number at least 3 days prior to the inspections. Any work without a proper work order number shall be considered as a free of charge service.

EMCS WARRANTY AND MAINTENANCE

.2 Perform as minimum (3) three minor inspections and one major inspection (more often if required by manufacturer) per year. Provide detailed written report to Owner's Representative as described in Submittal article.

.3 Perform inspections during regular working hours, 0800 to 1630 h, Monday through Friday, excluding statutory holidays.

.4 Following inspections are minimum requirements and should not be interpreted to mean satisfactory performance:

- .1 Perform calibrations using test equipment having traceable, certifiable accuracy at minimum 50% greater than accuracy of system displaying or logging value.
- .2 Check and calibrate random sample of 10% field input/output devices in accordance with Canada Labour Code - Part I and CSA Z204.
- .3 Provide dated, maintenance task lists, as proof of execution of complete system verification

.5 Minor inspections to include, but not limited to:

- .1 Perform visual, operational checks to Control Panels, peripheral equipment, interface equipment and other panels.
- .2 Check equipment cooling fans as required.
- .3 Visually check for mechanical faults, air leaks and proper pressure settings on pneumatic components.
- .4 Review system performance with Operations Supervisor and/or Owner's Representative to discuss suggested or required changes.

.6 Major inspections to include, but not limited to:

- .1 Minor inspection.
- .2 Clean OWS(s) peripheral equipment, Control Panels, interface and other panels, micro-processor interior and exterior surfaces.
- .3 Check signal, voltage and system isolation of Control Panels, peripherals, interface and other panels.
- .4 Verify calibration/accuracy of each input and output device and recalibrate or replace as required (as per 3.1. 4.2).
- .5 Run system software diagnostics as required.
- .6 Install all software and firmware enhancements (including those required by the EMCS LAN equipment) to ensure components are operating at most current revision for maximum capability and reliability.

EMCS WARRANTY AND MAINTENANCE

.7 Perform network analysis and provide report as described in Submittal article.

.8 Rectify deficiencies revealed by maintenance inspections and environmental checks.

.9 Continue system debugging and optimization.

.10 Testing/verification of occupancy and seasonal-sensitive systems to take place during four (4) consecutive seasons, after facility has been accepted, taken over and fully occupied.

.11 Test weather-sensitive systems twice: first at near winter design conditions and secondly under near summer design conditions.

END OF SECTION 25 08 20

EMCS LOCAL AREA NETWORK

EMCS LOCAL AREA NETWORK

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 System requirements for Local Area Network (LAN) for Building Energy Management Control System (EMCS).

.2 Related Sections:

.1 Section 25 05 01 - EMCS: General Requirements.

.3 References

.1 Canadian Standards Association (CSA International).

.1 CSA T529 Telecommunications Cabling Systems in Commercial Buildings (Adopted ANSI/TIA/EIA-568-A with modifications).

.2 CSA T530 , Commercial Building Standard for Telecommunications Pathways and Spaces (Adopted ANSI/TIA/EIA-569-A with modifications).

.2 Institute of Electrical and Electronics Engineers (IEEE)/Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements.

.1 IEEE Std 802.3™, Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications.

.3 Telecommunications Industries Association (TIA)/Electronic Industries Alliance (EIA)

.1 TIA/EIA-568-, Commercial Building Telecommunications Cabling Standards Set, Part 1 General Requirements Part 2 Balanced Twisted-Pair Cabling Components Part 3 Optical Fiber Cabling Components Standard.

.2 TIA/EIA-569-A, Commercial Building Standard for Telecommunications Pathways and Spaces

1.2 DEFINITIONS

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

1.3 SYSTEM DESCRIPTION

.1 Data communication network to link Supervisory Remote Digital Control Panel (SRPDC) to Remote Digital Control Panels (RPDC), Terminal Equipment Controllers (TEC) and OEM Application Specific Controllers (OEMASC) in accordance with CSA T529 and CSA T530.

.1 Provide reliable and secure connectivity of adequate performance between different sections (segments) of network.

.2 Allow for future expansion of network, with selection of networking technology and communication protocols.

.2 Data communication network to include, but not limited to:

.1 EMCS-LAN.

.2 Network interface cards.

.3 Network management hardware and software.

.4 Network components necessary for complete network.

1.4 DESIGN REQUIREMENTS

.1 EMCS Local Area Network (EMCS-LAN).

.1 High speed, high performance, local area network over which SRPDC, and RPDC communicate with other directly on peer to peer basis in accordance with CSA T529 and T530.

.2 EMCS-LAN (RPDC to RPDC and/or SPRDC): BACNet IP Communication Protocol

.3 EMCS-SUBLAN (RPDC to TEC): BACnet IP Communication Protocol and/or BACnet MS/TP Communication Protocol as indicated in project specific specifications.

.4 Each EMCS-SUB LAN to be capable of supporting at minimum of 100 devices.

.5 High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, upload/download information between network devices. Bit rate to be 10 Megabits per second minimum.

.6 Detection and accommodation of single or multiple failures of either SRPDC, RPDC, TEC, OEMASC or network media. Operational equipment to continue to perform designated functions effectively in event of single or multiple failures.

.7 Commonly available, multiple sourced, networking components and protocols to allow system to co-exist with other networking applications including office automation.

.2 Dynamic Data Access.

.1 LAN to provide capabilities for OWSs, either network resident or connected remotely, to access point status and application report data or execute control functions for other devices via LAN.

.2 Access to data to be based upon logical identification of building equipment.

.3 Network Medium.

.1 Network Medium (EMCS LAN): Ethernet Cable(IP) CAT 5,6,6E

.2 Network Medium (EMCS SUBLAN): Ethernet Cable(IP) CAT 5,6,6E or shielded twisted cable, compatible with network protocol to be used within buildings (as indicated in Project specifications).

.4 EMCS Switch/Router

.1 Vendor is to supply and install all necessary Switches/Routers for a complete EMCS network separate and distinct from the building's IT LAN.

.2 Switches/Routers are to be installed in a lockable Cabinet Enclosure Marked EMCS with dedicated power supplies.

.5 Network Security

.1 Security protocols of the EMCS LAN shall meet or exceed the requirements of the City of Mississauga Information Technology Services department

EMCS LOCAL AREA NETWORK

Part 2 Products

2.1 COMMUNICATION WIRING HANGERS

.1 Provide Communication system wiring hangers to supplement existing hangers such that communications cable maximum span is 4m for change in direction of greater than 45 degrees or 9m for a straight run

.2 Hangers are to be suitable for supporting up to 80 4-pair UTO low voltage cables with 50mm diameter loop. Provide multiple hangers on single support bracket as shown on detail drawing. Erico No. CAT32.

.3 Provide all required 10mm threaded hangers, rods, bolts, wall anchors, beam clamps and fittings as required for proper installation and support.

.4 Manufacturers: Caddy, B-Line, Approved Equal.

Part 3 Execution

3.1 NETWORK/COMMUNICATION CABLING

.1 EMCS communication BUS (between SRPDC and all field panels) shall be in EMT Conduit where exposed, and in plenum rated cable (FT 6) above rated ceiling plenums. Where EMCS network is run outside of conduit it must be neatly run with new communication hangers (where they are pre-existing, communication hangers be re-used).

.2 All Communication cable shall be of the same color with label at extremities indicating LAN identification, termination point and where applicable Switch and Port. Ethernet cable shall be Orange.

.3 Where there are insufficient hangers or structure existing, contractor shall install hangers to accommodate a maximum distance between strapping points of 4m (for change in direction of greater than 45 degrees) or 9m for a straight run.

.4 Where Ethernet communications for EMCS sub-network have been permitted, ethernet cable shall be in conduit throughout. EMCS Vendor shall supply designated EMCS Switch/Router and assign all sub-network addresses needed to communicate to controllers and OEMASC.

.5 EMCS Switch/Router shall be installed in a latched NEMA Rated cabinet within mechanical/electrical rooms

.6 Communications conduits to be minimum 21mm EMT maximum 50% full.

.7 In general, the following table shall be used for conduit sizing:

Conduit Size:	21mm	27mm	35mm	41mm
Max UTP	2	3	6	7

.8 Cables shall not be attached to pipe, conduit or ductwork, etc.

.9 Conduit ends shall be provided with non-metallic bushing to provide a round edge which will not abrade the cable jacket.

EMCS LOCAL AREA NETWORK

END OF SECTION 25 10 01

EMCS BUILDING CONTROLLERS, FAMILY OF CONTROLLERS

EMCS BUILDING CONTROLLERS, FAMILY OF CONTROLLERS

Part 1 General

1.1 SUMMARY

1.1.1 Section Includes:

1.1.1.1 Materials and installation for building automation controllers including:

1.1.1.1.1 Supervisory Remote Programmable Digital Controller (SRPDC).

1.1.1.1.2 Remote Programmable Digital Controller (RPDC)

1.1.1.1.3 Terminal Equipment Controllers (TEC)

1.1.1.1.4 Original Equipment Manufacturer Application Specific Controllers (OEMASC)

1.1.2 Related Sections:

1.1.2.1 Section 25 05 01 - EMCS: General Requirements.

1.1.2.2 Section 25 05 02 - EMCS: Submittals and Review Process.

1.1.2.3 Section 25 05 54 – EMCS: Identification

1.1.2.4 Section 25 05 03 - EMCS: Project Record Documents.

1.1.2.5 Section 25 30 02 - EMCS: Field Control Devices.

1.1.2.6 Section 25 90 01 - EMCS: Site Requirements Applications and Systems Sequences of Operation.

1.1.3 References

1.1.3.1 American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE)

1.1.3.1.1 ASHRAE, Applications Handbook, SI Edition.

1.1.3.2 Canadian Standards Association (CSA International)

1.1.3.2.1 C22.2 No.205-M1983(R1999), Signal Equipment.

1.1.3.3 Institute of Electrical and Electronics Engineers (IEEE)

1.1.3.3.1 IEEE C37.90.1-02, Surge Withstand Capabilities (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.

1.2 DEFINITIONS

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

1.3 SYSTEM DESCRIPTION

1.3.1 General: Network of controllers comprising of SRPDC, RPDC, TEC, OEMASC to be provided as indicated in System Architecture and Standard Wiring Diagram to support building systems and associated sequence(s) of operations as detailed in these specifications.

1.3.1.1 Provide sufficient controllers to meet intents and requirements of this section.

1.3.1.2 Controller quantity, and point contents to be approved by Consultant at time of preliminary design review.

1.3.2 Controllers: stand-alone intelligent Control Units.

1.3.2.1 Incorporate programmable microprocessor, non-volatile program memory, RAM, power supplies, as required to perform specified functions.

1.3.2.2 Incorporate communication interface ports for communication to LANs to exchange information with other Controllers.

1.3.2.3 Capable of interfacing with operator interface device.

1.3.2.4 Execute its logic and control using primary inputs and outputs connected directly to its onboard input/output field terminations or slave devices, and without need to interact with other controllers

1.3.2.4.1 Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).

1.4 SUBMITTALS

1.4.1 Provide submittals in accordance with Section 01 33 00 Submittal Procedures and Section 25 05 02 - EMCS: Submittals and Review Process.

1.4.2 Submit product data sheets for each product item proposed for this project.

1.5 DESIGN REQUIREMENTS

1.5.1 To include:

1.5.1.1 Scanning of AI and DI connected inputs for detection of change of value and processing detection of alarm conditions.

1.5.1.2 Perform On-Off digital control of connected points, including resulting required states generated through programmable logic output.

1.5.1.3 Perform Analog control using programmable logic, (including PID) with adjustable dead bands and deviation alarms.

1.5.1.4 Control of systems as described in sequence of operations.

1.5.1.5 Execution of optimization routines as listed in this section.

1.5.2 Total spare capacity for RPDC: at least 25 % of each point type (distributed throughout the RPDC's within each mechanical/electrical room) unless directed otherwise during tender.

1.5.3 Field Termination and Interface Devices:

1.5.3.1 To: CSA C22.2 No.205.

1.5.3.2 Electronically interface sensors and control devices to processor unit.

1.5.3.3 Include, but not be limited to, following:

1.5.3.3.1 Programmed firmware or logic circuits to meet functional and technical requirements.

1.5.3.3.2 Power supplies for operation of logics devices and associated field equipment.

1.5.3.3.3 Lockable wall cabinet.

1.5.3.3.4 Required communications equipment and wiring (if remote units).

1.5.3.3.5 Leave controlled system in "fail-safe" mode in event of loss of communication with, or failure of, processor unit.

1.5.3.3.6 Input Output interface to accept as minimum AI, AO, DI, DO functions as specified.

1.5.3.3.7 Wiring terminations: use conveniently located screw type or spade lug terminals.

1.5.3.4 AI interface equipment to:

1.5.3.4.1 Convert analog signals to digital format with 10 bit analog-to-digital resolution.

1.5.3.4.2 Provide for following input signal types and ranges:

- 4 - 20 mA;
- 0 - 10 V DC;
- 100/1000-ohm RTD input;

1.5.3.4.3 Meet IEEE C37.90.1 surge withstand capability.

1.5.3.4.4 Have common mode signal rejection greater than 60 dB to 60 Hz.

1.5.3.4.5 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.

1.5.3.5 AO interface equipment:

1.5.3.5.1 Convert digital data from controller processor to acceptable analog output signals using 8-bit digital-to-analog resolution.

1.5.3.5.2 Provide for following output signal types and ranges:

- 4 - 20 mA.
- 0 - 10 V DC.

1.5.3.5.3 Meet IEEE C37.90.1 surge withstand capability.

1.5.3.6 DI interface equipment:

1.5.3.6.1 Able to reliably detect contact change of sensed field contact and transmit condition to controller.

1.5.3.6.2 Meet IEEE C37.90.1 surge withstand capability.

1.5.3.6.3 Accept pulsed inputs up to 2 kHz.

1.5.3.7 DO interface equipment:

1.5.3.7.1 Respond to controller processor output, switch respective outputs. Each DO hardware to be capable of switching up to 0.5 amps at 24 V AC.

1.5.3.7.2 Switch up to 5 amps at 220 V AC using optional interface relay.

1.5.4 Controllers and associated hardware and software: operate in conditions of 0ºC to 44ºC and 20 % to 90 % non-condensing RH.

1.5.5 Controllers (SRPDC & RPDC): mount in **NEW** NEMA 1 wall mounted cabinet with hinged, keyed-alike locked door.

1.5.5.1 Provide for conduit entrance from top, bottom or sides of panel.

1.5.5.2 Except were otherwise noted, TEC's to be mounted inside a separate NEMA rated enclosure in nearest designated mechanical/electrical room. Wiring from enclosure to terminal equipment shall be in EMT conduit

(including the portion above ceiling system) with liquid tight conduit for the last 24-30" only.

1.5.5.3 All the controllers and panels to be installed eye level height, to be accessed without using ladder or stool, not behind doors or any mechanical equipment, in a way that panel door can be fully opened without restriction. With some exception for direct mounting controller (such as VAV box) unless otherwise approve by COM.

1.5.6 Cabinets to provide protection from dust water dripping from above, while allowing sufficient airflow to prevent internal overheating. For installations in dusty areas (ie – Transit Garage), cabinet enclosure will accommodate air filtration for cabinet venting.

1.5.7 Provide surge and low voltage protection for interconnecting wiring connections.

1.6 MAINTENANCE PROCEDURES

1.6.1 Provide manufacturers recommended maintenance procedures for insertion in Section 25 05 03 - EMCS: Project Record Documents.

Part 2 Products

2.1 SUPERVISORY REMOTE PROGRAMMABLE DIGITAL CONTROLLER (SRPDC)

2.1.1 The SRPDC is BAC-Net Compliant, stand-alone and fully user- programmable supervisory controller. The SRPDC shall comply with all mentioned EMCS System requirements and shall monitor the network of distributed application specific remote digital controllers (RPDC). The SRPDC shall communicate on a peer–to-peer basis across the Owners Ethernet network with the other SRPDC Controllers and to a Central Enterprise Server.

2.1.2 The SRPDC shall use one (or several) micro-computer(s) with sufficient memory to:

2.1.2.1 Acquire, process, and transfer data to the Owner's Enterprise Server OR OTHER SRPDC.

2.1.2.2 Accept, process, and execute orders coming from the Enterprise Server or other input devices;

2.1.2.3 Record, analyze, and signal the change of state or value that appears among the connected RPDC controllers to the SRPDC;

2.1.2.4 Access to any one SRPDC shall allow the user to gain access any other SRPDC on the owner's network without need to go through the Owner's server.

2.1.2.5 The SRPDC shall have the capability of generating and storing HTML5 Scalable Vector Graphics. NOTE: System Graphics for each Site shall reside on the server with secondary copies downloaded to the SRPDC on Site. A secondary back-up copy of all graphics shall also be automatically updated with each change and stored on the Owner's designate Enterprise Server.

2.1.3 Every SRPDC shall execute continuous diagnostics and all function failures shall be enunciated at one or more designated operator's workstations. Failure of an SRPDC shall not affect the function of the Server or any other SRPDC on the network.

2.1.4 If the EMCS Enterprise Server or network transmission fails, the SRPDC shall continue to control all the changes of state and/or value and shall have sufficient memory to store the readings of all analog inputs and the calculated values of the SRPDC for a minimum of 12 hours. After the failure, the SRPDC shall send the stored readings to the EMCS Enterprise Server.

2.1.5 Intervals between each reading shall depend on the type of reading and shall be determined by the Owner designated user(s) through commands established in the EMCS Enterprise Server Software.

2.1.6 These time intervals shall be adjustable and defined by the user and shall be selected based on the real capacities of the SRPDC provided by the supplier.

2.1.7 Each SRPDC shall function on a common communication bus line between different RPDC's 's on a peer-to-peer basis and shall provide real-time clock functions for scheduling and network time synchronization. The SRPDC shall be able to communicate with the Server in a selective manner and in a way to maintain stand-alone operation of the SRPDC.

2.1.7.1 The SRPDC shall be able to communicate with the COM network for network time synchronization

2.1.8 If there is a power failure, the SRPDC shall have sufficient memory to support its operating system, database, programming requirements. Battery shall maintain the static RAM memory and clock functions for minimum of 72 hours.

2.1.9 The SRPDC operating system, field database, and application programs shall reside in EEPROM.

2.1.10 The run time field data and values shall reside in battery backed-up on board memory or RAM.

2.1.11 SRPDC shall be **Tridium JACE 8000 Series controller**. Contractor shall provide required number of SPRDC(s) designed to manage the number of points and controllers on the specific site.

2.1.12 All data including programming and graphics shall be backed up by the contractor at the EMCS Enterprise Server upon completion of every change to the system.

2.2 REMOTE PROGRAMMABLE DIGITAL CONTROLLERS (RPDC)

2.2.1 Each RPDC shall be fully user-programmable, digital controller that communicates via MS/TP Bus supporting BAC-net Standard protocol ANSI/ASHRAE 135 2004.

2.2.2 The RPDC shall be factory programed with a continuous adaptive tuning algorithm that detects changes in the physical environment and continually adjusts loop tuning parameters suitably. Controllers that require manual tuning of loops or perform tuning on command only shall not be acceptable.

2.2.3 The RPDC shall provide a remote annunciation of any detected component failure, low battery conditions or repeated failure to establish communication.

2.2.4 Each RPDC shall incorporate direct digital control and shall operate as an independent control unit capable of distributed processing functions as described hereafter. It shall furnish real direct digital control replacing the transmitters and the existing analog controllers.

2.2.5 Each RPDC shall work as an independent unit and shall continue to operate independently even if the other parts of the system including the SRPDC and/or Enterprise Server are not operational.

2.2.6 RPDC shall have the following characteristics:

2.2.6.1 Automatic start-up after a power failure

2.2.6.2 Controller set-point reset, locally or remotely through the EMCS Enterprise Server and position readjustment of the controlled devices

2.2.6.3 The RPDC shall include troubleshooting LED indicators to identify conditions i.e. Power ON/OFF, Device fault, No fault, normal operation etc.

2.2.6.4 User capacity to define all the operational characteristics of each control loop by means of keyboard commands of a man-machine interface (MMI)

2.2.6.5 User capacity to define the control modes such as: proportional, integral, derivative, square error, and adaptive functions in response to the network needs;

2.2.6.6 Clear communication language oriented toward process control and not done in computer jargon

2.2.6.7 User capacity to define the operation logic such as: and/or equal to/unequal to, and greater than/less than

2.2.6.8 Self-diagnostics

2.2.6.9 Energy management functions (ex: optimal star/stop, enthalpy control, electric load shedding control, etc.

2.2.6.10 Library of control routines and program logic to perform the sequence of operation.

2.2.6.11 Contain sufficient memory to support its own operating system, database and have at least 25% of the memory available for future use.

2.2.6.12 In the event of the loss of normal power, there shall be an orderly shutdown of all digital controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for minimum of 72 hours.

2.2.6.13 Upon restoration of normal power, the RPDC shall automatically resume full operation without manual intervention.

2.2.6.14 Controllers shall include all point inputs and outputs necessary to perform the specified control sequences. Analog outputs shall be industry standard signals such as 24 Volts floating control,3-15 psi pneumatic, 0-10VDC or 20 mA, allowing for interface to a variety of modulating actuators.

2.2.6.15 All controller sequences and operation shall provide closed loop control of the intended application. Controlling by another upstream RPDC over the local field network is not acceptable.

2.3 TERMINAL EQUIPMENT CONTROLLERS (TEC)

2.3.1 TEC shall be utilized for control of each piece of terminal equipment including but not limited to the following:

- Variable Air Volume (VAV) boxes
- Constant Air Volume (CAV) boxes with reheat
- Dual Duct Terminal Boxes
- Unit Air conditioners
- Heat Pumps
- Unit Ventilators
- Fan Coils
- Room and or Laboratory Pressurization

2.3.2 TEC's shall include all point inputs and outputs necessary to perform the specified control sequences for associated terminal equipment. Analog outputs shall be industry standard signals such as 24 Volts floating point control, 0-10VDC or 4-20 mA, allowing for interface to a variety of modulating actuators.

2.3.3 All TEC sequences and operation shall provide closed loop control of the intended application.

2.3.4 Controlling terminal equipment by another upstream RPDC controller over the local field network is not acceptable.

2.4 ORIGINAL EQUIPMENT MANUFACTURER APPLICATION SPECIFIC CONTROLLERS (OEMASC)

2.4.1 The EMCS shall extend communication and operation through the integration of OEM Application Specific Controllers (OEMASC) via a dedicated BACNet Field BUS connected to the SRPDC.

2.4.2 Each OEMASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of all other controllers in the network. Each OEMASC shall include a microprocessor-based, multi-tasking, and real time digital control processor.

2.4.3 As listed in 2.4.1, the OEMASC are to reside on a dedicated EMCS Subnetwork, connected directly to the SRPDC and only communicating to OEMASC (i.e. – no other field controllers to reside on this network).

2.4.4 Equipment supplied with OEMASC may include:

- Chillers,
- Heat pumps,
- Gas fired furnaces,
- Boilers
- VFD's
- Rooftop Units

- Utility Meters/Sub Meters
- Lighting Controls
- Variable Refrigerant Flow (VRF) systems
- Heat Recovery Ventilators
- Chemical/Gas detector
- Air/Refrigeration Compressors
- Dehumidifiers
- Generators
- Humidifiers
- Overhead Doors
- Spray Pads
- Other equipment that come with OEM Installed On-board micro-processor controls.

2.4.5 The OEMASC shall include all points (inputs and outputs) necessary to perform the specified control sequences and shall be the responsibility of the Equipment supplier. Integration of the OEMASC to the EMCS shall require programming representatives of both systems to be present on site at the time of set-up to ensure all BACNet and/or other communication protocols are set up and mapped to the EMCS with proper priority to ensure specified sequence of operation is met.

2.5 HARDWARE CONFIGURATION AND CONSTRUCTION

2.5.1 Each SRPDC and associated RPDC's shall include a lockable cabinet, power supply, electronic cards, and termination modules, all CSA and ULC approved.

2.5.2 Each SRPDC and RPDC shall operate in an ambient environment of -10 °C to 35°C and 10% to 90% relative humidity.

2.5.3 Each SRPDC, RPDC and TEC shall be protected to eliminate transitory high voltage, electromagnetic noises, radio frequency interference (ex.: interferences caused by walkie-talkies).

2.5.4 The SRPDC, RPDC and TEC shall have integral power switch. If the device manufacturer does not provide an on-board power switch, then the System Contractor shall provide a separate dedicated transformer and switch within each enclosure for each controller.

2.5.5 The SRPDC, RPDC and TEC shall provide diagnostic LEDs for power, communications and microprocessor status i.e. device fault, normal data transmission, Download or start up in progress & not ready for normal operation. All programming sequences shall be stored in non-volatile memory.

2.5.6 Each RPDC and TEC shall contain both software and firmware to perform full DDC PID control loops.

2.5.7 Each controller type shall be able to support various types of zone temperature sensors, such as temperature sensor only, temperature sensor with built-in local override switch, with set point adjustment switch, temperature sensor with CO2 monitor or temperature sensor with occupancy switch.

2.5.8 Each TEC controller for VAV/CAV application shall have a built-in air flow transducer for accurate air flow measurements in order to provide the pressure independent VAV operation. If the transducer is not internal to the controller, the controller/transducer assembly shall be factory tested and approved for the intended use.

2.5.9 Astronomical Time: Astronomical capability shall allow the system to calculate sunrise and sunset times based on geographical location, and incorporate Daylight Savings Time, for dusk-to dawn control or dusk-to time control. This is required in any DDC controller with I/O for exterior lighting circuit(s) .The DDC controller may receive this value from SRPDC or RPDC and fail to a "safe" position (i.e., lights fail on) upon a loss of communication from the SEPDC or RPDC.

2.5.10 Type of Points

2.5.10.1 Each controller shall have the following types of points:

- Binary inputs and pulse accumulation;
- Universal inputs shall be capable of 0-20mA,dry contact, and 0-5VDC,2-10 VDC or 0-10 VDC;
- Binary outputs to command apparatus of 2 to 3 statuses;
- Analog inputs to measure real-time variables;
- Analog outputs (e.g. Current mode 4-20 mA, Voltage mode 0-10VDC, 2-10 VDC) to read and adjust the set-points and positions and for the direct digital control of apparatus.

2.5.10.2 The system shall allow the user to change the characteristics of the individual points on each function card. This characterization shall be made possible by means of a keyboard procedure where the user shall transfer specific parameters from the Server that are destined to the RPDC, or from a portable keyboard or one integrated in the RPDC. The user shall be able to modify these parameters from these keyboards.

2.5.10.3 If the controller uses multi-point type function cards for control and monitoring, each function card shall have an integrated capacity of auto-control and shall visually indicate its operational status. The failure of a function card in a controller shall not prevent the controller from controlling the other function cards and shall not affect the other controllers.

2.5.11 Termination Board

2.5.11.1 Each controller shall have a termination board to which the wiring or piping shall be connected. The controller shall be isolated from the command circuits or sensors either by **double voltage relays or optic couplers or** equivalent. All input/output signals shall be terminated on the board using screws or compression spring type terminals. Each analog input shall have the capacity to adapt standard inputs of the industry such as 4 to 20 mill-amperes or 1 to 5 volts DC, or 0 to 10 volts DC without physically modifying the control panel.

2.5.11.2 The Contractor shall identify all the wiring connected to the different elements of the system. The numbered auto-adhesive stickers are not acceptable. The Contractor shall use plastic mold (PVC) type reference

marks, to identify the wiring terminated to the board inside the control panel and at the end device. All wiring shall be identified using full and proper point descriptors.

2.5.12 Telecommunication Interface

2.5.12.1 Communication Network Use

2.5.12.1.1 The system shall supervise remote buildings. It shall be possible for the Enterprise Server to communicate with the Supervisory Remote Programmable Digital Controllers (SRPDC) by the ETHERNET communication network furnished by the Owner.

2.5.12.2 Remote Interfaces and Access to Installations on the Owner's Intranet

2.5.12.2.1 The communication interfaces such as the ETHERNET, communication cards, computers, and software etc. shall be included with the SRPDC (supervisory panel) for all sites. These interfaces shall be supplied by the Contractor.

2.5.12.2.2 The Owner shall provide one (1) network drop and IP address at a given site. EMCS and SRPDC solutions must support LAN-, WAN-, and cellular-connected facility installations based on network availability that will be specified for each location. The Control vendor shall be responsible for coordinating with the Owner's IT department designated personnel.

2.5.12.2.3 Each pre-qualified EMCS vendor may be granted Internet access to the Owner's Intranet system through an Owner supplied VPN (or other secure methodology in accordance with COM ITS policies and procedures). This access will be arranged for by the control vendor in coordination with the Owner's designated representative and shall be restricted to a specific duration of time. Each time the vendor accesses the system the date and time and name of person accessing the system shall be recorded and stored within the database. ***NO UNAUTHORIZED ACCESS to the Owner's Intranet and EMCS control systems will be permitted***.

2.5.12.3 Communication Modes

2.5.12.3.1 The only communication mode to the SRPDC shall be via the owner's ETHERNET network. All necessary accessories to establish communication shall be supplied by the Contractor. Communication modes such as dedicated or dial-up telephone lines or cable modems shall not be accepted.

2.5.13 Communication Protocol

2.5.13.1 The system shall be capable of high-speed ETHERNET communication using TCP/IP Protocol though the primary SRPDC (supervisory panel) and the Enterprise Server. The SRPDC at each site shall be assigned an IP address. Communication between SRPDC and RPDC shall be by BACNet IP or MS/TP as specified in the details project specifications.

2.5.13.2 Where BACNet over IP communication between SRPDC and RPDC is specified, EMCS vendor shall supply a dedicated EMCS Ethernet Managed Switch(es) to manage all sub-network communications between SRPDC and RPDC. All IP and MAC addresses shall be set up by and are the responsibility of the EMCS Vendor. The make/model of the Ethernet Managed Switch shall be discussed with and approved by the Owner.

2.5.14 Computer Interfaces

2.5.14.1 The computer interfaces shall communicate commands and access the SRPDC in each building using the Owner's ETHERNET network via the central Enterprise Server.

2.5.14.2 Communication Interfaces

2.5.14.2.1 The communication interfaces that allow the connection to the computer communication system are those mentioned in sub-section 2.

2.5.14.2.2 Each controller shall have a communication port for connection to the network and also available for a direct connection to an operator interface.

2.5.14.2.3 The operator interface connected to any controller shall allow the operator to interface with each inter-networked controller on the system as if directly connected. Controller information such as data, status, reports, system software, and custom programs shall be viewable and editable from each inter-networked controller.

2.6 SOFTWARE SPECIFICATIONS

2.6.1 General Principles

2.6.1.1 Interface at the EMCS Enterprise Server (SERVER)

2.6.1.1.1 The owner has purchased and installed Tridium Niagara 4 software of the latest revision. This EMCS Enterprise Server Software (ESS) package resides on a dedicated City of Mississauga EMCS Enterprise Server. The owner also maintains a secondary back-up server for the storage of all program files, graphics, trend data, alarms, and reports for the support of connection and monitoring of up to 350 buildings

2.6.1.1.2 The Contractor shall program completely the Owner's EMCS ESS of all described points in the points list of building(s) shown on the plans. The data base shall include the definitions and descriptions (key names) of each point connected to the SRPDC installed in the various buildings.

2.6.1.2 Software Furnished by the Contractor

2.6.1.2.1 The Contractor shall furnish all necessary software and software tools for programming and modification of field panels and for the communication and functional operation of the systems as specified. This software shall be "Open" in nature and licensed to allow for use and modification by the Owner or Owner designated service contractor(s).

2.6.1.2.2 The EMCS ESS shall be installed and operational prior to the delivery of any field based EMCS. The software described in this section of the specifications shall be applicable to all new SRPDC, RPDC, TEC, OEMASC, and as they relate to the new EMCS ESS and Back-up Server.

2.6.1.3 Proven Software

2.6.1.3.1 Only proven software shall be accepted.

2.6.1.4 Security Requirements

2.6.1.4.1 Only software with the minimum version of an un-deprecated TLS encryption subject to further requirements as specified in Section 250501 paragraph 1.5.10.2 and 1.5.10.3 shall be permitted.

2.6.1.4.2 Software shall utilize Active Directory Log-In and shall come with **False Log-in Protection**

2.6.1.5 Type of Points

2.6.1.5.1 The system shall have two (2) types of points: the first type shall derive from a physical measure. A physical point denotes a point physically connected to the system, for example, pressure temperature and relative humidity. These points are defined as “Real”.

2.6.1.5.2 The second type of point is identified as an information point by the operator but is not necessarily a number of a data corresponding to their physical point, for example, a prediction, or a calculation of energy or cost estimates. These points are defined as “Virtual”.

2.6.2 Real Time System Management

2.6.2.1 Power Failure and Automatic RE-start

2.6.2.1.1 In case of power failure, the system shall stop in an organized method and a routine procedure shall provide an automatic re-start of the system once the power is restored.

2.6.3 Acquisition of Data and Control Software

2.6.3.1 Binary (Digital) Inputs

2.6.3.1.1 The system shall monitor the binary inputs. The actual condition of a two-status device shall continually be saved in memory and represented by a pair of binary statuses. The indications at the SERVER operator and the binary statuses shall be described by the following abbreviations called “Descriptor” such as “OP-CL” for open-closed.

2.6.3.1.2 The system can record the number of changes of state of a binary input in order to measure the variables such as flow indicated by pulses.

2.6.3.1.3 Minimum requirements are to comply with the BAC-net standard for data sharing. The user must be able to specify either input condition for alarming. This Binary Input must also include the capability to record equipment run-time by counting the amount of time the hardware input is in an “on” condition. The user must be able to specify either input condition as the “on” condition.

2.6.3.2 Analog Inputs

2.6.3.2.1 Minimum requirements are to comply with the BAC-net standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.

2.6.3.2.2 The system shall read, convert, transmit and display the analog values of all the required points.

2.6.3.2.3 All displays and readings shall display analog point's value in a numerical form with appropriate units and the negative sign if necessary. The displayed values shall contain the necessary number of figures plus a decimal point if required.

2.6.3.2.4 The Owner shall define the units of measure to describe the changes of state and the information requests. Examples of units of measure: KPA for kilo Pascal, ºC for degree Celsius.

2.6.3.2.5 The system shall be capable of using the English system of measure as well as the International system without modifying the equipment. The Owner may define up to 50 analog ranges. Each range may define as linear, square root extract or whatever functions dependent on the results of a calculation.

2.6.3.2.6 The operator may assign specific limits to each analog point (2 high and 2 low). The system shall compare the analog readings with the predetermined limits and shall advise the operator every time a point goes into alarm or returns to normal conditions.

2.6.3.2.7 A simple differential shall be associated to every specific limit. This differential shall precisely determine the gap necessary for a return to normal indication when a point returns within its normal operation range.

2.6.3.2.8 The user shall enter all the limits and the entire differential directly with the same units of the measured variables. The system shall react on an analog point update when an analog point passes from a normal condition to a high or a low limit condition as well as a return to the normal condition, when stopping or starting the equipment, when displaying a graphic or message, when printing a report or a message, or when readjusting the setpoint of a controller according to the established interlock sequence.

2.6.3.2.9 The Owner shall be able to create a summary of the analog limits and differentials with the high and low limits and differentials for all the specified analog points.

2.6.3.3 Binary (Digital) Outputs

2.6.3.3.1 Minimum requirements are to comply with the BAC-net standard for data sharing. Properties to enable minimum on and off times for equipment protection as well as inter-start delay must be provided.

2.6.3.3.2 The system shall control local devices having 2 or 3 statuses. The operator shall be able to control the local devices. Descriptors defining the commands that the operator wishes to execute shall be used.

2.6.3.3.3 The commands shall be grouped, and one command is given per status. Each binary output shall be programmed to respond to only one group of commands. These command groups shall be for example: OP-AUTO-CL for Open-Auto-Closed or STR-STO for Start-Stop.

2.6.3.3.4 The operator shall be able to issue global commands including but not limited to:

- Time of day scheduling
- Weekly schedules
- Event/Holiday Schedules
- A positive feedback response shall be used for all the command points to make sure that the monitored device, motor, controller, etc. has in fact received and executed the command issued by the operator or the system.
- All commands not executed as requested, shall emit a message to the operator.

2.6.3.4 Analog Outputs

2.6.3.4.1 Minimum requirements are to comply with the BAC-net standard for data sharing.

2.6.3.4.2 The remote reset of controller setpoints and/or valves shall be possible for all the specified reset points. The reset values shall use units that correspond to the controlled variable such as degrees Fahrenheit, degrees Celsius, kilo Pascal's, etc.

2.6.3.4.3 The operator data entries shall be the same as the output data of the reset points. For example, to change a pressure controller setpoint from 10 KPA to 110KPA, the operator shall simply enter the reset value of 110KPA.

2.6.3.4.4 A power supply failure at the existing SERVER or at the local SRPDC shall not affect the setpoints. These setpoints shall maintain the last ordered value.

2.6.3.4.5 The operator shall be able to issue global zone temperature setup including occupied/unoccupied mode temperature set points.

2.6.3.5 Change of State

2.6.3.5.1 The system shall detect all changes of state of a point as specified hereafter and shall report these changes of state to the operator. Any change of state specified as such shall set off an audible alarm. Acknowledgement shall cancel the audible alarm.

2.6.3.5.2 Any change of state of a point shall include a descriptor, identification, data units, date and hour. The printout of a binary monitor point shall include binary status identification, indications relative to an abnormal condition or an alarm point condition, an indication that the point equipment is out of service, the date and the hour.

2.6.3.5.3 For an analog change of state, the system shall print the point identification, its analog value with its units, an indication identifying whether the value is high or low, the date and the hour.

2.6.3.5.4 For each alarm point, the system shall print a message, custom predefined by the User, which shall be printed immediately following the point display.

2.6.3.5.5 The system shall communicate the information of a change of state of a point towards a particular desk. The reception of the change of state shall not be interrupted by the display summary asked by the operator.

2.6.3.5.6 The display of the changes of state on the colour screen shall be done in priority as defined by the User. In addition, the User shall decide the change of colour related to the acquisition of the change of state.

2.6.3.5.7 Upon receiving changes of state, they shall be printed in chronological order. The print outs of acquisitions of change of states shall be done simultaneously as the acquisition itself.

2.6.3.5.8 The system shall report the multiple changes of state according to the established priority levels when generating the database. The Owner shall decide if a change of state necessitates an acknowledgement.

2.6.3.6 Access Control

2.6.3.6.1 Provide a minimum of 5 (Server) and 3 (SRPDC) levels of command security**. Individual operators shall be able to be assigned to security level**. Assignment to a security level shall allow the operator to use commands that have been assigned to that level of security or below only. It shall be possible to re-assign security levels to operators, and commands online, through an operator's terminal (by the owner's system manager). The City of Mississauga will be defining Access Levels as part of the individual projects.

2.6.3.6.2 Access to SRPDC shall be Restricted to Owner's administrator, EMCS Vendor and one (1) additional Owner assigned user. All other access to EMCS shall be routed through the Enterprise Server.

2.6.3.6.3 As outlined in part 2.6.1.4.2, operators shall log-in using Active Directory and the system shall prohibit False Login. A log of the time and date of each log-on/log-off (both a regular log-off and an accidental log-off by closing the browser) and activity of users shall be recorded on the server and accessible for print off by the Owner's system manager.

2.6.3.6.4 Multiple operators shall be able to be logged on different terminals, under different security levels, simultaneously. The fact that multiple operators are signed on concurrently shall be transparent to the individual operators. A minimum of 25 users/operators shall be able to access the system concurrently.

2.6.3.7 Reports Logs & Records

2.6.3.7.1 Provide a reporting package that allows operators with properly designated user access level(s) to select, modify, or create reports. Each report shall be definable as to data content, format, interval, and date.

Provide the ability for the operator to obtain real-time logs of all objects by type or status (i.e. alarms, lockout, normal). Reports and logs shall be stored on the central enterprise server memory in a format that is readily accessible by other standard software applications, including spreadsheets and word processing.

2.6.3.7.2 The report generator shall include time, day, month, year, report title, operator's initials, and shall produce as a minimum the following reports:

- All points in allocation
- All points of a point type
- All points in an individual system
- All points (SRPDC, RPDC, & TEC)
- Acronym summary
- Alarm summary
- Alarm Messages
- Lockout summary
- Disable "Locked –out" points summary: including point name, whether disable by system or by operator.
- Override summary
- Generate and format reports for graphical and numerical display from real time and store data.
- Print and store reports as selected by the operator.
- Summary of sensor spans and bases
- Summary of analog alarm limits and differentials
- Summary of point parameters
- Summary of RPDC loop parameters
- Run time summary: summary of accumulated time of selected equipment. Include point name, run, and time to date, alarm limit setting. Run time to accumulate until reset individually by the operator.
- Trend logs
- Historical profiles

2.6.3.7.3 Point Identifiers

2.6.3.7.3.1 The EMCS shall locate a point to be monitored or controlled with unique point identifier.

2.6.3.7.3.2 The EMCS shall be able to identify group's points in at least the following manners:

2.6.3.7.3.2.1 Points that are geographically in, for example, a penthouse, or building.

2.6.3.7.3.2.2 Points that are part of a closed system, for example, a fan system or a water system.

2.6.3.7.3.2.3 Points that perform similar functions, for example, all fans supply air temperatures or leaving chilled water temperatures.

2.6.3.7.4 Alarm Reports & Records

2.6.3.7.4.1 The alarm summary shall include the time and date of occurrence, the operator's username who acknowledge the alarm, the location, system and point descriptor, value or status at the time of alarm and alarm condition(i.e. high, low, return to normal etc.) The recording of alarms on specific points shall be able to be enabled or disabled on command. A summary of points disable for alarm recording shall be provided.

2.6.3.7.5 Alarm Scan

2.6.3.7.5.1 The EMCS system shall continuously scan all points connected to it and update the data base on binary changes of state and significance of analog changes. The system shall compare any change of state or analog update to establish parameters and determine if the point is in an alarm condition.

2.6.3.7.5.2 Alarms shall be queued for reporting and under NO circumstances shall any alarm go undetected due multiple alarms.

2.6.3.7.6 Alarm Messages

2.6.3.7.6.1 Provide capability to create and assign to any point a message to be printed or to be sent to a pager or other handheld device such as a smart phone, tablet, etc. at the time of alarm. Summaries of message content and points assigned to messages shall be displayed on the operator's terminal or printed on the assigned device on command.

2.6.3.7.7 Alarm Acknowledgement

2.6.3.7.7.1 Provide capability to display alarms on the operator's terminal and update these alarms once a minute. Alarms shall be acknowledged when displayed by prompting for operator's username. The operator's username shall be recorded with the alarm.

2.6.3.7.8 Alarm Management

2.6.3.7.8.1 Establish and provide alarm management programming using the server software and provide

any additional software as necessary to accomplish the following:

- **Critical Alarms** – Critical alarms are defined as those that require the immediate attention and action of Facility Operations. Examples – VSD Failure, low & high water temperature, over/under pressure, loss of outside air sensor, loss of power, computer room cooling high temperature, etc.
- These alarms shall provide both indication at the operator workstations through the EMCS server and shall be sent to nominated Building and/or Security Services Department staff (or other locations as defined by the owner) for immediate action. Alarms shall be sent via SMS and/or Email etc. indicating the Building ID, Alarm Indication and Alarm Parameter, Time of Alarm, etc.
- All alarm settings shall be super user adjustable through the Alarm Settings graphic page.
- Critical alarms indication on the graphics shall appear as a Flashing Red background with the Word ALARM (under Alarm condition) and Green Background with the Work Normal when not in alarm.
- Critical Alarms shall also be recorded and stored on the EMCS Server
- **Environmental Alarms** – Environmental Alarms are defined as Non-Critical (HVAC related) alarms and as indicated on site specific points list and sequences. Environmental alarms typically include but are not limited to the following:
    - Temperature/humidity out of specified range etc.
    - Mixed air low limit
    - Command vs Status
- Environmental alarms shall provide indication on the graphics (Flashing Yellow) both the EMCS ESS operator workstation(s) and workstations connected through the SRPDC and shall remain until the alarm condition is corrected.

- **Maintenance Alarms** – Maintenance alarms as defined as important operational alarms that require the attention and action of Maintenance personnel and as indicated on the site-specific points list and sequences.
- Examples include equipment run-times, pressure drop across filters, etc. These alarms shall be generated by the EMCS and stored in a database at the central EMCS server until acknowledged or removed by system operations. They shall also send out an Email indicating building, required maintenance, etc.
- **Utility Alarms** – Example – Peak Demand Exceeded, daily consumption exceeded. These alarm limits shall be set-up and established during commissioning. The alarms shall provide indication both at the operator workstation and shall send out an email to various email accounts indicating that anticipated parameters have been exceeded.
- All alarms shall be stored in a database under various file headings (i.e. critical, environmental, maintenance, energy), date and time stamped including the date of acknowledgement of the alarm parameter, until cleared by the system administrator.
- Alarms shall be set-up to be functional during the appropriate seasons and inactive when outside of the related season (i.e. – low water temperature alarms shall not be active during summer, chilled water alarms shall not be active after the central chilled water has been shut off to the building).

2.6.3.7.9 Scheduled Events/Modes

2.6.3.7.9.1 Any command point in the system shall be able to be assigned to a time of day and calendar operating schedule as well as temporary overrides, programmed events (though 3rd party database application), and temperature based operating parameters through any operator's terminal (based on assigned user authority level).

2.6.3.7.9.2 The number of starts and stops per point, per day, shall not be limited. Points shall be assigned "time windows" in which they shall either be ON or OFF during the time of the window. Points shall be able to

be assigned different time windows each day of the week plus holiday schedule.

2.6.3.7.9.3 The operator shall be able to list summaries of the time schedules on the operator's terminal. The summary shall indicate the point and the various time windows assigned for that particular day. The summary shall be able to be restricted to a particular location, system or point as well as those days of the week desired.

2.6.3.7.9.4 The system shall be capable of and set-up by the Vendor to access other 3rd party database programs to obtain data necessary for the scheduling of "EVENTS" that occur outside of the established Occupied Schedules. (Ex: Community Use Programming).

2.6.3.7.10 Overrides

2.6.3.7.10.1 Owner's designated administrator shall be able to override all point types, schedules, etc. until releasing from Manual to Auto.

2.6.3.7.10.2 Operators with specified security access level(s) shall be able to override analogue and digital output points with a Timed Override period not to exceed 24 hours. When timed override expires, the system shall revert to "Auto" mode.

2.6.3.7.10.3 The EMCS shall keep track of all override activities and store information on Enterprise Server indicating the Date/Time of override and Username who initiated.

2.6.3.7.10.4 When any point or schedule is overridden, the Graphical User Interface shall display a distinctive color indicating the system is not in Auto Mode and shall return to normal display once the override is removed.

2.6.3.7.11 Trending

2.6.3.7.11.1 The EMCS trending shall be set-up by the EMCS Vendor during each installation and shall store data at the SRPDC and then be automatically uploaded to the EMCS ESS. This shall include all inputs/outputs points.

2.6.3.7.11.2 The SRPDC shall communicate (upload) trend data to the ESS at regular intervals for long term storage and shall be capable of storing all site Trend Data for a minimum period of one (1) months without manual data handling.

2.6.3.7.11.3 As a minimum, provide capacity for set up of up to 150 trend logs per SRPDC at one time. Storage duration and data capture intervals shall be user adjustable. Provide data for review in both graphical and tabular format accessible through the EMCS server on operator workstations.

2.6.3.8 Auto-Diagnostic Message

2.6.3.8.1 The system shall continuously query itself to detect any failure or malfunction of the circuits and shall be able to report to the operator any change of state of any equipment. The diagnostic shall include at least the following messages:

- The system can/cannot communicate with a point.
- The system can/cannot communicate with the SRPDC & other RPDC.
- The system can/cannot communicate with an operator terminal.
- The SRPDC & other RPDC are operational/non-operational.
- A power failure was detected on such a day, and such an hour.

2.6.3.8.2 Summaries and readings, when used, shall indicate with special indications or references the state of the communication material of each point. These indicators shall be continuously updated.

2.6.3.9 Locking

2.6.3.9.1 There are two modes of locking. When the Owner locks the change of state report of a point, this point shall execute all addressed commands but shall not report its change of state as a normal or abnormal condition.

2.6.3.9.2 When the Owner locks the capacity of executing a command of a point, the point shall report all changes of its state without executing any addressed command except the unlock command.

2.6.3.9.3 In addition, the Owner can lock a point simultaneously in the two modes. The execution of the locking command shall clear all inhibition of change of state or command.

2.6.3.9.4 Upon the Owner's demand, the system shall supply a summary of locking showing the locked points and their mode of locking.

2.6.3.9.5 All requested reports and summaries shall display a locking indication for the locked points.

2.6.3.9.6 Reports and summaries shall indicate the locking/unlocking status of each point by means of special indications or reference marks.

2.6.3.10 Interlocks

2.6.3.10.1 The User may define the interlock sequences that connect two or more points. The User may assign different priorities for the interlock sequences in such a manner that a point used in multiple sequences shall respond to those of a higher level.

2.6.3.11 Totalization

2.6.3.11.1 This program shall allow totalizing of all binary or analog points.

2.6.3.11.2 The User may:

- Determine the state of an open-closed, normal-abnormal point that must be totalized.
- Designate the basic totalization units and the consumption units.
- Interrupt and resume the totalization of a point as required.
- Modify the total value of the day or the current period and define a warning limit. When the total exceeds the warning limit, it shall produce a change of state and the count shall be reset to zero. When the total exceeds the maximum physical limit of the computer, it shall produce another change of state and the count shall be reset to zero.

2.6.3.11.3 The Totalization Summary shall include:

- Point identification
- Appropriate indication
- Last sample value
- State of the totalization program: active or non-active
- Totalization basic units
- Totalization parameters
- Totalled value of the day with appropriate units of measure
- Total value for the current period with appropriate units of measure
- Total value for the last period
- Warning limit
- Reset to zero limit
- Associated optimal point to stop totalization

2.6.3.11.4 The summary of a point or a group of points may be requested as described by the User.

2.6.3.12 Precision

2.6.3.12.1 The system shall have a minimum precision of input to the SRPDC to the display or print out of + /- 0.5% of the displayed or printed value.

2.6.3.13 Point Segregation

2.6.3.13.1 The User may define segregation of the points as a function of his needs. For example, the points in a building or in a region may be referred to a specific terminal during the day, and for the evening or at night they may be referred automatically to another terminal without any operator intervention. Also, a point in one RPDC may be referred to one or many different terminals independently from the other points in the same RPDC.

2.6.3.14 SERVER-SRPDC & SRPDC-SERVER (Server) Communication

2.6.3.14.1 Every building shall have a stand-alone program and installation that shall render it independent from the SERVER and the other buildings. The data transfer between the SRPDC of the same building shall not be done through the SERVER when this data is necessary for a control sequence.

2.6.3.15 Remote Control

2.6.3.15.1 Remote control shall allow the verification of all digital, analog and calculated points. Setpoints may be changed and the position of the controlled devices may be fixed. All analog and calculated points, function of controlled elements and the status of the digital points may be displayed.

2.6.3.15.2 The SERVER may also simulate the operation of a terminal to be connected to a SRPDC. This terminal mode shall permit communication to the SRPDC in real time to change setpoints, schedules, take temperature readings and reprogram the SRPDC. All modifications shall be automatically updated on the hard disc.

2.6.3.16 Project Management

2.6.3.16.1 At the beginning of the project, the Contractor shall present to the Owner all the documentations and required forms for point definition and for programming.

2.6.3.16.2 All associated details regarding the segregation, the penetration and the communication of each point shall be established and communicated at the beginning of the project.

2.6.4 Owner's Programming Capacities

2.6.4.1 Programming Definition

2.6.4.1.1 The system shall be programmable at two levels.

2.6.4.1.1.1 The first level is the programming in the conversational English language. This kind of programming is used by the Owner to create his own graphs, his own displays and messages, etc. as explained in the following paragraphs.

2.6.4.1.1.2 The second level shall allow to modify the software furnished by the supplier and shall be used for example to add new symbols in the library of software to create graphics.

2.6.4.2 GUI Creation and Modification

2.6.4.2.1 Creation and Modification to the Database

2.6.4.2.1.1 By using the first level programming, the Owner may affect all the changes to the database with the system on-line and operational.

2.6.4.2.1.2 The Owner may at the very least do the following operations:

- Add and delete points
- Modify all point parameters
- Change, add, and delete point descriptions
- Change, add, and delete units
- Change, add, and delete points in various programs
- Choose the analog alarm limits and their differentials
- Define each function card or module to accept the different analog inputs or the different binary inputs
- Create custom links between points
- Write the program of the SRPDC & RPDC from the SERVER. Load this program in the SRPDC & RPDC while maintaining the capacity to receive alarms and coloured graphics.
- Modify the penetration menu
- Modify the point segregation
- Modify the communication parameters and the input/output ports

2.6.4.2.2 The owner shall be able to modify all points in the database. This modification shall include the addition, elimination and modification of the unit scales or operation modes. The addition of a new point on site shall be accomplished completed by the means of a keyboard once all the material is installed in its place.

2.6.4.2.3 Once the function cards or module of the SRPDC & RPDC are modified, a change of function can be executed consequently by entering a keyboard command. For example, an analog input point which is presently used by a temperature sensor can be modified to operate with a pressure sensor.

2.6.4.2.4 When new points are to be added on site, they may either be grouped in a new display system or may be substituted by existing points in the existing system or may simply be added to the existing systems.

2.6.4.3 Custom Made Equations and Links between Points

2.6.4.3.1 The system shall allow the Owner to develop custom made sequences of operation, unique control algorithms and interactive links between

the points, custom made calculations, etc. This program shall directly use the dynamic data of the system.

2.6.4.3.2 The system shall at the very least perform the following operations:

- Addition/subtraction
- Multiplication/division
- Square root/exponential
- Linear equations/quadratic equations

2.6.4.3.3 And can execute the following programming instructions:

- And/or
- Equal/unequal to
- Less than/more than

2.6.4.3.4 All connected points to the system such as temperature, pressure, flow, status, alarm points etc. shall be used in real time in these equations. Also, the Inputs shall include the real time, day of the week, date, constants, and results of other calculations.

2.6.4.3.5 As an equation result of any combination of mathematical or logical function of dynamic data of the system, the system shall, as a minimum, perform the following changes:

- Start-stop command or open/close
- Increase/decrease setpoints in the system
- Initiate reports and displays
- Activate the application programs
- Start/stop alarm functions
- Change the analog output for direct digital control

2.6.4.3.6 The Owner's entries for equation processing shall be made with a keyboard command using the first level programming. A step-by-step interactive routine shall be furnished to guide the User's entries. Systems that demand binary input, decimals, machine languages or digital codes shall not be accepted.

2.6.4.3.7 The computer shall be able, by using equations, to make all calculations and operations, as follows:

- Flows
- Predictions
- Comparison of forecasts and historical data
- Display or printout of a message or a graphic
- When an analog point in the system exceeds a certain limit, change of setpoint of a controller

- Display of instructions for actions to be taken by the operator when the value exceeds a certain limit
- Degree-days for heating and cooling

2.6.4.4 New Programming

2.6.4.4.1 The Owner, by using the second level language, may program the system to support all the following programs for the development, the compilation, the loading and the execution by the Owner.

2.6.4.5 Copy of the Software

2.6.4.5.1 The Contractor shall give the Owner a copy of the block diagram of programming logic included with 'As-Built'.

2.6.4.5.2 The Contractor shall furnish to the Owner any software/hardware and software tools necessary to edit, modify, add or delete a point from the system and the graphics. This applied to the Enterprise Server, SRPDC and RPDC.

2.6.4.6 Software and SRPDC, RPDC Programming

2.6.4.6.1 The SRPDC & RPDC shall have its own BAC-net standard software that shall allow it to function totally independent from the SERVER. In addition to the standard software already included in the existing SERVER, the SRPDC & associated RPDC controls shall have its own energy management software that includes but is not limited to the following software:

- Start/stop time schedule (weekly, holidays and alternative)
- Run-time
- Load shedding
- Duty cycling
- Run-time optimization
- Outdoor air quality optimization
- Inter-lock
- PID Control Loop (Each individual property must be adjustable as well as able to be disabled to allow proportional control only, or proportional with integral control, as well as proportional, integral and derivative control).
- Chiller and boiler optimization
- Optimization of water temperature or air supply
- Power failure/auto restart feature (when power is restarted the RPDC & RPDC controls shall automatically restart in an orderly fashion including all appropriate delay without the necessity for operator intervention)
- Point summary reports, alarms summary reports, trending

2.6.4.6.2 Load reset control; parameters shall include the following:

- Analog limits for heating and/or cooling as appropriate.
- Analog differential limits.
- Magnitude of set point increment.
- Program frequency.
- Communication between SRPDC and SERVER through a dedicated communication network or LAN/WEB technologies and network service providers.
- Communication between SRPDC and RPDC through a local bus communication line.

Part 3 Execution

3.1 LOCATION

3.1.1 Location of SRPDC and RPDC to be in dedicated mechanical/electrical rooms or as approved by Consultant and/or Owner.

3.1.2 Location of TEC shall be dictated by the placement of terminal equipment to be controlled (i.e. VAV Box, Heat Pump, etc.). Except where otherwise noted, TEC shall be located in a NEMA 1 enclosure within five (5) feet of terminal equipment being controlled and shall have liquid Tight flexible conduit between the Controller enclosure and Terminal equipment neatly installed and secure to structure (as close as possible to point of final termination).

3.1.3 Any controllers, control devices, sensors, etc. located in public space shall not have an accessible communication port for connecting to the controller/device and accessing the EMCS. If a communication port is present, the controller/device must be enclosed in a lockable cabinet prohibiting access to the communication port by un-authorized personnel.

3.2 HARDWARE INSTALLATION

3.2.1 Install Controllers in secure locking enclosures or as directed by Engineer/Consultant.

3.2.2 Terminal Equipment controllers above ceiling system may be unit mounted (i.e. VAV, Heat pumps, etc.).

3.2.3 Provide necessary power from local 120V branch circuit panel for equipment.

3.2.4 Install tamper locks on breakers of circuit breaker panel.

3.2.5 Use uninterruptible Power Supply (UPS) and emergency power when equipment must operate in emergency and co-ordinating mode.

EMCS BUILDING CONTROLLERS, FAMILY OF CONTROLLERS

3.3 SOFTWARE/PROGRAMMING INSTALLATION

3.3.1 Software shall be installed, and system programmed and run-tested prior to installation on site. Any adjustments and/or changes to programming as identified during the commissioning process shall be implemented by the contractor at no additional cost to the project and then re-tested with Commissioning Agent. Further adjustments may also be identified during seasonal commissioning process and shall be carried out by the contractor at no additional charge.

3.3.2 Custom site-specific graphics shall be generated using City of Mississauga (CoM) template workstations as guideline. Preliminary, site specific graphics shall be created and delivered to CoM (and Consultant) for review and comment, followed by multiple rounds of modification before final approval (and prior to uploading to site). Contractor shall make all necessary changes and updates as identified during shop drawing phase and again during commissioning phase. Final sequences and As-Built Documentation shall be updated each time there is a change and shall be included for both manual and PDF links through graphical Interface.

3.3.3 The system programmer shall be present during the commissioning process to ensure continuity throughout the project.

3.3.4 All changes shall be uploaded to Enterprise Server immediately prior to leaving the site.

END OF SECTION 25 30 01

EMCS: FIELD CONTROL DEVICES

EMCS: FIELD CONTROL DEVICES

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Control devices integral to the Building Energy Monitoring and Control System (EMCS):

.1 Transmitters, sensors, controls, meters, switches, transducers, dampers, damper operators, valves, valve actuators, and low voltage current transformers.

.2 Related Sections:

.1 Section 07 84 00 – Fire stopping.

.2 Section 25 01 11 - EMCS: Start-Up, Verification and Commissioning.

.3 Section 25 05 01 - EMCS: General Requirements.

.4 Section 25 05 02 - EMCS: Submittal and Review Process

.5 Section 25 05 54 - EMCS: Identification.

.3 REFERENCES

.1 American National Standards Institute (ANSI).

.1 ANSI C12.7-1993 (R1999), Requirements for Watthour Meter Sockets.

.2 ANSI/IEEE C57.13-1993, Standard Requirements for Instrument Transformers.

.2 American Society for Testing and Materials International, (ASTM).

.1 ASTM B148-97(03), Standard Specification for Aluminum-Bronze Sand Castings.

.3 National Electrical Manufacturer's Association (NEMA).

.1 NEMA 250-03, Enclosures for Electrical Equipment (1000 Volts Maximum).

.4 Air Movement and Control Association, Inc. (AMCA).

.1 AMCA Standard 500-D-98, Laboratory Method of Testing Dampers for Rating.

.5 Canadian Standards Association (CSA International).

.1 CSA-C22.1-02, Canadian Electrical Code, Part 1 (19th Edition), Safety Standard for Electrical Installations.

.6 City of Mississauga Communication Cabling Specification Standard

1.2 DEFINITIONS

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

1.3 SUBMITTALS

.1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 25 05 02 - EMCS: Submittals and Review Process.

.2 Pre-Installation Tests.

.1 Submit samples at random from equipment shipped, as requested by Consultant/Engineer, for testing before installation. Replace devices not meeting specified performance and accuracy.

.3 Manufacturer's Instructions:

.1 Submit manufacturer's installation instructions for specified equipment and devices.

1.4 EXISTING CONDITIONS

.1 Cutting and Patching: in accordance with Specifications supplemented as specified herein.

.2 Repair surfaces damaged during execution of Work.

.3 One (1) week after project kick-off meeting, Owner to review and identify any materials designated to be turned over for re-use (after removal by EMCS contractor). EMCS contractor shall dispose of all other redundant materials in an environmentally friendly manner.

Part 2 Products

2.1 GENERAL

.1 Control devices of each category to be of same type and manufacturer.

.2 External trim materials to be corrosion resistant. Internal parts to be assembled in watertight, shockproof, vibration-proof, assembly.

.3 Operating conditions: 0 - 32°C with 10 - 90% RH (non-condensing) unless otherwise specified.

.4 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.

.5 Transmitters and sensors to be unaffected by external transmitters including walkie talkies.

.6 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.

.7 Outdoor installations: use weatherproof construction in NEMA 4 enclosures.

.8 Devices installed in user occupied space not to exceed Noise Criteria (NC) of 35. Noise generated by any device must not be detectable above space ambient conditions.

.9 Range: including temperature, humidity, pressure, as indicated in project specific I/O summary (Points List).

2.2 TEMPERATURE SENSOR

.1 Temperature sensors (PT100 or1000 ohm) shall be “RTD” platinum element 100 or 1000 ohm at 0 degrees C (plus or minus 0.2 ohms), thin film type or equivalent, having accuracies as follows:

- Coefficient of resistivity: (0.00385) ohms/ohm ºC.

- Accuracy 0.2ºC over range of 0 to 70ºC.
- Stability 0.02ºC drift per year.

.2 Sensors shall have a time constant response of less than four (4) seconds to a temperature change of 10°C. Thermistors are not accepted.

.3 Sensors shall be manually calibrated on site so that the wiring length does not detract from the sensor accuracy specified.

.4 Temperature sensors shall be of the following types:

.1 Room sensor- suitable for all walls mounting, with metal protective guard. Element length of 0.4" to 2" (10 – 50mm) with ceramic tube protection or equivalent.

.2 General purpose duct sensor, suitable for insertion into air ducts. Element length of 18" (457 mm) or 30" (760 mm),junction box wiring connections and gasket to prevent air leakage or vibration noise.

.3 Averaging sensor duct type, continuous filament with immersion length of 18' (5486 mm) minimum, junction box wiring connections and gasket to prevent air leakage or vibration noise. For duct greater in any dimension that 48 inches (1219mm) and or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used. Capillary supports at the sides of the duct shall be provided to support the sensing string.

.4 Outside air sensor shall consist of a single device sensor, ventilated non- metallic sun shield designed to minimize solar and wind effect, utility box terminations, and watertight gasket to prevent water seepage.

.5 High Limit sensor shall be manual reset type. Sensing element shall be bimetal

.6 Terminal Unit space temperature sensors shall be provided in accordance with the drawing at the locations indicated with the following options:

- Standard Wall-mount Space sensor
- Set-point Adjustment Buttons ("+" & "-")
- Override/Bypass
- Occupancy
- RH
- NO Network Jack

.5 Thermostats shall provide flexibility to adjust the following Parameters:

.1 Adjustable Temporary Occupancy Over-ride (from 0 to 24 hours)

.2 Adjustable heating, cooling dead-band from 2ºC to 4ºC

.3 Adjustable set-point limits (i.e. +/- 2ºC)

.6 In all public areas as such as Arenas, Cafeterias, Hallways and corridors where additional security is required the sensor shall be a blank stainless steel wall plate temperature sensor equal to Greystone type model #TE200AS (PT 1000-1000 Ohms, Platinum)

.7 The Network Thermostat shall employ non-volatile electrical erasable programmable read-only memory (EEPROM) for all adjustable parameters.

EMCS: FIELD CONTROL DEVICES

2.3 TEMPERATURE TRANSMITTERS

.1 Temperature Transmitters (PT 100 or 1000 ohm) at 0º C shall be a platinum resistance detector type of sensors.

.2 The Power supply shall be 24 VDC with effect less than 0.01ºC per volt change.

.3 The output signal: 4-20 mA into (500) ohm maximum load. Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 0.5% of full-scale output.

.4 The maximum current to (100 or 1000 ohm) RTD sensor not to exceed 25 mA. Temperature effects: not to exceed plus or minus 1.0% of full scale 50ºC.

.5 Transmitter ranges: Select narrowest range to suit application from the following:

- - 50ºC to + 50ºC, plus or minus 0.5ºdegrees C
- - 0ºC to + 50ºC, plus or minus 0.25ºdegrees C
- - 0ºC to + 25ºC, plus or minus 0.1º degrees C
- -10ºC to + 35ºC, plus or minus 0.25º degrees C

2.4 LOW LIMIT CONTROLS (FREEZE STAT)

.1 Provide one (1) Low Limit sensor for each 20 sq. ft. (1.86 sq. m) of coil face. Low limit thermostats shall be of the vapor pressure remote element, manual reset type with adjustable set point. The device shall respond to the lowest temperature to which 1 foot of the element is exposed.

.2 Capillary sensing tubing serpentine vertically across the air flow entering the face of the coil and be supported firmly by mechanical clips.

.3 The Low Limit sensor shall be DPDT with a minimum of (1) NO contact and one (1) NC contact. One set of contacts shall be wired directly to controlled mechanical equipment contactor/VSD in order to affect both automatic and manual (HOA) switch positions. The second set of contacts will be wired to a digital input for annunciation of freeze protection alarm condition. Manual reset type is required.

2.5 HIGH LIMIT CONTROLS

.1 Provide High Limit Controls where indicated. Connect thermostat controllers that are capable of stopping fans in event of excessive temperatures in fan circuits. Provide thermostats with fixed or adjustable settings to operate at not less than 32ºC above normal maximum temperature at their location in the air handling system.

.2 The High Limit sensor shall be DPDT with a minimum of (1) NO contact and one (1) NC contact. One set of contacts shall be wired directly to controlled mechanical equipment contactor/VSD in order to affect both automatic and manual (HOA) switch positions. The second set of contacts will be wired to a digital input for annunciation of high limit alarm condition. Manual reset type is required.

2.6 IMMERSION WELLS

.1 Immersion wells shall be stainless steel or may be copper only if the medium being controlled is treated with appropriate chemicals products that inhibit corrosion and heat transfer compound to be compatible with sensors.

.2 Contractor shall be responsible for filling wells with suitable fluid for proper thermal conductivity transmittance.

2.7 RELATIVE HUMIDITY SENSORS/TRANSMITTERS

.1 Relative humidity transmitters and/or sensors shall have electronic circuits to compensate for element variations. The sensors shall have an operating range of 5 to 90% RH minimum, with a (±) 5% RH accuracy.

.2 Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with neoprene grommet, bushing, and a mounting bracket.

.3 Transmitters shall be shipped factory pre-calibrated.

.4 Outdoor Humidity sensor requirements:

- Range 0-100% RH minimum
- Operating temperature range: -40 to 50ºC
- Absolute accuracy: plus or minus 2%
- Temperature coefficient: plus or minus 0.03% RH/°C over 0 to 50 degrees.
- Must be unaffected by condensation or 100% saturation.
- No routine maintenance or calibration is required.

.5 The humidity station shall be suitable for duct or outside mounting and consist of sensors, ventilated non-metallic sun shield, utility box for terminations, and watertight gasket to prevent water seepage.

.6 The Humidity transmitters shall have the following requirements:

- Output signal of 4-20 mA into (500) ohm maximum load. or equivalent.
- Output variations: not to exceed 0.2% of full-scale output for supply voltage variations of plus or minus 10%.
- Output linearity error: plus or minus 1.0% maximum of full scale output.
- Shall have output short circuit and open circuit protection.
- Integral zero and span adjustments.

2.8 CO2 SENSORS

.1 CO2 sensors shall be a photo –acoustic type CO2 sensor with integral transducers and linear output. The devices shall read CO2 concentrations between 0 and 2000 ppm with full scale accuracy of at least plus or minus 100 ppm. The sensor shall have multiple outputs (0 -10 VDC or 4- 20 ma), annual zero drift + /- 10 ppm and automatic self-diagnostics.

2.9 AIR QUALITY SENSORS

.1 The Air Quality sensor shall monitor a wide range of gaseous volatile organic component common in indoor air contaminants like paint fumes, solvents, cigarette smoke, and vehicle exhaust. The sensor shall automatically compensate for temperature and humidity, have span and calibration potentiometers, operate on 24 VDC power with output of 0-10 VDC, and have service rating of 0 to 80ºC or 32 to 140ºF and 5 to 95% relative humidity.

2.10 STATIC PRESSURE TRANSMITTERS

.1 Static pressure transmitters shall have a multipoint sensing element with self-averaging manifold.

.2 Requirements:

- Maximum pressure loss shall be 0.75" w.g. at 2000 CFM with an accuracy of 1% of total duct static.
- Output signal of 4-20 mA into 500-ohm maximum load or equivalent.
- Accuracy:0.4% of span
- Repeatability: within .5% of output
- Linearity: within 1.5% of output
- Dead-band or hysteresis:0.1% of span
- Output short circuit protection.
- Calibrated span: not to exceed 150% of duct static pressure at maximum flow
- Pressure +/- 2% of the transmitter span.

2.11 FLOW (AIR FLOW & WATER)

.1 Electronic Air Flow Monitoring System shall be solid state electronic device comprised of a thermistor-based sensing grid and microprocessor-based electronics panel for flow averaging temperature compensation and signal transmission.

.2 Water flow In –Line Type: for Pipe Sizes up to 1.5 inches (38mm) in line type flow sensor shall have a nonmagnetic spinning impeller.

.3 Water flow Insertion Type: for Pipe 1.5 to 10 inches (38 to 254mm) provide a probe mounted insertion type turbine sensor.

2.12 VELOCITY PRESSURE SENSORS

.1 Sensors Requirements:

.1 Multipoint static and total pressure sensing element with self-averaging manifold with integral air equalizer and straightener section.

.2 Maximum pressure loss: 37 Pa at 1000 m/s

.3 Accuracy: plus or minus 1% of actual duct velocity.

2.13 VELOCITY PRESSURE TRANSMITTERS

.1 Transmitters Requirements:

- Output signal: 4-20 mA linear into 500-ohm maximum load.
- Calibrated span: not to exceed 125% of duct velocity pressure at maximum flow.
- Accuracy: 4% of span.
- Repeatability: within 0.1% of output.
- Linearity: within .5% of span.
- Dead-band or hysteresis: 0.1% of span.

EMCS: FIELD CONTROL DEVICES

2.14 LIQUID AND STEAM FLOW METERS

.1 Requirements: In accordance with CITY OF MISSISSAUGA Master Metering Specifications. Request copy from CITY OF MISSISSAUGA Facilities Project Manager when quoting a new project.

2.15 DIFFERENTIAL PRESSURE TRANSMITTERS & TRANSDUCERS

.1 Differential pressure transmitters shall be made of suitable materials for continuous contact with the process materials such as: compressed air water, glycol or steam etc.

.2 Output signal of 4-20 mA or equivalent, output short circuit and open circuit protection.

.3 Output variations: less than .2% full scale for supply voltage variations of plus or minus 10%.

.4 The controller shall determine airflow by dynamic pressure measurement using an integral dead-end differential pressure transducer. The transducer shall be maintenance-free and shall not require air filters

.5 The controller shall have the ability to automatically calibrate the flow sensor to eliminate pressure transducer offset error due to ambient temperature, humidity effects.

2.16 ELECTRIC/PNEUMATIC TRANSDUCERS (EPT) OR ELECTRIC/RESISTANCE TRANSDUCERS (ERT)

.1 Provide electric pneumatic transducers and/or electric resistance transducers that apply to the operation characteristics required in the specifications.

.2 The EPT shall have a nominal output 1 to 20 PSI, an adjustment span of 2 to 20 SPI, 5% span, and zero adjustment from 1 to 18 PSI.

.3 The ETR shall have a minimum of 3 linear rheostats, having a 5% tolerance.

.4 Each transducer shall have analog input adjustment point.

.5 Supply with each EPT a positive feedback system (pneumatic electric transducer PET) allowing a feedback of the demand from the pneumatic control signal to the controlled devices.

.6 Each pneumatic and/or electric control adjustment shall allow DDC to maintain the last output command during a malfunction or a power control failure of the control panel.

2.17 CURRENT SENSING RELAYS

.1 Current sensing relays shall be Carlo Gavazzi, 120 VAC, plug in type with remote sensor (donut). Relays shall be properly secured to cabinet/device enclosure using DIN rail or other manufacturer approved method

2.18 ELECTRIC RELAYS

.1 Electric control relays shall be double pole double throw with 24V or 120 V nominal (DPDT) coils. Contacts rated 10 amps at 120 VAC, plug-in type with sub-base, and wiring terminal blocks.

.2 Contacts shall be rated for 10 amps at 120 AC

.3 Relays shall have an integral indicator light and check button.

2.19 FRACTIONAL HORSEPOWER MOTOR CONTROL

.1 For fractional HP motors (i.e. Exhaust Fans) to be controlled by the EMCS, new starters shall be Veris Hawkeye H548.

.2 Shall be used for monitoring motor status and providing Hand/Off/Auto control of the FHP motor.

2.20 PRESSURE SWITCHES

.1 Pressure switches shall have Bourdon tube, bellows or diaphragm type sensing element. Pressure switches shall be snap action type, voltage rated at 120 VAC, 15 AMPS or 24 volts DC, with adjustable setpoint and differential.

.2 Sensing element shall be isolated between the sensor and the pressure source (steam, high temperature how water, etc.)

.3 Pressure switch range shall be according to their application and shall be commercial building industry standard.

2.21 CURRENT ELECTRIC TRANSDUCERS

.1 Current electric transducers shall measure line current and produce a proportional signal with the following range:

- 4 – 20 Ma
- 0 – 1 VDC
- 0 – 10 VDC
- 0 – 20 VDC
- 2 – 10 VDC

.2 Frequency insensitive from 10-80 Hz

.3 Accuracy to 0.5% full scale.

.4 Zero and span adjustments. Field adjustable range to suit motor applications.

.5 Adjustable mounting bracket to allow for secure/safe mounting inside MCC.

2.22 ELECTRONIC SIGNAL ISOLATION TRANSDUCERS

.1 The signal isolation transducer shall be provided whenever an analog output signal from BAS is to be connected to an external control system as an input or is to receive as input signal from remote system.

2.23 SUMP LEVEL SWITCHES

.1 Requirements:

- Indicate high/low water level and to alarm.
- Maximum operating temperature: 120ºC.
- Snap action contacts rated (15 amp at 120 V)
- Adjustable set-point and differential.

2.24 TANK LEVEL SWITCHES

.1 Switches shall be sealed mercury tube type in waterproof and shockproof enclosure. Contacts shall be rated 15 amps at 120 VAC.

2.25 WIND VELOCITY TRANSMITTERS

.1 Requirements:

.1 3-cup anemometer and airfoil vane mounted on common vertical axis, designed for mast mounting.

.2 Anemometer:

- Range: 0-160 km/h.
- Threshold: 3.0 km/h.
- Accuracy: +/- 2%.

.3 Airfoil vane

- Range: 0-360 degrees with infinite resolution potentiometer with no loss of reading at transition point.
- Starting threshold: 1.1 M/s.
- Accuracy: +/- 0.5%.
- Output signals: 4 to 20 Ma into 500-ohm load.
- Provide two output signals: velocity, direction.
- Mast: aluminum, size and height as indicated.
    - Provide at least 3 stainless steel guys, turnbuckles, anchor bolts. Follow manufacturer's installation guidelines.
    - Lightning protection as indicated on electrical drawings.

2.26 SOLAR SENSORS

.1 Monitor solar radiation as indicated.

.2 Pyranometer, black and white, producing proportional 0-50 mV signal. Include converter for 4-20 mA signal.

2.27 PLC MULTIPOINT DAYLIGHT HARVESTING PHOTOSENSOR

.1 Monitor lighting levels for control of lighting systems as indicated.

.2 Kele Model: MK7-B-CR (0-10Vdc or 4-20ma)

.3 Supply Voltage:12-24 VDC, 20 mA max

.4 Analog Output:(model specific) 4-20 mA @ 850Ω, or 0-10VDC @ 5KΩ min

.5 Range Adjust & Response Time: Field adjustable

.6 Operating Conditions:-40° to 140°F (-40° to 60°C); 10% to 95% RH Non-condensing

.7 Wiring Terminations: 3 wire 18 AWG pigtails

.8 Mounting:

- Indoor (-CCF):Smooth back for ceiling down mounting w/double stick tape

- Outdoor (-CR):1/2″ MNPT for Horizontal mount
- Skylight (-CS):1/2″ MNPT for Vertical-up mount

.9 Enclosure Rating: NEMA 1-Indoor (-CCF) and Skylight (-CS), NEMA 3R Outdoor (-CS)

.10 Warranty:2 year

2.28 SURFACE WATER DETECTORS

.1 Requirements:

- Provide alarm on presence of water on floor.
- Expendable cartridge sensor.
- Internal waterproof switch.
- One set of dry contacts 2 amps at 24 V.
- Unaffected by moisture in air.
- Self-powered.

2.29 ELECTRONIC DAMPER ACTUATORS

.1 Electronic damper actuators shall be direct shaft mount. The actuator shall be direct couple over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The fastening clamp assembly shall be of a 'V' bolt design with associated 'V' shaped toothed cradle attaching to the shaft for maximum strength and eliminating slippage. Spring return actuators shall have a 'V' clamp assembly of sufficient size to be directly mounted to an integral jackshaft of up to 1.05 inches. Single bolt or screw type fasteners are not acceptable.

.2 Modulating and two-position actuators shall be provided as required by the sequence of operations.

.3 The actuator mounting arrangement and spring return `` fail-safe` `feature shall permit normally open or normally closed positions of the dampers, as required.

.4 The actuator shall be size to control dampers against maximum pressure and dynamic closing/opening pressure, whichever is greater.

.5 All actuators (except terminal units i.e. VAV boxes etc.) shall be furnished with mechanical spring return unless otherwise specified in the sequence of operations.

.6 All actuators shall have external adjustable stops to limit the travel in either direction, or gear release to allow manual positioning.

.7 Power requirements: Modulating actuators shall accept 24 VAC or VDC power supply, consume no more 15 VA. The control signal shall be 2-10 VDC or 4-20 mA, and the actuator provide position feedback signal of 2-10 VDC.

.8 The feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication.

.9 For VAV box applications floating control type actuators may be used.

.10 Damper actuators shall drive damper from fully open to fully closed, in less than 120 seconds.

.11 Actuators shall be designed for a minimum of 100,000 full stroke cycles and 1,000,000 part cycles at the actuator's rated torque and shall have a 2-year manufacturer's warranty, starting from the date of start-up.

2.30 ELECTRONIC / ELECTRIC VALVE ACTUATORS

.1 Each actuator shall be equipped with current limiting circuitry incorporated in its design to prevent damage to the actuator.

.2 Modulating and two-position actuators shall be provided as required by the sequence of operations.

.3 The actuators shall provide the minimum torque required for proper valve close-off against system pressure for the required application.

.4 All actuators shall fail in the last position unless specified with mechanical spring return in the sequence of operations.

.5 The spring return feature shall permit normally open or closed positions of the valves a, specified.

.6 All direct shaft mount rotational actuators shall have external adjustable stops to limit the travel in either direction.

.7 Scale or dial indication of actual control valve position.

.8 Size actuator to meet requirements (CV`s) and performance of the control valve specifications.

.9 For interior and perimeter heating and cooling applications floating control actuators are acceptable.

.10 Power requirements: Modulating actuators shall accept 120 VAC or 24 VDC power supply, consume no more 15 VA. The control signal shall be 2-10 VDC or 4-20 mA, and the actuator provide position feedback signal of 2-10 VDC.

.11 The feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication.

.12 Two- position or open/ closed actuators shall accept 24Vdc or 120 VAC power supply.

.13 Butterfly isolation and other valves, as specified in the sequence of operations, shall furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop the associated heating /cooling pump or chiller.

2.31 POWER AND ELECTRIC CONSUMPTION TRANSDUCER

.1 Power transducers shall measure the electric power in Kilowatts (proportional signal) with ranges of 4 to 20 mA, 0 TO 5 VDC, 2-10 VDC, 0 to 20 VDC and shall measure electric consumption in KWH (pulsed signal).

.2 Power transducers shall have a local LCD display on the unit of instantaneous power (kW) and shall be VERIS model #H6004.

2.32 POWER SUPPLIES

.1 General

.1 DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.

- Input: 120 VAC +10% line change.
- Output: 24 VDC.
- Load Regulation: +0.05% for 50% load change.
- An appropriately sized fuse and fuse block shall be provided and located next to power supply.

.2 A lockable power disconnect switch shall be provided next to the power supply or as an integral component of the power supply.

.3 The 120-Volt circuits used for the BAS shall be dedicated to the BAS and shall not be used for any other purposes.

.4 Each BAS Control Panel (including the Building Controller) shall have a "packaged" Power Supply in a separate enclosure, such that the BAS Control Panel door can be opened without exposure to the 120-Volt wiring connections (Arc-Flash hazard) (see 2.33.5)

.2 Uninterrupted Power Supply (UPS)

.1 The UPS unit shall be supplied by a 120 VAC source and shall have enough capacity (VA) to support the associated SRPDC. The UPS shall be continuous operation type with battery reserve of 30 minutes minimum (at full charge) during a power failure. The UPS shall have internal fuse protection. The UPS shall supply the Communication Interface as well (if applicable). The primary role of the UPS shall be to maintain the primary RPDC microprocessor function as well as the modules for input/output points. This will allow the reading of data from the SRPDC in continuous mode and at the central computer via the communication network during the delay of the generator start-up.

.2 In absence of power failure, the internal rectifier and sine wave circuit of the UPS allows the UPS to regulate the power supply to the CNP ex. Frequency, voltage variation, etc.

.3 The UPS shall be supplied and installed by the EMCS contractor and shall be of the following type: Power Ware Model BE850M2 or approved equivalent. The UPS shall be a true UPS meaning the inverter shall be active at all times, not just on a loss on input power. The UPS (and all DDC equipment) shall powered through dedicated circuit(s) from the nearest power panel. The UPS shall be monitored and signal an alarm to the DDC system when the UPS batteries are dead

.3 Other Primary Elements

All other primary elements shall be of the highest quality for commercial building industry. The precision shall be (+/-) 1% of the normal reading for the application.

2.33 PANELS

.1 Wall mounted NEMA 1 enamelled steel cabinets with hinged and key-locked front door.

.2 Multiple panels as required to handle requirements with additional space to accommodate 25% additional capacity as without adding additional cabinets.

.3 Panels shall have DIN Rail mounting for controllers, relays, and other control devices.

.4 Panel shall have separate color coded terminal strip for termination of end devices (sensors, relays, etc) entering panel, and then from terminal strip to the termination point on controller. End devices shall not be wired directly to controller.

.5 Panels shall have external 120Vac to 24Vdc transformer. There shall be no 120V wiring inside of panel enclosure.

.6 Panels shall have plastic raceway/cable tray system for routing of wires into/out of panel.

.7 All panels shall be installed with Termination diagram showing the proper point names or each wire into panel, where it terminates on the terminal strip and where the wiring from terminal strip terminates at controller.

.8 Panels to be lockable with same key.

.9 Color Grey

Part 3 Execution

3.1 INSTALLATION

.1 The contractor shall inform the owner and receive a written approval for the installation location of all field control devices, before any installation

.2 The contractor should examine projects plans for control devices and equipment locations, and report any discrepancies, conflicts, or omissions to the project manager for resolution before proceeding for installation. The contractor should examine projects plans for control devices and equipment locations, and report any discrepancies, conflicts, or omissions to the project manager for resolution before proceeding for installation.

.3 The Contractor shall supply all primary elements as indicated on the drawings and as described in the sequences of operation. It includes all sensors, contacts for the analog and binary inputs and includes all controllers, relays and controlled devices necessary for the analog and binary outputs.

.4 The Contractor shall make all the final connections to the new elements to render a complete and operational control system.

.5 All sensors, transmitters, instruments, etc. which are to be replaced to permit the installation of the new system, shall be replaced with corresponding ones according to the new specifications. The Contractor shall present shop drawings for approval to the Owner before ordering the equipment.

.6 All holes made in ducts for the installation of primary elements shall be sealed properly in order not to affect the readings due to ambient air aspirating through these holes.

.7 Install all equipment and piping in readily accessible locations. Do not run tubing and conduit concealed under insulation or inside ducts.

.8 Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

.9 Install equipment, piping, cables, wiring/conduit parallel to or right angles to building lines. Refer to Category 6 Structured Cabling specification in Appendix C for additional requirements.

.10 Fabricated control panels built to support auxiliary devices such power supplies, relays, controllers, and control devices.

.11 Install all sensors and instrumentation according to manufacturer's instructions. Temperature sensor locations shall be readily accessible, permitting quick replacement and servicing of them without special skills and tools.

.12 Install room sensors prenatally supported on wall frame. They shall be mounted at 1.5 meter (5.0 feet) above finished floor.

.13 The blank stainless steel wall plate sensors shall be flush mounted directly to a single gang electrical box or directly to a wall. Insulating foam is adhered to the back of the wall plate in order to provide a thermal barrier from internal wall temperatures.

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

.15 Install field control devices in accordance with manufacturers recommended methods, procedures and instructions.

.16 Temperature transmitters, humidity transmitters, current-to-pneumatic transducers, solenoid air valves, controllers, relays: install in NEMA I enclosure or as required for specific applications. Provide for electrolytic isolation in cases when dissimilar metals make contact.

.17 Support field-mounted panels, transmitters and sensors on pipe stands or channel brackets.

.18 Fire stopping: provide space for fire stopping in accordance with Section 07 84 00 - Firestopping. Maintain fire rating integrity.

.19 Electrical:

- .1 Complete installation in accordance with Local, Provincial and National Electrical Codes
- .2 Modify existing starters to provide for EMCS as indicated in points list.
- .3 Refer to electrical control schematics as supplied by equipment manufacturer's installation manual. Trace any existing control wiring installation and provide updated wiring schematics including additions, deletions to control circuits for review by Consultant before beginning Work.
- .4 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.
- .5 Where exposed install communication wiring in conduit. Above rated ceiling, contractor may run plenum rated cable neatly tie wrapped to existing structure.
  - .1 Provide complete conduit system to link all Controllers and field devices.
  - .2 Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems.
  - .3 Maximum conduit fill not to exceed 40%.
  - .4 Design drawings do not show conduit layout.

EMCS: FIELD CONTROL DEVICES

3.2 IDENTIFICATION

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

3.3 AIR FLOW MEASURING STATIONS

.1 Protect air flow measuring assembly until cleaning of ducts is completed.

3.4 TESTING AND COMMISSIONING

.1 Calibrate and test field devices for accuracy and performance in accordance with Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

END OF SECTION 25 30 01

EMCS: SITE REQUIREMENTS, APPLICATIONS AND SYSTEMS SEQUENCES OF OPERATION

EMCS: SITE REQUIREMENTS, APPLICATIONS AND SYSTEMS SEQUENCES OF OPERATION

Part 1 General

1.1 SUMMARY

1.1.1 Section Includes:

1.1.1.1 Generic Sequence of Operation that are common to City of Mississauga Energy Management Control System (EMCS) Installations.

1.1.2 Related Sections:

1.1.2.1 Section 01 33 00 – Submittal Procedures

1.1.2.2 Section 01 77 00 – Closeout Procedures

1.1.2.3 Section 25 05 01 - EMCS: General Requirements

1.1.2.4 Section 25 05 02 - EMCS: Submittals and Review Process.

1.1.2.5 Appendix A – CoM Standards and Guidelines

1.1.3 References:

1.1.3.1 Not Used

1.2 SUBMITTALS

1.2.1 Provide Submittal drawings in accordance with Section 01 33 00 Submittal Procedures and Section 25 05 02 EMCS Submittals and Review Process.

1.2.2 Submittals information shall include:

1.2.2.1 A detailed narrative description of Sequence of Operation of each system including initial ramping periods and reset schedules.

1.2.2.2 Control Description Logic (CDL) for each system.

1.2.2.3 Completed Input/Output Point Matrix Summary Tables populated with COM point naming conventions for each system and related equipment/device fields.

1.2.2.4 System Diagrams consisting of the following; EMCS System architectural diagram, Control Design Schematic for each system (as viewed on OWS), System flow diagram for each system with electrical ladder diagram for MCC starter interface.

1.2.2.5 Final As-Built submittals shall be updated to reflect the final conditions upon completion of installation and commissioning process. A link to PDF version of as-builts shall be provided on all pages of graphical user interface, specific to the system on that graphical page (i.e. – RTU1 shall have link to Sequence and Wiring Diagrams for RTU1, RTU2…)

1.3 SEQUENCES OF OPERATION

1.3.1 Application of Specified Sequences

1.3.1.1 The CoM Typical Points List and Standard Sequence of Operation can be found in Appendix A CoM Standards and Guidelines. The sequences are generic in nature and are meant to form the basis of design for all CoM EMCS Projects

EMCS: SITE REQUIREMENTS, APPLICATIONS AND SYSTEMS SEQUENCES OF OPERATION

1.3.1.2 The sequences shall be used as the initial starting point for each project, customized by the specifying Consultant and tailored for the specifics of individual project and system requirements.

1.3.1.3 All project specific sequences to be submitted to the CoM for review and approval prior to Tender. – Refer to **EMCS Design Guidelines**, Approval Process.

1.3.2 HVAC Operating Schedules & Modes

1.3.2.1 Refer to **CoM Typical Points List and Standard Sequence of Operation**, in Appendix A

1.3.3 System Sequences

1.3.3.1 Refer to **CoM Typical Points List and Standard Sequence of Operation**, in Appendix A

Part 2 Products

2.1 NOT USED

2.1.1 Not Used.

Part 3 Execution

3.1 NOT USED

3.1.1 Not Used.

END OF SECTION 25 90 01

Common Work Results - Electrical

Common Work Results - Electrical

Part 1 General

1.1 RELATED SECTIONS

1.1.1 Section 25 05 01 EMCS General Requirements

1.1.2 Section 25 30 01 EMCS Building Family of Controllers

1.1.3 Section 25 30 02 EMCS Field Control Devices

1.2 REFERENCES

1.2.1 Canadian Standards Association (CSA International)

1.2.1.1 CSA C22.1, Canadian Electrical Code, Part 1 (20th Edition), Safety Standard for Electrical Installations.

1.2.1.2 CSA C22.2.

1.2.2 CAN/CSA-C22.3 No. 1, Overhead Systems.

1.2.3 CAN3-C235, Preferred Voltage Levels for AC Systems, 0 to 50,000 V.

1.2.4 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)

1.2.5 EEMAC 2Y-1 , Light Gray Colour for Indoor Switch Gear.

1.2.6 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)

1.2.7 IEEE SP1122, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

1.3 DEFINITIONS

1.3.1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.

1.3.2 This section covers items common to Sections of Division 26. This section supplements requirements of General Conditions, Supplemental General Conditions and the General Requirements of these specifications.

1.3.3 This Contractor shall be responsible for all cutting and patching required for the removal of existing and installation of new electrical services associated with mechanical systems as indicated and/or specified within.

1.3.4 Where there is a discrepancy between these specifications on those on the drawings, the drawing shall be taken as correct.

Part 2 Codes and Standards

2.1 GENERAL

2.1.1 Do complete installation in accordance with CSA C22.1-1990 and Ontario Hydro code requirements except where specified otherwise.

2.1.2 Do overhead and underground systems in accordance with CSA C22.3No.1-M1979 except where specified otherwise.

2.1.3 Abbreviations for electrical terms: to CSA Z85-1983.

2.1.4 Comply with most recent electrical, building and other applicable codes and authorities having jurisdiction. All new equipment must be CSA approved or approved by special Ontario Hydro inspection.

Part 3 Execution

3.1 CARE, OPERATION AND START-UP

3.1.1 Instruct Consultant and operating personnel in the operation, care and maintenance of equipment.

3.1.2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components.

3.1.3 Provide these services for such period, and for as many visits as necessary, to put equipment in operation and ensure that operating personnel are conversant with all aspects of its care and operation.

3.2 VOLTAGE RATINGS

3.2.1 Operating voltages: to CAN3-C235-83.

3.2.2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

3.2.3 Voltage drop: voltage drop on new systems wired under this contract shall not exceed 3%. Provide calculations at the request of consultant.

3.3 PERMITS, FEES AND INSPECTION

3.3.1 Submit to Electrical Inspection Department and Supply Authority necessary number of drawings and specifications for examination and approval prior to commencement of work.

3.3.2 Pay associated fees. Apply for, obtain and pay for all permits, licences, inspections, examinations and fees required.

3.3.3 Ameresco will provide drawings and specifications required by Electrical Inspection Department and Supply Authority at no cost.

3.3.4 Notify Ameresco of changes required by Electrical Inspection Department prior to making changes. Comply with any changes requested prior to making changes.

3.3.5 On completion of work, furnish to the Owner **Certificates of Acceptance** from authorities having jurisdiction.

3.4 MATERIALS AND EQUIPMENT

3.4.1 Provide materials and equipment in accordance with these specifications and associated drawings.

3.4.2 Equipment and material to be CSA certified. Where there is no alternative to supplying equipment that is not CSA certified, obtain special approval from Electrical Inspection

Department of governing authority. Should any dispute arise as to quality or fitness of products, decision rests strictly with Ameresco based on requirements of Contract Documents.

3.4.3 Factory-assemble control panel and component assemblies.

3.5 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

3.5.1 Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections for direct digital controls, which are related to control systems specified in Division 25 (**All other controls, interlocks, etc shall be by Division 26**).

3.6 FINISHES

3.6.1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two (2) coats of finish enamel.

3.6.2 Clean and touch-up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

3.6.3 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

3.7 EQUIPMENT IDENTIFICATION

3.7.1 Identify electrical equipment with nameplates in accordance with existing building nomenclature.

3.7.2 Nameplates

3.7.2.1 Lamacoid 3 mm thick plastic engraving sheet, black face, white core.

Nameplate Sizes:

Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

3.7.3 Labels

3.7.3.1 Embossed plastic labels with 6 mm high letters unless specified otherwise.

3.7.3.2 Wording on nameplates to be approved by Consultant prior to manufacture.

3.7.3.3 Allow for average of 25 letters per nameplate.

3.7.3.4 Identification to be English.

3.7.3.5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.

3.7.3.6 Disconnects, starters and contactors: indicate equipment being controlled and voltage.

3.7.3.7 Terminal cabinets and pull boxes: indicate system and voltage.

3.7.3.8 Transformers: indicate capacity, primary and secondary voltages.

3.8 WIRING IDENTIFICATION

3.8.1 Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.

3.8.2 Maintain phase sequence and colour coding throughout.

3.8.3 Colour code: to CSA C22.1-1990.

3.8.4 Use colour coded wires in communication cables, matched throughout system.

3.9 CONDUIT AND CABLE IDENTIFICATION

3.9.1 Colour code conduits, boxes and metallic sheathed cables.

3.9.2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals

3.9.3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

	Prime	Auxiliary
up to 250 V	yellow	
up to 600 V	yellow	green
up to 5 kV	yellow	blue
up to 15 kV	yellow	red
Telephone	green	
Other communication systems	green	blue
Fire alarm	red	
Emergency voice	red	blue
Other security systems	red	yellow

3.10 WIRING TERMINATIONS

3.10.1 Lugs, terminals, and screws used for termination of wiring to be as specified on drawings.

3.11 MANUFACTURER'S AND CSA LABELS

3.11.1 Must be visible and legible after equipment is installed.

3.12 WARNING SIGNS

3.12.1 As specified and to meet requirements of Electrical Inspection Department and Consultant.

3.12.2 Decal signs, minimum size 175 x 250 mm.

3.13 MOUNTING HEIGHTS

3.13.1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.

3.13.2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.

3.13.3 Install electrical equipment at following heights unless indicated otherwise.

3.13.3.1 Local switches: 1,400 mm

3.13.3.2 Wall receptacles:

3.13.3.3 General: 300 mm.

3.13.3.4 Above top of continuous baseboard heater: 200 mm.

3.13.3.5 Above top of counters or counter splash backs: 175 mm

3.13.3.6 In mechanical rooms: 1,200 mm.

3.13.3.7 Panelboards: as required by Code or as indicated.

3.13.3.8 Telephone and interphone outlets: 300 mm.

3.13.3.9 Wall-mounted telephone and interphone outlets: 1,500 mm.

3.13.3.10 Fire alarm stations: 1,500 mm.

3.13.3.11 Fire alarm bells: 2,100 mm.

3.13.3.12 Television outlets: 300 mm.

3.13.3.13 Wall-mounted speakers: 2,100 mm

3.13.3.14 Clocks: 2,100 mm

3.13.3.15 Doorbell pushbuttons: 1,500 mm

3.14 LOAD BALANCE

3.14.1 Measure phase current to panelboards with normal loads operating at time of acceptance. Adjust branch circuit connections as required to obtain best balance of current between phases and record changes.

3.14.2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.

3.14.3 Submit, at completion of work, report listing phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

3.15 CONDUIT AND CABLE INSTALLATION

3.15.1 Install conduit and sleeves prior to pouring of concrete. Sleeves through concrete: schedule 40 steel pipe, sized for free passage of conduit, and protruding 50 mm.

3.15.2 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.

Part 4 Field Quality Control

4.1 TESTING

4.1.1 Conduct and pay for following tests:

4.1.1.1 Power distribution system including phasing, voltage, grounding and load balancing.

4.1.1.2 Circuits originating from branch distribution panels.

4.1.1.3 Lighting and its control.

4.1.1.4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.

4.1.2 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.

4.2 INSULATION RESISTANCE TESTING.

4.2.1.1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.

4.2.1.2 Megger 350-600 V circuits, feeders and equipment with a 1,000 V instrument.

4.2.1.3 Check resistance to ground before energizing.

4.2.2 Carry out tests in presence of Consultant.

4.2.3 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

4.2.4 Submit test results for Consultant to review.

4.3 CO-ORDINATION OF PROTECTIVE DEVICES

4.3.1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

END OF SECTION 26 05 00

Appendix A: City of Mississauga Standards & Guidelines

Appendix A
City of Mississauga Standards and Guidelines

A1- CoM Point Naming Convention
A2- CoM Building ID and Type List
A3- CoM EMCS Cabinet Installation Standard
A4- CoM System Architectures
A5- CoM Graphical Standard
A6- CoM Points List and Typical Sequences of Operation

Appendix A1
CITY OF MISSISSAUGA
POINT NAMING CONVENTION

GUIDE RULES

All objects must be defined with the site number followed by system identifier, Device Location (Floor number or area) and the point Description. (See acronym list)

EXAMPLE: ***Building Name:*** *Iceland Arena* ***Site ID:*** *IA1*

Acronym	**System Identifier**	**Device/Equip**	**Action/Feedback**
SITE ID	Dehumidifier 1	Supply Fan	Command
IA1	DH1	SF	CMD

Point Name: IA1_DH1SF_CMD

Acronym	**System Identifier**	**Device/Equip**	**Action/Feedback**
SITE ID	Air Handling Unit 1	MA Damper	Modulate
IA1	AHU1	MADPR	MOD

Point Name: IA1_AHU1MADPR_MOD

Acronym	**System Identifier**	**Device/Equip**	**Action/Feedback**
SITE ID	Boiler 1	Boiler Alarm	Alarm
IA1	BLR1	ALM	ALM

Point Name: IA1_BLR1ALM_ALM

Acronym	**System Identifier**	**Device/Equip**	**Action/Feedback**
SITE ID	Boiler1	Supply Water Temp	Temperature
IA1	BLR1	SWT	T

Point Name: IA1_BLR1SWT_T

Table 1: City of Mississauga Sample Facility Identification Tags

For Complete List of Facility ID Tags please see Appendix A2 – Facility ID and Building Type

Facility	Site ID
Burnhamthorpe Community Centre & Arena	BCC1
Burnhamthorpe CC Parks Bunker/Change House	BCC2
Burnhamthorpe CC Covered Outdoor Rink	BCC3
Carmen Corbasson/Cawthra Community Centre & Arena	CAW1
Mississauga Senior Citizens Centre	CAW2
Port Credit Lawn Bowling Club	CAW3
Iceland Arena	IA1
Iceland Arena & Sports Park Electrical Bunker	IA2
Iceland Arena & Sports Park Park Bunker (not FPM)	IA3
Iceland Arena & Sports Park Gazebo	IA4

Table 2: Typical System Tags

Equipment Description	Tag
Air Handling Unit (Indoor)	AHU
Rooftop Air Handler (Outdoor)	RTU
Make Up Air Handler (100% OA)	MUA
Energy Recovery Ventilator	ERV
Heat Recovery Ventilator	HRV
Exhaust Fan	EF
Dehumidifier	DH
Unit Ventilator	UV
Fan Coil	FC
Heat Pump	HP
Boiler	BLR
Radiator	RAD
Chiller	CHLR
Cooling Tower	CT
Air Cooled Condenser	CND
Refrigeration Plant Compressor	CMPR
Lighting	LTG
Generator	GEN
Evaporative Condenser	ECND
Fluid Cooler	FCL
Domestic Hot Water Tank	DHWT
Refrigeration (ice) Plant	ICEP
Heat Exchanger	HX
Radiant Heater	RADH
Unit Heater	UH
Pool	Pool
Steam Generator	SGEN
Elevator Sump Pump	ESUMP
Fire Alarm	FIRE
Gas Detection System	GASD
Reclaimed Rain Water System	RRWS
Electric System	ELEC
Meters (Gas-NG, Water - WT, Hydro-ELC)	xxMTR

Table 2: Typical Device Tags

Device Description	Tag
Supply Fan	SF
Return Fan	RF
Exhaust Fan	EF
Supply Fan VSD	SFVSD
Return Fan VSD	RFVSD
Heating Control Valve	HTGVLV
Cooling Valve	CLGVLV
Differential Pressure Valve	DPVLV
Refrigeration Solenoid Valve	DXVLV
Make-Up Water Valve	MUWVLV
Reversing Valve	REVLV
Drain Valve	DRVLV
Burner	BUR
Damper	DPR
Filter	FILT
Freeze Stat	FRZ
Occupancy Sensor	OCC
Room Temperature Sensor/Thermostat	RMT
Return Air Temperature Sensor	RAT
Return Air Humidity Sensor	RAH
Return Air Static Pressure	RASP
Supply Air Temperature Sensor	SAT
Supply Air Humidity Sensor	SAH
Supply Air Static Pressure Sensor	SASP
Heating Pump	HTGPMP
Cooling Pump	CLGPMP
Condenser Water Pump	CNDPMP
Condensate Pump	CONPMP
Domestic Water Recirc Pump	DWRPMP
Domestic Water Booster Pump	DWBPMP
Cold Brine Pump	CBPMP
Warm Brine Pump	WBPMP
Glycol Pump	GLPMP
Compressor Jacket Pump	CJPMP
Mixed Air Temperature Sensor	MAT
Differential Pressure Sensor	DP

Table 3: Typical Point Type & Units

Point Type	Description	Tag	Typical Units
DI	Status	STS	Open/Closed
			On/Off
			Alarm/Normal
			Occupied/Unoccupied
AI	Status	STS	Amps
	Level	LVL	ppm
			Lux
	Relative Humidity	RH	%RH
	Temperature	T	^{o}C
	Feedback	FBK	Hz
			%
	Pressure	PRS	Psi
	Setpoint	SPT	(Variant)
	Flow	FLOW	L/s
DO	Command	CMD	Open/Close
			On/Off
	Alarm	ALM	Alarm/Normal
AO	Modulate	MOD	% Open
			%
			% Fresh Air
COM	Communication Protocol BacNet/LON/Modbus	VP	As defined by the available read/write permissions of the specified equipment.

EXAMPLE POINT NAMES

Single Zone AHU Systems

Anticipated Points:

AHUxSF-STS	- Supply Fan Status (1 DI)
AHUxSF-CMD	- Supply Fan Start/Stop (1 DO)
AHUxRF-STS	- Return Fan Status (1 DI)
AHUxRF-CMD	- Return Fan Start/Stop (1 DO)
AHUxMAT-T	- Mixed Air Temp (AI)
AHUxMADPR-MOD	- Mixed Air Dampers CTL (1 AO)
AHUxSAT-T	- Supply Air Temp (1 AI)
AHUxRAT-T	- Return Air Temp (1 AI)
AHUxHTGVLV-MOD	- Heating Coil Valve CTL (1 AO)
AHUxHTGPMP-CMD	- Heating Coil Pump CMD (1 DO)
AHUxHTGPMP-STS	- Heating Coil Pump Status (1 DI)
AHUxCLGVLV-MOD	- Cooling Coil Valve CTL (1 AO)

VAV Terminal Control

Points

VAV###RMT-T	- VAV Rm ### Space Temp (1 AI)
VAV###RMT-SPT	- Room Temp Set Point (1 AI)
VAV###OCC-STS	- Occu Button/Sensor Status (1 DI)
VAV###VP-PRS	- VAV Velocity Pressure (1 AI)
VAV###FLW-LPS	- VAV Total Air Flow (1 AI)
VAV###DPR-MOD	- VAV Damper Modulation (1 AO)

Optional w/Reheat

VAV###HTGVLV-MOD	-VAV Htg Valve Modulation (1 AO)
VAV###SAT-T	-Supply Air Temp (1 AI)

Refer to Appendix A6 for a list of Typical Points and Standard CoM Sequences of Operation.

Appendix A2

City of Mississauga Facility ID Numbers and Building Types

Building ID	Description	Address	Building Type
ACC1	Animal Services Centre	735 CENTRAL PKY W	WRKPRK-DEP
AE1	Adamson Estate Main House-Heritage Designation	850 ENOLA AVE	PARK-OTHER
AE2	Adamson Estate Derry House-Heritage Designation	875 ENOLA AVE	PARK-OTHER
AE3	Adamson Estate Folly-Heritage Designation	850 ENOLA AVE	PARK-OTHER
AE4	Adamson Estate Barn-Heritage Designation	850 ENOLA AVE	PARK-OTHER
AEC1	A.E. Crookes Park Clubhouse & Concession Stand	140 LAKEFRONT PROMENADE	REC-MINOR
AEC2	A.E. Crookes Park Storage Building	140 LAKEFRONT PROMENADE	REC-BNKSTR
AEC3	A.E. Crookes Park Scorers Booth	140 LAKEFRONT PROMENADE	REC-BNKSTR
AHP1	Applewood Heights Outdoor Pool	3119 CONSTITUTION BLVD	ODPOOL
BC1	Britannia Church	5961 HURONTARIO ST	MUSEUM-HER
BCC1	Burnhamthorpe Community Centre & Arena	1500 GULLEDEN DR	REC-MAJOR
BCC2	Burnhamthorpe CC Parks Bunker/Change House	1500 GULLEDEN DR	REC-MINOR
BCC3	Burnhamthorpe CC Covered Outdoor Rink	1500 GULLEDEN DR	REC-MAJOR
BE1	Benares Estate House-Heritage Designation	1503 CLARKSON RD N	MUSEUM-HER
BE2	Benares Estate Visitor Centre On Heritage Designated Land	1507 CLARKSON RD N	MUSEUM-HER
BE3	Benares Estate Barn/Stable-Heritage Designation	1503 CLARKSON RD N	MUSEUM-HER
BE4	Benares Estate Dairy Building Ice House-Heritage Designation	1504 CLARKSON RD N	MUSEUM-HER
BE5	Benares Estate Potting Shed-Heritage Designation	1505 CLARKSON RD N	MUSEUM-HER
BE6	Benares Estate Baking House-Heritage Designation	1506 CLARKSON RD N	MUSEUM-HER
BGC1	Braeben Golf Course Club House-Heritage Listed	5700 TERRY FOX WAY	REC-MAJOR
BGC2	Braeben Golf Course Academy-Heritage Listed	5650 TERRY FOX WAY	REC-MINOR
BGC3	Braeben Golf Course Maintenance Building-Heritage Listed	5750 TERRY FOX WAY	REC-MINOR
BGC4	Braeben Golf Course Ball Shack-Heritage listed	5650 TERRY FOX WAY	REC-MINOR
BL1	Burnhamthorpe Library & Maja Prentice Theatre-DBNC-Herita	3650 DIXIE RD	LIBRARY
BP1	Brookmede Centre	2264 COUNCIL RING RD	REC-MINOR
BRT1	Mississauga Transitway: Central Parkway Station-North (westl	4327 CENTRAL PKWY E	TRANSIT
BRT10	Mississauga Transitway: Tahoe Blvd Station-East (eastbound)	4653 TAHOE BLVD	TRANSIT
BRT11	Mississauga Transitway: Etobicoke Creek Station	1915 EGLINTON AVE E	TRANSIT
BRT12	Mississauga Transitway: Spectrum Way Station-South (eastbo	5005 SPECTRUM WAY	TRANSIT
BRT13	Mississauga Transitway: Spectrum Way Station-North (westbo	5007 SPECTRUM WAY	TRANSIT

BRT14	Mississauga Transitway: Orbitor Drive Station-South (eastbou	5015 ORBITOR DR	TRANSIT
BRT15	Mississauga Transitway: Orbitor Drive Station-North (westbou	5017 ORBITOR DR	TRANSIT
BRT16	Mississauga Transitway: Renforth Drive Station	5001 COMMERCE BLVD	TRANSIT
BRT17	Mississauga Transitway: Erin Mills Station-North (westbound)	4430 ERIN MILLS PKWY	TRANSIT
BRT18	Mississauga Transitway: Erin Mills Station-South (eastbound)	4380 ERIN MILLS PKWY	TRANSIT
BRT19	Mississauga Transitway: Erin Mills Station-Service Building	4381 ERIN MILLS PKWY	TRANSIT
BRT2	Mississauga Transitway: Central Parkway Station-South (eastb	4325 CENTRAL PKWY E	TRANSIT
BRT20	Mississauga Transitway: Winston Churchill Station-North (wes	4334 WINSTON CHURCHILL BLVD	TRANSIT
BRT21	Mississauga Transitway: Winston Churchill Station-South (east	4300 WINSTON CHURCHILL BLVD	TRANSIT
BRT22	Mississauga Transitway: Winston Churchill Station-Service Bui	4301 WINSTON CHURCHILL BLVD	TRANSIT
BRT3	Mississauga Transitway: Cawthra Rd Station-North (westboun	775 EASTGATE PKWY	TRANSIT
BRT4	Mississauga Transitway: Cawthra Rd Station-South (eastbound	776 EASTGATE PKWY	TRANSIT
BRT5	Mississauga Transitway: Tomken Rd Station-North (westboun	4452 TOMKEN RD	TRANSIT
BRT6	Mississauga Transitway: Tomken Rd Station-South (eastbound	4450 TOMKEN RD	TRANSIT
BRT7	Mississauga Transitway: Dixie Rd Station-North (Westbound)	4442 DIXIE RD MISSISSAUGA ON	TRANSIT
BRT8	Mississauga Transitway: Dixie Rd St-South (eastbound)	4440 DIXIE RD MISSISSAUGA ON	TRANSIT
BRT9	Mississauga Transitway: Tahoe Blvd Station-West (westbound	4651 TAHOE BLVD MISSISSAUGA ON	TRANSIT
BWP1	Birchwood Park Comfort Station	1547 LAKESHORE RD W MISSISSAUG	COMSTA
BYP1	Brickyard Park Electrical Bunker	3061 CLAYHILL RD MISSISSAUGA ON	PRK-BNKSTR
BYP2	Brickyard Park Comfort Station & Parks Bunker	3061 CLAYHILL RD MISSISSAUGA ON	COMSTA
CAF1	Courtneypark Athletic Field Comfort Station & Parks Bunker	600 COURTNEYPARK DR W MISSISSA	COMSTA
CAW1	Carmen Corbasson/Cawthra Community Centre & Arena	1399 CAWTHRA RD MISSISSAUGA O	REC-MAJOR
CAW2	Mississauga Senior Citizens Centre	1389 CAWTHRA RD MISSISSAUGA O	REC-MINOR
CAW3	Port Credit Lawn Bowling Club	1375 CAWTHRA RD MISSISSAUGA O	REC-MINOR
CCC1	Community Common Comfort Station	355 PRINCESS ROYAL DR MISSISSAU	COMSTA
CCP1	Century City Park Gazebo	933 FOCAL RD MISSISSAUGA ON L5V	SHELTER
CD1	Clarkson Depot Main Building	2167 ROYAL WINDSOR DR MISSISSA	WRKPRK-DEP
CD2	Clarkson Depot Dome-1 (east)	2167 ROYAL WINDSOR DR MISSISSA	WRK-STORAG
CD3	Clarkson Depot Operational Hub	2167 ROYAL WINDSOR DR MISSISSA	WRKPRK-DEP
CD4	Clarkson Depot Fabric Dome-2 (west)	2167 ROYAL WINDSOR DR MISSISSA	WRK-STORAG
CD5	Clarkson Depot Storage Building East	2167 ROYAL WINDSOR DR MISSISSA	WRK-STORAG
CD6	Clarkson Depot Storage Building West	2167 ROYAL WINDSOR DR MISSISSA	WRK-STORAG
CE1	Riverwood-Chappell Estate House/ Parker Estate-Heritage Des	4300 RIVERWOOD PARK LANE MISSI	PARK-OTHER
CE2	Riverwood-Chappell Estate/ Parker Estate Carport-Heritage D	4300 RIVERWOOD PARK LANE MISSI	PARK-OTHER
CEE1	Cawthra Elliott Estate House-Heritage Designation	1507 CAWTHRA RD MISSISSAUGA O	REC-MINOR

CHC1	Churchill Meadows Community Centre & Pool	5320 NINTH LINE MISSISSAUGA ON L	REC-MAJOR
CL1	Cooksville Library in Cooksville Colonnade-Leased	3024 HURONTARIO ST MISSISSAUGA	LIBRARY
CLK1	Clarkson Community Centre Pool Arena & Library	2475 TRUSCOTT DR MISSISSAUGA O	REC-MAJOR
CMC1	Churchill Meadows Common Comfort Station	3370 MCDOWELL DR MISSISSAUGA (	COMSTA
CMC2	Churchill Meadows Common Park Gazebo	3370 MCDOWELL DR MISSISSAUGA (	SHELTER
CMH1	Clarke Memorial Hall-Heritage Designation	161 LAKESHORE RD W MISSISSAUGA	REC-MINOR
CML1	Churchill Meadows Branch Library & Activity Centre	3801 THOMAS ST MISSISSAUGA ON	LIBRARY
CPL1	Courtneypark Library	730 COURTNEYPARK DR W MISSISSA	LIBRARY
CPP1	Cawthra Park Pool	1305 CAWTHRA RD MISSISSAUGA O	REC-MAJOR
CSP1	Clarkson Pool(NOT IN USE)	2524 BROMSGROVE RD MISSISSAUG	REC-MAJOR
CT1	Camp Totoredaca Building A (SMALL CABIN)	2715 MEADOWVALE BLVD MISSISSA	REC-MINOR
CT2	Camp Totoredaca Building B (LARGE CABIN)	2715 MEADOWVALE BLVD MISSISSA	REC-MINOR
CT3	Camp Totoredaca Hut-1 Nurses Hut	2715 MEADOWVALE BLVD MISSISSA	REC-MINOR
CT4	Camp Totoredaca Hut-2 Chief's Hut	2715 MEADOWVALE BLVD MISSISSA	REC-MINOR
CVM1	Credit Village Marina-Heritage Listed	12 STAVEBANK RD S MISSISSAUGA C	PARK-OTHER
DAF1	Dunton Athletic Field Comfort Station	6180 KENNEDY RD MISSISSAUGA ON	COMSTA
DAF2	Dunton Athletic Field Picnic Shelter East	6180 KENNEDY RD MISSISSAUGA ON	SHELTER
DAF3	Dunton Athletic Field Picnic Shelter West	6180 KENNEDY RD MISSISSAUGA ON	SHELTER
DAF4	Dunton Athletic Field Parks Bunker (not FPM)	6180 KENNEDY RD MISSISSAUGA ON	PRK-BNKSTR
DAF5	Dunton Athletic Field Electrical Bunker	6180 KENNEDY RD MISSISSAUGA ON	PRK-BNKSTR
DKP1	Douglas Kennedy-Tenth Inning Concession Stand-Heritage List	810 LAKEFRONT PROMENADE MISSI	REC-MINOR
DMD1	Dr. Martin Dobkin Park Comfort Station & Parks Bunker	395 FAIRVIEW RD W MISSISSAUGA C	COMSTA
DRC1	Don Rowing Club-Heritage Listed	25 FRONT ST N MISSISSAUGA ON L5	REC-MINOR
DRP1	David Ramsey Outdoor Pool	2470 THORN LODGE DR MISSISSAUG	ODPOOL
DUC1	Dixie Union Chapel - Heritage Listed	707 DUNDAS ST E MISSISSAUGA ON	MUSEUM-HER
ECH1	Erindale Community Hall-Heritage Designation	1620 DUNDAS ST W MISSISSAUGA O	REC-MINOR
EMA1	Erin Mills Twin Arena	3205 UNITY DR MISSISSAUGA ON L5	REC-MAJOR
EMA2	Erin Mills Twin Arena Parks Bunker (not FPM)	3205 UNITY DR MISSISSAUGA ON L5	PRK-BNKSTR
EMC1	Erin Meadows Community Centre Pool & Library	2800 ERIN CENTRE BLVD MISSISSAU	REC-MAJOR
EP1	Erindale Park Comfort Station & Parks Bunker - Heritage Listed	1695 DUNDAS ST W MISSISSAUGA O	COMSTA
EP2	Erindale Park Parks Bunker (not FPM)	1695 DUNDAS ST W MISSISSAUGA O	PRK-BNKSTR
EP3	Erindale Park Picnic Shelter-Heritage Listed	1695 DUNDAS ST W MISSISSAUGA O	SHELTER
FBP1	Fallingbrook Park Comfort Station	5135 FALLINGBROOK DR MISSISSAU	COMSTA
FCC1	Fire - 911 Call Centre Brampton	7750 HURONTARIO ST BRAMPTON C	FIRE
FMC1	Frank McKechnie Community Centre Library & Pool	310 BRISTOL RD E MISSISSAUGA ON	REC-MAJOR

FMC2	Frank McKecknie CC Picnic Shelter	310 BRISTOL RD E MISSISSAUGA ON	SHELTER
FP1	Fleetwood Park Comfort Station	2000 BURNHAMTHORPE RD E MISSI	COMSTA
FS01	Fire Station 101 (HQ)	15 FAIRVIEW RD W MISSISSAUGA O	FIRE
FS02	Fire Station 102 (Lakeview)	710 THIRD ST MISSISSAUGA ON L5E-	FIRE
FS03	Fire Station 103 (Clarkson)	2035 LUSHES AVE MISSISSAUGA ON	FIRE
FS04	Fire Station 104 (Port Credit)-Heritage Designation	62 PORT ST W MISSISSAUGA ON L5H	FIRE
FS05	Fire Station 105 (Malton East)	7101 GOREWAY DR MISSISSAUGA O	FIRE
FS06	Fire Station 106 (Winding Trail)	1355 WINDING TR MISSISSAUGA ON	FIRE
FS061	Fire Station 106 Storage/Garbage Building	1355 WINDING TR MISSISSAUGA ON	FIRE
FS07	Fire Station 107 (Erindale)	1965 DUNDAS ST W MISSISSAUGA O	FIRE
FS08	Fire Station 108 (Streetsville)	2267 BRITANNIA RD W MISSISSAUG	FIRE
FS09	Fire Station 109 (Fire Hall/Training)	1735 BRITANNIA RD E MISSISSAUGA	FIRE
FS091	Fire Station 109 Training Tower	1735 BRITANNIA RD E MISSISSAUGA	FIRE
FS092	Fire Station 109 Fire House	1735 BRITANNIA RD E MISSISSAUGA	FIRE
FS093	Fire Station 109 Portable 1	1735 BRITANNIA RD E MISSISSAUGA	FIRE
FS094	Fire Station 109 Portable 2	1735 BRITANNIA RD E MISSISSAUGA	FIRE
FS10	Fire Station 110 (Queensway)	2316 HURONTARIO ST MISSISSAUGA	FIRE
FS11	Fire Station 111 (Meadowvale)	2740 DERRY RD W MISSISSAUGA ON	FIRE
FS12	Fire Station 112 (Creditview)	4090 CREDITVIEW RD MISSISSAUGA	FIRE
FS14	Fire Station 114 (Heartland)	5845 FALBOURNE ST MISSISSAUGA O	FIRE
FS15	Fire Station 115 (Erin Mills)	4595 GLEN ERIN DR MISSISSAUGA O	FIRE
FS16	Fire Station 116 (Malton West) & Peel Ambulance Reporting C	6825 TOMKEN RD MISSISSAUGA ON	FIRE
FS17	Fire Station 117 (North Dixie)	1090 NUVIK CRT MISSISSAUGA ON L	FIRE
FS18	Fire Station 118 (East Credit)	1045 BRISTOL RD W MISSISSAUGA O	FIRE
FS19	Fire Station 119 (Airport) & ROP Station S11	6375 AIRPORT RD MISSISSAUGA ON	FIRE
FS20	Fire Station 120	125 EGLINTON AVE W MISSISSAUGA	FIRE
FS21	Fire Station 121 (Meadowvale Village)	6745 MAVIS RD MISSISSAUGA ON L5	FIRE
FS22	Fire Station 122 (Churchill Meadows)	3600 THOMAS ST MISSISSAUGA ON	FIRE
GMC1	Garry W. Morden Fire Training Centre	7535 NINTH LINE MISSISSAUGA ON L	FIRE
GMC2	Garry W. Morden Fire Training Centre Smoke Tower	7535 NINTH LINE MISSISSAUGA ON L	FIRE
GMC3	Garry W. Morden Fire Training Centre Field Shelter	7535 NINTH LINE MISSISSAUGA ON L	FIRE
GMC4	Garry W. Morden Fire Training Centre Burn Building	7535 NINTH LINE MISSISSAUGA ON L	FIRE
GMC5	Garry W. Morden Fire Training Centre Storage Building	7535 NINTH LINE MISSISSAUGA ON L	FIRE
GMC6	Garry W. Morden Fire Training Centre Track Observation Tow	7535 NINTH LINE MISSISSAUGA ON L	FIRE
GP1	Garnetwood Park Comfort Station	1996 RATHBURN RD E MISSISSAUGA	COMSTA

GSP1	Glenforest Pool	3575 FIELDGATE DR MISSISSAUGA O	REC-MAJOR
HAN1	Hancock Woodlands Greenhouses Header Building-Heritage L	2151 CAMILLA RD MISSISSAUGA ON	PARK-OTHER
HAN2	Hancock Woodlands Greenhouse 1-Heritage Listed	2151 CAMILLA RD MISSISSAUGA ON	PARK-OTHER
HAN3	Hancock Woodlands Greenhouse 2-Heritage Listed	2151 CAMILLA RD MISSISSAUGA ON	PARK-OTHER
HAN4	Hancock Woodlands Greenhouse 3-Heritage Listed	2151 CAMILLA RD MISSISSAUGA ON	PARK-OTHER
HAN5	Hancock Woodlands Office Building-Heritage Listed(under rec	2151 CAMILLA RD MISSISSAUGA ON	PARK-OTHER
HF1	Harris Farm Main House- heritage listed	6545 CREDITVIEW RD MISSISSAUGA	PARK-OTHER
HF10	Harris Farm Pump House-Not In Use-heritage listed	6545 CREDITVIEW RD MISSISSAUGA	PARK-OTHER
HF11	Harris Farm Silo-not in use-heritage listed	6545 CREDITVIEW RD MISSISSAUGA	PARK-OTHER
HF2	Harris Farm Small Coverall-heritage listed	6545 CREDITVIEW RD MISSISSAUGA	PARK-OTHER
HF3	Harris Farm Greenhouse Shed-heritage listed	6545 CREDITVIEW RD MISSISSAUGA	PARK-OTHER
HF4	Harris Farm Biege Coverall-heritage listed	6545 CREDITVIEW RD MISSISSAUGA	PARK-OTHER
HF5	Harris Farm Green Steel Shed-heritage listed	6545 CREDITVIEW RD MISSISSAUGA	PARK-OTHER
HF6	Harris Farm Green Coverall-heritage listed	6545 CREDITVIEW RD MISSISSAUGA	PARK-OTHER
HF7	Harris Farm Garage & Loft-heritage listed	6545 CREDITVIEW RD MISSISSAUGA	PARK-OTHER
HF8	Harris Farm Smoke/Ice Hut-heritage listed	6545 CREDITVIEW RD MISSISSAUGA	PARK-OTHER
HKP1	Harold E Kennedy Park Shelter	20 ROSEWOOD AVE MISSISSAUGA O	SHELTER
HMR1	Hyde Mill Ruins-Heritage Designation	56 ONTARIO ST E MISSISSAUGA ON I	CULT-OTHER
HP1	Huron Park Community Centre Pool & Arena	830 PAISLEY BLVD W MISSISSAUGA (	REC-MAJOR
HP2	Huron Park Parks Bunker Main	830 PAISLEY BLVD W MISSISSAUGA (	PRK-BNKSTR
HP3	Huron Park Electrical Bunker	830 PAISLEY BLVD W MISSISSAUGA (	PRK-BNKSTR
HP4	Huron Park Credit Valley Tennis Club	830 PAISLEY BLVD W MISSISSAUGA (	REC-MINOR
HP5	Huron Park Picnic Shelter	830 PAISLEY BLVD W MISSISSAUGA (	SHELTER
HP6	Huron Park Prefab Parks Bunker (not FPM)	830 PAISLEY BLVD W MISSISSAUGA (	PRK-BNKSTR
HP7	Huron Park Credit Valley Tennis Club Storage Shed	830 PAISLEY BLVD W MISSISSAUGA (	REC-BNKSTR
HWE1	Harding Waterfront Estate: Bell-Gairdner House- Heritage Des	2700 LAKESHORE RD W MISSISSAUG	REC-MINOR
HWE2	Harding Waterfront Estate: Coach House-Heritage Designation	2682 LAKESHORE RD W MISSISSAUG	REC-MINOR
HWE3	Harding Waterfront Estate: Garage-Heritage Designation	2700 LAKESHORE RD W MISSISSAUG	REC-MINOR
IA1	Iceland Arena	705 MATHESON BLVD E MISSISSAUG	REC-MAJOR
IA2	Iceland Arena & Sports Park Electrical Bunker	705 MATHESON BLVD E MISSISSAUG	PRK-BNKSTR
IA3	Iceland Arena & Sports Park Park Bunker (not FPM)	705 MATHESON BLVD E MISSISSAUG	PRK-BNKSTR
IA4	Iceland Arena & Sports Park Gazebo	705 MATHESON BLVD E MISSISSAUG	SHELTER
JCS1	JC Saddington Park Comfort Station-Heritage Designation	53 LAKE ST MISSISSAUGA ON	COMSTA
JCS2	JC Saddington Park Pump House/ Port Credit Old Pumping Sta	53 LAKE ST MISSISSAUGA ON	PRK-BNKSTR
JCS3	JC Saddington Park/ Port Credit Old Pumping Station Garage-H	53 LAKE ST MISSISSAUGA ON	PRK-BNKSTR

JCS4	JC Saddington Park Water Storage Tank- Not In Use-Heritage L	53 LAKE ST MISSISSAUGA ON	PRK-BNKSTR
JCS5	JC Saddington Park Pavilion-Heritage Designation	53 LAKE ST MISSISSAUGA ON	SHELTER
JDP1	Jack Darling Park Comfort Station East	1180 LAKESHORE RD W MISSISSAUG	COMSTA
JDP2	Jack Darling Park Comfort Station West	1180 LAKESHORE RD W MISSISSAUG	COMSTA
JDP3	Jack Darling Park Parks Bunker (not FPM)	1180 LAKESHORE RD W MISSISSAUG	PRK-BNKSTR
JDP4	Jack Darling Park Picnic Shelter	1180 LAKESHORE RD W MISSISSAUG	SHELTER
JDP5	Jack Darling Park Comfort Station North (leased)	1180 LAKESHORE RD W MISSISSAUG	COMSTA
JJP1	J.J.Plause Park- Snug Harbour Restaurant Building	14 STAVEBANK RD S MISSISSAUGA C	REC-MINOR
JMP1	Jim Murray Park Shelter	5225 TENTH LINE WEST MISSISSAUG	SHELTER
KEN1	Applewood Tennis Club (Kennedy Park)	3505 GOLDEN ORCHARD DR MISSISS	REC-MINOR
KP1	Kariya Park Service Building North (not FPM)	3620 KARIYA DR MISSISSAUGA ON L	PRK-BNKSTR
KP2	Kariya Park Service Building South(not FPM)	3620 KARIYA DR MISSISSAUGA ON L	PRK-BNKSTR
KP3	Kariya Park Pavillion & Bell Cover Shelter-Heritage Listed	3620 KARIYA DR MISSISSAUGA ON L	SHELTER
KP4	Kariya Park Mechanical Electrical Bunker-Heritage Listed	3620 KARIYA DR MISSISSAUGA ON L	PRK-BNKSTR
LAC1	Living Arts Centre-Heritage Listed	4141 LIVING ARTS DR MISSISSAUGA	CIVIC-PREC
LAP1	Lake Aquatain Park Comfort Station West & Parks Bunker-Her	2750 AQUITAINE AVE MISSISSAUGA	COMSTA
LAP2	Lake Aquatain Park-Comfort Station East-Heritage Listed	2750 AQUITAINE AVE MISSISSAUGA	COMSTA
LBM1	Bradley Museum-Heritage Designation	1620 ORR RD MISSISSAUGA ON L5J-4	MUSEUM-HER
LBM2	Bradley Museum-The Anchorage-Heritage Designation	1610 ORR RD MISSISSAUGA ON L5J-4	MUSEUM-HER
LBM3	Bradley Museum-Barn-Heritage Designation	1620 ORR RD MISSISSAUGA ON L5J-4	MUSEUM-HER
LBM4	Bradley Museum-Log Cabin-Heritage Designation	1600 ORR RD MISSISSAUGA ON L5J-4	MUSEUM-HER
LBM5	Bradley Museum-Wood Shed-Heritage Designation	1620 ORR RD MISSISSAUGA ON L5J-4	MUSEUM-HER
LBM6	Bradley Museum-Outhouse - Heritage Designation	1620 ORR RD MISSISSAUGA ON L5J-4	MUSEUM-HER
LBP1	Lewis Bradley Outdoor Pool-Heritage Listed	745 INVERHOUSE DR MISSISSAUGA (	ODPOOL
LBP2	Lewis Bradley Park Barn (Parks Bunker)-Heritage Listed	2019 ORR RD MISSISSAUGA ON	PRK-BNKSTR
LCP1	Lions Club Of Credit Valley Outdoor Pool	20 ROSEWOOD AVE MISSISSAUGA O	ODPOOL
LFP1	Lisgar Fields Park Parks Bunker (not FPM)	3805 DOUG LEAVENS BLVD MISSISSA	PRK-BNKSTR
LFP2	Lisgar Fields Park Shelter (at splash pad)	3805 DOUG LEAVENS BLVD MISSISSA	SHELTER
LFP3	Lisgar Fields Park Comfort Station & Parks Bunker	6735 LISGAR DR MISSISSAUGA ON L5	COMSTA
LGC1	Lakeview Golf Course Club House-Heritage Designation	1190 DIXIE RD MISSISSAUGA ON L5E	REC-MAJOR
LGC2	Lakeview Golf Course Maintenance Building-On Heritage Desi	1190 DIXIE RD MISSISSAUGA ON L5E	REC-MINOR
LGC3	Lakeview Golf Course Greens Keeper House- Heritage Designa	1392 DIXIE RD MISSISSAUGA ON L5E	REC-MINOR
LGC4	Lakeview Golf Course Starters Shed-On Heritage Designated L	1190 DIXIE RD MISSISSAUGA ON L5E	REC-MINOR
LGC5	Lakeview Golf Course Pumphouse-On Heritage Designated Lar	1190 DIXIE RD MISSISSAUGA ON L5E	REC-MINOR
LGC6	Lakeview Golf Course Cart Storage Bldg-On Heritage Designat	1190 DIXIE RD MISSISSAUGA ON L5E	REC-MINOR

LGC7	Lakeview Golf Course Fuel Station Shelter-On Heritage Design	1190 DIXIE RD MISSISSAUGA ON L5E	REC-BNKSTR
LGC8	Lakeview Golf Course Sign Shelter-On Heritage Designated Lar	1190 DIXIE RD MISSISSAUGA ON L5E	REC-MINOR
LL1	Lakeview Library	1110 ATWATER AVE MISSISSAUGA O	LIBRARY
LP1	Lakeview Park Picnic Shelter 1-Heritage Listed	811 LAKEFRONT PROMENADE MISSI	SHELTER
LP2	Lakeview Park Picnic Shelter 2-Heritage Listed	811 LAKEFRONT PROMENADE MISSI	SHELTER
LPC1	Lakeside Park Comfort Station & Parks Bunker	2268 LAKESHORE RD W MISSISSAUG	COMSTA
LPC2	Lakeside Park Irrigation Bunker	2268 LAKESHORE RD W MISSISSAUG	PRK-BNKSTR
LPC3	Lakeside Park Picnic Shelter East	2268 LAKESHORE RD W MISSISSAUG	SHELTER
LPC4	Lakeside Park Picnic Shelter West	2268 LAKESHORE RD W MISSISSAUG	SHELTER
LPH1	Lorne Park Hall	1288 LORNE PARK RD MISSISSAUGA	REC-MINOR
LPL1	Lorne Park Library	1474 TRUSCOTT DR MISSISSAUGA O	LIBRARY
LPP1	Lakefront Promenade Parks Depot	725 LAKEFRONT PROMENADE MISSI	WRKPRK-DEP
LPP2	Lakefront Promenade Splashpad Comfort Station (at Douglas	155 LAKEFRONT PROMENADE MISSI	COMSTA
LPP3	Lakefront Promenade Marina & Comfort Station-Heritage List	135 LAKEFRONT PROMENADE MISSI	PARK-OTHER
LPP4	Lakefront Promenade Comfort Station (at A.E. Crookes Headla	110 LAKEFRONT PROMENADE MISSI	COMSTA
LPP5	Lakefront Promenade Picnic Shelter (at A.E. Crookes Headlan	95 LAKEFRONT PROMENADE MISSIS	SHELTER
LPP6	Lakefront Promenade- Comfort Station (@ RK McMillan Head	830 AVIATION RD MISSISSAUGA ON	COMSTA
MAD1	Malton Depot Main Building	7100 FIR TREE DR MISSISSAUGA ON	WRKPRK-DEP
MAD2	Malton Depot Dome-1 (south)	7100 FIR TREE DR MISSISSAUGA ON	WRK-STORAG
MAD3	Malton Depot Dome-2 (north)	7100 FIR TREE DR MISSISSAUGA ON	WRK-STORAG
MAD4	Malton Depot Operational Hub	7100 FIR TREE DR MISSISSAUGA ON	WRKPRK-DEP
MAD5	Malton Depot Garage	7100 FIR TREE DR MISSISSAUGA ON	WRK-STORAG
MAD6	Malton Depot Storage 1 (North)	7100 FIR TREE DR MISSISSAUGA ON	WRK-STORAG
MAD7	Malton Depot Storage 2 (South)	7100 FIR TREE DR MISSISSAUGA ON	WRK-STORAG
MAH1	Malton Hall(Victory)-Heritage Listed	3091 VICTORY CRES MISSISSAUGA O	REC-MINOR
MAL1	Malton Community Centre Pool & Library	3540 MORNING STAR DR MISSISSAU	REC-MAJOR
MAL2	Malton CC Parks Bunker (not FPM)	3540 MORNING STAR DR MISSISSAU	PRK-BNKSTR
1-Mar	Front Street Pumping Station/Port Credit Light House/BIA/Cor	105 LAKESHORE RD W MISSISSAUGA	COMSTA
2-Mar	Marina Park Comfort Station Old-Heritage Designation	21 FRONT ST S MISSISSAUGA ON	COMSTA
3-Mar	Marina Park Fish Grinding Station/Shelter-Heritage Designatio	21 FRONT ST S MISSISSAUGA ON	SHELTER
MC1	Mount Charles Park Comfort Station (Under Construction)	1265 CARDIFF BLVD MISSISSAUGA O	COMSTA
MCA1	Meadowvale Conservation Area Comfort Station	1081 OLD DERRY RD MISSISSAUGA C	COMSTA
MCA3	Meadowvale Conservation Area Picnic Shelter A	1081 OLD DERRY RD MISSISSAUGA C	SHELTER
MCA4	Meadowvale Conservation Area Picnic Shelter B	1081 OLD DERRY RD MISSISSAUGA C	SHELTER
MCA5	Meadowvale Conservation Area Sign Shelter	1081 OLD DERRY RD MISSISSAUGA C	PRK-BNKSTR

MCC1	Mississauga Canoe Club-Heritage Listed	31 FRONT ST N MISSISSAUGA ON L5	REC-MINOR
MCH1	Mississauga City Hall (Civic Centre)-Heritage Listed	300 CITY CENTRE DR MISSISSAUGA C	CIVIC-PREC
MCH2	Mississauga City Hall Day Care Storage Building-Heritage Liste	300 CITY CENTRE DR MISSISSAUGA C	CIVIC-PREC
MCH3	201 City Centre Drive- City Hall Satellite Offices-Leased	201 CITY CENTRE DR MISSISSAUGA C	CORP
MCL1	Mississauga Central Library-Heritage Listed	301 BURNHAMTHORPE RD W MISSIS	CIVIC-PREC
MCP1	Malton Community Pool (NOT IN USE)	3545 MORNING STAR DR MISSISSAU	REC-MAJOR
MCT1	Meadowvale Theatre	6315 MONTEVIDEO RD MISSISSAUG	THEATRE
MDC1	Malton Day Care Centre	3500 MORNING STAR DR MISSISSAU	REC-MINOR
MDC2	Malton Day Care Storage Building	3500 MORNING STAR DR MISSISSAU	REC-BNKSTR
MDV1	Meadowvale Community Centre Pool & Library	6655 GLEN ERIN DR MISSISSAUGA O	REC-MAJOR
MDV2	Meadowvale CC Exterior Shade Structure	6655 GLEN ERIN DR MISSISSAUGA O	PRK-BNKSTR
ME1	Riverwood-MacEwan Estate House-Heritage Designation	4190 RIVERWOOD PARK LANE MISSI	PARK-OTHER
ME2	Riverwood-MacEwan Estate Barn-Heritage Designation	4150 RIVERWOOD PARK LANE MISSI	PRK-BNKSTR
ME3	Riverwood-MacEwan Estate Parks Maintenance Bunker- On H	4150 RIVERWOOD PARK LANE MISSI	PRK-BNKSTR
MED1	Meadowvale Depot Main Building	6300 MILLCREEK DR MISSISSAUGA O	WRKPRK-DEP
MED2	Meadowvale Depot Dome-1 (East)	6300 MILLCREEK DR MISSISSAUGA O	WRK-STORAG
MED3	Meadowvale Depot Dome-2 (West)	6300 MILLCREEK DR MISSISSAUGA O	WRK-STORAG
MED4	Meadowvale Depot Operational hub	6300 MILLCREEK DR MISSISSAUGA O	WRKPRK-DEP
MED5	Meadowvale Depot Storage Building	6300 MILLCREEK DR MISSISSAUGA O	WRK-STORAG
MEH1	Meadowvale Hall-Heritage Designation	6970 SECOND LINE WEST MISSISSAU	REC-MINOR
MFH1	Mary Fix House-Heritage Designation	25 PINETREE WAY MISSISSAUGA ON	REC-RESID
MFR1	Meadowvale Four Rinks (Arena)	2160 TORQUAY MEWS MISSISSAUGA	REC-MAJOR
MFR2	Meadowvale Four Rinks Hydro Vault	2160 TORQUAY MEWS MISSISSAUGA	REC-BNKSTR
MN1	Mavis North Main Building	3235 MAVIS RD MISSISSAUGA ON L5	WRKPRK-DEP
MN2	Mavis North Storage Building(NOT FPM MAINTAINED)	3235 MAVIS RD MISSISSAUGA ON L5	WRK-STORAG
MN3	Mavis North Greenhouse Shed(NOT FPM MAINTAINED)	3235 MAVIS RD MISSISSAUGA ON L5	WRK-STORAG
MN4	Mavis North Warehouse	3235 MAVIS RD MISSISSAUGA ON L5	WRK-STORAG
MP1	Meadowwood Park Tennis Club Storage Building	484 APPLE LANE MISSISSAUGA ON L	REC-MINOR
MS1	Mavis South Main Building	3185 MAVIS RD MISSISSAUGA ON L5	WRKPRK-DEP
MS10	Mavis South Carpentry Shop (Lightbody) Storage Building	3185 MAVIS RD MISSISSAUGA ON L5	WRK-STORAG
MS2	Mavis South Small Engine Repair	3185 MAVIS RD MISSISSAUGA ON L5	WRKPRK-DEP
MS3	Mavis South Dome-1 (North)	3185 MAVIS RD MISSISSAUGA ON L5	WRK-STORAG
MS4	Mavis South Carpentry Shop (Lightbody)	3185 MAVIS RD MISSISSAUGA ON L5	WRKPRK-DEP
MS5	Mavis South Operational Hub	3185 MAVIS RD MISSISSAUGA ON L5	WRKPRK-DEP
MS6	Mavis South Dome-2 (South)	3185 MAVIS RD MISSISSAUGA ON L5	WRK-STORAG

MS7	Mavis South Storage Building	3185 MAVIS RD MISSISSAUGA ON L5	WRK-STORAG
MS8	Mavis South Recycling Building	3185 MAVIS RD MISSISSAUGA ON L5	WRK-STORAG
MS9	Mavis South Modular Office	3185 MAVIS RD MISSISSAUGA ON L5	WRKPRK-DEP
MSC1	Mississauga Sailing Club-Heritage Listed	120 LAKEFRONT PROMENADE MISSI	REC-MINOR
MSC2	Mississauga Sailing Club Garage-Heritage Listed	120 LAKEFRONT PROMENADE MISSI	REC-BNKSTR
MSP1	Meadowvale Sports Park Comfort Station	2255 MEADOWVALE BLVD MISSISSA	COMSTA
MSP2	Meadowvale Sports Park Parks Bunker (not FPM)	2255 MEADOWVALE BLVD MISSISSA	PRK-BNKSTR
MST1	Malton Satellite Terminal	6780 PROFESSIONAL CRT MISSISSAU	TRANSIT
MST2	Malton Satellite Terminal-Canopy	6780 PROFESSIONAL CRT MISSISSAU	TRANSIT
MTC1	Meadowvale Town Centre Transit Washroom (leased)	6677 MEADOWVALE TOWN CENTRE	TRANSIT
MV1	Mississauga Valley Community Centre Library Pool & Arena	1275 MISSISSAUGA VALLEY BLVD MI	REC-MAJOR
MV2	Mississauga Valley Gymnasium	1395 MISSISSAUGA VALLEY BLVD MI	REC-MAJOR
MV3	Mississauga Valley Park Parks Bunker Old	1385 MISSISSAUGA VALLEY BLVD MI	PRK-BNKSTR
MV4	Mississauga Valley Park Parks Bunker New	1385 MISSISSAUGA VALLEY BLVD MI	PRK-BNKSTR
MV5	Mississauga Valley Park Comfort Station	1385 MISSISSAUGA VALLEY BLVD MI	COMSTA
MV6	Mississauga Valley Park Picnic Shelter A	1385 MISSISSAUGA VALLEY BLVD MI	SHELTER
MV7	Mississauga Valley Park Picnic Shelter B	1275 MISSISSAUGA VALLEY BLVD MI	SHELTER
MVP1	Malton Village Park Gazebo	39 BEVERLEY ST MISSISSAUGA ON L4	SHELTER
MWP1	Max Ward Park Parks Bunker- not FPM	2380 MATHESON BLVD E MISSISSAU	PRK-BNKSTR
NIN1	Bussell House - Heritage Designation	7420 NINTH LINE MISSISSAUGA ON L	CULT-OTHER
NIN2	Trafalgar House - Heritage Listed- 7238 Ninth Line (Burned-To	7238 NINTH LINE MISSISSAUGA ON L	PARK-OTHER
NLP1	Ninth Line Sports Park Parks Bunker-not FPM	3115 NINTH LINE MISSISSAUGA ON	PRK-BNKSTR
OCJ1	Ontario Court of Justice (950 Burnhamthorpe)	950 BURNHAMTHORPE RD W MISSIS	CORP
OFS1	Old Fire Hall Streetsville-Heritage Listed	180 BROADWAY ST MISSISSAUGA ON	CULT-OTHER
OP1	O'Connor Park Gazebo	3570 BALA DR MISSISSAUGA ON L5M	SHELTER
PCA1	Port Credit Arena-Heritage Designation	40 STAVEBANK RD MISSISSAUGA ON	REC-MAJOR
PCL1	Port Credit Library-Heritage Listed	20 LAKESHORE RD E MISSISSAUGA O	LIBRARY
PCM1	Port Credit Memorial Park Electrical Bunker-On Heritage Desig	32 STAVEBANK RD MISSISSAUGA ON	PRK-BNKSTR
PCM2	Port Credit Memorial Park Parks Bunker (not FPM)	32 STAVEBANK RD MISSISSAUGA ON	PRK-BNKSTR
PCM3	Port Credit Memorial Park Gazebo-Heritage Listed	32 STAVEBANK RD MISSISSAUGA ON	SHELTER
PCP1	Paul Coffey Arena-Heritage Listed	3430 DERRY RD E MISSISSAUGA ON	REC-MAJOR
PCP2	Paul Coffey Park Comfort Station Concession-Heritage Listed	3430 DERRY RD E MISSISSAUGA ON	COMSTA
PCP3	Paul Coffey Park Malton Tennis Club-Heritage Listed	3430 DERRY RD E MISSISSAUGA ON	REC-MINOR
PCP4	Paul Coffey Park Parks Bunker North (not FPM)	3430 DERRY RD E MISSISSAUGA ON	PRK-BNKSTR
PCP5	Paul Coffey Park Parks Bunker South (not FPM)	3430 DERRY RD E MISSISSAUGA ON	PRK-BNKSTR

PCP6	Paul Coffey Park Picnic Shelter North A-Heritage Listed	3430 DERRY RD E MISSISSAUGA ON	SHELTER
PCP7	Paul Coffey Park Picnic Shelter North B-Heritage Listed	3430 DERRY RD E MISSISSAUGA ON	SHELTER
PCP8	Paul Coffey Park Picnic Shelter South-Heritage Listed	3430 DERRY RD E MISSISSAUGA ON	SHELTER
PFF1	Paramount Fine Foods Centre - Main Bowl Arena	5500 ROSE CHERRY PL MISSISSAUGA	REC-MAJOR
PFF2	Paramount Fine Foods Centre - Community Rinks (Arena)	5500 ROSE CHERRY PL MISSISSAUGA	REC-MAJOR
PFF3	Paramount Fine Foods Centre - Fieldhouse	5600 ROSE CHERRY PL MISSISSAUGA	REC-MAJOR
PFF4	Paramount Fine Foods Centre - Outdoor Fields & Change Hou	5725 ROSE CHERRY PL MISSISSAUGA	COMSTA
PP1	Pinchin Property Leslie Log House-Heritage Designation	4415 MISSISSAUGA RD MISSISSAUGA	CULT-OTHER
PP5	Pinchin Property Steel Storage Shed (B1) On Heritage Designa	4415 MISSISSAUGA RD MISSISSAUGA	PARK-OTHER
QM2	Quenippenon Meadows Comfort Station & Parks Bunker	2625 ERIN CENTRE BLVD MISSISSAU	COMSTA
RBP1	Red Brush Park Parks Bunker (not FPM)	5139 RED BRUSH DR MISSISSAUGA O	PRK-BNKSTR
RCC1	River Grove Community Centre & Pool	5800 RIVER GROVE AVE MISSISSAUG	REC-MAJOR
RCC2	River Grove CC Parks Bunker (not FPM)	5800 RIVER GROVE AVE MISSISSAUG	PRK-BNKSTR
RGP1	Brueckner Rhododendron Gardens Comfort Station & Parks B	660 LAKESHORE RD W MISSISSAUGA	COMSTA
RLS1	Russell Langmaid School (Streetsville Cadets/Kendellhurst Aca	170 CHURCH ST MISSISSAUGA ON L5	REC-MINOR
RMP1	Richards Memorial Park Comfort Station	804 LAKESHORE RD W MISSISSAUGA	COMSTA
RMP2	Richards Memorial Park Picnic Shelter	804 LAKESHORE RD W MISSISSAUGA	SHELTER
RP1	Riverwood-Art Studio (Visual Arts Mississauga)-On Heritage D	4170 RIVERWOOD PARK LANE MISSI	CULT-OTHER
SAL1	Small Arms Ltd Inspection Building - Heritage Designation	1352 LAKESHORE RD E MISSISSAUGA	CULT-OTHER
SBT1	City Centre Transit Terminal/ Square One Bus Terminal	200 RATHBURN RD W MISSISSAUGA	CORP
SC1	Semenyk Court T&W Admin	3484 SEMENYK CRT MISSISSAUGA O	TRANSIT
SCC1	South Common Community Centre Pool & Library	2233 SOUTH MILLWAY MISSISSAUGA	REC-MAJOR
SCC2	South Common Park Parks Bunker (not FPM)	2233 SOUTH MILLWAY MISSISSAUGA	PRK-BNKSTR
SCC3	South Common Park Tennis Shelter (Erin Mills Tennis Club)	2233 SOUTH MILLWAY MISSISSAUGA	SHELTER
SCD1	Streetsville Cadet Centre (vacant)-On Heritage Designated Lar	56 ONTARIO ST E MISSISSAUGA ON L	PARK-OTHER
SCD2	Streetsville Cadet Centre Garage Building-On Heritage Designa	56 ONTARIO ST E MISSISSAUGA ON L	PRK-BNKSTR
SCD3	Streetsville Cadet Centre- Silo Building on Hill-On Heritage De	56 ONTARIO ST E MISSISSAUGA ON L	PARK-OTHER
SGP1	Sherwood Green Park Gazebo	1864 DEER'S WOLD MISSISSAUGA O	SHELTER
SKH1	Streetsville Kinsmen Hall/ Old Grammar School-Heritage Desig	327 QUEEN ST S MISSISSAUGA ON L5	REC-MINOR
SL1	Streetsville Library-Heritage Listed	112 QUEEN ST S MISSISSAUGA ON L5	LIBRARY
SLP1	St. Lawrence Park Gazebo	75 ST. LAWRENCE DR MISSISSAUGA	SHELTER
SLP2	St. Lawrence Park Mechanical/Electrical Bunker	75 ST. LAWRENCE DR MISSISSAUGA	PRK-BNKSTR
SML1	Sheridan Mall Library	2225 ERIN MILLS PKY MISSISSAUGA (	LIBRARY
SMP1	Streetsville Memorial Park Comfort Station & Concession-Heri	335 CHURCH ST MISSISSAUGA ON L5	REC-MINOR
SMP2	Streetsville Memorial Park Electrical Bunker-Heritage Listed	335 CHURCH ST MISSISSAUGA ON L5	PRK-BNKSTR

SMP3	Streetsville Memorial Park Old Water Treatment Building-Her	335 CHURCH ST MISSISSAUGA ON L5	PRK-BNKSTR
SOP1	Streetsville Outdoor Pool-Heritage Listed	335 CHURCH ST MISSISSAUGA ON L5	ODPOOL
SP1	Ron Lenyk Springfield Park Erindale Baseball Club House	3325 THE CREDIT WOODLANDS MIS	REC-MINOR
SP2	Ron Lenyk Springfield Park Tennis Club	3325 THE CREDIT WOODLANDS MIS	REC-MINOR
SP3	Ron Lenyk Springfield Park-Erindale Outdoor Pool	1244 SHAMIR CRES MISSISSAUGA O	ODPOOL
SPC1	Streetsville Public Cemetary Parks Bunker (not FPM)	1786 BRISTOL RD W MISSISSAUGA O	PRK-BNKSTR
SVH1	Streetsville Village Hall (B.I.A.) -Heritage Designation	280 QUEEN ST S MISSISSAUGA ON L5	REC-MINOR
TCP1	Tom Chater Memorial Park Club House	3195 THE COLLEGEWAY MISSISSAUG	REC-MINOR
TCP2	Tom Chater Memorial Park Parks Bunker (not FPM)	3195 THE COLLEGEWAY MISSISSAUG	PRK-BNKSTR
TCT1	Transit Central-Edward J. Dowling Transit Facility (Bldg ABCD)	975 CENTRAL PKY W MISSISSAUGA O	TRANSIT
TCT2	Transit Central-Body Shop (Bldg F)	3585 ERINDALE STATION RD MISSIS	TRANSIT
TCT3	Transit Central-New Bus Storage Building (Bldg E)	3567 ERINDALE STATION RD MISSIS	TRANSIT
TCT4	Transit Central-Bldg ABCD Generator Bldg	975 CENTRAL PKY W MISSISSAUGA O	TRANSIT
TCT5	Transit Central-Bldg E Generator Bldg	3567 ERINDALE STATION RD MISSIS	TRANSIT
TCT6	Transit Central-Bldg E Electrical Bldg	3567 ERINDALE STATION RD MISSIS	TRANSIT
TG1	The Grange/ Robinson-Adamson House-Heritage Designation	1921 DUNDAS ST W MISSISSAUGA O	CULT-OTHER
TMP1	Tobias Mason Park Shelter (at splash pad)	3274 CACTUS GATE MISSISSAUGA O	SHELTER
TTA1	Tomken Twin Arena	4495 TOMKEN RD MISSISSAUGA ON	REC-MAJOR
TTA2	Tomken Twin Arena Parks Bunker (not FPM)	4495 TOMKEN RD MISSISSAUGA ON	PRK-BNKSTR
UP1	Union Park Shelter	6627 TENTH LINE WEST MISSISSAUG	SHELTER
VJA1	Vic Johnston Community Centre & Streetsville Arena-Heritage	335 CHURCH ST MISSISSAUGA ON L5	REC-MAJOR
WHP1	Woodhurst Heights Park Rink/Tennis and Change House	3475 ASH ROW CRES MISSISSAUGA O	REC-MINOR
WL1	Woodlands Library	3255 ERINDALE STATION RD MISSIS	LIBRARY
WMT1	Westwood Mall Transit Building (Bus Terminal, Control Rm, Lo	3480 MORNING STAR DR MISSISSAU	TRANSIT
WOP1	Whiteoaks Park Tennis Club House	1608 BIRCHWOOD DR MISSISSAUGA	REC-MINOR
WPP1	Don McLean Westacres Outdoor Pool	2166 WESTFIELD DR MISSISSAUGA O	ODPOOL
WPT1	Woodeden Park Tennis Shelter(Tecumseh Tennis Club)	1538 WOODEDEN DR MISSISSAUGA	SHELTER

Appendix A4
CITY OF MISSISSAUGA
BAS SYSTEM ARCHITECTURES & COMMUNICATION PROTOCOLS

System Architectures

The new CoM BAS system architecture will be based on BacNet over IP controller technology using the project specified Network Cable (ie CAT 5/CAT6/CAT6E – Minimum CAT 5). The installing BAS contractor shall supply and install all necessary components of the BAS system including the Supervisory Controller(s) (SRPDC – JACE800) and any necessary switches/routers. The new facility BAS shall communicate to the Niagara N4 Supervisor using Fox Communication Protocol and shall communicate to all downstream field controllers using BacNet over IP. The CoM will provide a singular CoM IT network drop, all controller addressing shall be by the installing BAS contractor.

In some instances (where directed by CoM) connection to existing (non-obsolete) Legacy BAS systems already operating on either BacNet or LON network may be required. In those instances it may be applicable to retain existing 3-wire BacNet MS/TP or LON Networks. Approval from CoM is require in advance.

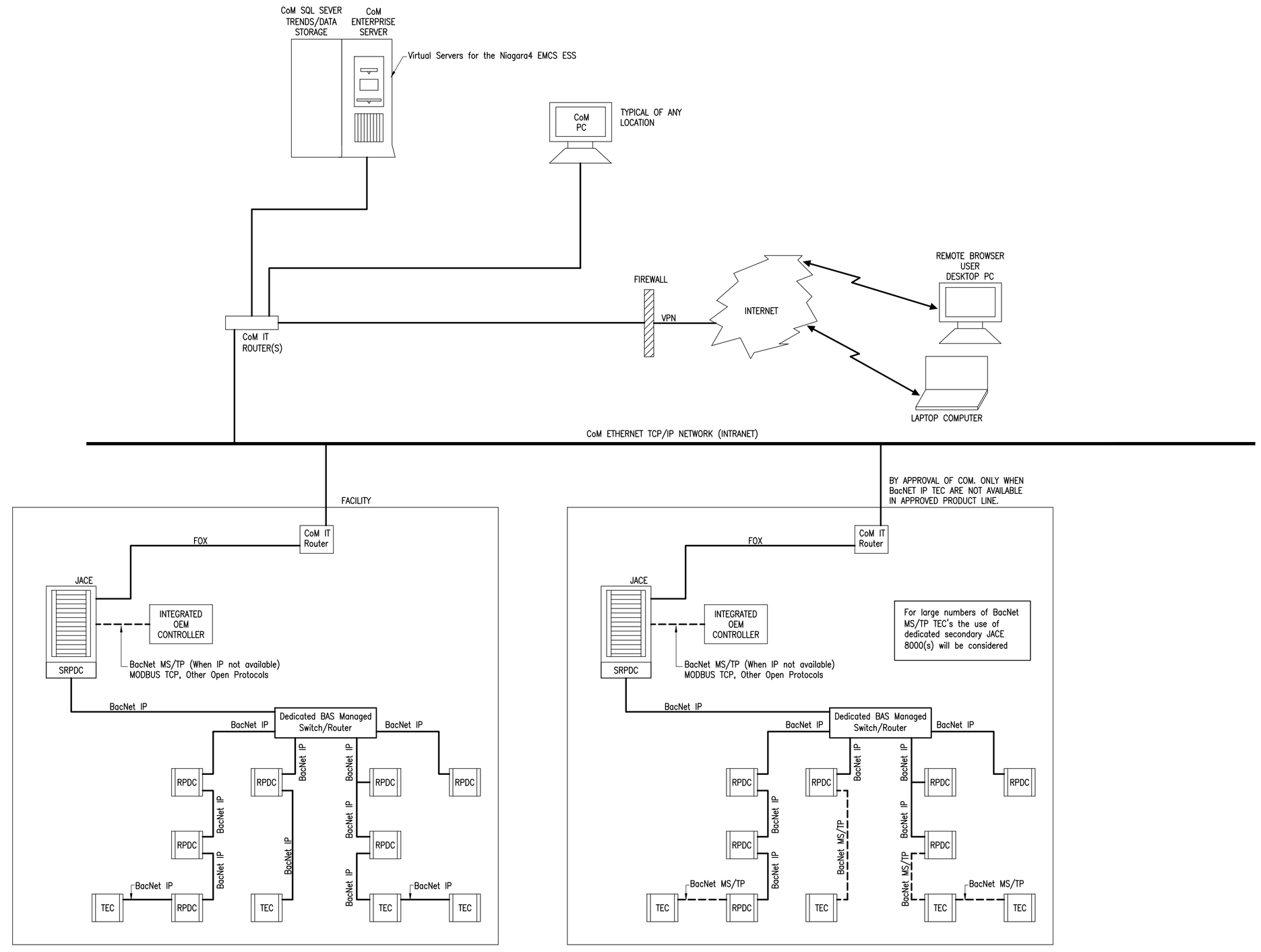
Connection to other OEMASC shall be via dedicated sub-networks using available open communication protocol of that systems (BacNet/IP, BacNET MSTP, LON, etc)

Description of system architecture is as follows:

- CoM IT Network to SRDPC (JACE 8000 Series Controller): 1-IP Drop using Specified Network Cable (ie CAT 5/CAT6/CAT6E)
- IT Network to dedicated managed switch/router: 1 IP Drop per managed switch using Specified Network Cable
- Dedicated BAS Managed Switch/Router to connect up-to four (4) BacNet-IP Subnetworks (per managed switch). Sub-networks can each handle up-to 20 IP Based field controllers (RPDC), daisy chained together in series using Specified Network Cable (ie CAT 5/CAT6/CAT6E)
- From RPDC to any Non-IP based Terminal Equipment controllers (TEC), install a new 3-wire MS/TP network from an RPDC connect multiple TEC in that same area of facility. (This only applies where BacNet IP terminal controllers are not available in the pre-approved Family of controllers – ie VAV Box controllers). **Contractors must identify this in their Bid Submission.**

- SRPDC (JACE) to be configured to manage the Sub-Network controller(s) using FOX Communication protocol. This limits the Niagara device count (for licensing) to one (1) per building.
- From the Sub-Network Controller(s) to RPDC the communication protocol shall be BacNet/IP.
- From RPDC to terminal equipment controllers (TEC) communication shall be BacNet IP or in certain instances BacNet MS/TP (see above).
- Connection to other OEMASC shall be a dedicated sub-network or via IP connection from OEMASC to CoM IT using available open communication protocol of that systems (BacNet/IP, BacNET MS/TP, LON, etc)

Refer to Drawing SK-2 Attached



GENERAL NOTES

- INTEGRATED OEM CONTROLLERS REPRESENT A MULTITUDE OF DIFFERENT CONTROLLER APPLICATION INCLUDING DEDICATED APPLICATION SPECIFIC CONTROL SYSTEMS SUCH AS LIGHTING, REFRIGERATION PLANT CONTROL, METERING, AND/OR DIRECT CONNECTION OF OEMASC SUCH AS ROOFTOP UNITS, CHILLERS, BOILERS, ETC
- SRPDC – SUPERVISORY REMOTE PROGRAMMABLE DIGITAL CONTROLLER
- RPDC – REMOTE PROGRAMMABLE DIGITAL CONTROLLER
- TEC – TERMINAL EQUIPMENT CONTROLLERS
- DAISY CHAIN SUBNETWORK CAN REACH A MAXIMUM OF 2000FT.
- CAT 5 MAX CABLE LENGTH OF 100m. DEVICE COUNT PURCHASED BY VENDOR ON EACH PROJECT.
- COMMUNICATION FROM N4 WORKSTATION TO SRPDC SHALL BE FOX COMMUNICATION PROTOCOL DOWNSTREAM SUB-NETWORK SHALL BE SET-UP BY CONTRACTOR AND SHALL BE BACNET IP

LEGEND

SPECIFIED IT NETWORK CABLING CAT 5, 6, 6E

MS/TP NETWORK CABLING 3-WIRE BELDON CABLE

FILE NAME: MISSISSAUGA-BAS_SK2_APRIL15 2021.DWG
DATE SAVED: 15-Apr-2021 10:05 AM
DATE PLOTTED: 15-Apr-2021 10:50 AM

Contractor must verify all dimensions on the job and report any discrepancy to consultant before proceeding with the work.

All drawings and specifications are instruments of service and the property of the consultant and must be returned at the completion of the work.

Key to detail location

Detail number
Where drawn

This drawing is not to be used for construction until countersigned.

Signed Date

Prints issued to

Particulars	No.	Date	By
ISSUED FOR REVIEW	4	APR 15/21	G.M.
ISSUED FOR REVIEW	3	APR 06/21	G.M.
ISSUED FOR REVIEW	2	AUG 18/20	G.M.
ISSUED FOR REVIEW	1	JUN 02/20	G.M.

Revisions to drawing

All previous issues of this drawing are superseded.

Client

AMERESCO
Green • Clean • Sustainable
30 Leek Crescent, Suite 301
Richmond Hill, ON, L4B 4N4, tel: 647-788-6030

North Sign

Stamp

Project title

CITY OF MISSISSAUGA

BAS STANDARDIZATION STUDY

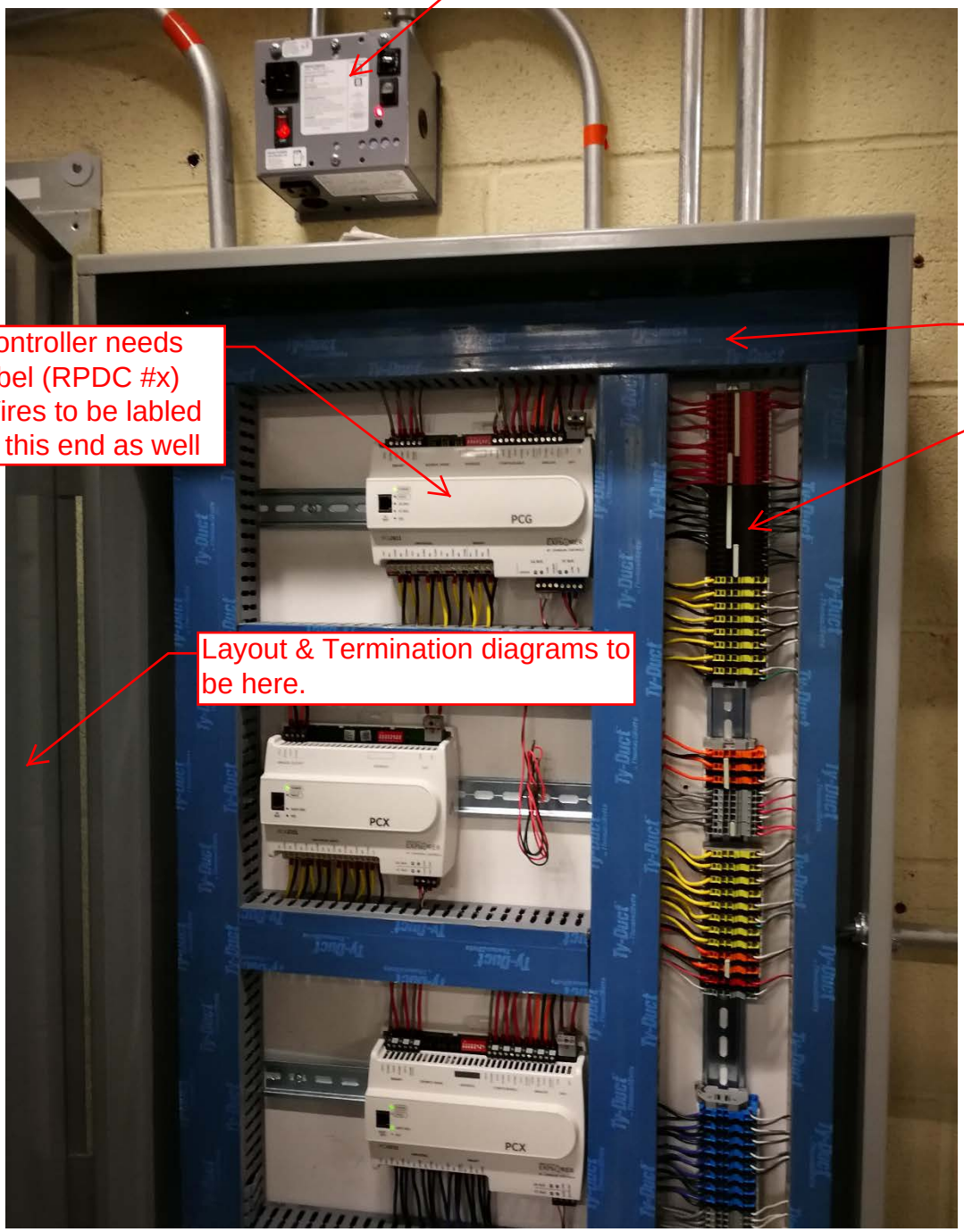
Project number	Checked by	Scale
#840754	G.M.	AS NOTED
	Drawn by: B.G.	Date: JUNE 2020

Sheet title: FACILITY BAS PROPOSED SYSTEM ARCHITECTURE

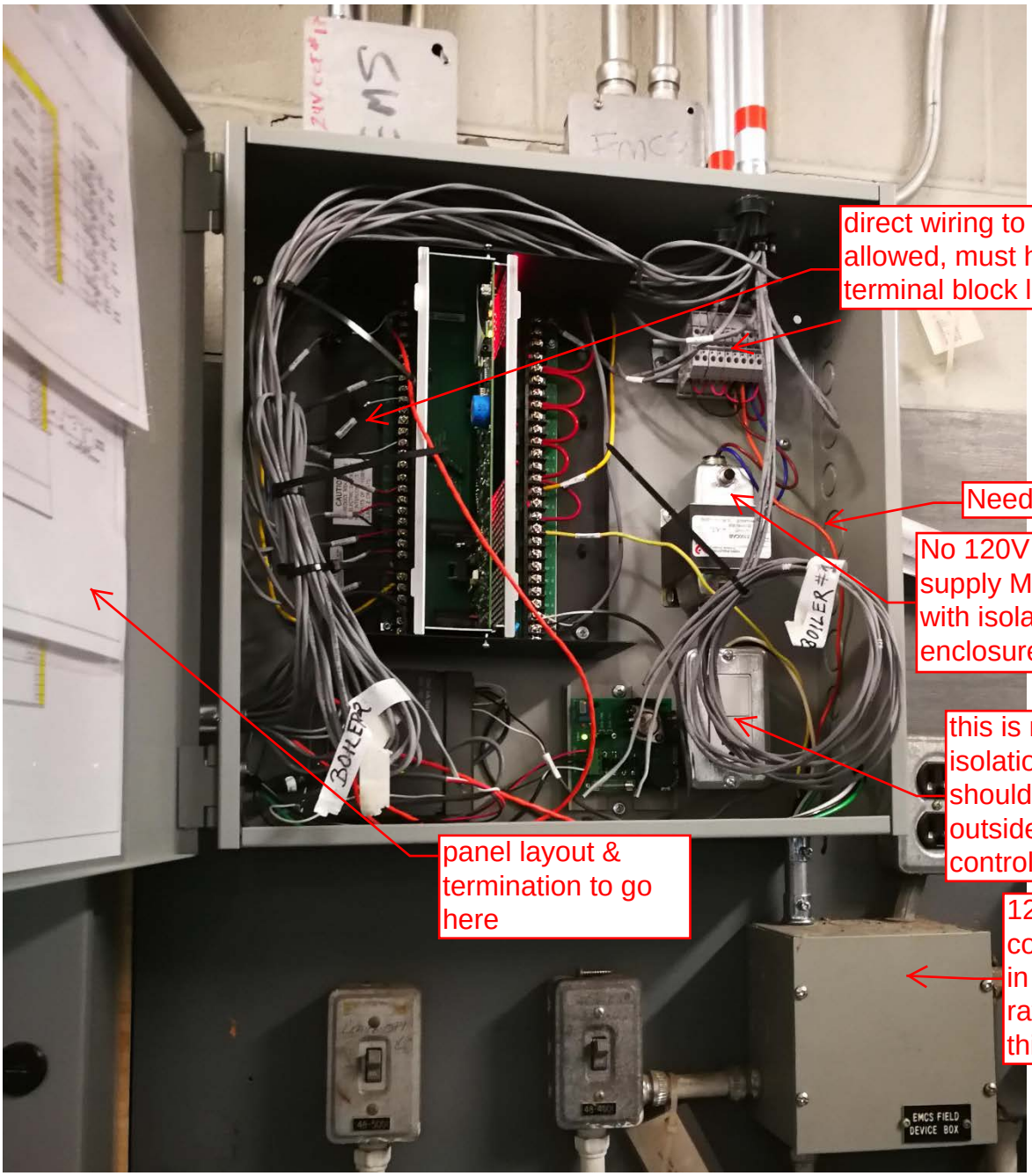
Drawing no.: SK2
2 of 2

EMCS Cabinet Expectations

Acceptable:



Not Acceptable:



Appendix A4
CITY OF MISSISSAUGA
BAS SYSTEM ARCHITECTURES & COMMUNICATION PROTOCOLS

System Architectures

The new CoM BAS system architecture will be based on BacNet over IP controller technology using the project specified Network Cable (ie CAT 5/CAT6/CAT6E – Minimum CAT 5). The installing BAS contractor shall supply and install all necessary components of the BAS system including the Supervisory Controller(s) (SRPDC – JACE800) and any necessary switches/routers. The new facility BAS shall communicate to the Niagara N4 Supervisor using Fox Communication Protocol and shall communicate to all downstream field controllers using BacNet over IP. The CoM will provide a singular CoM IT network drop, all controller addressing shall be by the installing BAS contractor.

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Connection to other OEMASC shall be via dedicated sub-networks using available open communication protocol of that systems (BacNet/IP, BacNET MSTP, LON, etc)

Description of system architecture is as follows:

- CoM IT Network to SRDPC (JACE 8000 Series Controller): 1-IP Drop using Specified Network Cable (ie CAT 5/CAT6/CAT6E)
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- From RPDC to any Non-IP based Terminal Equipment controllers (TEC), install a new 3-wire MS/TP network from an RPDC connect multiple TEC in that same area of facility. (This only applies where BacNet IP terminal controllers are not available in the pre-approved Family of controllers – ie VAV Box controllers). **Contractors must identify this in their Bid Submission.**

- SRPDC (JACE) to be configured to manage the Sub-Network controller(s) using FOX Communication protocol. This limits the Niagara device count (for licensing) to one (1) per building.
- From the Sub-Network Controller(s) to RPDC the communication protocol shall be BacNet/IP.
- From RPDC to terminal equipment controllers (TEC) communication shall be BacNet IP or in certain instances BacNet MS/TP (see above).
- Connection to other OEMASC shall be a dedicated sub-network or via IP connection from OEMASC to CoM IT using available open communication protocol of that systems (BacNet/IP, BacNET MS/TP, LON, etc)

Refer to Drawing SK-2 Attached

Insert SK-2

Appendix A5
City of Mississauga Graphical Standard

- Dynamic objects shall include analog and binary values, dynamic text, static text, and animation files. Graphics shall show animation by shifting imaged based on the status of the object. The Graphical representation of dynamic equipment shall also be color coded based on equipment Status as follows:

    - Commanded ON and Status ON – Equipment shall be GREEN
    - Commanded ON and Status OFF – Equipment shall be FLASHING RED
    - Commanded OFF and Status OFF – No Color
    - Commanded OFF and Status ON – Equipment shall be FLASHING RED

- System graphics shall permit operators with authorized access level to command outputs and change operator settings directly from interactive command and value fields. Any object contained within the system graphics can be selected and opened to access the full set of object properties.

- System graphics can be custom created and modified while on-line with a built-in system graphics editor.

- All graphics shall be fully scalable

- The graphical user interface (GUI)shall employ browser-like functionality for ease of navigation. It shall include outside of the graphical viewing a navigation tree for quick viewing of the controllers associated with the building that is being accessed and access to, hierarchical structure of the database.

- Schedule times will be adjusted using graphical slider, without requiring any keyboard entry from the operator. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-menu. No entry of text shall be required. Adjustments to analog objects, such as set points, shall be done by right-clicking the selected object and using a graphical slider to adjust the value. No entry of text shall be required.

- Development of the initial NIAGARA 4 CoM graphical template workstation shall occur during a pilot project with the successful vendor, City of Mississauga (CoM), and Consultant. The CoM and consultant shall meet with successful bidder to review examples of other projects and to discuss the new Niagara 4 CoM graphical standardization. The EMCS vendor will then create an initial pass at the graphics for the

pilot site for review. CoM and consultant to mark-up and send back with required changes. The approval of final version will be a reiterative process and the EMCS Vendor shall anticipate this to take multiple submissions before finalization. Some additional changes may also be required during the commissioning and will be carried out as part of the project.

- Access to the Template workstation will be provided to all vendors after in the initial pilot project and will be the basis of development for Customized Site Specific Graphics for all other CoM sites and EMCS projects.

- Using **Active Directory** each CoM user Access Login Name and Password will be assigned to a Group which will be used by the EMCS to determine the level of Authority when Accessing the System (refer to Master Specifications). Upon initial Log in to the EMCS Software, All Buildings/EMCS Installations connected to the CoM Intranet shall be presented in a Table Format or on a Mapping system (TBD - developed during the Pilot project) for selection by the User to Navigate to the desired system Installation. As systems are added to the CoM portfolio, the EMCS Vendor working on the specific project will be responsible for adding their site to the system.

- Once a site has been selected, the User Shall then be allowed to Navigate the Building EMCS Starting at the MAIN LANDING PAGE. A General description of Site Navigation as follows:

    - **Graphic Title**: Provide a prominent, descriptive title on each graphic page.

    - **Main Landing Page:** Once access has been granted to the operator and user level has been determined, the graphics shall display a picture of the building exterior (or possibly the 1st floor plan – TBD during pilot). Each page including the Main landing page shall have the same background file and color scheme with the City of Mississauga Corporate "LOGO" shown at all times on the Top Left.

    - **Common Elements:**

        - On the top right part of the Graphic Display shall be indication of the Critical Building Information including: **OAT Temp, heating system supply water Temp, cooling system supply water Temp. NOTE: Critical Information will be dependent on the Actual Building HVAC systems – i.e. Condenser/Ground Loop Temps, etc.**

        - Along the left side of the graphics shall be the System Menu Navigation Bars listing all floor plans and HVAC systems pages associated with the Building and colour-coded.

Note: All of the above elements shall be common to every graphical page. **Refer to Samples shown in these appendices**.

- **Building Floor Plans**: A floor plan graphic for each of the building`s floors (and roof) with dynamic display shall be provided and will be accessible through the Navigation Bar Menu along the bottom of all graphics. When possible, use the project`s electronic drawing files (CAD files) for the graphic backgrounds. Clear names for important areas, such as " Main Conference Room" including room names and room numbers shall be provided. Include building features such as Elevators, Main Entrances, Stairs, etc. Include the location of mechanical rooms, major equipment, and control component locations, with corresponding links to the equipment graphics directly and in addition to the Navigation BAR menu along the left side of all graphics.

    - The floor plans graphic (Minimum 1 per floor) shall show dynamic display of space temperatures, DDC controllers' locations and identify which system or how many systems are serving this floor. Each system shall continue with the associated system color scheme and there shall be a graphical interface button provided for each system i.e. (HVAC units, Rooftop units, unit ventilators, etc.).

    - When the interface button for the corresponding system is activated, the graphic shall provide a navigational link to open up a new graphical window with the system details displayed. This link shall be in addition to the Navigation Bar Menu for Systems along the left hand side of all graphics.

    - Where thermostats are shown on the floor plan graphic, the operator shall be able to link to associated systems such as a fan coil unit, VAV terminal, radiation, unit ventilators or air handling units, etc. and display the System Graphic. This link shall also be in addition to the Navigation Bar Menu for Systems along the left hand side of all graphics.

- **Sub-floor plan Areas:** Where a building`s floor plan is too large to adequately display on the screen, sub-divide the plan into distinct areas, and provide a separate graphic display for each area. The same level of detail requested in the building floor plan section above shall be provided.

- **System Graphics:** Provide a graphic page for each system controlled, accessible through the System Navigation Bar Menu along the bottom of all graphics and other links as described previously.

    - The system graphic shall be a dynamic representation of the actual system being controlled and shall display all control variables and command points including but not limited to Fan/Pump start/stop/status, Damper and Actuator Command, damper positions, stages of cooling and heating, etc. (Refer to sample graphics shown in these appendices)

    - Along the left side of the system graphic display the associated reset schedules (i.e. heating or cooling) with all set-points and parameters including the Calculated Set-Point shall be displayed, so the operator is able to edit set-points and parameters directly from the screen.

    - On the right side of the system display shall be a table with links to the system's associated time schedule (i.e. MBOS) and individual schedules such as Event Schedules (ES) and Timed Override Schedules (TOS). These Links will allow various users to view the schedules and users with sufficient access to edit and modify schedules and events as required.

    - System graphics shall be dynamic and color coded as described at the beginning of this Standard to show the operational status of the equipment.

    - Through the system display, the operator shall be able to interface with the system and provide commands to control the operation of the system and related devices including temporary and permanent over-rides (depending on user authority level).

    - On the bottom of every system display there shall be navigational buttons to link and display the written sequence of operations and the as-built wiring diagrams.

- **Settings Page:**

    - Each system page will have a link to associated Settings page.

    - The Settings page will only be accessible to specified user access levels and will access to view and modify schedules, adjustment of reset schedule parameters (ie – Outdoor Air Reset Schedules, etc), adjustment of temperature differential, time delays, and other control parameters as well as adjustment of all Alarm parameters.

- **Terminal Equipment Controller Quick Reference Summary Charts**

    - Where thermostats or equipment are shown on the floor plan graphic, the operator shall be able to link from this point to the associated systems such as Heat Pumps, VAV terminal, fan coils radiation elements, unit ventilators, exhaust fans or air handling units, etc. and display the individual Terminal Equipment system graphic. There shall also be a link provided through the Navigation Bar Menu along the left hand side of all graphics for Terminal Equipment Controller Quick Reference Summary graphics.

    - In addition to the individual equipment system displays there will be quick reference tables of summarizing all terminal equipment serving the floor or floor area i.e. (all VAV terminals, Heat Pumps, radiation elements, fan coils, etc.). These tables shall offer a quick view of the state of all units, on each particular floor area providing information on the status of units operation, temperatures, set-points, and commands modes, i.e. occupied/unoccupied, overrides and dampers, valves control statuses.

    - The operator with proper access level shall be able to utilize these tables to control and command set-point changes and trouble shoot the systems.

- **Dynamic update**: When the workstation is on line, all graphic I/O object values shall update with change- of- value services, or by operator selected discrete intervals.

- **Graphic Linking**: Provide forward and backward linking between floor plans, sub plans, and equipment.

- **Graphic Editing**: Provide all necessary software to create, modify, and delete the DDC graphics. Include the ability to store graphic symbols in a symbol directory stored on the Owner's server and the ability to import these symbols into the graphics. The system graphics editor also shall include a complete library of standard HVAC equipment graphics such as Chillers, Boilers, Air Handlers, Terminals, Fan coils, and Unit Ventilators. The library also shall include standard symbols for other equipment including Fans, Pumps, Coils, Valves, Piping, Dampers, and Ductwork.

Graphical Samples

Sample Graphics to be used as a guideline only for the various vendor Site specific Graphical Applications. As each vendor creates a new installation, screen shots of actual and approved graphics shall be inserted to update and/or replace the samples in the Master Specifications and form the new Template for future projects.

Initial graphical sample will be generated during the pilot project

Appendix A6
City of Mississauga - Typical Points List & Standard Sequences of Operation

Overview

This document forms a part of the City of Mississauga BAS Installation Standard. The document is intended to be a Design Guideline for the specifying Engineer/Consultant working on City of Mississauga (control system upgrade) projects and shall be used as the basis of all BAS design work for the City of Mississauga (CoM).

Engineers/Consultants working for the CoM shall use these points list and sequences as the starting point to design, modifying them to the extent necessary to meet the needs of a particular project. The final specifications issued by any Engineer/Consultant and used in the design and specification of building automation controls shall not deviate from the basic concepts and requirements set forth in this document.

Engineers/Consultants working for the CoM are expected to produce their own project specifications incorporating the elements and design principals of this Design Guideline and the CoM Master Specifications and shall make clear reference to these **City of Mississauga Master Specifications for EMCS Installation (Latest Revision)** within their own design document.

In order to create a facilities network of buildings that can be maintained and operated efficiently, each new BAS system designed and installed for the City of Mississauga (CoM) must conform to CoM BAS standard. The following outlines a **Typical Points list** and **standard sequence of operation** for a variety of systems found within the City of Mississauga Facilities. For new systems not currently included in the list, the specifying Engineer/Consultant shall use the same format, point naming conventions, and design principals to create additional templates for the guideline. The points list and sequences are to be submitted to the CoM project manager for review and approval by the City before incorporation into the BAS Design Guideline and the project specific specifications (the Engineer/Consultant should anticipate a reiterative process of submission/review/approval).

Application of Specified Sequences

.1 The following sequences are generic in nature and are meant to form the basis of design for all CoM EMCS Projects

.2 The sequences shall be used as the initial starting point for each project, customized by the specifying Consultant and tailored for the specifics of individual project and system requirements.

.3 All project specific sequences to be submitted to the COM for review and approval prior to Tender.

Appendix A6
City of Mississauga - Typical Points List & Standard Sequences of Operation

Part 1 HVAC Operating Schedules & Modes (Common)

1.1 GENERAL:

.1 Equipment/Systems will be controlled to operate continuously in a variety of different modes of operation. Control shall be done locally at RPDC, TEC and OEMASC, interfaced with the EMCS ESS through the SRPDC.

.2 All scheduling shall be time of day (TOD) calendar based and shall factor in; Holidays, Weekends, and other modes of operation where indicated. In some cases, indoor or outdoor temperatures shall dictate a part of the permissible operation of equipment.

.3 Whenever fan systems are scheduled "off", outdoor and exhaust air dampers will be closed, hot water heating coil valves will be open, chilled water coil valves will be closed (except as noted), electrical heating coils, humidifiers, and refrigeration coils (DX cooling) shall be locked out. (as applicable)

.4 Mixing damper and valve actuators shall be powered such that when the fan system if OFF (in either "auto" or "manual") the actuators shall be de-energized and will return to the fail-safe position.

1.2 MASTER BUILDING OCCUPANCY SCHEDULE (MBOS):

.1 The EMCS shall run each defined system (or groups of equipment/Systems) according to a Master System Occupancy Schedule (MSOSx), and then again individually for programmed events and temporary overrides outside of the MSOSx.

.2 Occupied Mode

.1 The EMCS shall run the associated equipment/systems continuously according to the (MSOSx) occupied operating schedule. During occupied operation of the equipment, systems shall run according to a specified Time of Day (TOD) and calendar operating schedule. The specific **Mode of Operation** (Occupied/Unoccupied/Holiday/etc.) shall be identified as "MODE" and displayed on the systems page. The calendar and start/stop times shall be accessed through the associated system "Settings" page and adjustable through the graphics by assigned user levels.

.2 Each occupancy schedule shall have three distinct modes of operation – OCCUPIED, UNOCCUPIED, and HOLIDAY. **The Calendar dates for the Holidays shall be pulled from the EMCS ESS by the local EMCS SRPDC**.

.3 Activity Settings (AS)

.1 Various **Activity Settings** will be required for systems serving different rooms/spaces associated with the City of Mississauga Room Booking Database System (**NAME of System TBD**). The AS will permit different control settings based on the scheduled activity of the room/space that occur during the MSOSx (ie – minimum ventilation, pre-cool/heat time, room temperature, room humidity, ice surface temperature, lighting levels, etc) .

.2 The scheduled time of different AS shall occur through a specified methodology still to be defined by the City of Mississauga (example – programmed link to external database, or ACTIVITY SCHEDULE button on graphics, etc.). EMCS vendors shall be provided pre-programmed sub-routines for use and customization to accomplish the site/system specific sequence of operation associated with the Activity (example – Concert Settings, Orchestra Settings, Public Swim Settings,

Competitive Swim Settings, Yoga Settings, Aerobics Settings, etc) causing the system to take priority over all other specified modes of operation.

.3 The EMCS shall operate all necessary HVAC system(s) associated with maintain the environmental settings of the Activity including all related axillary services as necessary (such as chillers, pumps, make-up air, exhaust, etc.) to allow for the specified conditioning of the specified activity with the Room/Zone. **Refer to ACTIVITY SETTINGS Table and individual Specified Sequence of Operation of associated systems.** The EMCS will utilize the Activity Settings for that room/zone when the booking starts and will return to default settings (NONE) when the booking is over.

.4 When an Activity begins, the EMCS will provide graphical indication (on the system page) identifying the current "Activity"

.5 Schedule of Modes and Settings

.1 **Designer/Consultant** (in collaboration with CoM project team) to complete a Facility Schedule (per site) of the systems, areas served operating schedules and activity settings to be included in specifications of new/replacement EMCS.

.2 Please see Sample Facility Schedule below:

Facility/Site Name

Master System Occupancy (MSOS) Schedules and Activity Settings

Sched #	System	Room(s)	MSOSx	Activity	Activity Settings	Notes
1	AHU 1	Gym A	6am to 11pm Mon to Fri 7am to 3 pm Sat/Sun Holidays - UNOCC	UNOCC (Default)	RMT_SP = UNOCC MIN OA = 0% LTG_CMD =OFF	AHU 1 will operate to the default "UNOCC" settings 10 Min (Adjustable) after the last booked activity setting.
				SPORT1 (Light Play)	RMT_SP = 22.5C MIN OA = 20% LTG_CMD = ON	Pre-Cool =0min
				SPORT2 (Team Sports)	RMT_SP = 21.0C MIN OA = 25% LTG_CMD = ON	Pre-Cool = 5min
				VOTE (Election)	RMT_SP = 22.5C MIN OA = 35% LTG_CMD = ON	Pre-Cool = 15min
3	RTU 1	RM 201	6am to 7pm Mon to Fri	NONE (Default)	RMT_SP = UNOCC MIN OA = 0%	

		(Multi-Purpose Rm)	7am to 3 pm Sat/Sun Holidays - UNOCC	MTG1 (<10 people)	RMT_SP = 22.5C MINOA = CO2_SP	Pre-cool = 0min CO2_SP = 900ppm
				MTG2 (>10 people)	RMT_SP = 21.0C MIN OA = CO2_SP	Pre-cool = 5 min CO2_SP = 1000ppm
				CLASS1 (Art, Seniors)	RMT_SP = 23.0C MIN OA = CO2_SP	Pre-cool = 0 min CO2_SP= 900 ppm
				CLASS2 (Spin, Areobics)	RMT_SP = 20.5C MIN OA = CO2_SP	Pre-cool time = 7 min CO2_SP = 800ppm
3,4,…	System ID	Rooms served from booking systems	Primary operating schedule	Activities options in Room Booking Settings	Settings for the activity (adjustable on system settings page)	Additional control notes.

.3 Holiday Mode

.1 During scheduled holidays, systems shall remain in their Unoccupied operational state.

.4 Unoccupied Mode

.1 In un-occupied mode fans, heating, and cooling will all be de-energized, and the outside air dampers will be closed unless required by the specified sequence for maintaining un-occupied heating and cooling set points or as required for night purge/morning warm-up, etc.

.2 For units with VSD's when cycled on the fans shall operate at a reduced speed of 60% output (user adjustable) to start, after 15 Min (adjustable) if the un-occupied heating/cooling setpoint has not be attained, the fan system will start to ramp up slowly until the unoccupied setpoints have been satisfied.

.5 Night Purge Mode

.1 Between the hours of 3am and 5am, if the outdoor air temperature is between 10ºC and 19ºC (user adjustable via associated Settings page) and the average room temperature associated with a fan or make-up air system is above 26ºC (user adjustable via associated settings page), the fan (or make-up air) system will be energized with economizer cooling until the space temperatures is 21ºC (user adjustable via associated systems Settings page) and then shall be switched off.

.6 Morning Start-up Mode

.1 The EMCS shall use an optimized morning start-up routine, incorporating outside air temperature, zone temperatures, heating valves and cooling valves positions, and past history of the building response to determine the optimum time to start the HVAC systems. The maximum start-up period shall not exceed 3 hours (adjustable).

.7 Activity Modes

Appendix A6
City of Mississauga - Typical Points List & Standard Sequences of Operation

.1 The following Activity Modes shall be applied to each of the different Facility Types:

Typical Facility Activity Modes

Building Type	Activity Modes	Activity Settings	Notes
Indoor/Outdoor Ice Rinks	Unoccupied		
	Occupied		
	General Skating		
	Figure Skating		
	Ice Hockey		
	Tournament		
	Ice Skating		
Sports Complex	Unoccupied		
	Occupied		
	Sport 1		
	Sport 2		
	Sport 3		
	Sport 4		
Community Centres/Indoor Pools/Senior Citizen Centres	Unoccupied		
	Occupied		
	Swimming 1		
	Swimming 2		
	Sport 1		
	Sport 2		
	Sport 3		
	Sport 4		
	Party 1		
	Party 2		
	Party 3		
	Meeting 1		
	Meeting 2		
Admin Buildings, Transit, Depots/Yards, Libraries	Unoccupied		
	Occupied		
	Meeting 1		
	Meeting 2		
Cultural and Performing Arts, Golf Courses, Outdoor Pools	Unoccupied		
	Occupied		
	Event 1		
	Event 2		
	Event 3		

1.3 TEMPORARY OVERRIDE SCHEDULES (TOS)

.1 Temporary overrides will be provided to the operator through the thermostat override button or where the space sensor is flat plate (no occupancy button) through a graphical Override Button on the associated floor plan and HVAC system graphic. The override will enable the associated HVAC unit with fan operation and heating control only to maintain the Daytime Occupied Heating set point for a period of up to 2 hours (adjustable via associated Settings Page). Minimum ventilation setting shall remain 0% and no mechanical cooling shall be permitted.

1.4 ALARM MANAGEMENT

.1 There shall be **Four (4)** types of primary alarms, Critical, Environmental, Maintenance, and Energy. The vendor shall set up EMCS system to provide appropriate level of response as follows:

.1 Critical Alarms:

.1 Critical Alarms are those designated to send a signal to the Security System and the following email address (BASAlerts@mississauga.ca) on site. There are no situations where a Critical Alarm only shows up on the graphics/alarming console, without sending a signal to the Security System and specified email. Refer to part 1.4.1.3 (to follow) for a detailed list of the CoM typical critical alarms.

.2 Critical alarms shall also provide indication on the graphics (Flashing Red) both the Enterprise Server Software (ESS) operator workstation(s) and workstations connected through the SRPDC.

.3 Records of a Critical Alarms shall be stored on the EMCS ESS and an Email generated and sent to the Owner's designate email address (BASAlerts@mississauga.ca) indicating the Building ID, Alarm Indication/Descriptor, Alarm Parameter, Time of Alarm, etc.

.2 Environmental Alarms:

.1 Environmental alarms shall provide indication on the graphics (Flashing Yellow) both the ESS operator workstation(s) and workstations connected through the SRPDC and shall remain in alarm until the condition has been corrected.

.2 The history or environmental alarms will not be recorded at the EMCS server.

.3 Maintenance Alarms:

.1 Maintenance alarms shall provide indication on the graphics (Solid Yellow) both the ESS operator workstation(s) and workstations connected through the SRPDC and shall remain in alarm until the specified alarm condition has been removed. For "Time Based" Maintenance Alarms, the graphical indication of alarm shall remain active for 2 hours then shall return to normal until the alarm conditions have been flagged again.

.2 A secondary separate graphic on the EMCS ESS shall be created by the EMCS Vendor and populated with live data to track the cumulative number of Maintenance Alarms at each site until reset by the Administrative User.

.3 Record of a Maintenance Alarm shall be stored on the EMCS Server, separated by site. NOTE: You could route maintenance alarms to an email as well or just have a dedicated graphical page on the EMCS server where Operator Level 1 & 2 go to daily/weekly and will see the alarms by site listed and then can be addressed at a later date.

.4 Energy Alarms:

.1 Energy alarms shall not generate any indication on the SRPDC graphics

.2 An EMCS ESS Graphical Page shall be created and populated with live data by the EMCS Vendor for Energy Alarms. The Graphic will have a listing of all sites with a cumulative running total of Energy alarms generated for each site. The number will continue to increase until reset by the Administrative Level User.

.3 A Record of an Energy Alarm shall be stored in the database at the EMCS ESS server. They shall also send out an Email to owner designated email indicating record of a new alarm.

.4 All alarm limits shall be as specified in the sequence of operation and with final set-up established during the commissioning process.

.2 Alarms shall be set-up to be functional during the appropriate seasons and inactive when outside of the related season (i.e. – low heating water temperature alarms shall not be active during summer; chilled water alarms shall not be active after the central chilled water has been shut off to the building).

.3 Alarms that are stored at the EMCS Server shall be stored under various file headings (i.e. Critical, Maintenance, Energy) date and time stamped to include when the occurred and the date of acknowledgement of the alarm parameter.

.4 All alarms in database shall remain until cleared by the system administrator access level.

Part 2 System Sequences

2.1 CRITICAL ALARMS

.1 Critical alarms are designate specifically as alarms that send a direct signal to the Security Panel on site and to the following email address: BASAlerts@mississauga.ca. Each alarm type will have a separate digital output to the security panel. *Needs to be coordinated with Security company and process put in place for when they receive alarms – ie CALL OUT LIST.*

.2 In addition to the output command to the security panel, critical alarms shall follow the requirements of part **1.4. Alarm Management**

.3 Critical Alarm points will be listed in the points matrix for each site and may include the following:

- Low Boiler Temp (HWST<35ºC when OAT<5ºC)
- Low Room Temp (RMT<14ºC when OAT<5ºC)
- Cooling Tower Temp (Tower Leaving Temp>40ºC or <15ºC)
- Temperature based alarms above shall all have an adjustable time delay before triggering alarm (10 min – adjustable)
- Heat Pump Flow (No Flow indication or pump status for >30s)
- Power Phase Loss (Monitored Dry Contact)
- Sewage pump level (Monitored High Limit Sensor)
- Sump pump level (Monitored High Limit Sensor)
- Greenhouse temp (Dry Contact or Specified EMCS Temp Sensor Limit)
- Inverter Trouble (Monitored Dry Contact)
- Generator Trouble (Monitored Dry Contact)
- Server high temp (Server RMT>26ºC or monitored dry contact)
- *LIST ANY COM SPECIFIC CRITICAL ALARMS HERE, DELTE THOSE NOT DESIGNATED AS CRITICAL*

.4 All alarm settings shall be user adjustable via the Associated Settings page by the assigned level of access.

.5 Adjustable Points (to be displayed and accessed on system Setting Page):

.1 Alarm Settings – (setpoints and time delay parameters as noted in part 2.1.3 Alarms)

Appendix A6
City of Mississauga - Typical Points List & Standard Sequences of Operation

NOTE: *These are the typical systems we have sequences for please review with your Operations Group to see Typical Points/Sequence/alarms – the list can be added to at a later date as projects are put out for tender and then added to future revisions of the Master Spec*

2.2 SINGLE ZONE AHU SYSTEMS

.1 Anticipated Points:

- AHUxSF_STS -Supply Fan Status (1 DI)
- AHUxSF_CMD -Supply Fan Start/Stop (1 DO)
- AHUxRF_STS -Return Fan Status (1 DI)
- AHUxRF_CMD -Return Fan Start/Stop (1 DO)
- AHUxMAT_T -Mixed Air Temp (AI)
- AHUxMADPR_MOD -Mixed Air Dampers MOD (1 AO)
- AHUxSAT_T -Supply Air Temp (1 AI)
- AHUxRAT_T -Return Air Temp (1 AI)
- AHUxHTGVLV_MOD -Heating Coil Valve MOD (1 AO)
- AHUxHTGPMP_CMD -Heating Coil Pump CMD (1 DO)
- AHUxHTGPMP_STS -Heating Coil Pump Status (1 DI)
- AHUxCLGVLV_MOD -Cooling Coil Valve MOD (1 AO)

  or
- AHUxCLGx_CMD -Cooling Coil DX Stage x (1 DO)
- AHUxFRZ_ALM - Freeze Stat Status – (1 DI)

Note: All Freeze Stats should be DPDT, hardwired to shut down motor starters (or VFD as applicable) and disable power to damper and valve actuators. The second set of contacts shall be monitored by DDC Controller.

.2 Optional Points (by project):

- **CO2 Control**
  - AHUxRACO2_PPM -Return Air CO2 Level (1 AI)
- **VSD Control**
  - AHUxSFVSD_CMD -Supply Fan VSD Start/Stop (1 DO)
  - AHUxSFVSD_MOD -Supply Fan VSD Freq Modulation (1AO)
  - AHUxSFVSD_FBK -Supply Fan VSD Freq Feedback (1 AI)
  - AHUxSFVSD_ALM -Supply Fan VSD Fault Alm Status (1 DI)
  - AHUxRFVSD_CMD -Return Fan VSD Start/Stop (1 DO)
  - AHUxRFVSD_MOD -Return Fan VSD Modulation (1 AO)
  - AHUxRFVSD_FBK -Return Fan VSD Freq Feedback (1 AI)
  - AHUxRFVSD_ALM -Return Fan VSD Fault Alarm (1 DI)

.3 Start/Stop:

.1 The EMCS shall enable the fan system to start when commanded on through either MSOSx or other specified modes of operation. When commanded on, supply fan shall start first. Once the supply fan status is proven on, the EMCS shall start the return fan. Once return fan status is proven the EMCS shall allow application of the specified mixed air, heating and cooling sequences. (Note: Where fans are hard wire interlocked – both shall be started simultaneously).

.2 When the EMCS sends the signal to stop; both fans shall stop, mixed air dampers shall close to full re-circulation, heating and cooling valves shall return to their fail-safe position.

.3 When the system is in UNOCCUPIED mode (outside of the MSOSx) the system shall remain off unless called back on in another mode of operation (Night Purge, Optimum Start, Night Set Back).

.4 When the system is activated in Night Setback Mode (NSB) the fan system shall come on in full recirculation to maintain the specified unoccupied heating/cooling set points.

.4 Mixed Air/Supply Air Control

.1 During occupied operation of the unit the EMCS shall modulate the mixed air dampers (MADPR) between minimum ventilation and 100% outside air, in sequence with heating and cooling coils to maintain the supply air set-point (SAT_SPT). The EMCS shall reset the supply air temperature to maintain the space temperature set point as follows:

.2

Space Temp SP Deviation	Supply Air Temp Set-point
RMT_SP -2 ºC	26 ºC
RMT_SP +2oC	14ºC

.3 The minimum ventilation set point and damper position shall be displayed on the system graphics. Initial Minimum Ventilation set point shall be 25% (Adjustable) or as outlined in the **Master Facility Operating and Settings Schedule** listed for the project.

.4 A mixed air low limit set-point (MAT-LL) shall be used to override the mixed air dampers to maintain a minimum temperature of 6.6 ºC (adjustable and displayed on "System" graphics).

.5 If the MAT is below the MAT-LL the EMCS shall generate an **Environmental Alarm.**

.6 If the MAT-LL requires the dampers to be below the Minimum Ventilation setting for more than 2 minutes (adjustable) the EMCS shall generate a **Maintenance Alarm.**

.7 If the outdoor temperature rises above the economizer set point (ECON-SPT) of 18ºC (adjustable and displayed on system graphics) and mechanical cooling is available, the mechanical cooling strategy shall be as follows:

- Mixed air dampers shall revert to minimum ventilation position.

- When the space (or return) temperature rises 1.0ºC above the occupied cooling set-point, the cooling valve shall start to modulate (or DX cooling shall be energized) in order to satisfy the cooling requirements.

- When the space temperature drops 1.0ºC below the occupied cooling set point of 23ºC (adjustable), the cooling valve shall modulate closed (or DX cooling shall be switched off).

.5 Night Setback Control

.1 During un-occupied operating, the fan system shall remain off unless the space temperature falls below the Night Set-Back Temperature of 18ºC (adjustable).

.2 When the space temperature falls to NSB_SPT -0.5ºC, the fan system shall be enabled in full recirculation mode, heating valve full open, until the space temperature reaches NSB_SPT +1.0ºC. The fan system will then shut off until the next cycle.

.6 (Optional) Minimum Ventilation and CO2 Control

.1 The maximum Minimum Ventilation Setting shall be 25% (adjustable via associated settings pages). The EMCS shall monitor return air CO2 levels and lower the active minimum ventilation from the (Maximum) minimum ventilation of 25% down to 0% based on maintain a maximum CO2 level of 900ppm.

.2 When the RA CO2< 900 ppm, the EMCS shall reduce the active Minimum Ventilation setting by 2% every minute until reaching 0% or until the RACO2>900ppm.

.3 When the RACO2>900ppm the EMCS shall increase the active minimum damper position until reaching the (Maximum) minimum ventilation setting. If the MAT is below the MAT-LL, the EMCS shall generate an **Environmental Alarm**.

.7 (Optional) Variable Speed Fan Control

.1 Application – for large spaces with light occupancy/variable occupancy ie Atrium

.2 The EMCS will modulate the supply fan variable speed drive (VSD) based on space conditions as described below. The return fan VSD shall track the supply fan VSD at an adjustable offset as established by the air balancer at the start of the project.

.3 The EMCS shall reset the supply air temperature to maintain the space temperature set point as defined in 1.4.2.4 (Single Zone AHU Mixed Air/Supply Air Control)

.4 Per the specified sequence, the EMCS shall modulate heating/cooling valves and mixing dampers in sequence to achieve SAT_SP. On initial start-up the supply fan shall operate at speed of 60% (user adjustable).When the space temperature is more than 1.5C outside of the heating/cooling set point dead band, the BAS shall increase the VSD's speed to a maximum of 100% (with ramp duration of 240 seconds or until the space temperature set point is satisfied). When the space temperature set point is satisfied for more than 5 minutes (adjustable), the fan shall start to reduce speed (over ramp duration of 240 seconds) until reaching the minimum speed setting or until the space temperatures starts to fall outside of occupied temperature dead band.

.5 Upon shutdown of the fan system, both the supply and return fan VSD's shall stop and the speed modulation signal shall go be 0%.

.8 Heating Coil Circulation Pump Control (where applicable)

.1 If the outdoor temperature rises above the Warm Weather Lock Out Set Point (WWLO_SPT) (Refer to Heating Plant Sequences and Graphics) the heating coil pump shall turn off.

.2 If the outdoor air temperature is below 5ºC (41ºF) and the pump status is "off", the EMCS shall generate a maintenance alarm.

.9 Safeties

.1 Low Temperature Protection Control: When air temperature downstream of the heating coil drops below 5ºC (40ºF - adjustable, as sensed by low limit (DPDT) freeze stat), the supply and return fans will shut down, outdoor air dampers will close and return air damper will open, the heating/cooling coil valves will open to full flow to the coil. A maintenance alarm will be generated. The freeze stat will need to be manually reset for normal operation to resume.

.2 High Temperature Protection Control: If high temperature limit located in the return air duct rises above the setting of 60ºC the supply and return fans shall shut down and

a maintenance alarm will be generated. Once the high temperature protection control has been manually reset, the unit will return to normal control.

.3 Fire Alarm Fan Shutdown: Where Fire Alarm interlocks exist, the EMCS shall not restrict the fire alarm system from shutting down all fans on a fire alarm condition (with starter in either hand or auto position). Where FA panel is monitored by EMCS< upon clearing all fire alarms the EMCS shall start all the fans in a staggered manner to prevent excessive power demand.

.10 Alarms

.1 **Critical**

.1 None

.2 **Environmental**

.1 Fan Status vs Command

.2 CO2 Level Alarms (900ppm adjustable, if CO2 sensor present)

.3 Supply, Mixed, Return Air, High and Low Limits (adjustable)

.3 **Maintenance**

.1 Freeze Stat Alarm

.2 Heating Coil Pump Status Off Below 5ºC (adjustable)

.3 Mixed air dampers operating below the Minimum Ventilation setting for more than 2 minutes (adjustable)

.4 When OAT< 0ºC (adjustable) and mixed air dampers operating above the minimum setting for more than 2 minutes (adjustable)

.4 **Energy Alarms**

.1 Fan Status On for more than 2 hours cumulatively (adjustable) during un-occupied (NSB) operation.

.2 Fan system operating in Occupied Mode outside of Originally Scheduled MSOSx

.3 VFD Modulation greater than 80% (adjustable) for more than 2 hours cumulatively (adjustable) during occupied operation.

.11 The initial set up values for all alarms shall be established during the commissioning process.

.12 Adjustable Points (to be displayed and made adjustable via the system “Settings” Page)

- MSOS
- Activity Settings (where applicable)
- Minimum Ventilation Setpoint
- Supply Air/Return/Space Air Reset Schedule Parameters
- Mixed Air Temperature Low Limit (MATLL)
- MATLL Time Delay
- Economizer Setpoint (ECON_SPT)
- Occupied Heating/Cooling Setpoints
- Warm Weather Lockout Setpoint (Displayed, adjustable only from Heating Plant Graphics
- Alarm Settings – (setpoints and time delay parameters as noted in part 1.4.2.10 Alarms)

2.3 MULTI-ROOM AHU SYSTEMS (RECIRCULATORY)

.1 Anticipated Points:

- AHUxSF_STS -Supply Fan Status (1 DI)
- AHUxSF_CMD -Supply Fan Start/Stop (1 DO)
- AHUxRF_STS -Return Fan Status (1 DI)
- AHUxRF_CMD -Return Fan Start/Stop (1 DO)
- AHUxMAT_T -Mixed Air Temp (AI)
- AHUxMADPR_MOD -Mixed Air Dampers MOD (1 AO)
- AHUxSAT_T -Supply Air Temp (1 AI)
- AHUxRAT_T -Return Air Temp (1 AI)
- AHUxHTGVLV_MOD -Heating Coil Valve MOD (1 AO)
-
- AHUxHTGPMP_CMD -Heating Coil Pump CMD (1 DO)
- AHUxHTGPMP_STS -Heating Coil Pump Status (1 DI)
- AHUxCLGVLV_MOD -Cooling Coil Valve MOD (1 AO)

or

- AHUxCLGx_CMD -Cooling Coil DX Stage x (1 DO)
- AHUxFRZ_ALM - Freeze Stat Status – (1 DI)

Note: All Freeze Stats should be DPDT, hardwired to shut down motor starters (or VFD as applicable) and disable power to damper and valve actuators. The second set of contacts shall be monitored by DDC Controller.

.2 Start/Stop:

.1 The EMCS shall enable the fan system to start when commanded on through either MSOSx or other specified modes of operation. When commanded on, supply fan shall start first. Once the supply fan status is proven on, the EMCS shall start the return fan. Once return fan status is proven the EMCS shall allow application of the specified mixed air damper and heating sequences. (Note: Where fans are hard wire interlocked – both shall be started simultaneously).

.2 When the EMCS sends the signal to stop; both fans shall stop, mixed air dampers shall close to full re-circulation, heating valves shall return to their fail-safe position.

.2 Mixed Air/Supply Air Control

.1 During occupied operation of the unit the EMCS shall modulate the mixed air dampers (MADPR) between minimum ventilation setting and 100% outside air, in sequence with heating coil to maintain the supply air set-point (SAT_SPT). The EMCS shall reset the supply air temperature to maintain the space (or return air) temperature as follows:

Return Air/Space Temp RAT/RMT	Supply Air Temp Set-point SAT_SPT
20ºC (adjustable)	22ºC (adjustable)
24ºC (adjustable)	18ºC (adjustable)

.2 The minimum ventilation set point and damper position shall be displayed on the system graphics. Initial Minimum Ventilation set point shall be 30% (Adjustable).

.3 A mixed air low limit set-point (MAT_LL) shall override the mixed air dampers to maintain a minimum temperature of 6.6ºC (adjustable and displayed on system graphics).

.4 If the MAT is below the MAT_LL, the EMCS shall generate an **Environmental Alarm**.

.5 If the MAT_LL requires the dampers to be below the Minimum Ventilation setting for more than 2 minutes (adjustable) the EMCS shall generate a **Maintenance Alarm.**

.3 Heating Coil Circulation Pump Control

.1 If the outdoor temperature rises above the Warm Weather Lock Out Set Point (WWLO_SPT) (Refer to Heating Plant Sequences and Graphics) the heating coil pump shall turn off.

.2 If the outdoor air temperature is below 5oC and the pump status is "off", the EMCS shall generate a maintenance alarm.

.4 Safeties

.1 Low Temperature Protection Control: When air temperature downstream of the heating coil drops below 5ºC (adjustable - as sensed by low limit (DPDT) freeze stat), the supply and return fans will shut down, outdoor air dampers will close and return air damper will open, the heating/cooling coil valves will open to full flow to the coil. A maintenance alarm will be generated. The freeze stat will need to be manually reset for normal operation to resume.

.2 High Temperature Protection Control: If high temperature limit located in the return air duct rises above the setting of 60ºC the supply and return fans shall shut down and a maintenance alarm will be generated. Once the high temperature protection control has been manually reset, the unit will return to normal control.

.3 Fire Alarm Fan Shutdown: Where Fire Alarm interlocks exist, the EMCS shall not restrict the fire alarm system from shutting down all fans on a fire alarm condition (with starter in either hand or auto position). Where FA panel is monitored by EMCS< upon clearing all fire alarms the EMCS shall start all the fans in a staggered manner to prevent excessive power demand.

.5 Alarms

.1 **Critical**

.1 None

.2 **Environmental**

.1 Fan Status vs Command

.2 Supply, Mixed, Return Air, High and Low Limits

.3 **Maintenance**

.1 Freeze Stat Alarm

.2 Heating Coil Pump Status Off Below 5ºC(Adjustable) for more than 1 Min (adjustable)

.3 Mixed air dampers operating below the Minimum Ventilation setting for more than 2 minutes (adjustable)

.4 When OAT< 0ºC (adjustable) and mixed air dampers operating above the minimum setting for more than 2 minutes (adjustable)

.4 **Energy Alarms**

.1 Fan system operating in Occupied Mode outside of Originally Scheduled MSOSx

.2 Fan status "On" for more than 5 minutes outside of MSOSx.

.5 The initial set up values for all alarms shall be established during the commissioning process.

.6 Adjustable Points (to be displayed on system Setting Page)

- MSOS
- Minimum Ventilation Setpoint
- Supply Air/Return Air Reset Schedule Parameters
- Mixed Air Temperature Low Limit (MATLL)
- MATLL Time Delay
- Economizer Setpoint (ECON_SPT)
- Occupied Cooling Setpoint
- Warm Weather Lockout Setpoint (Displayed, adjustable from Heating Plant Graphics
- Alarm Settings – (setpoints and time delay parameters as noted in part 2.3.5 Alarms)

2.4 MAKE-UP AIR SYSTEMS (100% OA)

.1 Anticipated Points:

- MUAxSF_STS -Supply Fan Status (1 DI)
- MUAxSF_CMD -Supply Fan Start/Stop (1 DO)
- MUAxOADPR_CMD -OA Damper Command (1DO)
- MUAxOADPR_STS -OA Damper Proving Switch Status (1DI)
- MUAxSAT_T -Supply Air Temp (1 AI)
- MUAxEAT_T -Return Air Temperature (1AI)
- MUAxEAH_RH -Exhaust Air Humidity (1AI)
- MUAxHTGVLV_MOD -Heating Coil Valve MOD (1 AO)
- MUAxCLGVLV_MOD -Cooling Coil Valve MOD (1 AO)
- MUAxHTGPMP_CMD -Heating Coil Pump CMD (1 DO)
- MUAxHTGPMP_STS -Heating Coil Pump Status (1 DI)
- MUAxFRZ_ALM -Freeze Stat Status – (1 DI)
- EFx_STS -Exhaust Fan Status (1DI)
- EFx_CMD -Exhaust Fan Command (1DO)
- MAUxEAT_T -Exhaust Air Temp (1AI)

.2 Start/Stop:

.1 The EMCS shall enable the fan system(s) to start when commanded on through either MSOSx or other specified modes of operation.

.2 When commanded on, the outdoor air damper shall open first. Once damper position is proven open, the supply fan shall be allowed to start. If after 30 seconds (after the start command) the fan status is “off” the outdoor air damper shall be closed.

.3 When the EMCS sends the signal to stop; the fans shall stop, outdoor air damper shall close, and the heating valve shall return to the fail-safe (open) position.

.4 The associated classroom exhaust fan (where applicable) shall operate with the supply fan.

.3 Supply Air Control

.1 During occupied operation of the unit the EMCS shall modulate the heating coil to maintain the supply air set-point (SAT-SPT). The EMCS shall reset the supply air temperature to maintain the space (or return air) temperature as follows:

Return Air/Space Temp RAT/RMT	Supply Air Temp Set-point SAT_SPT
20ºC (adjustable)	22ºC (adjustable)
24ºC (adjustable)	18ºC (adjustable)

.4 Exhaust Air Humidity Control

.1 During Occupied operation of the unit, when ever mechanical cooling is available, the EMCS shall modulate the cooling coil valve to maintain the exhaust air humidity level set point (EAH_SPT) of 50% (Adjustable).

.5 Heating Coil Circulation Pump Control

.1 If the outdoor temperature rises above the Heating Lock Out Set Point (HLO_SPT) of 15oC (adjustable and displayed on heating plant graphics) the heating coil pump shall turn off.

.2 If the outdoor air temperature is below 5oC (41oF) and the pump status is "off", the EMCS shall not allow the fan to operate and shall generate a **maintenance alarm**.

.6 Safeties

.1 The outdoor air damper shall be wired in such a way that when the fan starter is in the "Hand" position the outdoor air damper shall drive open and the fan will start after the damper switch has proven the damper to be open. When Starter is in the "Off" position, the outdoor air damper shall be de-energized closed, and the fan shall remain off.

.2 Low Temperature Protection Control: When air temperature downstream of the heating coil drops below 5oC (adjustable, as sensed by low limit (DPDT) freeze stat), the supply fan will shut down, the outdoor air damper will be de-energized closed, and the heating valve will be de-energized open to allow full flow to the coil. A maintenance alarm will be generated. The freeze stat will need to be manually reset for normal operation to resume.

.3 Fire Alarm Fan Shutdown: Where Fire Alarm interlocks exist, the EMCS shall not restrict the fire alarm system from shutting down all fans on a fire alarm condition (with starter in either hand or auto position). Where FA panel is monitored by EMCS< upon clearing all fire alarms the EMCS shall start all the fans in a staggered manner to prevent excessive power demand.

.7 Alarms

.1 **Critical**

.1 None

.2 **Environmental**

.1 Fan Status vs Command

.2 Supply Air High and Low Limits

.3 **Maintenance**

.1 Freeze Stat Alarm

.2 Heating Coil Pump Status Off Below 5oC (adjustable)

.3 Fan Command "On" but damper status not open after 40s (adjustable)

.4 **Energy Alarms**

.1 Fan system operating in Occupied Mode outside of Originally Scheduled MSOSx

.2 Fan status "On" for more than 5 minutes outside of MSOSx

.5 The initial set up values for all alarms shall be established during the commissioning process.

.8 Adjustable Points (to be displayed on system Setting Page)

- MSOSx Schedules
- Initial Start-Up Heating Valve Ramp Time
- SAT-LL and Time Delay
- Supply Air Temperature Reset Schedule Parameters
- Return Air Humidity Setpoint
- Warm Weather Lockout Setpoint (Displayed, adjustable from Heating Plant Graphics
- Cold Weather Cooling Lock Out Setpoint

- Alarm Settings – (setpoints and time delay parameters as noted in part 2.4.7 Alarms)

2.5 MAKE-UP SYSTEM (100% OA) WITH ENERGY RECOVERY

.1 Anticipated Points

- MUAxFAN_CMD - Supply/Exhaust Fan Start/Stop (1 DO)
- MUAxSF_STS - Supply Status (1 DI)
- MUAxEF_STS - Exhaust Fan Status (1 DI)
- MUAxDPR_CMD - OA/EA Damper Command (1 DO)
- MUAxOADPR_STS - OA Damper Proving Switch Status (1 DI)
- MUAxEADPR_STS - EA Damper Proving Switch Status (1 DI)
- MUAxOAT_T - Outdoor Air Temperature (1 AI)
- MUAxERWLAT_T - ERW Leaving Air Temperature (1AI)
- MUAxRAT_T - Return Air Temperature (1AI)
- MUAxRAH_RH - Return Air Humidity (1AI)
- MUAxEAT_T - Exhaust Air Temperature (1AI)
- MUAxSAT_T - Supply Air Temp (1 AI)
- MUAxERW_CMD - Energy Recovery Wheel Command (1 DO)
- MUAxERW_STS - Energy Recovery Wheel Status (1 DI)
- MUAxHTGVLV_MOD - Heating Coil Valve Modulate (1 AO)
- MUAxHTGPMPA_CMD - MUA Htg Pump A Command (1DO)
- MUAxHTGPMPA_STS - MUA Htg Pump A Status (1DI)
- MUAxHTGPMPB_CMD - MUA Htg Pump B Command (1DO)
- MUAxHTGPMPB_STS - MUA Htg Pump B Status (1DI)
- MUAxFRZ_ALM - Freeze Stat Status (1 DI)

  Note: The Freeze Stat should be DPDT hardwired to shut down VSD's and disable power to actuators. The second set of contacts is to be monitored by DDC Controller.
- MUAxCLG1_CMD - DX Cooling Stage 1 (1DO)
- MUAxCLG2_CMD - DX Cooling Stage 2 (1DO)

  Or
- MUAxCLGVLV_MOD - Cooling Coil Valve Modulate (1AO)

.2 Start/Stop:

.1 The EMCS shall enable the fan system to start when commanded on through either MSOSx or other specified modes of operation.

.2 When commanded on, the outdoor air damper and exhaust air dampers shall open first. Once damper positions are proven open, the supply and exhaust fans shall be allowed to start. If after 30 seconds (after the start command) either fan status is "off" the outdoor and exhaust air dampers shall be closed.

.3 When the fans are off the heating valve shall be powered off and remain in the full open (Normal) position. Once the fans are enabled, the heating valve shall be powered and allowed to modulate under EMCS control. The EMCS shall slowly modulate the heating valve from 100% to 20% over 5 minutes (adjustable) or until reaching the SAT_LL. Once reaching 20% the heating valve shall be allowed to operate according to the intended control sequence.

.4 When the EMCS sends the signal to stop; the fans shall stop, outdoor and exhaust air dampers shall close, and the heating valve shall return to the fail-safe (open) position.

.3 Supply Air Temperature Control:

.1 When the MUA fan status is "ON" the ERV, heating coil valve and stages of mechanical cooling shall be operated in sequence to maintain the supply air temperature set point.

.2 During occupied operation, when the outdoor air temperature is below 15oC (adjustable) the ERV shall be allowed to operate and mechanical cooling shall remain off. When the OAT is less than 10oC or greater than 18oC (adjustable) the ERV shall remain energized.

.3 The supply temperature sensor shall be used as a low limit control and shall override the heating valve if the supply air temperature falls below 8°C (adjustable). The supply air set-point shall be reset based on the following schedule (Heating and Cooling):

Outdoor Air Temperature OAT-T	Supply Air Temperature SAT-SPT
< 10°C (adjustable)	23°C (adjustable)
>18°C (adjustable)	15°C (adjustable)

.4 Return Air Humidity Control

.1 Enable stages of mechanical cooling to maintain the maximum return air humidity setpoint of 55% (adjustable)

.5 Cold Weather Cooling Lockout

.1 When OAT < 15°C (adjustable), mechanical cooling shall be locked out.

.2 Mechanical cooling shall also be locked out during summer operation unless required by Event programming.

.6 Heating Coil Circulation Pump Control

.1 If the outdoor temperature rises above the Heating Lock Out Set Point (HLO_SPT) of 15oC (adjustable and displayed on heating plant graphics) the heating coil pump shall turn off.

.2 If the outdoor air temperature is below 5oC (41oF) and the pump status is "off", the EMCS shall not allow the fan to operate and shall generate a maintenance alarm.

.3 If there is a secondary coil circulation pump (standby), if the lead (operational) pump status is lost, the standby pump shall become operational and a maintenance alarm shall be generated.

.4 If the lead pump status returns to "On" both pumps shall operate together for a period of 30s and then the standby pump shall be shut off.

.7 Safeties

.1 The outdoor air damper and heating valve shall be powered in such a way that whether the fan starter is in the "Hand" or "Auto" position, the outdoor air damper shall drive open first and damper status must prove open before the fan will start. Once the fan has started the heating valve will be energized and put under control.

.2 When Starter is in the "Off" position or commanded off by the EMCS, the outdoor air damper and heating valve shall be de-energized closing the damper and opening the heating valve while the fan remains off.

.3 Low Temperature Protection Control: When air temperature downstream of the heating coil drops below 5ºC (adjustable, as sensed by low limit (DPDT) freeze stat), the supply fan will shut down, the outdoor air damper will be de-energized closed, and the heating valve will be de-energized open to allow full flow to the coil. A maintenance alarm will be generated. The freeze stat will need to be manually reset for normal operation to resume.

.4 Fire Alarm Fan Shutdown: Where Fire Alarm interlocks exist, the EMCS shall not restrict the fire alarm system from shutting down all fans on a fire alarm condition (with starter in either hand or auto position). Where FA panel is monitored by EMCS< upon clearing all fire alarms the EMCS shall start all the fans in a staggered manner to prevent excessive power demand.

.8 Alarms

.1 **Critical**

.1 None

.2 **Environmental**

.1 Fan Status vs Command

.2 Supply Air High and Low Limits

.3 **Maintenance**

.1 Freeze Stat Alarm

.2 (Lead) Heating Coil Pump Status Off Below 5oC (Adjustable)

.3 Lead Pump status lost; standby pump becomes energized

.4 Fan Command “On” but damper status not open after 40s (adjustable)

.4 **Energy Alarms**

.1 Fan system operating in Occupied Mode outside of Originally Scheduled MSOSx

.2 Fan status “On” for more than 5 minutes outside of MSOSx

.3 Coil circulation pump status is ON when OAT> 10oC

.4 Mechanical Cooling ON outside of MSOSx or programmed event.

.5 The initial set up values for all alarms shall be established during the commissioning process.

.9 Adjustable Points (to be displayed on system Setting Page)

- MSOSx Schedules
- Initial Start-Up Heating Valve Ramp Time
- ERV cooling enable temperature
- ERV heating enable temperature
- SAT-LL
- Supply Air Temperature Reset Schedule Parameters
- Return Air Humidity Setpoint
- Warm Weather Lockout Setpoint (Displayed, adjustable from Heating Plant Graphics
- Cold Weather Cooling Lock Out Setpoint
- Alarm Settings – (setpoints and time delay parameters as noted in part 2.5.8 Alarms)

2.6 VARIABLE VOLUME AHU SYSTEMS

.1 Anticipated Points:

- AHUxSFVSD_CMD - Supply Fan VSD Start/Stop (1 DO)
- AHUxSFVSD_MOD - Supply Fan VSD freq Modulation (1AO)
- AHUxSFVSD_FBK - Supply Fan VSD freq feedback (1 AI)
- AHUxSFVSD_ALM - Supply Fan VSD Fault Alarm (1 DI)
- AHUxRFVSD_CMD - Return Fan VSD Start/Stop (1 DO)
- AHUxRFVSD_MOD - Return Fan VSD Freq Modulation (1AO)
- AHUxRFVSD_FBK - Return Fan VSD Frequency Feedback (1 AI)
- AHUxRFVSD_ALM - Return Fan VSD Fault Alarm (1 DI)
- AHUxMAT_T - Mixed Air Temp (AI)
- AHUxMADPR-MOD - Mixed Air Dampers Modulation (1 AO)
- AHUxSAT_T - Supply Air Temp (1 AI)
- AHUxSADSP_PRS - Supply Air Duct Static Pressure (AI)
- AHUxSAHSP_ALM - Supply Air High Static Pressure Limit (DI)

Note: The Duct Pressure High Limit switch should be hardwired to shut down VSD's and shall be monitored by DDC Controller.

- AHUxRAT_T - Return Air Temp (1 AI)
- AHUxHTGVLV_MOD - Heating Coil Valve Modulation (1 AO)
- AHUxHTGPMP_CMD - Heating Coil Pump Start/Stop (1 DO)
- AHUxHTPGMP_STS - Heating Coil Pump Status (1 DI)
- AHUxCLGVLV_MOD - Cooling Coil Valve Modulation (1 AO)
- AHUxFRZ_ALM - Freeze Stat Status – (1 DI)

Note: The Freeze Stat should be DPDT hardwired to shut down VSD's and disable power to actuators. The second set of contacts is to be monitored by DDC Controller.

.2 Start/Stop:

.1 The EMCS shall enable the fan system to start when commanded on through either MOSx or other specified modes of operation. When commanded on, the supply fan shall start first and ramp up to a speed of 25%. Once the supply fan status is proven on (through speed feedback), the EMCS will start the return fan and ramp the fan speed up to 25%. Once the return fan is proven on (through speed feed back), the unit will be allowed to operate under VSD control.

.2 Starting value of 25% output and a ramp duration of 120 seconds, the VSD supply and return fan speeds shall increase together by 1% increments until the minimum duct static pressure set-point has been reached. Once the duct static pressure set point has been reached, Fan speed control for variable volume sequence shall take over.

.3 If either fan fails to prove flow, an alarm will be sent to the EMCS.

.4 When the EMCS sends the signal to stop; both fans shall stop, mixed air dampers shall close to full re-circulation, heating and cooling valves shall return to their fail-safe position.

.3 Fan Speed Control for Variable Volume:

.1 The EMCS will modulate the supply fan variable speed drive to maintain the Supply air static pressure set-point (SADSP_SPT) of 1.2'' WG (adjustable) from a sensor located approximately 2/3 of the way downstream of the fan. The EMCS will modulate the return fan VSD to maintain a fixed differential between the supply fan

speed and the return fan speed. This differential will be coordinated with the air balance contractor for proper building pressurization or as set-up by the CA during commissioning.

.4 Mixed Air/Supply Air Temperature Control

.1 During occupied operation of the unit the EMCS shall modulate the mixed air dampers (MADPR) between minimum ventilation and 100% outside air, in sequence with the cooling coils to maintain the supply air set- point (SAT_SPT). SAT_SP shall be reset from the return as follows:

Return Air Temp RAT-T	Supply Air Temp Set-point SAT_SPT
20ºC (adjustable)	18ºC (adjustable)
24ºC (adjustable)	13ºC (adjustable)

.2 The mixed air low limit set-point (MAT-LLSPT) shall override the mixed air dampers to maintain a minimum temperature of 6.6ºC (adjustable and displayed on system graphics).

.3 The economizer control strategy shall incorporate a single economizer enable/disable control point (ECOS) and economizer set-point (ECON-SPT).

.4 The economizer control shall be disabled when the outdoor temperature rises above 18oC (64ºF – Adjustable) or whenever the chiller is running, and mechanical cooling is available. The mixed air dampers shall close to minimum ventilation position.

.5 Safeties

.1 Low Temperature Protection Control: When air temperature downstream of the heating coil drops below 5ºC (40ºF - adjustable, as sensed by low limit (DPDT) freeze stat), the supply and return fans VSD's will shut down, outdoor air dampers will close and return air damper will open, the cooling coil valve will open to full flow to the coil. A maintenance alarm will be generated. The freeze stat will need to be manually reset for normal operation to resume.

.2 High Duct Static Pressure: Upon detection of high duct static pressure from the supply static pressure switch the supply and return fans VSD's will cycle off, the outdoor air and exhaust dampers will close, and a Maintenance Alarm will be generated. Once the static pressure switches are reset, the unit will return to normal control.

.3 Fire Alarm Fan Shutdown: Where Fire Alarm interlocks exist, the EMCS shall not restrict the fire alarm system from shutting down all fans on a fire alarm condition (with starter in either hand or auto position). Where FA panel is monitored by EMCS< upon clearing all fire alarms the EMCS shall start all the fans in a staggered manner to prevent excessive power demand.

.6 Alarms

.1 **Critical**

.1 None

.2 **Environmental**

.1 Fan Status vs Command

.2 Supply, Mixed, Return Air, High and Low Limits

.3 **Maintenance**

.1 Freeze Stat Alarm

.2 High Duct Static Pressure Alarm

.3 Heating Coil Pump Status Off Below 5oC(Adjustable)

.4 Mixed air dampers operating below the Minimum Ventilation setting for more than 2 minutes (adjustable)

.5 When OAT< 0oC (adjustable) and mixed air dampers operating above the minimum setting for more than 2 minutes (adjustable)

.6 Differential between Modulation Signal and Speed Feedback greater than 5% for more than 5 minutes (adjustable)

.4 **Energy Alarms**

.1 Fan Status On for more than 2 hours cumulatively (adjustable) during un-occupied (NSB) operation.

.2 Fan system operating in Occupied Mode outside of Originally Scheduled MOSx

.3 VFD Modulation greater than 80% (adjustable) for more than 2 hours cumulatively (adjustable) during occupied operation.

.4 The initial set up values for all alarms shall be established during the commissioning process.

.7 Adjustable Points (to be displayed and accessed on system Setting Page)

- Summer/Academic Schedules
- Minimum Ventilation Setpoint
- Supply Air/Return Air Reset Schedule Parameters
- Mixed Air Temperature Low Limit (MATLL)
- MATLL Time Delay
- Economizer Setpoint (ECON_SPT)
- Supply Air Duct Static Pressure set-point
- Return Fan Speed Offset
- Warm Weather Lockout Setpoint (Displayed, adjustable from Heating Plant Graphics
- Alarm Settings – (setpoints and time delay parameters as noted in part 2.6.6 Alarms)

2.7 VAV TERMINAL CONTROL

.1 Anticipated Points

- VAV###RMT_T - VAV Rm ### Space Temp (1 AI)
- VAV###RMT_SPT - Thermostat Temp Set Point (1 AI)
- VAV###OCC_STS - Occu Button/Sensor Status (1 DI)
- VAV###VP_PRS - VAV Velocity Pressure (1 AI)
- VAV###FLW_CFM - VAV Total Air Flow (1 AI)
- VAV###DPR_MOD - VAV Damper Modulation (1 AO)

Optional Reheat Points

- VAV###HTGVLV_MOD -VAV Htg Valve Modulation (1 AO)
- VAV###SAT_T -Supply Air Temp (1 AI)

.2 General:

.1 The VAV terminal controller and room sensor shall be equipped with warmer/cooler set-point adjustment and override button (or Occupancy Sensor).

.2 Each room (or zone) shall allow a fixed range of set-point adjustment 20oC to 22oC (Max Range +/-2ºC from Set Point). The EMCS shall adjust the range, or the user may adjust, within this range, via the "Warmer/Cooler" selector on the thermostat.

.3 Each room or space shall have the capability of an individual occupied/unoccupied schedule, which may be different from the AHU schedule, except that when AHU is in unoccupied operation mode; all rooms must also be in unoccupied mode.

.4 All thermostats shall have an occupancy override button (and/or room occupancy Sensor). The EMCS shall enable the override button feature on an Owner defined basis, so that only Owner approved rooms and offices can utilize the override button feature.

.5 A number of rooms and offices should be in occupied mode to assure that when AHU unit is energized it is meeting the manufacturer's minimum airflow requirements.

.3 Occupied Operation Mode:

.1 The VAV Terminal equipment controller (TEC) shall measure the room temperature and inlet duct velocity and modulate the VAV control damper through control logic to close the volume damper on decreasing room temperature and open the damper on increasing room temperature, to maintain room temperature set-point while providing pressure independent operation.

.2 For VAV with heating coils, when the minimum primary air volume is reached and the room temperature continues to fall below the heating set-point, the heating valve shall start modulation to 100 % and then VAV will increase the air volume in order to meet the heating setpoint.

.3 VAV Box Max and Min Airflow settings shall be per schedules on the drawings and verified by the TAB agent in coordination with EMCS contractor

.4 Unoccupied Operation Mode:

.1 The AHU shall be de-energized. The VAV DDC controller shall switch to the unoccupied heating or cooling set-point of 18ºC or 26.5ºC, respectively (adjustable), and the VAV volume dampers shall be closed to a minimum position.

.2 If the space temperature falls outside the unoccupied range, the AHU may be activated. When the unoccupied heating mode is initiated at the AHU unit, the VAV DDC controller will measure room temperature and inlet duct velocity and shall modulate the VAV volume damper through control logic to open the damper on decreasing room temperature and close the damper on increasing room temperature. Otherwise the VAV shall operate similar to occupied mode.

.5 Morning Start-up:

.1 Upon initiation of morning Start-up, room set-points are returned to Occupied Mode. If the EMCS determines the need for morning warm-up, all VAV controllers shall be set to 50% open and the room temperature sensors shall be switched to the occupancy mode. If the EMCS determines the need for morning cool-down or recirculation, the VAV boxes shall operate similar to occupied mode.

.6 Safeties

.1 N/A

.7 Alarms

.1 **Critical**

.1 Low Space Temperature Alarm

.2 **Environmental**

.1 Discharge Air, and Space Temperature; High and Low Limits

.3 **Maintenance**

.1 Discharge Air greater than 3oC (adjustable) above setpoint for more than 2 minutes (adjustable) – applies to units with reheat coils

.2 Space Temperature greater than 2oC above/below set point for greater than 5 minutes (Adjustable)

.3 Airflow higher/lower by 5% (adjustable) of airflow set point for greater than 5 minutes (adjustable)

.4 **Energy Alarms**

.1 During Occupied mode, control Damper command at 100% for greater than 5 minutes (adjustable).

.8 Adjustable Points (to be displayed and accessed on system Setting Page)

- Unoccupied heating/cooling setpoints
- Occupied/Unoccupied Max/Min Airflow Settings
- Alarm Settings – (setpoints and time delay parameters as noted in part 2.7.7 Alarms)

2.8 MULTI ZONE AHU SYSTEM (INDOOR UNIT)

.1 Anticipated Points:

- AHU# SF_CMD - Supply Fan Start/Stop - (1 DO)
- AHU#SF_STS - Supply Fan Status - (1 DI)
- AHU# RF_CMD - Return Fan Start/Stop - (1 DO)
- AHU# RF_STS - Return Fan Status - (1 DI)
- AHU# MAT_T - Mixed Air Temp- (1 AI)
- AHU# RAT_T - Return Air Temp- (1 AI)
- AHU#MADPR_MOD -Mixed Air Damper Modulation- (1AO)
- AHU#HTGVLV_MOD -Htg Valve Modulation- (1AO)
- AHU#HTGSAT_T - Hot Deck Temp- (1 AI)
- AHUxHTGPMP_CMD - Heating Coil Pump CMD (1 DO)
- AHUxHTGPMP_STS - Heating Coil Pump Status (1 DI)
- AHUxFRZ_ALM - Freeze Stat Status – (1 DI)

Note: The Freeze Stat should be DPDT hardwired to Shut down SF1 & RF1 and disable power to actuators. The second set of contacts is to be monitored by DDC Controller.

- AHUxCLGVLV_MOD - Cooling Coil Valve Modulation (1 AO)

or

- AHUxCLG1_CMD - Cooling Coil DX Stage (1 DO)
- AHU#CLGSAT_T - Cold Deck Temp - (1 AI)
- AHU#ZN#DPR_MOD - AHU Zone# Damper Modulation- (1 AO)
- AHU#ZN#SAT_T - Zone # Supply Air Temperature (1AI)
- AHU#ZN#RMT_T - Zone # Space Temp (1 AI)
- AHU#ZN#RMT_SPT - Zone # Space Temp Set Point (1 AI)
- AHU#ZN#OCC_STS - Zone # Occu Button/Sensor Status (1 DI)

.2 Start/Stop:

.1 The EMCS shall enable the fan system to start when commanded on through either MOSx or other specified modes of operation. When commanded on, supply fan shall start first. Once the supply fan status is proven on, the EMCS shall start the return fan. Once return fan status is proven the EMCS shall allow application of the specified mixed air, heating and cooling sequences. (Note: Where fans are hard wire interlocked – both shall be started simultaneously).

.2 When the EMCS sends the signal to stop; both fans shall stop, mixed air dampers shall close to full re-circulation, heating and cooling valves shall return to their fail-safe position.

.3 Mixed Air Control

.1 During occupied operation, the minimum outdoor air damper shall open first, and the mixed air dampers shall modulate to maintain the cold deck set-point, with a mixed air low limit (MAT-LL) of 6°C. (adjustable).

.2 The economizer control strategy shall incorporate a single economizer enable/disable control point and economizer set-point (ECON-SPT).

.3 The economizer control shall be disabled when the outdoor temperature rises above 18oC (adjustable) or whenever the chiller is running and/or mechanical cooling is available

.4 If the outdoor temperature rises above Economizer set point (ECON-SPT) and the mechanical cooling is available, the mixed air dampers shall close to 20% (adjustable) minimum position.

.4 Hot Deck Control

.1 During occupied operation, the hot deck set-point shall be reset according to the following (adjustable) schedule:

Zone Space Temp	Hot Deck Temp Set-point
18.0ºC (adjustable)	45ºC (adjustable)
22.0ºC (adjustable)	28ºC (adjustable)

.2 The EMCS shall modulate the heating control valve (or gas burner) to maintain the hot deck temperature set-point. The hot deck set point shall be further reset by heating demand as follows:

.1 If maximum hot deck zone damper position is more than 85% open to hot deck, the hot deck calculated set-point shall be offset in 0.5ºC increments to a maximum of SPT+5ºC, which means that the zone with the greatest heating demand will increase the hot deck temperature set-point.

.2 If the maximum hot deck zone damper position is less than 60% open to hot deck, the hot deck temperature set-point shall be offset by -0.5ºC to a minimum of SPT-5ºC.

.3 The calculated (active) set point shall be displayed with the reset schedule on the system graphics.

.4 When the Air Handling Unit is OFF, the heating valve shall continue to modulate (for gas fired unit the burner shall remain off).

.5 Cold Deck Control

.1 During occupied operation, the cold deck set-point shall be reset based on cooling demand as follows:

.1 If the maximum cold deck zone damper is more than 80% open to cooling, the cold deck temperature set-point shall be decreased slowly in 0.5ºC increments to a minimum cooling set point of 13ºC (adjustable), which means that the zone with the maximum cooling demand shall decrease the cold deck temperature set-point.

.2 If the maximum cold deck zone damper position is less than 60% open, the cold deck temperature set-point shall be increased in 0.5ºC increments to a maximum of 18ºC.

.3 When the outside temperate is below 16.5ºC, the mixed air dampers shall be modulated to maintain the cold deck set-point. If the outside temperature is more than 18ºC, the EMCS shall modulate the cooling control valve to maintain the cold deck temperature set-point and the mixed air dampers shall be closed to the minimum fresh air position.

.6 Zone Damper and Temperature Control

.1 The cold and hot deck zone dampers shall modulate in sequence to maintain individual zone temperature cooling and heating set-points.

.2 If the space temperature associated with the zone control is also controlling a radiation valve for the same area, the EMCS shall modulate first the zone damper to 100%

heating open position. If the heating set-point is not satisfied, the EMCS shall start to modulate the radiation valve to meet the heating requirements.

.3 Occupied mode set-points:

- Space heating set-point: 21.5ºC (adjustable)
- Space cooling set-point 24.5ºC (adjustable)
- Minimum dead band 2.5ºC (adjustable)

.4 Unoccupied mode set-points

- Space heating set-point: 18ºC (adjustable)
- Space cooling set-point 26ºC (adjustable)
- Minimum dead band 2.5ºC (adjustable)

.5 Where applicable, occupancy sensors shall be used to detect vacancy of zones during occupied operation as follows:

.1 If the zone is vacant for a period of 15 minutes (adjustable) the associated zone shall be “un-occupied” and not include in the reset of Hot/Cold deck algorithms.

.7 Safeties

.1 Low Temperature Protection Control: When air temperature downstream of the heating coil drops below 5ºC (40ºF - adjustable, as sensed by low limit (DPDT) freeze stat), the supply and return fans will shut down, outdoor/exhaust air dampers will close and return air damper will open, the heating coil valve will open to full flow to the coil. A maintenance alarm will be generated. The freeze stat will need to be manually reset for normal operation to resume.

.2 High Temperature Protection Control: If high temperature limit rises above the setting of 60oC or 140oF the supply and return fans shall shut down. Once the high temperature protection control has been manually reset, the unit will return to normal control.

.3 Fire Alarm Fan Shutdown: Where Fire Alarm interlocks exist, the EMCS shall not restrict the fire alarm system from shutting down all fans on a fire alarm condition (with starter in either hand or auto position). Where FA panel is monitored by EMCS< upon clearing all fire alarms the EMCS shall start all the fans in a staggered manner to prevent excessive power demand.

.8 Alarms

.1 **Critical**

.1 Low Room Temperature

.2 **Environmental**

.3 Fan Status vs Command

.4 Cold/Hot Deck Supply, Mixed, and Return Air High and Low Limits

.5 **Maintenance**

.1 Freeze Stat Alarm

.2 Heating Coil Pump Status Off Below 5ºC(Adjustable)

.3 Mixed air dampers operating below the Minimum Ventilation setting for more than 10 minutes (adjustable)

.4 When OAT< 0oC (adjustable) and mixed air dampers operating above the minimum setting for more than 2 minutes (adjustable)

.5 Compressor Failure Alarm (when monitored)

.6 Cold Deck Temperature below 9oC for more than 5 minutes (adjustable)

.7 Mixed air temperature below MAT-LL SPT for more than 5 minutes (adjustable)

.8 Zone Temperature below setpoint by more than 3oC for more than 15 minutes (adjustable)

.6 **Energy Alarms**

.1 Fan Status On for more than 2 hours cumulatively (adjustable) during un-occupied (NSB) operation.

.2 Fan system operating in Occupied Mode outside of Originally Scheduled MOSx

.7 Alarm condition initial set up values to be established during the commissioning process.

.9 Adjustable Points (to be displayed and accessed on the System Setting Page)

- Summer/Academic Schedules
- Mixed Air Temperature Low Limit (MATLL)
- MATLL Time Delay
- Hot Deck & Cold Deck Reset Schedule Parameters
- Economizer Setpoint
- Minimum Ventilation
- Unoccupied Heating Set Points
- Zone Vacancy Period (15 min)
- Alarm Settings – (setpoints and time delay parameters as noted in part 2.8.8 Alarms).

2.9 PACKAGED ROOFTOP UNITS (NO BACNET)

.1 Anticipated Points

- RTUxFAN_CMD – Fan Start/Stop – (1 DO)
- RTUxSF_STS – Supply Fan Status – (1 DI)
- RTUxECONDIS_CMD - Economizer Disable – (1 DO)
- RTUxSAT_T - Supply Air Temp - (1-AI)
- RTUxRAT_T - Return Air Temp - (1-AI)
- RTUxMAT_T - Mixed Air Temp - (1-AI)
- RTUxHTG1_CMD - Heating Stage 1 Command - (1-DO)
- RTUxHTG2_CMD - Heating Stage 2 Command - (1-DO)
- RTUxCLG1_CMD - Cooling Stage 1 Command - (1-DO)
- RTUxCLG2_CMD - Cooling Stage 2 Command - (1-DO)
- RTUx4CLG1_STS - Cooling Stage 1 Status - (1-DI)
- RTUx4CLG2_STS - Cooling Stage 2 Status - (1-DI)
- RTUxRM###_SPT - Room # Room Temp Setpoint (1-AI)
- RTUxRM###_T - Room # Room Temp (1-AI)
- RTUxRM###_OCC - Room # Occ Sensor/Button Status (1-DI)

.2 Start/Stop:

.1 The EMCS shall enable the rooftop unit fan to start when commanded on through MSOSx or other specified modes of operation (Night Purge, Morning Warm-Up, Night Setback).

.2 When commanded on in occupied mode, the supply fan shall operate continuously with heating, cooling or economizer cooling to maintain the occupied set points.

.3 During un-occupied operation, the supply fan shall remain off unless required to satisfy un-occupied heating and cooling set points or for night purge/morning warm-up mode.

.3 Heating/Cooling/Ventilation Control:

.1 During occupied mode, the EMCS shall enable the dampers the Economizer disable command (ECONDIS_CMD) allowing the RTU to operate the mixing dampers between a fixed minimum ventilation setting and full economizer cooling.

.2 Heating and Cooling demand shall be determined by the room temperature setpoint (RM###RMT_SPT). Users shall have an adjustable thermostat with a range of +/- 2oC or for public areas there shall be a flat plate sensor and Occupied Heating/Cooling Setpoint shall be established by the Facility Operator through the Settings page. Heating and Cooling set-point shall be established based on a deadband of set-point +/-1oC (adjustable via settings page)

.4 Cooling Mode:

.1 When the room temperature rises to RMT_SPT +1oC the first stage of cooling shall be energized. The on-board RTU controls will determine if outdoor temperature is below the economizer set point (free cooling mode) or if mechanical cooling (DX) shall be activated.

.2 When the room temperature reaches RMT_SPT, cooling shall be deactivated.

.5 Heating Mode:

.1 If the room temperature falls to RMT_SPT-1oc, (when present) the room convector shall act as the first stage of heating and shall modulate to maintain RMT_SPT. If RMT_SPT falls to RMT_SPT -1.5ºC, the first stage of mechanical heating shall be enabled.

.2 If the room temperature falls to RMT_SPT-2ºC, the second stage of heating shall be enabled.

.3 When the room temperature reached RMT_SPT-1.5ºC, the second stage of heating shall be deactivated.

.4 When the room temperature reaches RMT_SPT the first stage of heating shall be deactivated.

.6 Night Set-Back Control:

.1 During un-occupied operation, the fan system shall remain off unless the space temperature falls below the night set-back temperature of 18ºC (adjustable).

.2 When the space temperature falls to NSB_SPT -0.5ºC, the fan system shall be enabled with the perimeter heating valve acting as the source of heat and shall operate until the space temperature reaches NSB_SPT +1.0ºC. The fan system will then shut off until the next cycle.

.3 During on-occupied and night set-back modes, the dampers shall be commanded “off” (ECONDIS_CMD) and will remain closed to 0% outdoor air (full return air). Where present, the perimeter heating valve shall continue to modulate to maintain NSB_SPT +1ºC.

.7 Safeties

.1 Mechanical Cooling Lock Out (Low Ambient). When the outside temperature is less than on board RTU Ambient cooling lock-out set point (typically 12oC) the compressor shall note be allowed to run

.2 Anti-Short Cycle Timer. Minimum run times for the cooling shall be provided to prevent short cycling and avoid compressor failure.

.3 Fire Alarm Fan Shutdown: The fire alarm system may shut down all fans on a fire alarm condition. Upon clearing all fire alarms the EMCS shall start all the fans in a staggered manner to prevent excessive power demand.

.8 Alarms

.1 **Critical**

.1 Low Room Temperature

.2 **Environmental**

.1 Fan Status vs Command

.2 Supply, Return Air High & Low Limits

.3 **Maintenance**

.1 Discharge Air greater than 3°C (adjustable) above setpoint for more than 2 minutes (adjustable).

.2 Supply Air Temperature <8oC(adjustable) when OAT<5oC for more than 2 minutes (adjustable)

.3 Burner Failure

.4 Fan Failure

.4 **Energy**

.1 Fan Status On for more than 2 hours cumulatively (adjustable) during un-occupied (NSB) operation.

.2 Fan system operating in Occupied Mode outside of Originally Scheduled MSOSx

.3 The initial set up values for all alarms shall be established during the commissioning process.

.9 Adjustable Points (to be displayed on system Setting Page)

- Operating Schedules
- Unoccupied Heating/Cooling SP
- Supply Air Low Limits
- Occupied Heating/Cooling deadbands
- Alarm Settings – (setpoints and time delay parameters as noted in 2.9.8 Alarms)

2.10 ROOFTOP UNIT WITH BACNET INTERFACE CARD

.1 Anticipated Points

- RTUxBACNET_COM RTUx BACNet Communications (COM)

.1 Virtual Read/Write Points are vendor and product dependant and will be determined during the individual project design phase process. Some of these points will including but not limited to: Occupied/Unoccupied Heating/Cooling Setpoints, Occupied/Unoccupied Command, Minimum Ventilation Setting, Heating Demand, Cooling Demand, Supply Air Temperature, Space Temperature, Return Air Temperature, Return Air Humidity, Return Air/space CO2, Compressor Status, Fan Status, Fan Speed, etc.

.2 General

.1 The OEMASC should be BACNet Certified Open controller that comes as an integrated component of a Rooftop unit. Its internal application programing is designed to provide optimum Rooftop performance and energy efficiency. The RTU OEMASC enables the unit to run 100% stand-alone control mode or it can communicate to the EMCS via BACnet (typically via DIP switch settings on the On-Board Controller which also allowing User to select the baud rate for the associated communication protocol.

.2 The OEMASC generally operates by using set points in and out of service. This method consists of BACnet objects that the EMCS can access to control and monitor the status of the rooftop units.

.3 It is important to define the amount of control that the EMCS system will apply to the unit. This can be done by configuring the OEMASC with the RTU manufacturer's technician.

.3 Operation Modes

.1 The rooftop unit shall operate in Four (4) specific modes of operation according to user adjustable (TOD) time of day schedules as follows:

.1 Occupied Mode: The EMCS shall send a signal to the OEMASC commanding "Occupied Operation".

.2 Unoccupied Mode: When in unoccupied mode, the unit shall remain off unless duty cycled in order to maintain un- occupied heating/cooling set-points with minimum ventilation set to 0%.

.3 Optimized Start Mode: The RTU OEMASC shall operate on the EMCS based optimized time schedules. During the warm-up mode, the rooftop unit shall operate on full return air with heating enabled to reach the daytime occupied heating setpoint.

.4 Night Purge Mode: The night purge control strategy uses outside air to pre-cool the building before the occupancy mode and mechanical cooling is turned ON. The outdoor air and space temperature and RH relative humidity shall be analyzed by the EMCS. When conditions are met, the EMCS shall enable the unit with 1st stage cooling to allow for fresh-air to purge the space prior to the start of the occupied day.

.5 The following conditions apply:

- Outdoor air temperature is above the Heating/Cooling changeover setpoint of 13ºC (adjustable).
- The outside dry bulb temperature is below space temperature.
- Outside relative humidity is below the 16ºC dew point.

.4 Active Ventilation Control Option.

.1 Optional CO2 sensors may be supplied by the Rooftop unit Manufacturer. During Occupied Mode, EMCS shall send a signal to the OEMASC for setting the CO2 control set-point to 1100 ppm (adjustable).

.2 If the measured CO2 is 900 ppm or less, the minimum ventilation setting shall be 10% . (adjustable). If the CO2 level reading rises above 900 ppm, the OEMASC shall increase the minimum ventilation to a maximum "minimum Ventilation" setting of 30% (adjustable).

.5 Power Exhaust & Building Static Pressure Control

.1 Rooftop units (10 Tons and over) are equipped with a constant speed power exhaust fan and barometric relief dampers with a limiter control arm (or optional VFD on the fan).

.2 The OEMASC controller monitors the fresh air damper position to determine when the power exhaust fan is to be enabled/disabled utilizing an on-board building static pressure sensor to adjust the limiter arm position (or control the speed of the fan).

.3 The EMCS shall send a control signal to the OEMASC to adjust the exhaust fan enable air setting and the building static pressure set point through a user adjustable setting on the graphics.

.6 Heating & Cooling Control

.1 The EMCS shall monitor the space temperature through the OEMASC and shall display it on the system graphics page. On the settings page the EMCS shall display the adjustable Heating & Cooling set points with the associated dead bands in order to avoid simultaneous heating and cooling.

.7 Safeties

.1 Mechanical Cooling Lock Out (Low Ambient). When the outside temperature is less than on board RTU Ambient cooling lock-out set point (typically 12oC) the compressor shall note be allowed to run

.2 Anti-Short Cycle Timer. Minimum run times for the cooling shall be provided to prevent short cycling and avoid compressor failure.

.3 Fire Alarm Fan Shutdown: The fire alarm system may shut down all fans on a fire alarm condition. Upon clearing all fire alarms the EMCS shall start all the fans in a staggered manner to prevent excessive power demand.

.8 Alarms

.1 **Critical**

.1 Low Room Temperature

.2 **Environmental**

.1 Fan Status vs Command

.2 Supply, Return Air High & Low Limits

.3 **Maintenance**

.1 Discharge Air greater than 3°C (adjustable) above setpoint for more than 2 minutes (adjustable).

.2 Supply Air Temperature <8oC(adjustable) when OAT<5oC for more than 2 minutes (adjustable)

.3 Burner Failure

.4 Fan Failure

.4 **Energy**

.1 Fan Status On for more than 2 hours cumulatively (adjustable) during un-occupied (NSB) operation.

.2 Fan system operating in Occupied Mode outside of Originally Scheduled MSOSx

.5 The initial set up values for all alarms shall be established during the commissioning process.

.9 Adjustable Points (to be displayed on system Setting Page)

- Operating Schedules
- Unoccupied Heating/Cooling SP
- Minimum Ventilation Settings
- CO2 Setpoint
- Building Static pressure setpoint
- Power Exhaust Enable Set point
- Supply Air Low Limits
- Occupied Heating/Cooling deadbands
- Alarm Settings – (setpoints and time delay parameters as noted in 2.10.8 Alarms)

2.11 ARENA DEHUMIDIFIER

.1 Associated Points

- DHxSF_STS - Supply Fan Status (1DI)
- DHxRF_STS – Return Fan Status (1DI)
- DHxERW_STS – Energy Recovery Wheel Status (1DI)
- DHxSAT_T – Supply Air Temp (1AI)
- DHxRAT_T – Return Air Temp (1AI)
- DHxEAT_T – Exhaust Air Temp (1AI)
- DHxENA_CMD – Dehumidifier Enable Command (1DO) (Typical 2 pad system)
- PADxCO_LVL – Pad X CO Level (2 AI)
- PADxRMT_T – Pad X Room Temperature (2AI)
- PADxHUM_LVL - Pad X Humidity Level (2AI)
- PADxEF_CMD - Pad X Exhaust Fan Command (2DO)
- PADxEF_STS - Pad X Exhaust Fan Status (2DI)
- PADxFADPR_CMD - Pad X Fresh Air Damper Command (2DO)
- PADxFADPR_STS - Pad X Fresh Air Damper Status (2DI)

.2 Start/Stop:

.1 The EMCS shall enable the dehumidification system to operate when commanded on through MSOSx and based on seasonal operating schedule

.2 All control functionality shall remain with the unit mounted OEMASC. The EMCS vendor is to interface with an existing terminal strip within the unit to monitor status of unit operation.

.3 Arena Exhaust Fan and Intake Dampers Controls:

.1 The EMCS shall monitor CO levels in the arena

.2 When the CO levels rise above the setpoint, the EMCS shall open the Fresh Air Intake Damper. When the end switch on this damper closes the EMCS shall command the Exhaust Fan ON

.3 When CO levels drops 9 ppm below the CO setpoint, the EMCS shall command the exhaust fan OFF and close the associated damper

.4 If the CO level rises above the CO alarm level limit, a critical alarm shall be generated

.4 Humidity Controls

.1 The EMCS is to monitor temperature and humidity in the Arena space and send a signal to DH-1 when humidity rises above the humidity setpoint.

.2 All other controls are to remain with the unit mounted OEM controller. The EMCS vendor is to interface with an existing terminal strip within the unit to monitor status of unit operation.

.5 Safeties:

.1 N/A

.6 Alarms

.1 **Critical**
  .1 High CO Level
.2 **Environmental**
  .1 High RH Level
  .2 Other TBD (based on what is available from OEMASC BacNet)
.3 **Maintenance**
  .1 TBD (based on what is available from OEMASC BacNet)
.4 **Energy**
  .1 TBD (based on what is available from OEMASC BacNet)

.7 Adjustable Points (to be displayed on system Setting Page)

- Operating Schedules
- CO Level Setpoint
- RH Setpoint
- RH Deadbands
- Alarm Settings – (setpoints and time delay parameters as noted in 2.11.6 Alarms)

2.12 MISCELLANEOUS EXHAUST FANS

.1 Anticipated Points:

- WREFx-CMD -Washroom Exhaust Start/Stop (1 DO)
- WREFx-STS -Washroom Exhaust Status (1 DI)

.2 Start/Stop:

.1 The EMCS shall enable the exhaust fan(s) to start when commanded on through an associated MSOSx or for a programmed event.

.2 At all other times the exhaust fan(s) shall be scheduled OFF.

.3 If equipped with an isolating damper, on a command from the EMCS, the exhaust damper shall open and when the end switch makes, the fan shall start, and the damper status shall be available at EMCS.

.3 Safeties:

.1 N/A

.4 Alarms:

.1 **Critical**

.1 N/A

.2 **Environmental**

.1 N/A

.3 **Maintenance**

.1 Command ON – Status OFF

.4 **Energy**

.1 Command OFF – Status ON

.2 The initial set up values for all alarms shall be established during the commissioning process.

.5 Adjustable Points (to be displayed and accessed on system Setting Page)

- Schedules
- Alarm Settings – (setpoints and time delay parameters as noted in part 2.12.4 Alarms)

2.13 TWO (2) CONDENSING BOILERS CONTROL STRATEGY

.1 Anticipated Points:

BOILER 1

- BLR1ENA_CMD -Boiler 1 Enable/Disable (1 DO)
- BLR1SWT_T -Boiler 1 Supply Water Temp (1 AI)
- BLR1BUR_MOD -Boiler 1 Burner Modulation (1 AO)
- BLR1ALM_ALM -Boiler 1 Alarm Status (1 DI)
- BLR1MOD_FBK -Boiler 1 Modulation Feed Back (1 AI)
- BLR1CPMP_STS -Boiler 1 Circulation Pump Status (1 DI)

BOILER 2

- BLR2ENA_CMD -Boiler 2 Enable/Disable (1 DO)
- BLR2SWT_T -Boiler 2 Supply Water Temp (1 AI)
- BLR2BUR_MOD -Boiler 2 Burner Modulation (1 AO)
- BLR2ALM_ALM -Boiler 2 Alarm Status (1 DI)
- BLR2MOD_FBK -Boiler 2 Modulation Feed Back (1 AI)
- BLR2CPMP_STS -Boiler 2 Circulation Pump Status (1 DI)

COMMON SYSTEM POINTS

- BLDGOAT_T -Building Outdoor Air Temperature (1 AI)
- MHWST_T -Main Heating Water Supply Temperature (1AI)
- MHWRT_T -Main Heating Water Return Temperature (1AI)
- MHTGPMP1_CMD -Main Heating Pump 1 Enable/Disable (1DO)
- MHTGPMP1_STS -Main Heating Pump 1 Status (1DI)
- MHTGPMP2_CMD -Main Heating Pump 2 Enable/Disable (1DO)
- MHTGPMP2_STS -Main Heating Pump 2 Status (1DI)

.2 Start/Stop

.1 The Heating System shall be enabled by the EMCS when the outside air temperature is 1oC below WWLO-SP (15ºC adjustable) and disabled when the outdoor air temperature rises 1oC above the WWLO-SP as follows:

.1 When the Heating System has been enabled, the primary heating pumps and coil circulators shall be switched on first, after a 3-minute delay and at minimum one (1) pump status verification the boilers shall be allowed to operate in accordance to the specified Boiler control sequence.

.2 When the heating system has been disabled, the boilers shall be shut off first, and after a 3-minute time delay all primary pumps and coil circulators shall be switched off.

.3 Heating pumps with one operational and one standby shall operate as Lead/Lag operation. The “Lead” shall be rotated on a weekly basis (every Tuesday at 8am) with graphical indication as to which pump is Lead and which is Lag. If the lead pump status is off, the lag pump shall be started within 3 seconds. If the primary pump status returns to “on”, both pumps shall operate for 2 minutes before the standby pump is shut off. When switching New primary pump shall be started and status proven before standby (old primary) pump is switched off.

.4 When an individual boiler is commanded off, the associated boilers circulated shall continue to run for 3 minutes to dissipate heat and then will shut off (internal to boilers).

.5 The boilers shall operate as Lead/Lag operation. The "Lead" shall be rotated on a weekly basis (every Tuesday at 8am) with graphical indication as to which boiler/pump is Lead and which is Lag. If the lead boiler is in Alarm or status has not be verified within 3 minutes (adjustable) after enable, the lag boiler shall become the lead boiler and a maintenance alarm shall be generated.

.6 When the heating system has first be enabled through the WWLO_SPT and the primary heating water pump has operated for 3 minutes, the lead boiler and associated circulation pump should be turned ON at high fire, once status is proven the burner shall be allowed to modulate. After Lead Boiler burner status has been proven and boiler command is at 100% for 10 minutes (adjustable), the lag boiler shall be enabled at high fire. Once the lag boiler burner status has proven, both boilers shall be allowed to modulate together on the same command signal.

.7 Both boilers shall be operated together until the Main Heating Water Supply Temperature setpoint (MHSWT-SPT) has been satisfied and then normal boiler sequence of operation shall begin.

.3 Boiler Control

.1 When the main heating water supply temperature (MHWST_T) is more than 2.5ºC (Adjustable) below set point (MHWST_SP) the lead boiler shall be commanded ON by the EMCS, followed by burner modulation. The burner shall first be enabled at low fire, 3 Minutes (adjustable) after Burner Status is proven the burner shall be allowed to gradually increase output using PID control to maintain the heating system set point (MHSWT_ SP).

.2 If the MHWST_T falls to more than 8.5ºC (User Adjustable) below the MHWST_ SP, and the lead boiler is burner modulation is at 90% or greater output, the lag boiler (and associated circulation pump) shall be commanded "ON" and held at low fire while The lead boiler continues to modulate according to its PID loop to maintain MHWST_SP.

.3 When the lag boiler Burner Status has proven there shall be a 3 minute (adjustable) time delay followed stepped control of burner (increases in increments of 5% output every 2 minutes) until reaching 50% output or until the lead boiler output command falls to 60% modulation output or lower. When either of these conditions are met, both boilers (lead and lag) shall go to low fire and then be allowed to modulate together to satisfy the MHWST_SP.

.4 When the MHWST_T reaches set point, the lag boiler shall be disabled, and the lead boiler shall continue to modulate. When the MHWST_T rises to set point + 3oC, the lead boiler shall hold at minimum fire. When at low fire, if the MHWST_T reaches set point + 5oC the lead boiler shall be switched off. If the MHWST_T drops to set point - 1oC the boiler may begin to modulate again according to the PID loop command.

.4 Hot Water Supply Reset

.1 The outside air temperature reset schedule shall reset the heating water supply temperature set-point (MHWST_ SP) according to the following schedule:

Outdoor Air Temp	Hot Water Supply Temp

OAT-T	MHWST SP
-15ºC	80ºC
10ºC	35ºC

.2 All parameters of the reset schedule shall be (super used) adjustable through the graphics. The indoor/outdoor reset schedule shall also be offset by actual heating demand and the calculated setpoint shall be displayed on the system graphics.

.5 Heating Demand Offset

.1 Actual heating demand shall be measured by available (site specific) conditions including but not limited to the following:

- Perimeter Heating Demand (1-2 classrooms per zone or the zone 3-way valve).
- AHU Heating Valve Demand (AHU with greatest heating demand)
- Condenser Water Loop Heating Valve Demand

.2 If all of the heating valves are less than 60% heating demand, decrease the MHWST_SP by 1ºC every 2 minutes to a maximum of MHSWT-SP -7.5ºC. This shall be considered the ACTIVE MHSWT-SP (displayed on the Graphics).

.3 If any of the heating valves have greater than 95% heating demand, increase the ACTIVE MHSWT_SP by 1ºC every 2 minutes until reaching the original MHWST_SP or when the maximum heating demand is less than 70%.

.6 Safeties

.1 When the boiler lead pump is commanded on by the EMCS, and no proof is received after 30 seconds, then the lead pump shall be commanded off and a maintenance alarm shall be generated. The lag pump shall start on failure of the lead pump. If the lag pump also fails, then a critical alarm shall be generated.

.2 A manual reset in programming shall be provided to release all pumps from emergency status and return to normal status and restart lead/lag sequence.

.3 The hot water return temperature for noncondensing boilers shall not be less than 48ºC.

.7 Alarms

.1 **Critical**

.1 Low Boiler Temp (MHWST<35ºC when OAT<5ºC)

.2 **Environmental**

.1 MHWST/MHWRT out of anticipated range.

.3 **Maintenance**

.1 Boiler failures/alarm

.2 Pump failure

.4 **Energy Alarms**

.1 Boiler cycles more than 4 times/hour (adjustable)

.2 Minimum Boiler operating time < 5 minutes (adjustable)

.5 The initial set up values for all alarms shall be established during the commissioning process.

.8 Adjustable Points (to be displayed and accessed on system Setting Page)

- Calendar Operating Schedule
- Outdoor/Supply Water Reset Schedule Parameters
- Lead Boiler Minimum Run Time
- Boiler Staging Differential Set Points and Lead/Lag Boiler Time Delays
- Warm Weather Lockout Setpoint and differential
- Alarm Settings – (setpoints and time delay parameters as noted in part 2.13.7 Alarms)

2.14 THREE (3) CONDENSING BOILER CONTROL STRATEGY

.1 Anticipated Points:

BOILER 1

- BLR1ENA-CMD -Boiler 1 Enable/Disable (1 DO)
- BLR1SWT-T -Boiler 1 Supply Water Temp (1 AI)
- BLR1BUR-MOD -Boiler 1 Burner Modulation (1 AO)
- BLR1ALM-ALM -Boiler 1 Alarm Status (1 DI)
- BLR1MOD-FBK -Boiler 1 Modulation Feed Back (1 AI)
- BLR1CPMP-STS -Boiler 1 Circulation Pump Status (1 DI)

BOILER 2

- BLR2ENA-CMD -Boiler 2 Enable/Disable (1 DO)
- BLR2SWT-T -Boiler 2 Supply Water Temp (1 AI)
- BLR2BUR-MOD -Boiler 2 Burner Modulation (1 AO)
- BLR2ALM-ALM -Boiler 2 Alarm Status (1 DI)
- BLR2MOD-FBK -Boiler 2 Modulation Feed Back (1 AI)
- B2CPMP-STS -Boiler 2 Circulation pump Status (1 DI)

BOILER 3

- BLR3ENA-CMD -Boiler 3 Enable/Disable (1 DO)
- BLR3SWT-T -Boiler 3 Supply Water Temp (1 AI)
- BLR3BUR-MOD -Boiler 3 Burner Modulation (1 AO)
- BLR3ALM-ALM -Boiler 3 Alarm Status (1 DI)
- BLR3MOD-FBK -Boiler 3 Modulation Feed Back (1 AI)
- BLR3CPMP-STS -Boiler 3 Circulation Pump Status (1 DI)

Common points to all boilers:

- BLDGOAT-T -Building Outdoor Air Temperature (1 AI)
- MHWST-T -Main Heating Water Supply Temperature (1AI)
- MHWRT-T -Main Heating Water Return Temperature (1AI)
- MHTGPMP1-CMD -Main Heating Pump 1 Enable/Disable (1DO)
- MHTGPMP1-STS -Main Heating Pump 1 Status (1DI)
- MHTGPMP2-CMD -Main Heating Pump 2 Enable/Disable (1DO)
- MHTGPMP2-STS -Main Heating Pump 2 Status (1DI)

.2 Start/Stop

.1 The Heating System shall be enabled by the EMCS when the outside air temperature is 1ºC below WWLO-SP (15ºC adjustable) and disabled when the outdoor air temperature rises 1oC above the WWLO-SP as follows:

.1 When the Heating System has been enabled, the primary heating pumps and coil circulators shall be switched on first, after a 3-minute delay and at minimum one (1) pump status verification the boilers shall be allowed to operate in accordance to the specified Boiler control sequence.

.2 When the heating system has been disabled, the boilers shall be shut off first, and after a 3-minute time delay all primary pumps and coil circulators shall be switched off.

.2 Heating pumps with one operational and one standby shall operate as Lead/Lag operation. The “Lead” shall be rotated on a weekly basis (every Tuesday at 8am) with graphical indication as to which pump is Lead and which is Lag. If the lead pump status is off, the lag pump shall be started within 3 seconds. If the primary pump status

returns to "on", both pumps shall operate for 2 minutes before the standby pump is shut off. When switching New primary pump shall be started and status proven before standby (old primary) pump is switched off.

.3 When an individual boiler is commanded off, the associated boilers circulated shall continue to run for 3 minutes to dissipate heat and then will shut off (internal to boilers).

.4 When there are three (3) boilers – (unless otherwise stated) two (2) are to be operational and one (1) shall always be standby. Lead, Lag and Standby Boilers shall be rotated on a weekly basis (every Tuesday at 6am) and graphically indicated as to which boiler is Lead, Lag and Standby. If either the Lead or Lag Boiler is in Alarm or status has not be verified within 3 minutes (adjustable) after enable command, the standby boiler shall replace that boiler as either Lead or Lag and a maintenance alarm shall be generated to indicate Boiler Failure. This standby boiler shall remain in rotation in the operating sequence until the alarm has been reset.

.5 When the heating system has first be enabled through the WWLO_SPT and the primary heating water pump has operated for 3 minutes, the lead boiler and associated circulation pump should be turned ON at high fire, once status is proven the burner shall be allowed to modulate. After Lead Boiler burner status has been proven and boiler command is at 100% for 10 minutes (adjustable), the lag boiler shall be enabled at high fire. Once the lag boiler burner status has proven, both boilers shall operate together until the Main Heating Water Supply Temperature setpoint (MHSWT-SPT) has been satisfied and then normal boiler sequence of operation shall begin.

.3 Boiler Control

.1 When the main heating water supply temperature (MHWST_T) is more than 2.5ºC (Adjustable) below set point (MHWST_SP) the lead boiler shall be commanded ON by the EMCS, followed by burner modulation. The burner shall first be enabled at low fire, 3 Minutes (adjustable) after Burner Status is proven the burner shall be allowed to gradually increase output using PID control to maintain the heating system set point (MHSWT_ SP).

.2 If the MHWST_T falls to more than 8.5ºC (User Adjustable) below the MHWST_ SP, and the lead boiler is burner modulation is at 90% or greater output, the lag boiler (and associated circulation pump) shall be commanded "ON" and held at low fire while the lead boiler continues to modulate according to its PID loop to maintain MHWST_SP.

.3 When the lag boiler Burner Status has proven there shall be a 3 minute (adjustable) time delay followed stepped control of burner (increases in increments of 5% output every 2 minutes) until reaching 50% output or until the lead boiler output command falls to 60% modulation output or lower. When either of these conditions are met, both boilers (lead and lag) shall go to low fire and then be allowed to modulate together to satisfy the MHWST_SP.

.4 When the MHWST_T reaches set point, the lag boiler shall be disabled, and the lead boiler shall continue to modulate. When the MHWST_T rises to set point + 3oC, the lead boiler shall hold at minimum fire. When at low fire, if the MHWST_T reaches set point + 5oC the lead boiler shall be switched off. If the MHWST_T drops to set point - 1oC the boiler may begin to modulate again according to the PID loop command.

.4 Hot Water Supply Reset

.1 The outside air temperature shall reset the heating water supply temperature set-point (MHWST_ SP) according to the following schedule:

Outdoor Air Temp OAT-T	Hot Water Supply Temp MHWST SP
-15ºC	80ºC
10ºC	35ºC

.2 All parameters of the reset schedule shall be (super used) adjustable through the graphics. The indoor/outdoor reset schedule shall also be offset by actual heating demand and the calculated setpoint shall be displayed on the system graphics.

.5 Heating Demand Offset

.1 Actual heating demand shall be measured by available (site specific) conditions including but not limited to the following:

- Perimeter Heating Demand (1-2 classrooms per zone or the zone 3-way valve).
- AHU Heating Valve Demand (AHU with greatest heating demand)
- Condenser Water Loop Heating Valve Demand (where applicable)

.2 If all of the heating valves are less than 60% heating demand, decrease the MHWST_SP by 1ºC every 2 minutes to a maximum of MHSWT-SP -7.5ºC. This shall be considered the ACTIVE MHSWT-SP (displayed on the Graphics).

.3 If any of the heating valves have greater than 95% heating demand, increase the ACTIVE MHSWT_SP by 1ºC every 2 minutes until reaching the original MHWST_SP or when the maximum heating demand is less than 70%.

.6 Safeties

.1 When the boiler lead pump is commanded on by the EMCS, and no proof is received after 30 seconds, then the lead pump shall be commanded off and a maintenance alarm shall be generated. The lag pump shall start on failure of the lead pump. If the lag pump also fails, then a critical alarm shall be generated.

.2 A manual reset in programming shall be provided to release all pumps from emergency status and return to normal status and restart lead/lag sequence.

.3 The hot water return temperature for noncondensing boilers shall not be less than 48ºC.

.7 Alarms

.1 **Critical**

.1 Low Boiler Temp (MHWST<35oC when OAT<5oC)

.2 **Environmental**

.1 MHWST/MHWRT High and Low Limits.

.3 **Maintenance**

.1 Boiler failures/alarm

.2 Pump failure

.4 **Energy Alarms**

.1 Boiler cycles more than 4 times/hour (adjustable)

.2 Minimum Boiler operating time < 5 minutes (adjustable)

.5 The initial set up values for all alarms shall be established during the commissioning process.

.8 Adjustable Points (to be displayed and accessed on system Setting Page)

- Calendar Operating Schedule
- Outdoor/Supply Water Reset Schedule Parameters
- Lead Boiler Minimum Run Time
- Boiler Staging Differential Set Points and Lead/Lag Boiler Time Delays
- Warm Weather Lockout Setpoint and differential
- Alarm Settings – (setpoints and time delay parameters as noted in part 2.14.7 Alarms)

2.15 PERIMETER RADIATION LOOP HEATING SYSTEM

.1 Anticipated Points:

- HTGZxPMPx-CMD - Heating Pump x CMD (1 DO)
- HTGZxPMP-STS - Heating Pump x Status (1 DI)
- HTGZxHTGVLV-MOD -Heating Valve Control (1 AO)
- HTGZxSWT-T - Zone x Supply Water Temp (1 AI)
- HTGZxRWT-T - Zone x Return Water Temp
- BLDGxOAT-T - Building Outside Air Temp (1 AI)

Zone Controls

Anticipated Points:

- RMxxxRMT-T - Room xxx Room Temp (1 AI)
- RMxxxHTGVLV_MOD - Room xxx Htg Valve Modulation (1AO)

.2 Start/Stop:

.1 The perimeter radiation loop pump(s) will be switched on/off according to the same parameters as specified in the Boiler Control Sequence.

.3 Perimeter Radiation Control:

.1 The radiation 3-way mixing valve shall be modulated based on the radiation zone heating water supply temperature set point (HTGZxSWT_SPT).

.2 The outside air temperature shall reset the heating zone water supply temperature set-point (HTGZxSWT_ SP) according to the following schedule:

Outdoor Air Temp OAT-T	Zone Supply Water Temp HTGZxSWT SP
-10ºC	75ºC
10ºC	40ºC

.3 All parameters of the reset schedule shall be (super used) adjustable through the graphics. The indoor/outdoor reset schedule shall also be offset by actual heating demand within the associated zone and the calculated setpoint shall be displayed on the system graphics.

.4 Heating Demand Offset

.1 Actual heating demand shall be measured by available (site specific) room conditions within the zone including but not limited to the following:

.1 Perimeter Heating Demand (Minimum 1-2 rooms per heating zone.

.2 If the monitored heating valves are less than 60% heating demand, decrease the HTGZxSWT_SP by 1ºC every 2 minutes to a minimum of HTGZxSWT_SP -10ºC. This shall be considered the ACTIVE HTGZxSWT_SP and shall be displayed on the Graphics.

.3 If any of the monitored heating valves have greater than 95% heating demand, increase the ACTIVE HTGZxSWT_SP by 1ºC every 2 minutes until reaching the original outdoor reset schedule or until the maximum heating demand is less than 70%.

.4 The monitored and control rooms on the associated radiation loop shall have an occupied, and unoccupied room temperature set-points. These points shall be adjustable from the graphics.

.5 Occupied Mode:

.1 The EMCS shall modulate the heating valve to maintain occupied heating set point of 21.5ºC (adjustable).

.6 Unoccupied Mode:

.1 The EMCS shall modulate the heating valve to maintain an un-occupied room temperature setpoint of 18ºC (adjustable).

.7 The Occupied/Unoccupied heating schedule shall be according to the MSOSx for the related area of the building and as identified in the specified points list. The EMCS shall switch the rooms from un-occupied to occupied 1 hour prior to the start of the MSOSx).

.5 Safeties:

.1 Heating valves shall fail normally open.

.6 Alarm Points

.1 **Critical**

.1 Low Room Temp (RMT<14ºC when OAT<5ºC)

.2 **Environmental**

.1 Room temperature high/low limits

.3 **Maintenance**

.1 OAT< 5ºC, heating valve at 100% demand for greater than 1 hour (adjustable)

.4 **Energy**

.1 OAT< 5ºC, heating valve demand <20% for more than 1 hour (adjustable).

.5 The initial set up values for all alarms shall be established during the commissioning process.

.7 Adjustable Points (to be displayed and accessed on system Setting Page)

- Outdoor/Supply Water Reset Schedule Parameters
- Alarm Settings (setpoints and time delay parameters as noted in part 2.16.6 Alarms)

2.16 DOMESTIC HOT WATER CONTROL

.1 Anticipated Points.

- DHWPMP-CMD - Domestic Hot Water Pump Start/Stop (1DO)
- DHWPMP-ST - Domestic Hot Water Pump Status (1DI)
- DHWVLV-CTL - Domestic Hot Water Valve Modulation (1AO)
- DHWT-T - Domestic Hot Water Temp Temperature (1AI)

.2 Start/Stop

.1 The domestic hot water recirculation pump (DHW PMP) shall be switched ON/OFF automatically by the EMCS on a time of day operating schedule.

.3 Temperature Control

.1 Modulate the steam/hot water control valve to maintain a leaving water temperature (DHWT-T) from the heat exchanger of 120 F .(adjustable).

.4 Safeties:

.1 Anti-scalding valves shall dump cold water into the system to prevent overheating of the DHW supply.

.5 Alarm Points

.1 **Critical**

.1 N/A

.2 **Environmental**

.1 DHWST High/Low Limits

.3 **Maintenance**

.1 DHWST <DHWSTSP for more than 20 consecutive minutes (adjustable)

.4 **Energy**

.1 DHWPMP_ST on when DHWPMP_CMD is off

.5 The initial set up values for all alarms shall be established during the commissioning process.

.6 Adjustable Points (to be displayed and accessed on system Setting Page)

- DHWST_SP
- Pump Operating Schedule
- Alarm Parameters (Setpoints and time delay parameters as noted in part 2.16.5 Alarms)

Appendix B: City of Mississauga Forms and Templates

Appendix B
City of Mississauga Forms and Templates

B1 – CoM Points List Template
B2 – CoM Sample Points List
B3 – CoM Pre-Commissioning Checklist Form
B4 – CoM Project Acceptance Form
B5 – CoM Training Sign-Off Form

EMCS PROJECT ACCEPTANCE SIGN-OFF FORM
DEFICIENCIES AND ACTION ITEMS

Project/Site:

Submitting for:

- ☐ Provisional Acceptance
- ☐ Final Acceptance
- ☐ Warranty Monitoring

The project has been reviewed against the prescribed acceptance criteria:

PROVISIONAL ACCEPTANCE

- ☐ • System is completely installed, calibrated, tested and operational
- ☐ • Preliminary deficiency items have been corrected
- ☐ • Preliminary as-builts have been received
- ☐ • Functional Testing Check List complete as specified (**Pre-Commissioning Checklist attached**)
- ☐ • Commissioning has been scheduled with the owner and/or owner's agent
- ☐ • Graphics Submitted are in accordance with the Graphical Template
- ☐ • User Sign-In Levels have been Tested and are Operational with Proper Authorities and Restrictions
- ☐ • Trend have been set up to specified intervals and Auto-upload to server is verified
- ☐ • All Alarms have been tested and routing verified

FINAL ACCEPTANCE

- ☐ • Final commissioning is complete
- ☐ • Attached deficiency list has been completed by the vendor
- ☐ • Final documentation has been received
- ☐ • Final as-builts updated and uploaded to graphics, hard copies received
- ☐ • Software/Programming turned over to Owner
- ☐ • Training is complete and Sign off Form Attached

WARRANTY MONITORING

- ☐ • No identified deficiencies remain

This project stage is complete as indicated above.

Approver for the Vendor: Date:

_____ _____

Approver for the Consultant: Date:

_____ _____

Approver for the City of Mississauga: Date:

_____ _____

EMCS PROJECT ACCEPTANCE SIGN-OFF FORM
DEFICIENCIES AND ACTION ITEMS

Project/Site:

ITEM	DESCRIPTION	ACTION BY	Date Completed	Contractor	Owner
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

EMCS PROJECT ACCEPTANCE SIGN-OFF FORM
DEFICIENCIES AND ACTION ITEMS

Project/Site:

Additional Project Comments/Notes:

EMCS PROJECT ACCEPTANCE SIGN-OFF FORM
STAFF TRAINING

Project/Site:

STAFF TRAINING

- [ ] • Final commissioning of the new EMCS is complete
- [ ] • Facilities Staff can log on to the new EMCS
- [ ] • Facilities Staff have the proper levels of EMCS access
- [ ] • Facilities Staff have been trained to operate the new EMCS
- [ ] • Facilities Staff questions have been addressed by the vendor

This project stage is complete as indicated above.

BAS Vendor: Date:

Name Signature

Date:

City of Mississauga Employee:

Name Signature

City of Mississauga Employee: Date:

Name Signature

Appendix B1 - CoM Points List Template

Site
Site Address
Points Matrix

All existing power supplies, cabinets, relays, sensors, wiring to be replaced unless otherwise noted. Conduits may be reused in whole or in part. Unused conduit to be removed. Applies to all existing points unless otherwise noted.

The Site ID for ######## is ####. All points are to use this Site ID as a prefix (e.g.####_RTU1FAN_CMD).

System Identifier	**Location**	**Power Panel**	**Sequence**	**Serving**	
Existing Point Name	Tag	Point Description	Type	Units in Display	Comments

System Identifier	**Location**	**Power Panel**	**Sequence**	**Serving**	
Exhaust Fans	Various			Washrooms/Changerooms	
Existing Point Name	Tag	Point Description	Type	Units in Display	Comments

Appendix B3 - CoM Sample Points List

Port Credit Arena
40 Stavebank Rd, Mississauga ON
Points Matrix

All existing power supplies, cabinets, relays, sensors, wiring to be replaced unless otherwise noted. Conduits may be reused in whole or in part. Unused conduit to be removed. Applies to all existing points unless otherwise noted.

The Site ID for Port Credit Arena is PCA1. All points are to use this Site ID as a prefix (e.g. PCA1_RTU1FAN_CMD).

System Identifier	**Location**	**Power Panel**	**Sequence**	**Serving**	
HHA1	Roof (ADDITION)			Rink B Change Rooms	
Existing Point Name	Tag	Point Description	Type	Units in Display	Comments
New Point	RTU1BACNET_COM	RTU-1 BacNet Communucation (MS/TP)	COM	Online/Offline	Integrate with existing Delta DDC Controller via BACNet MS/TP
New Point	RTU1FAN_CMD	RTU-1 Fan Command	VP	On/Off	Control point via BACNet
New Point	RTU1MODE_CMD	RTU-1 Control Mode	VP	Unoccupied/Ventilation	Control point via BACNet
New Point	RTU1SF_STS	RTU-1 Supply Fan Status	VP	On/Off	Point read via BACNet
New Point	RTU1EF_STS	RTU-1 Exhaust Fan Status	VP	On/Off	Point read via BACNet
New Point	RTU1ERW_STS	RTU-1 ERV Wheel Status	VP	On/Off	Point read via BACNet
New Point	RTU1ERW_SPD	RTU-1 ERV Wheel Speed	VP	%	Point read via BACNet
New Point	RTU1OAT_T	RTU-1 Outdoor Air Temperature	VP	°C	Point read via BACNet (if available)
New Point	RTU1OAH_HUM	RTU-1 Outdoor Air Relative Humidity	VP	% RH	Point read via BACNet (if available)
New Point	RTU1SAT_T	RTU-1 Supply Air Temperature	VP	°C	Point read via BACNet
New Point	RTU1RAT_T	RTU-1 Return Air Temperature	VP	°C	Point read via BACNet
New Point	RTU1ERWDISCHT_T	RTU-1 ERW Discharge Air Temperature	VP	°C	Point read via BACNet (if available)
New Point	RTU1EAT_T	RTU-1 Exhaust Air Temperature	VP	°C	Point read via BACNet
New Point	RTU1BUR_STS	RTU-1 Burner Status	VP	%	Point read via BACNet
New Point	RTU1CLG1_STS	RTU-1 Cooling Stage 1 Status	VP	On/Off	Point read via BACNet - May not be required if Cooling is not enabled
New Point	RTU1CLG2_STS	RTU-1 Cooling Stage 2 Status	VP	On/Off	Point read via BACNet - May not be required if Cooling is not enabled
New Point	RTU1SAT_SPT_WINT	RTU-1 Winter Supply Air Setpoint	VP	°C	Virtual Point
New Point	RTU1SAT_SPT_HTG	RTU-1 Heating Supply Air Setpoint	VP	°C	Virtual Point
New Point	RTU1SAT_SPT_SUMM	RTU-1 Summer Supply Air Setpoint	VP	°C	Virtual Point - May not be required if Cooling is not enabled
New Point	RTU1SAT_SPT_CLG	RTU-1 Cooling Supply Air Setpoint	VP	°C	Virtual Point - May not be required if Cooling is not enabled
New Point	RTU1ECON_SPT_ENTH	RTU-1 Economizer Enthalpy Setpoint	VP	BTU/lb	Virtual Point - May not be required if Cooling is not enabled
New Point	RTU1ROOM_SPT	RTU-1 Space Setpoint	VP	°C	Virtual Point
New Point	RTU1RMT134_T	RTU-1 Room 134 Space Temperature	Ai	°C	New Flat Plate Sensor Installed in Room 134
New Point	RTU1RMT136_T	RTU-1 Room 136 Space Temperature	Ai	°C	New Flat Plate Sensor Installed in Room 136
New Point	RTU1RMT138_T	RTU-1 Room 138 Space Temperature	Ai	°C	New Flat Plate Sensor Installed in Room 138
New Point	RTU1RMT142_T	RTU-1 Room 142 Space Temperature	Ai	°C	New Flat Plate Sensor Installed in Room 142
New Point	RTU1RMT134_OCC	RTU-1 Room 134 Occupancy	Di	Occupied/Unnocupied	Utilize Existing Occupancy Sensor Installed in Room 134
New Point	RTU1RMT136_OCC	RTU-1 Room 136 Occupancy	Di	Occupied/Unnocupied	Utilize Existing Occupancy Sensor Installed in Room 136
New Point	RTU1RMT134_OCC	RTU-1 Room 138 Occupancy	Di	Occupied/Unnocupied	Utilize Existing Occupancy Sensor Installed in Room 138
New Point	RTU1RMT142_OCC	RTU-1 Room 142 Occupancy	Di	Occupied/Unnocupied	Utilize Existing Occupancy Sensor Installed in Room 142

System Identifier	**Location**	**Power Panel**	**Sequence**	**Serving**	
Exhaust Fans	Various			Washrooms/Changerooms	
Existing Point Name	Tag	Point Description	Type	Units in Display	Comments
New Point	WREF1_CMD	Washroom Exhaust Fan 1 Command	Do	On/Off	
New Point	WREF2_CMD	Washroom Exhaust Fan 2 Command	Do	On/Off	
New Point	WREF1_STS	Exhaust Fan 1 Status	Di	On/Off	
New Point	WREF2_STS	Exhaust Fan 2 Status	Di	On/Off	
New Point	CR117_OCC	Changeroom 117 Occupancy	Di	On/Off	Utilize Existing Occupancy Sensor Installed in Room 117
New Point	CR117EF_STS	Changeroom 117 Exhaust Fan Status	Di	On/Off	Commanded through occupancy Sensor
New Point	CR118_OCC	Changeroom 118 Occupancy	Di	On/Off	Utilize Existing Occupancy Sensor Installed in Room 118
New Point	CR118EF_STS	Changeroom 118 Exhaust Fan Status	Di	On/Off	Commanded through occupancy Sensor

Pre-Commissioning Check List

The following Check List will be prepared by the controls Vendor and Submitted to Ameresco Prior to scheduling of Commissioning

Facility Name _____
Municipal Address _____
IP Address _____
Company _____

Panel No:	**Location:**	**Power Supplied From:**

Auto Restoration on Loss of Power ____
Wires Labelled ____
Panel Schedule Enclosed ____
Existing Redundant Controls Removed ____

Point No	Name Descriptor	Description	Type	Device	Fail Mode	Verified By	Comments

Additional Comments/Site Notes:

_____
Control Technition

_____
Print Name

_____
Date

EMCS PROJECT ACCEPTANCE SIGN-OFF FORM
DEFICIENCIES AND ACTION ITEMS

Project/Site:

Submitting for:

- ☐ Provisional Acceptance
- ☐ Final Acceptance
- ☐ Warranty Monitoring

The project has been reviewed against the prescribed acceptance criteria:

PROVISIONAL ACCEPTANCE

- ☐ • System is completely installed, calibrated, tested and operational
- ☐ • Preliminary deficiency items have been corrected
- ☐ • Preliminary as-builts have been received
- ☐ • Functional Testing Check List complete as specified (**Pre-Commissioning Checklist attached**)
- ☐ • Commissioning has been scheduled with the owner and/or owner's agent
- ☐ • Graphics Submitted are in accordance with the Graphical Template
- ☐ • User Sign-In Levels have been Tested and are Operational with Proper Authorities and Restrictions
- ☐ • Trend have been set up to specified intervals and Auto-upload to server is verified
- ☐ • All Alarms have been tested and routing verified

FINAL ACCEPTANCE

- ☐ • Final commissioning is complete
- ☐ • Attached deficiency list has been completed by the vendor
- ☐ • Final documentation has been received
- ☐ • Final as-builts updated and uploaded to graphics, hard copies received
- ☐ • Software/Programming turned over to Owner
- ☐ • Training is complete and Sign off Form Attached

WARRANTY MONITORING

- ☐ • No identified deficiencies remain

This project stage is complete as indicated above.

Approver for the Vendor: Date:

_____ _____

Approver for the Consultant: Date:

_____ _____

Approver for the City of Mississauga: Date:

_____ _____

EMCS PROJECT ACCEPTANCE SIGN-OFF FORM
DEFICIENCIES AND ACTION ITEMS

Project/Site:

ITEM	DESCRIPTION	ACTION BY	Date Completed	Contractor	Owner
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

EMCS PROJECT ACCEPTANCE SIGN-OFF FORM
DEFICIENCIES AND ACTION ITEMS

Project/Site:

Additional Project Comments/Notes:

EMCS PROJECT ACCEPTANCE SIGN-OFF FORM
STAFF TRAINING

Project/Site:

STAFF TRAINING

- ☐ • Final commissioning of the new EMCS is complete
- ☐ • Facilities Staff can log on to the new EMCS
- ☐ • Facilities Staff have the proper levels of EMCS access
- ☐ • Facilities Staff have been trained to operate the new EMCS
- ☐ • Facilities Staff questions have been addressed by the vendor

This project stage is complete as indicated above.

BAS Vendor: Date:

Name Signature

Date:

City of Mississauga Employee:

Name Signature

City of Mississauga Employee: Date:

Name Signature

EMCS: GENERAL SCOPE OF WORK

EMCS: GENERAL SCOPE OF WORK

Part 1 General

1.1 REQUIREMENTS

1.1.1 Conform to the General requirements of Divisions 00, 01, 22, 23 and 24

1.1.2 Conform to the requirements of the "Master Specifications for Energy Management Control Systems" Latest Revision including requirements of the following Sections:

1.1.2.1 Section 25 01 11 – EMCS: Start-up, Verification and Commissioning

1.1.2.2 Section 25 01 12 – EMCS: Training

1.1.2.3 Section 25 05 01 – EMCS: General Requirements

1.1.2.4 Section 25 05 02 – EMCS: Submittals and Review Process

1.1.2.5 Section 25 05 03 – EMCS: Project Record Documents

1.1.2.6 Section 25 05 54 – EMCS: Identification

1.1.2.7 Section 25 08 20 – EMCS: Warranty and Maintenance

1.1.2.8 Section 25 10 01 – EMCS: Local Area Network (LAN)

1.1.2.9 Section 25 30 01 – EMCS: Building Controllers, Family of Controllers

1.1.2.10 Section 25 03 02 – EMCS Field Control Devices

1.1.2.11 Section 25 90 01 – EMCS Site Requirements, Applications and System Sequences of Operation

1.1.2.12 Appendix A – City of Mississauga Standards and Guidelines

1.1.2.13 Appendix B – City of Mississauga Forms and Templates

1.2 GENERAL OBJECTIVES

1.2.1 This project is [PROJECT NAME/DESCRIPTION] for the City of Mississauga Energy Management Control Systems (EMCS) involving the [replacement of existing controls],[installation of a new control system] including work at site and the modification of Owner's EMCS Enterprise Server Software (ESS) for the City of Mississauga.

1.2.2 The scope of work for this contract shall include [the complete removal of existing electrical/pneumatic/digital controls (including abandoned and redundant controls) and] the installation of new direct digital controls including Niagara JACE 8000 Series Supervisory Controller(s), all remote programable digital controllers (RPDC), Terminal Equipment Controllers (TEC) and connection to OEMASC for a complete and functional control system. The number of field controllers shall be of sufficient number to accommodate the points identified in the points list and specified here within. The new control system shall be in accordance with the City of Mississauga "Master Specifications for Energy Management Control Systems (EMCS)" operating on the City of Mississauga Niagara 4 platform.

1.2.3 This contract requires the full development of NEW site-specific customized graphics in accordance with the City of Mississauga Graphical Standards. The contractor shall utilize existing graphical workstation(s) as a guideline for the starting point of development of the new graphics and shall work closely with the Owner and Consultant to create the site specific graphics (including possible enhancements to the existing Graphical Standard).

1.2.4 The EMCS contractor shall meet with the Owner and Consultant within 2 weeks of the Project Start-Up meeting to specifically discuss the requirements for new system graphics and associated plan of execution.

EMCS: GENERAL SCOPE OF WORK

1.2.5 The EMCS contractor shall anticipate a reiterative process whereby the graphics will be submitted multiple times for review and comment, followed by revision(s) until both the Owner and Consultant are satisfied with the end result (and graphics approval is granted). **NO CONTROL INSTALLATION WORK CAN BEGIN ON SITE UNITL THE GRAPHICS ARE SUBMITTED AND APPROVED.**

1.2.6 [Remove existing, supply and install all new cabinet enclosures, new controllers, power supplies, control wiring, hardware and end devices for a complete and total system as indicated. The contractor shall NOT re-use existing cabinets, controllers, wiring, relays, sensors, or other end devices unless otherwise noted. Conduits may be re-used to run new wiring].

1.2.7 Provide all new programming to achieve energy efficiency in accordance with the specified sequence of operation and at the direction of the consultant.

1.2.8 Perform all Pre-Commissioning activities including Functional and Performance Testing, Completion of Pre-Commissioning Checklists, Submission of Provisional Acceptance Forms.

1.2.9 Upon submission and acceptance of the Provisional Acceptance Forms by the Owner and Consultant, arrange for a Commissioning date through the Prime Contractor. EMCS contractor shall guide and assist Commission Agent to inspect and verify a second round of functional and performance testing to achieve optimized performance of the building and building systems.

1.2.10 Complete training, submit documentation and correct all deficiencies in a timely manner prior to submission of Final Acceptance Forms

1.3 SPECIFIC SCOPE OF WORK – [SITE NAME]

Specification Note: This section is where the details of the site-specific project should be described by the Consultant/Design Engineer. The following is a typical example:

1.3.1 The scope of work for [SITE NAME] shall include the complete disconnect and removal of existing abandoned and redundant electrical/pneumatic/digital controls, including all control cabinets, power supplies, wiring, relays, sensors and other end devices. Contractor shall walk through the job site with Owner/Consultant at the start of the job to confirm and review total extent of removals.

1.3.2 Supply and install all new control cabinets, power supplies, relays, actuators, sensors, thermostats, wiring, etc. as specified and as necessary to achieve the specified sequence of operation associated with the replacement of existing and addition of new control points. Refer to points list and sequences of operation in Appendix [A].
Specification Note: Consultant/Design Engineer to make use of the CoM materials as outlined in the Design Guideline and Master Specifications to generate a points lists and associated sequence of operation to be included in the project specifications. All points to be named using the CoM point naming convention. Sequences and points list shall be submitted to,, and approved by, the CoM before tender.

1.3.2.1 The contractor may re-use existing conduits where possible. All wiring, sensors, relays, end devices, etc. as indicated in points list to be replaced shall be removed and replaced with new.

1.3.2.2 Provide all programming as outlined in the Sequences of Operation detailed in Appendix [A] including all new customized site-specific graphics in accordance with the City of Mississauga Master Specifications for Energy Management Control systems EMCS.

EMCS: GENERAL SCOPE OF WORK

1.3.2.3 All graphics, EMCS control programming, trend data, security settings, access level priorities, etc. shall be uploaded by the EMCS contractor and stored on the EMCS Server prior to the start of commissioning and again upon completion of deficiency clean-up and submission of as-built. The EMCS contractor shall set-up automatic back-up of the site databased and programming to the server at the direction of CoM Energy Management Specialist.

1.3.2.4 The dedicated EMCS server shall be the primary global interface.

1.3.2.5 The SRPDC shall have an Open Nics statement and be licensed to the owner and shall have a minimum of 20% spare capacity for additional points/controllers associated with this installation.

1.3.3 Provide new "as-built" drawings including all new/modified points, communication BUS and location of field panels, terminal equipment controllers, and associated power supplies, updated panel termination diagrams and revised sequence of operation.

1.4 SHOP DRAWINGS AND PRODUCT DATA

1.4.1 Submit shop drawings and product data in accordance with Section 01 33 00 of these specifications and the requirements of City of London Master Specifications for EMCS Upgrades.

1.5 ELECTRICAL WIRING

1.5.1 Submit shop drawings and product data in accordance with Section 01 33 00 of these specifications.

1.5.2 All wiring shall comply with local and national electrical codes and the requirements of Divisions 22, 23 and 24.

1.5.3 All control and sensor wiring shall be colour coded in compliance with designated colour scheme by vendor.

1.5.4 All wiring shall be plenum rated Beldon or equivalent, #18, #20 or #22-gauge, non-shielded wiring when in conduit, shielded where exposed. Lengths for specific gauge and applications shall comply with the control's manufacturer's guidelines. Exposed wiring in service areas (Mechanical/Electrical) shall be in EMT conduit, plenum rated cable above ceilings. Any exposed wiring in corridors, classrooms, etc. (finished areas) shall be in wire mold.

1.5.5 Size 24 VAC wiring according to length. Refer to manufacturer's voltage drop table and size wire to achieve a minimum of 22 VAC at the control being powered.

1.5.6 The use of wire-nuts for connections on communication bus is prohibited. Use "Scotchlok" 3M terminals or other similar terminal block type product.

1.5.7 All new controls shall have an independent power supply with dedicated breaker. This contractor shall be responsible for finding available power and labelling panel(s) for new control circuits.

1.5.8 **120VAC to 24 V power control transformers shall be supplied and installed in a rated electrical enclosure and wired to control panel(s). Control cabinets shall have 24Vdc only and a dedicated terminal strip as per the Master Specifications Rev 1**.

EMCS: GENERAL SCOPE OF WORK

Part 2 Products

2.1 GENERAL

2.1.1 The control system shall be comprised of complete stand-alone controllers, sensor, relays, power and control wiring where required, and other required accessories for the complete control of the specified renovations under this Contract. Control system shall be capable of accomplishing the sequence of operation as specified herein.

2.1.2 New controls shall be in accordance with the City of Mississauga "Master Specifications for Energy Management Control Systems" latest revision. Pre-Qualified bidders shall only submit for the Family of Controllers as listed in Section 25 30 01 and as follows:

Company Name	Branch Location	Contact Person	EMCS Family of Products
Facio Corporation	145 West Beaver Creek Rd, Richmond Hill, ON L4B 1C6	Gary MacMillan gmacmillan@facio.ca	Honeywell Spyder BacNet IP series (programmable via Niagara Workbench) and Ciper series controller. Distech Eclypse BacNet IP series controllers
Automated Controls and Energy Solutions Group Inc.	5285 Solar Dr Unit 103, Mississauga, ON L4W 5B8	Murat Kinaci estimates@acesolutionsgroup.ca	Honeywell Spyder BacNet IP series (programmable via Niagara Workbench) and Ciper series controller
Airon HVAC and Control Ltd.	5150 Fairview St, Burlington, ON L7L 6B7	Tanya Meade ***tanyam@airongroup.ca***	Honeywell Spyder BacNet IP series (programmable via Niagara Workbench) and Ciper series controller
Ainsworth Inc.	131 Bermondsey Rd, North York, ON M4A 1X4	Julian Rogochevsky ***Julian.Rogochevsky @ainsworth.com***	Schneider Smart X BacNet IP series, with Niagara module (programmable via Niagara Workbench)
Accu-Temp Systems Inc.	226 St Leger St, Kitchener, ON N2H 4M5	Scott Ward ***Scottw@accutempsystems.com***	Honeywell Spyder BacNet IP series (programmable

			via Niagara Workbench) and Ciper series controller
Modern Niagara Toronto Inc	8125 Hwy 50 Vaughan, Ontario L4L 1A5	Sam Boyajian ***Sboyajian@modernniagara.com***	Distech – Eclypse – Bacnet IP series controllers

2.1.3 All products must be CSA approved and BACnet certified.

2.1.4 Where the number of connected field controllers requires multiple SRPDC (Jace) panels for proper operation, contractor shall supply and connect to the EMCS Network including any necessary switches/routers.

2.1.5 All JACE panels shall come with Open NiCS statements.

Part 3 EXECUTION

3.1 GENERAL

3.1.1 The complete control system installation shall be the responsibility of pre-approved Energy Management Control System (EMCS) Contractors only (see 2.1.2). Unsolicited bids/proposals from other vendors will not be considered.

3.1.2 The wiring of the controls system shall be done in accordance with all code authorities having jurisdiction.

3.1.3 Exposed wiring shall be in EMT conduit, plenum rated (FT6) shall be acceptable above ceiling system, and wire mold shall be used in finished areas. Ethernet Communication cabling for EMCS Sub-Networks shall be in conduits throughout.

3.1.4 All conduits shall be extended to with 24-36 in of equipment/end devices before converting to flexible (liquid tight) conduit. Liquid tight/flexible conduit shall not be run for extended lengths, or from sensor to sensor.

3.1.5 Control relays shall be in accordance with Master Specifications and mounted in a dedicated electrical box (unless otherwise noted). RIB shall NOT be accepted.

3.1.6 Safety controls shall have priority with respect to control of equipment. Coordinate installation of the system to ensure that interfacing and connection of controls to equipment will not bypass or interfere with freeze stats, heat detector or other safety controls.

3.2 LOCATION OF CONTROL SYSTEM EQUIPMENT

3.2.1 New controllers, actuators, etc., to be mounted in the associated mechanical/electrical room within a NEMA rated enclosure, in accordance to Section 25 05 01 of the Master Specifications for EMCS Installations.

3.2.2 All wiring shall be brought to a dedicated Terminal Strip within the control cabinet and terminated. Wiring shall then be run from each associated termination point on the Terminal strip to the corresponding termination point on the controller Termination Board. Direct wiring or sensors/devices to the controller shall not be permitted.

EMCS: GENERAL SCOPE OF WORK

3.2.3 The location of Terminal Equipment Controllers (TEC) shall be dictated by the placement/location of terminal equipment to be controlled (i.e. Heat-Pump, Unit Ventilator, perimeter radiation etc.). Only VAV Boxes shall have direct mounted control equipment, all other equipment shall have controller mounted within a rate enclosure (see 3.2.4 below).

3.2.4 Except where otherwise noted, TEC shall be mounted in a NEMA 1 enclosure located on the building structure within five (5) feet of terminal equipment being controlled (duct work & piping are not building structure). Wiring shall be run in liquid Tight flexible conduit between the Controller enclosure and Terminal equipment to be controlled, neatly installed and secured to structure (running as close as possible to point of final termination). EMCS Contractor shall place a lamacoid plate or P-Touch label on the ceiling tile support system directly below each terminal device indicating the controller name (i.e. VAV1).

3.2.5 Controllers may be mounted inside of the equipment where dedicated control space is possible. If controller cannot be mounted inside equipment, it should be mounted in an enclosure located in the ceiling space above. In some instances, it may be necessary (with approval of Owner) to install within the occupied space in a lockable, NEMA enclosure, mounted at serviceable height (4 ft) on wall.

3.3 SEQUENCE OF OPERATIONS

3.3.1 Refer to specified Sequences of Operation in Appendix A.

3.3.2 Sequences are somewhat generic in nature. Contractor shall work with Owner and/or consultant to modify sequences as necessary to achieve optimal system performance. This shall be done at no additional cost to the project.

3.4 WARRANTIES

3.4.1 Control system component manufacturers shall guarantee a minimum one (1) year for all control devices and five (5) years of software updates for the SRPDC. All warranties shall be given to the Owner.

3.4.2 Note that all warranties to commence from time of final acceptance. Contractor to utilize the EMCS Project Acceptance Forms (See Appendix B).

END OF SECTION 25 01 00

Spec Note: Consultant to include points list, Sequence of operations, and applicable CoM Forms (EMCS Acceptance, Training sign-off, Pre-commissioning Checklist) with the project specifications. Refer to CoM EMCS Design Guidelines.

1 General

1.1 RELATED REQUIREMENTS

.1 Division 23 – Heating, Ventilating, and Air Conditioning.

.2 The Section references provided below are provided to describe the work results, and the Section itself may or may not appear in the Project Manual.

2 HVAC Operating Schedule and Modes (Common)

2.1 GENERAL

.1 Equipment/Systems will be controlled to operate continuously in a variety of different modes of operation. Control shall be done locally at RPDC, TEC and OEMASC, interfaced with the EMCS ESS through the SRPDC.

.2 All scheduling shall be time of day (TOD) calendar based and shall factor in; Holidays, Weekends, and other modes of operation where indicated. In some cases, indoor or outdoor temperatures shall dictate a part of the permissible operation of equipment.

.3 Whenever fan systems are scheduled “off”, outdoor and exhaust air dampers will be closed, hot water heating coil valves will modulate to maintain mixed air low limit setpoint, cooling water coil valves will be closed (except as noted), electrical heating coils, humidifiers, and refrigeration coils (DX cooling) shall be locked out. (as applicable)

.4 Mixing damper and valve actuators shall be powered such that when the fan system if OFF (in either “auto” or “manual”) the actuators shall be de-energized and will return to the fail-safe position.

2.2 MASTER SYSTEM OCCUPANCY SCHEDULE(MSOS)

.1 Modes of Operation

.1 The EMCS shall run each defined system (or groups of equipment/Systems) according to a Master System Occupancy Schedule (MSOSx), and then again individually for programmed events and temporary overrides outside of the MSOSx.

.2 Occupied Mode.

.1 The EMCS shall run the associated equipment/systems according to the master system occupancy schedule (MSOSx). Occupied operation of the equipment shall be in accordance with a specified Time of Day (TOD) and Calendar operating schedule.

.2 Each occupancy schedule shall have three distinct modes of operation – OCCUPIED, UNOCCUPIED, and HOLIDAY.

.3 Occupied Mode

.1 The specific Mode of Operation (Occupied/Unoccupied/Holiday/etc.) shall be identified as “MODE” and displayed on the systems page. The calendar and start/stop times shall be accessed through the associated system “Settings” page and adjustable through the graphics by assigned user levels.

.2 Vacant Mode (for systems with occupancy sensors)

.1 During Occupied Mode when the space/area has become “vacant” for the prescribed period of time, the EMCS shall widen the heating and cooling dead band by 1°C (adjustable) and shall ignore minimum ventilation settings. Fans shall continue to operate according to the specified mode

.2 When occupancy is detected, the system shall revert back to occupied settings.

.3 Fan Mode

.1 During occupied operation there shall be two distinct fan modes:

.1 Continuous – Fan operates continuously

.2 Automatic – Fan Duty Cycles based on heating/cooling/humidification/CO2 demand

.2 There shall be graphical indication on the systems page as to which mode the fan is operating in and a selectable switch on the associated system setting page to allow the facility operator to choose the mode of fan operation.

.3 Schedule to be discussed with facility operations and CoM project manager prior to start of commissioning. System may be combined to operate on the same time schedule(TBD) but each shall have a bility to operate outside of the MSOSx via the event schedule.

.4 Event shall be a secondary temporary schedule outside of the MSOSx and shall take priority. Systems shall operate to brings area upto occupied settings 30 min (Adjustable) ahead of programmed event schedule and shall stop at th end of the event to return to the MSOSx

.4 Holiday Mode

.1 During scheduled holidays, systems shall remain in their Unoccupied operational state.

.5 Unoccupied Mode

.1 In un-occupied mode fans, heating, and cooling will all be de-energized, and the outside air dampers will be closed unless required by the specified sequence for maintaining un-occupied heating and cooling set points or as required for night purge etc.

.2 For units with VSD's when cycled on the fans shall operate at a reduced speed of 60% output (user adjustable) to start, after 15 Min (adjustable) if the un- occupied heating/cooling setpoint has not be attained, the fan system will start to ramp up slowly until the unoccupied setpoints have been satisfied.

.6 Night Purge Mode

.1 Between the hours of 3am and 5am, if the outdoor air temperature is between 10°C and 19°C(user adjustable via associated setting page) and avaerage room temp associated with a fan or make-up air system is above 26°C (user adjustable via associated setting page), the fan (or make-up air) system will be energized with economizer cooling until the space temperatures is 21°C (user adjustable via associated setting page) and then shall be switched off.

.7 Morning Start-up Mode

.1 The EMCS shall use an optimized morning start-up routine, incorporating outside air temperature, zone temperatures, heating valves and cooling valves positions, and past history of the building response to determine the optimum time to start the HVAC systems. The maximum start-up period shall not exceed 3 hours (adjustable).

2.3 TEMPORARY OVERRIDE SCHEDULES (TOS)

.1 Temporary overrides will be provided to the operator through a graphical Override Button on the associated floor plan and HVAC system graphic. The override will enable the associated HVAC

unit with fan operation and heating control only to maintain the Daytime Occupied Heating set point for a specified date and time (adjustable via associated Settings Page).

2.4 ALARM MANAGEMENT

.1 There shall be Four (4) types of primary alarms, Critical, Environmental, Maintenance, and Energy. The vendor shall set up EMCS system to provide appropriate level of response as follows:

.1 Critical Alarms:

.1 Critical Alarms are those designated to send a signal to the Security System and the following email address (BASAlerts@mississauga.ca) on site. There are no situations where a Critical Alarm only shows up on the graphics/alarming console, without sending a signal to the specified email. Refer to part 2.1.3 (to follow) for a detailed list of the CoM typical critical alarms.

.2 Critical alarms shall also provide indication on the graphics (Flashing Red) both the Enterprise Server Software (ESS) operator workstation(s) and workstations connected through the SRPDC.

.3 Records of a Critical Alarms shall be stored on the EMCS ESS and an Email generated and sent to the Owner's designate email address (BASAlerts@mississauga.ca) indicating the Building ID, Alarm Indication/Descriptor, Alarm Parameter, Time of Alarm, etc.

.2 Environmental Alarms:

.1 Environmental alarms shall provide indication on the graphics (Flashing Yellow) both the ESS operator workstation(s) and workstations connected through the SRPDC and shall remain in alarm until the condition has been corrected.

.2 The history or environmental alarms will not be recorded at the EMCS server.

.3 Maintenance Alarms:

.1 Maintenance alarms shall provide indication on the graphics (Solid Yellow) both the ESS operator workstation(s) and workstations connected through the SRPDC and shall remain in alarm until the specified alarm condition has been removed. For "Time Based" Maintenance Alarms, the graphical indication of alarm shall remain active for 2 hours then shall return to normal until the alarm conditions have been flagged again.

.2 A secondary separate graphic on the EMCS ESS shall be created by the EMCS Vendor and populated with live data to track the cumulative number of Maintenance Alarms at each site until reset by the Administrative User.

.3 Record of a Maintenance Alarm shall be stored on the EMCS Server, separated by site. NOTE: You could route maintenance alarms to an email as well or just have a dedicated graphical page on the EMCS server where Operator Level 1 & 2 go to daily/weekly and will see the alarms by site listed and then can be addressed at a later date.

.4 Energy Alarms:

.1 Energy alarms shall not generate any indication on the SRPDC graphics.

.2 An EMCS ESS Graphical Page shall be created and populated with live data by the EMCS Vendor for Energy Alarms. The Graphic will have a listing of all sites with a cumulative running total of Energy alarms generated for each site. The number will continue to increase until reset by the Administrative Level User.

.3 A Record of an Energy Alarm shall be stored in the database at the EMCS ESS server. They shall also send out an Email to owner designated email indicating record of a new alarm.

.4 All alarm limits shall be as specified in the sequence of operation and with final set-up established during the commissioning process

.2 Alarms shall be set-up to be functional during the appropriate seasons and inactive when outside of the related season (i.e. – low heating water temperature alarms shall not be active during summer; chilled water alarms shall not be active after the central chilled water has been shut off to the building).

.3 Alarms that are stored at the EMCS Server shall be stored under various file headings (i.e. Critical, Maintenance, Energy) date and time stamped to include when the occurred and the date of acknowledgement of the alarm parameter.

.4 All alarms in database shall remain until cleared by the system administrator access level

3 System Sequences

3.1 CRITICAL ALARMS

.1 Critical alarms are designate specifically as alarms that send a direct signal to the following email address: BASAlerts@mississauga.ca.

.2 In addition to the output command to the security panel, critical alarms shall follow the requirements of part 1.4. Alarm Management

.3 Critical Alarm points will be identified during construction by the Facility Operator and CoM project manager and may include the following:

.1 Low Room Temp (RMT<14oC when OAT<5oC

.2 CO High Limit (CO above alarm limit and associated exhaust fan fails to start after 2 minutes (adjustable).

.3 NO2 High Limit (NO2 above alarm limit and associated exhaust fan fails to start after 2 minutes (adjustable).

.4 NH3 (Ammonia) High Limit (NH3 above alarm limit and associated exhaust fan fails to start after 2 minutes (adjustable).

.5 Cl2 (Chlorine) High Limit (Cl2 above alarm limit and associated exhaust fan fails to start after 2 minutes (adjustable).

.4 All alarms shall all have an adjustable time delay before triggering critical alarm.

.5 All alarm settings shall be user adjustable via the Associated Settings page by the assigned level of access.

3.2 SINGLE ZONE ROOF TOP UNITS RTU-9A, RTU-9B, RTU-10, RTU-11 AND RTU-12

.1 General

.1 The Unit provides heating, cooling and ventilation air to the space.

.2 The unit consists of a supply fan, an exhaust fan, economizer, a gas fired burner and a DX cooling coil.

.2 Start/Stop

.1 The EMCS shall enable the rooftop unit fan to start when commanded on through either MSOSx or other specified modes of operation.

.2 When commanded on, the EMCS shall start the supply fan first followed by return fan. Once fan status is proven the EMCS shall allow application of the specified heating/cooling/ventilation sequences. (Note: Where fans are hard wire interlocked – both shall be started simultaneously).

.3 When the RTU is commanded on in occupied mode, the fans shall operate either continuously or automatically (Duty cycle) with heating, cooling, or economizer cooling to maintain the occupied set points. The selection of Continuous or Auto Fan mode shall be graphically displayed and selectable by the facility operator.

.4 During unoccupied operation, the fan shall remain off unless called on to satisfy unoccupied heating/cooling set points or for night purge/morning warm-up mode.

.5 If the "ON" status is not verified 30 seconds (adjustable) after fan is enabled, the dampers shall close to full recirc and a maintenance alarm shall be generated.

.6 When the EMCS send the signal to stop; all fans shall stop, mixed air dampers shall close to full re-circulation, heating and cooling shall remain off.

.3 Heating/Cooling/Ventilation Control

.1 (Full Economizer Control – Contractor to site verify)

.1 During occupied operation of the unit the EMCS shall modulate the mixed air dampers (MADMPR_MOD) between minimum ventilation, 100% outside air in sequence with stages of heating and cooling to maintain occupied heating and cooling set points.

.2 The mixed air temperature shall be used as a mixed air low limit to override the minimum position

.2 (Alt - Minimum FA Damper Control)

.1 During occupied operation of the unit the EMCS shall enable the economizer (ECONDIS_CMD=OFF) allowing the mixed air dampers to modulate on their own between minimum ventilation and 100% outside air in sequence with stages of heating and cooling to maintain occupied heating and cooling set points.

.2 The EMCS shall send a signal to the fresh air dampers to operate between the Low minimum and max minimum based on CO2.

.3 Heating and Cooling demand shall be determined by the Room Temperature Setpoint (RM###_RMT_SP). There shall be a flat plate sensor(s) to monitor room temperature. The EMCS shall provide an adjustable dead-band for both heating and cooling. The RMT_SP and Heating/Cooling dead bands shall all be adjustable through the System Settings Page. Each RTU will have its own Settings Page as well as a combined summary Settings Page for all RTUs serving the facility. Initial stages of heating and cooling setpoints shall be based on a dead-band of setpoint +/ - 1 °C(adjustable via setting page).

.4 Mechanical Cooling Mode:

.1 For cooling, when the room temperature rises to RMT_SP + 1°C (adjustable dead-band), the first stage of cooling shall be energized.

.2 When the room temperature reaches RMT_SP+2 °C (adjustable dead band) the second stage of cooling shall be energized (where applicable).

.3 The second stage of cooling shall be deactivated when the room temperature reaches RMT_SP+0.5°C and the first stage of cooling shall be disabled when the room temperature = RMT_SP.

.5 Economizer Mode (Full Damper Control):

.1 When the Outdoor air temperature is 0.5°C below the Economizer set point (ECON_SP) of 14.5°C (adjustable), mechanical cooling shall be locked out and the economizer cooling be utilized. On a call for cooling the EMCS shall modulate the mixed air dampers between the minimum ventilation setting and 100% open to satisfy a SAT_SP of 13°C.

.2 Power exhaust of the RTU x_EFAN_CMD shall be enabled whenever the mixed air dampers are greater than 50% open (adjustable) and shall be disabled when the dampers close below 48% (adjustable).

.6 Economizer Mode (Alt - Min FA Damper Control)

.1 When the Outdoor air temperature is 0.5oC below the Economizer set point (ECON_SP), mechanical cooling shall be locked out and the economizer cooling be utilized. The on-board RTU OEMASC will determine if the outdoor temperature is below economizer setpoint (free cooling mode), or if mechanical cooling (DX cooling), staging shall be energized to satisfy the cooling requirements.

.7 Mixed Air Low Limit

.1 A mixed air low limit set-point (MAT-LL) shall be used to override the mixed air damper to maintain a minimum temperature of 6.6oC (adjustable)

.2 If the mixed air temperature falls below the mixed air low limit, the EMCS shall generate an environmental alarm.

.3 If the mixed air low limit requires the dampers to be below the minimum ventilation position for more than 2 minutes (adjustable), the EMCS shall generate a maintenance alarm.

.4 If the MAT-LL requires the dampers to be below the Minimum Ventilation setting for more than 2 minutes (adjustable) the EMCS shall generate a maintenance alarm.

.4 Heating Mode:

.1 Heating shall only be enabled with the OAT is below the heating lock-out temperature of 18°C (adjustable).

.2 When the room temperature falls to RMT_SP -1°C (adjustable dead-band), the first stage of heating shall be enabled. If RMT_SP falls to -2 °C(adjustable), the second stage of heating shall be enabled.

.3 When the room temperature reaches RMT_SP-0.5°C, the second stage of heating shall be deactivated. When the room temperature = RMT_SP the first stage of heating shall be deactivated. (All dead-bands shall be adjustable)

.5 Minimum Ventilation and CO2 Control

.1 Each unit shall have a minimum ventilation setting with Upper and Lower minimum ventilation settings. A CO2 sensor shall be used to reset the minimum ventilation between the “upper” and a “lower” minimum ventilation limit (adjustable limits via associated settings pages).

.2 The EMCS shall monitor return air CO2 levels will lower the Active Minimum Ventilation setting in 2% increments every 30seconds from the Upper limit of 25% down to Lower limit of 10% based on maintaining a maximum CO2 level of 1000ppm (adjustable).

.3 When the RA CO2< 900 ppm, the EMCS shall reduce the Active Minimum Ventilation setting by 2% every minute from the upper limit until reaching lower limit or until the RA CO2>1000ppm.

.4 When the RA CO2>1000ppm the EMCS shall increase the active minimum damper position in 2% increments every 30 seconds until reaching the (Maximum) minimum ventilation setting.

.6 Vacancy Mode (RTU 9 A AND 9B Only)

.1 During occupied operation of the fan system the EMCS will look at the status of occupancy sensors in the gym to determine of the space has is vacant. When the last detected occupancy is more that 10 minutes (adjustable) then the EMCS shall adjust the heating and cooling dead-band a further +/-1°C (adjustable) from the occupied heating/cooling dead band and the minimum ventilation position shall be 0% outside air.

.2 When occupancy is detected, the fan system shall immediately return to occupied settings.

.7 Energy Recovery Wheel (RTU-9A, 9B AND 12)

.1 Heat Wheel is enable when roof top is in operation and economizer (free cooling) control is not required or available.

.8 Unoccupied/Night-Set-Back Mode

.1 During unoccupied operation, the EMCS shall look at the space temperature and compare it to the Night Setback temperature setpoint (NSB_SP) to determine if heating is required. Unoccupied heating set-point shall be 18°C (adjustable).

.2 When the space temperature falls to NSB_SP - enabled in full recirculation mode with 1 stage of heating enabled until the space temperature reaches NSB_SP then shut off the heating and after a 2 minute delay (adjustable) then fan will shut off until the next cycle.

.3 (Alt - Minimum FA Damper Control)

.1 During unoccupied and night set-back modes, the fresh air dampers will be commanded to 0% OA and the Economizer will be commanded “off” (ECONDIS_CMD).

.9 Safeties

.1 Mechanical Cooling Lock Out (Low Ambient). When outdoor temperature is less than on board RTU Ambient cooling lock-out set point (typically 12°C), the compressor shall not be allowed to run.

.2 Anti-Short Cycle Timer. Minimum run times for the cooling shall be provided to prevent short cycling and avoid compressor failure.

.3 High Temperature Protection Control: If high temperature limit located in the return air duct rises above the setting of 60oC the supply and return fans shall shut down and a maintenance alarm will be generated. Once the high temperature protection control has been manually reset, the unit will return to normal control.

.4 Fire Alarm Fan Shutdown: The fire alarm system shall shut down all fans on a fire alarm condition. Upon clearing all fire alarms, the EMCS shall start all the fans in a staggered manner to prevent excessive power demand.

.10 Alarms

.1 Critical Low Room Temp (RMT<14°C when OAT<5°)

.2 Environmental

.1 Fan Status ON and Command OFF

.2 Fan Status OFF and Command ON

.3 Supply, Mixed, Return Air, High and Low Limits (adjustable)

.4 Room Temperature and Humidity High and Low Limits

.5 RA CO2 Level Alarm [RA CO2< 900 ppm (adjustable)]

.3 Maintenance

.1 Discharge Air greater than 3°C (adjustable) above setpoint for more than 2 minutes (adjustable).

.2 Supply Air Temperature < 8°C (adjustable) when OAT<5°C for more than 2 minutes (adjustable)

.3 Mixed air dampers operating above the minimum setting for more than 2 minutes (adjustable).

.4 When OAT< 0°C (adjustable) and mixed air dampers operating above the minimum setting for more than 2 minutes (adjustable).

.5 Fan Fail Alarm

.6 Cooling Failure

.7 Burner Failure

.8 Humidity Sensor Deviation (10% RH (adjustable)).

.9 Heating stage enabled and SAT is below 25oC (adjustable) for 5 minutes (adjustable) .4 Energy Alarms

.10 Dirty Filters

.4 Energy Alarms

.1 Fan Status On for more than 2 hours cumulatively (adjustable) during unoccupied (NSB) operation.

.2 Fan system operating in Occupied Mode outside of Originally Scheduled MSOSx

.5 The initial set up values for all alarms shall be established during the commissioning process.

.11 Adjustable Points (to be displayed on the system Settings Page)

.1 Calendar Operating Schedule (MSOS)

.2 Room Temperature set point (RMT_SP)

.3 Occupied, unoccupied, vacancy modes Heating/Cooling Dead-bands and staging limits

.4 CO2 Setpoint and staging limits

.5 Supply Air, Mixed Air, Return Air, High and Low Limit

.6 Mixed Air Damper Min Position

.7 Room/Return Air Humidity Setpoint, Supply Air Humidity High Limit

.8 Alarm Settings – (setpoints and time delay parameters as noted in 2.3.9 Alarms)

.9 ERW COOLING ENABLE TEMPERATURE

.10 ERW HEATING ENABLE TEMPERATURE

4 Execution

4.1 INSTALLATION

.1 In accordance with Division 23 requirements.

End of Section

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1 General

1.1 SECTION INCLUDES

.1 Common requirements for electrical work.

.2 Mounting heights for electrical equipment and devices.

1.2 RELATED REQUIREMENTS

.1 Provisions of this section apply to all sections of Division 26.

.2 Section 07 62 00 – Flashing and Sheet Metal.

.3 Section 07 85 00 – Firestopping and Smoke Seals.

.4 Section 08 31 00 – Access Doors and Panels.

1.3 INTENT

.1 Include all material, labour, equipment, and plant construction as necessary to make a complete installation as shown and specified hereinafter.

.2 Leave complete systems ready for continuous and efficient satisfactory operation.

.3 Discipline and Trade Jurisdiction:

.1 In accordance with CCDC 2-2020 GC 1.1.9: Neither the organization of the Specifications nor the arrangement of Drawings shall control the Contractor in dividing the work among Subcontractors and Suppliers.

.2 MasterFormat's organizational structure used in a project manual does not imply how the work is assigned to various design disciplines, trades, or subcontractors. MasterFormat is not intended to determine which particular elements of the project manual are prepared by a particular discipline. Similarly, it is not intended to determine what particular work required by the project manual is the responsibility of a particular trade. A particular discipline or trade is likely to be responsible for subjects from multiple Divisions, as well as from multiple Subgroups.

1.4 DRAWINGS AND SPECIFICATIONS

.1 The drawings and specifications are complementary each to the other and what is called for by one to be binding as if called for by both. Should any discrepancy appear between the drawings and specifications, which leaves the Contractor in doubt as to the true intent and meaning of plans and specifications, a ruling is to be obtained from the Consultant in writing before submitting Bid. If this is not done, the maximum, the most expensive alternate or option will be provided in base tender bid.

.2 All drawings and all Divisions of these specifications shall be considered as a whole, and work of this Division shown anywhere therein shall be furnished under this Division.

.3 Drawings are diagrammatic and indicate the general arrangement of equipment and pathways. Most direct routing of conductors and wiring is not assured. Exact requirements are governed by architectural, structural, and mechanical conditions of the job. Consult all other drawings in preparation of the bid. Extra lengths of wiring or addition of pull and junction boxes, etc. necessitated by such conditions are to be included in the bid. Check all information and report and apparent discrepancies before submitting the bid.

.4 Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pathways so as to best fit the layout of the job. Plan, coordinate, and establish exact locations

and routing of services with affected trades prior to installation such that services clear each other, as well as other obstructions.

.5 Determine final locations of major work within ceiling spaces based on the largest equipment first.

.6 Unless otherwise shown or specified, conceal work in finished areas, and conceal work in partially finished and/or unfinished areas to extent made possible by the area construction. Install services as high as possible to conserve headroom and/or ceiling space. Notify the Consultant where headroom or ceiling space appears to be inadequate prior to installation of the work.

.7 Scaling off the drawings will not be sufficient or accurate for determining these locations. Where job conditions require reasonable changes in indicated arrangement and locations, such changes shall be made at no additional cost to the Owner.

.8 Because of the scale of the drawings, certain basic items, such as junction boxes, pull boxes, conduit fittings, etc. may not be shown, but where such items are required by other sections of the specifications of where there are required for proper installation of the work, such items are to be furnished and installed.

.9 Before ordering any conduit, cable tray, conductors, wireways, raceway bus duct, fittings, etc., verify all pertinent dimensions at the job site and be responsible for their accuracy.

.10 If obvious ambiguities or omissions are noticed when tendering refer same to the Consultant for a ruling and obtain the ruling in writing in the form of an Addendum. Claims for extras for ambiguities or omission of items brought to the attention of the Consultant after the award of a contract which, due to the nature of the ambiguity or omission, should have been brought to the attention of the Consultant during the tendering period, will not be allowed.

.11 The drawings are performance drawings, diagrammatic, and show locations for apparatus and materials. The drawings are intended to convey the scope of work and do not intend to show Architectural and Structural details. The locations shown are approximate, and may be altered, when approved by the Consultant, to meet requirements of the material and/or apparatus, other equipment and systems being installed, and of the building. Do not scale drawings.

.12 Control devices, equipment requiring maintenance, junction boxes, and similar products, particularly such products located above suspended ceilings must be located for easy access for servicing and/or removal. Products which do not meet this location requirement are to be relocated to an accessible location at no additional cost.

.13 Be responsible for making necessary changes, at no additional cost, to accommodate structural and building conditions that were foreseeable by a review of existing conditions or a review of drawings prepared by other disciplines.

.14 Where drawings indicate that acoustic tile ceiling is being suspended below existing plaster ceilings, coordinate the design of framework used to support this suspended ceiling, lighting, diffusers, and other components that are mounted within or through ceiling. Do not mount devices to suspended ceilings. Secure and mount to ceiling slab above. Seal ceiling openings to maintain required fire rating.

.15 Provide any fitting, offset, transformation, etc., required to suit architectural and structural details but not shown.

1.5 WORK RESTRICTIONS

.1 Refer to Section 01 10 00.

.2 Existing buildings:

.1 Examine the existing building, the site and surrounding areas and by fully informed as to the conditions and limitations under which the work has to be executed. Claims for additional costs will not be entertained with respect to conditions which could reasonably been ascertained by an inspection prior to Tender closing.

.2 All work in the existing building, other than minor works required to permit construction of the new addition, is to be performed in such a manner as to not disrupt the building operations.

.3 All systems are to be kept in full operation during normal building hours.

.4 Note that any noise generating works that disrupt the building operation shall be coordinated accordingly and carried out after/before normal operating hours.

.5 Cut, modify, or extend as necessary or as directed by the Consultant, the existing material or equipment to be reused or relocated to suit work under this contract.

.6 Existing materials and equipment which are to be used in new work shall be repaired and refinished as necessary. Provide additional new materials and components as required to facilitate reinstallation of such existing materials and equipment.

.7 Co-ordinate with the Owner, and refer to General Conditions.

.8 Do work in existing areas to best suit available space and not interfere with or obstruct use of existing facilities.

.9 Where disruptions of existing services are required, coordinate shut down with the Owner's operating staff and do the work at a time and in a manner mutually acceptable. Carefully schedule disruptions to keep "down time" to a minimum.

.3 Do all cutting, patching and making good to leave in a finished condition and to make the several parts of the Work come together properly. Co-ordinate work to keep cutting and patching to a minimum.

.4 Quality of workmanship and materials used in patching, making good and refinishing of existing construction and/or compartments shall be of a standard equal to that specified for new construction and if not specified, equal to or exceeding that of original existing work.

.5 Prior to cutting openings, examine wall, floor and ceiling construction for buried electrical cables and pipes; and take adequate protection. Conduct cable locating tests to locate buried cables in existing work.

1.6 SUBSTITUTION PROCEDURES

.1 Refer to General Provisions of the Contract.

.2 Additionally, "Approved equal" shall be defined as a substitution approved by the Consultant.

.3 If during the tender bid process, the bidding contractor wishes to substitute the specified equipment for an "Approved equal", the bidding contractor must submit shop drawings to the Consultant before the tender close for approval. If no substitution request is made, the as-specified equipment is that to be provided.

.4 Where several manufacturers' names are given, the first named manufacturer constitutes the basis for job design and establishes the equipment quality required to be used in this contract.

.5 This contractor, at his option, may use equipment as manufactured by any of the listed manufacturers. This Contractor is responsible to ensure that all items submitted by these other manufacturers meets are requirements of the drawings and specification and fits in the allocated

space. The final determination of a product being equivalent is to be determined by the Consultant when a catalog number is not listed, or listed in part.

.6 Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Consultant as described in the General Provisions of the Contract for Submittals. The Contractor bears full responsibility for the unnamed manufacturers' equipment adequately meeting the intent of the design. The Owner or the Consultant may reject manufacturer at time of shop drawing submittal.

.7 In addition to manufacturer's products base specified or named as acceptable, other manufacturers of products may be proposed as substitutions to the Consultant for review and consideration for acceptance, listing in each case a corresponding credit for each substitution proposed. However, base Bid Price on products base specified or named as acceptable. Certify in writing to the Consultant that proposed substitution meets space, power, design, energy consumption, and other requirements of base specified or acceptable product. It is understood that there will be no increase in Contract Price by reason of any changes to associated equipment, mechanically, electrically, structurally or architecturally, required by acceptance of proposed substitution. The Consultant has sole discretion in accepting any such proposed substitution of product. Indicate any proposed substitutions in areas provided on Bid Form. Do not order such products until they are accepted in writing by the Consultant.

1.7 CONTRACT MODIFICATION PROCEDURES

.1 Refer to Section 01 26 00.

.2 When submitting quotations in response to changes in the contract, quotations for electrical work are to include a breakdown of all material, including material unit rates, and labour units as indicated in the NECA Manual of Labor Units (MLU).

1.8 COORDINATION

.1 Refer to Section 01 30 00.

.2 Coordinate work with other trades to avoid conflict and to provide correct rough-in and connection for equipment furnished under other trades that require electrical connection. Inform Contractors of other trades of the required access to and clearances around electrical equipment to maintain serviceability and code compliance.

.3 Verify equipment dimensions and requirements with provision specified under this Section. Check actual job conditions before fabricating work. Report necessary changes in time to prevent needless work. Changes or additions subject to additional compensation, which are made without written authorization and an agreed price, shall be at Contractor's risk and expense.

.4 Read specifications and drawings of other trades and conform with their requirements before proceeding with any work specified in this Division related to other trades. Co-operate with all other trades on the job, so that all equipment can be satisfactorily installed, and so that no delay is caused to any other trades.

.5 Coordinate utility service outages with the owner. Obtain permission from Owner at least 24 hours before partially or completely disabling system. Minimize outage duration.

.6 Existing Fire Alarm System: Maintain existing system in service. Disable system only to make switch overs and connections. Notify Owner at least 24 hours before partially or completely disabling system. Minimize outage duration.

.7 Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

.8 Co-ordinate work with all trades to ensure a proper and complete installation. Notify all trades concerned of the requirement for openings, sleeves, insets and other hardware necessary for the installation and, where work is to be integrated with the work of other trades or is to be installed in close proximity with the work of other trades, carefully co-ordinate the work prior to installation.

.9 Working Detail Drawings

.1 The contractor is to prepare working detail drawings supplementary to the contract drawings, when deemed necessary by the Consultant, for all areas where a multiplicity of materials and or apparatus occur, or where the work due to architectural and structural considerations involves special study and treatment. Such drawings may be prepared jointly by all trades affected, or by the one trade most affected with due regard for and approval of the other trades, all as the Consultant will direct in each instance. Such drawings must be reviewed by the Consultant before the affected work is installed.

.2 Carry out all alterations in the arrangement of work which has been installed without proper study and approval, even if in accordance with the contract documents, in order to make such work come within the finished lines of walls, floors and ceilings, or to allow the installation of other work, without additional cost. In addition, make any alterations necessary in other work required by such alterations, without additional cost.

1.9 SUBMITTAL PROCEDURES

.1 Refer to Section 01 30 00.

.2 Before delivery to site of any item of equipment, submit shop drawings complete with all data, pre-checked and stamped accordingly, for review by the Consultant. Indicate project name on each brochure or sheet, make reference to the number and title of the appropriate specification section, type identifier such panelboard ID or luminaire type as indicated on appropriate schedule, and provide adequate space to accommodate the Consultant’s review stamp(s).

.3 Verify field measurements and affected adjacent Work are coordinated, including passageway clearances for movement of equipment into location.

.4 Submit shop drawings to the Consultant in electronic (PDF) format, as coordinated after award of contract. Where submittals are derived from digital originals, do not print and rescan documents; submittals made as such will be immediately rejected.

.5 Submit a schedule of shop drawings within one week after award of contract. Group submittals by specification division as appropriate.

.6 Shop Drawings

.1 Submit for review, properly identified shop drawings showing in detail the design and construction of all equipment and materials as requested in sections of the specification governed by this Section.

.2 Obtain and comply with the manufacturer's installation instructions.

.3 Endorse each shop drawing copy "CERTIFIED TO BE IN ACCORDANCE WITH ALL REQUIREMENTS", stamp each copy with your company name, date each copy with the

submittal date, and sign each copy. Shop drawings which are received and are not endorsed, dated and signed will be returned for re-submittal.

.4 The Consultant will stamp shop drawings as follows:

.1 Reviewed ( )

.2 Reviewed as Modified ( )

.3 Revise and Re-Submit ( )

.4 Not Reviewed ( )

.5 If "REVIEWED" is checked-off, the shop drawing is satisfactory. If "REVIEWED AS MODIFIED" is checked-off, the shop drawing is satisfactory subject to requirements of remarks put on shop drawing copies. If "REVISE AND RE-SUBMIT" is checked-off, the shop drawing is entirely unsatisfactory and must be revised in accordance with comments written on shop drawing copies and resubmitted. If "NOT REVIEWED" is checked-off, the shop drawing is in error of submission, not applicable for this project.

.6 This review by the Consultant is for the sole purpose of ascertaining conformance with the general design concept. This review shall not mean that the Consultant approved the detail design inherent in the shop drawings, responsibility for which shall remain with the Contractor, and such review shall not relieve the Contractor of responsibility for errors or omissions in the shop drawings or of responsibility for meeting all requirements of the contract documents. Be 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 co-ordination of the work as well as compliance with codes and inspection authorities such as CSA, etc.

.7 Confirm layouts of major electrical equipment rooms with the dimensions of as-procured equipment, and submit a layout sketch to the Consultant showing the major equipment and required clear spaces. The contractor may, at their option, revise the layout of the major electrical equipment rooms, but take responsibility for these new layouts and meeting the requirements of the local electrical utilities. Capture final room layouts on as-built drawings.

1.10 SUBMITTALS

.1 The Contractor is to submit dimensioned drawings or sketches that indicates the dimensions of the procured equipment, demonstrates that the equipment will fit in the allocated spaces, and demonstrates that manufacturer and code required clear spaces are provided.

1.11 SAFETY REQUIREMENTS

.1 Refer to Division 01.

.2 Be responsible for the safety of workers and the equipment on the project in accordance with all applicable safety legislation passed by Federal, Provincial, and local authorities governing construction safety. The more stringent regulations prevail.

1.12 REGULATORY REQUIREMENTS

.1 Refer to Section 01 41 00.

.2 Codes and Standards

.1 Ontario Electrical Safety Code including all bulletins and amendments.

.2 Ontario Building Code and its referenced standards.

.3 Applicable CSA and ULC standards.

.4 All work shall be in accordance with Owner's Design Guidelines.

.3 Permits and Fees

.1 Obtain and pay for all permits and fees required for the execution and inspection of the electrical work and pay all charges incidental to such permits. Submit to Electrical Inspection Department and Supply authority necessary number of drawings and specifications for examination and approval prior to commencement of work. Arrange and pay for any special inspection of equipment specified if and when required.

.2 Apply, pay and obtain all permits as required for the electrical work.

.3 Upon substantial completion of your work, supply and turn over to the Consultant all required inspection certificates from governing authorities to certify that the work as installed conforms to the rules and regulations of the governing authorities.

.4 Patents

.1 Pay all royalties and licence fees, and defend all suits or claims for infringement of any patent rights, and save the Owner, Architect, Project Manager and Consultants harmless of loss or annoyance on account of suit, or claims of any kind for violation or infringement of any letters patent or patent rights, by this Subcontractor or anyone directly or indirectly employed by him or by reason of the use by him or them of any part, machine, manufacture or composition of matter on the work, in violation or infringement or such letters patent or rights.

1.13 REFERENCES

.1 CSA Group

.1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.

.2 CSA C235:19, Preferred voltage levels for AC Systems up to 50 000 V.

.3 Do underground systems in accordance with CSA C22.3 No. 7-15, Underground systems, except where specified otherwise.

.4 Ontario Electrical Safety Code (28th edition/2021), and all bulletins.

.2 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)

.1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.

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

.1 Material Safety Data Sheets (MSDS).

.4 Electrical utility requirements and local applicable codes and regulations.

.5 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)

.1 IEEE SP1122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

.6 2012 Ontario Building Code.

.7 CAN/ULC-S1001-11, Integrated Systems Testing of Fire Protection and Life Safety Systems.

1.14 DEFINITIONS

.1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.

1.15 QUALITY ASSURANCE

.1 Refer to Section 01 40 00.

.2 The specifications contained herein are set forth as the minimum acceptable requirements. This does not relieve the Contractor from executing other quality assurance measures to obtain a complete operating system within the scope of this project.

.3 Ensure that all workmanship, all materials employed, all required equipment and the manner and method of installation conforms to accepted construction and engineering practices, and that each piece of equipment is in satisfactory working condition to satisfactorily perform its functional operation.

.4 Provide quality assurance tests and operational check on all components of the electrical distribution system, all lighting fixtures, and communication systems.

.5 Only first class workmanship will be accepted, not only in regards to durability, efficiency and safety, but also in regards to neatness of detail. Present a neat and clean appearance on completion to the satisfaction of the Consultant. Any unsatisfactory workmanship will be replaced at no extra cost.

.6 Conform to the best practices applicable to this type of work. Install all equipment and systems in accordance with the manufacturer's recommendations, but consistent with the General Requirements of this specification. Electrical Contractor will be held responsible for all damage to the work of his own or any other trade, resulting from the execution of his work. Store all electrical equipment and materials in dry locations.

.7 Provide foreman in charge of this work at all times.

.8 The contractor shall be fully liable to provide and maintain in force during the life of this Contract, such insurance, including Public Liability Insurance, Product Liability Insurance, Auto Liability Insurance, Worker’s Compensation, and Employer’s Liability Insurance.

.9 Governing Federal, Provincial and Municipal codes and regulations will be considered minimum standards for the work and where these are at variance with the drawings and specification, the more stringent ruling will apply.

.10 Where any code, regulation, bylaw, or standard is quoted it shall mean the current edition including all revisions or amendments at the time of the tender.

.11 In case of conflict, the codes and regulations take precedence over the Contract Documents. In no instance reduce the standard or scope of work or intent established by the drawings and specifications by applying any of the codes referred to herein.

1.16 QUALITY CONTROL

.1 Refer to Section 01 40 00.

.2 Provide a full time Superintendent to oversee and coordinate all sub-trades in these divisions.

1.17 TEMPORARY UTILITIES

.1 Refer to Section 01 50 00.

.2 Do not use any of the permanent facility systems during construction except as may be specified, or unless written approval is obtained from the Consultant.

.3 The use of permanent facilities for temporary construction service will not affect in any way the commencement day of the warranty period.

.4 Temporary heating during the construction period will be provided as described in Division 01.

1.18 TEMPORARY FACILITIES AND CONTROLS

.1 Refer to Section 01 50 00.

.2 Prior to start of each work period in occupied area, install temporary protection to prevent damage to any personal property or furnishing. Coordinate with Owner's representative if any furniture must be relocated to facilitate work.

.3 Submit temporary protection plan to Owner's Representative for approval prior to use.

.4 Take necessary steps to ensure that required firefighting apparatus is accessible at all times. Flammable materials shall be kept in suitable places outside the building.

1.19 PRODUCT REQUIREMENTS

.1 Refer to Section 01 61 00.

.2 The design, manufacture and testing of electrical equipment and materials shall conform to or exceed the latest applicable CSA, IEEE, and ANSI standards.

.3 All materials must be new and be ULC or CSA listed. Any materials not covered by the aforementioned listing standards shall be tested and approved by an independent testing laboratory, Technical inspection Services, or other government agency.

.4 Materials and equipment are specifically described and named in this Specification in order to establish a standard of material and workmanship.

.5 Materials required for performance of work shall be new and the best of their respective kinds and of uniform pattern throughout work.

.6 Materials shall be of Canadian manufacture where obtainable. Materials of foreign manufacture, unless specified, shall be approved before being used.

.7 Equipment items shall be standard products of approved manufacturers. Identical units of equipment shall be of same manufacturer. In any unit of equipment, identical component parts shall be of same manufacturer, but the various component parts comprising the unit need not be of one manufacturer.

.8 Chemical and physical properties of materials and design performance characteristics and methods of construction and installation of items of equipment, specified herein, shall be in accordance with latest issue of applicable Standards or Authorities when such are either mentioned herein, or have jurisdiction over such materials or items of equipment.

.9 Materials shall bear approval labels as required by Code and/or Inspection Authorities.

.10 Install materials in strict accordance with manufacturer's recommendations.

.11 Include items of material and equipment not specifically noted on Drawings or mentioned in Specification but which are necessary to make a complete and operating installation.

.12 Remove materials, condemned as not approved for use, from job site and deliver and install suitable approved materials in their place.

.13 Unless otherwise noted, equipment and material specifications in Sections of the Specification governed by this Section are based on products of a manufacturer selected by the Consultant for the purpose of setting a standard of quality, size, performance, capacity, appearance, and serviceability.

.14 In most instances the names of acceptable manufacturers are also stated for materials and equipment, and you may base your tender price on equipment and materials produced by either the specified manufacturer or a manufacturer listed as acceptable.

.15 For any items of equipment, material, or for any system where acceptable manufacturers are not stated, you must provide only the equipment, material or system specified.

.16 If materials or equipment manufactured and/or supplied by a manufacturer named in the specifications are used in lieu of products of the manufacturer noted as “basis of design”, be responsible for ensuring that the substituted material or equipment is equivalent in size, performance and operating characteristics to the specified materials or equipment, and it shall be understood that all costs for larger starters, additional space, larger power feeders, and changes to associated or adjacent work required as a result of providing materials and equipment named as acceptable in lieu of the specified product will be borne by the Contractor.

.17 In addition to the manufacturers specified or named as acceptable, the Contractor may propose substitute manufacturers of equipment and/or apparatus to the Consultant for acceptance, listing in each case a corresponding credit for each substitute proposed, however, the tender price must be based on apparatus or materials specified or named as acceptable. Certify in writing to the Consultant that the substitute meets all space, power, design, and all other required of the specified or equivalent material or apparatus. In addition, it shall be understood that all costs for larger starters, space, power feeders, and changes to associated equipment, mechanical and/or electrical, required by acceptance of proposed substitutions, will be borne by the party making the proposal. Substitute equipment requiring greater than specified energy requirements or unduly limiting service space requirements will not be accepted.

.18 Where a manufacturer is not listed for a particular product, it will be deemed to mean that the Contractor will provide the specified manufacturer's product.

1.20 EXAMINATION AND PREPARATION

.1 Refer to Section 01 70 00.

.2 Examine the existing equipment, the site and surrounding areas and be fully informed as to the conditions and limitations under which the work has to be executed. Claims for additional costs will not be entertained with respect to conditions which could reasonably have been ascertained by an inspection prior to Tender closing.

.3 Examine work upon which your work depends. Report in writing defects in such work. Application of your work shall be deemed acceptance of work upon which your work depends.

.4 Drawings are, in part, diagrammatic and are intended to convey scope of work and indicate general and approximate location, arrangement and sizes of equipment, piping, and similar items. Obtain more accurate information about locations, arrangement and sizes from study and coordination of drawings, including shop drawings and manufacturers’ literature and become familiar with conditions and spaces affecting these matters before proceeding with work.

.5 Where job conditions require reasonable changes in indicated locations and arrangements, make such changes with approval of the Consultant at no additional cost to the Owner. Similarly, where existing conditions interfere with new installation and require relocation, such relocation is included in work.

1.21 CUTTING AND PATCHING

.1 Refer to Section 01 70 00.

.2 The Electrical Contractor will be responsible for all cutting and patching required for the electrical installation. Structural members are not to be cut without the consent of the Consultant.

.3 All cutting and patching required under Division 26 shall be in accordance with Division 01. Layout such work for approval before undertaking same.

.4 Cutting shall be kept to an absolute minimum and performed in a neat and workmanlike manner using the proper tools and equipment. Caution shall be exercised in all cutting and procedures to ensure that concealed services are not affected. Do not cut if in doubt. Request the Consultant's presence to determine if concealed services exist.

.5 Assume responsibility for prompt installation of Work in advance of concrete pouring or similar Work. Should any cutting or repairing of finished/unfinished Work be required because such installation was not done, employ the particular trade, whose Work is involved, to do such cutting and patching. Pay for any resulting costs. Layout such Work for approval before undertaking same.

1.22 CLEANING AND WASTE MANAGEMENT

.1 Refer to Section 01 74 00.

.2 The Contractor and associated sub trades, at all times during construction, to keep the site free of all debris, boxes, packing, etc., resulting from work of this trade. At the completion of this work, the electrical installation is to be left in a clean and finished condition to the satisfaction of the Consultant.

.3 Clean and repair existing materials and equipment which remain or are to be reused.

.4 Luminaires to be reinstalled: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.

.5 Assume responsibility for removing tools and waste materials on completion of Work, and leave Work in clean and perfect condition.

1.23 STARTING AND ADJUSTING

.1 Refer to Division 01.

.2 Conduct acceptance tests to demonstrate that the equipment and systems actually meet the specified requirements. Tests may be conducted as soon as conditions permit, and consequently make all changes, adjustments, or replacements required as the preliminary tests may indicate prior to the final tests. Tests shall be as specified in various sections of this Division. Carry out tests in the presence of the Consultant. Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project. The Electrical Contractor shall be in charge of the plant during tests. He shall assume responsibility for damages in the event of injury to the personnel, building, equipment, and shall bear all costs for liability, repairs, and restoration in this connection. Submit test results.

.3 Make tests of equipment and wiring at times requested.

.4 Tests shall include meggered insulation values, voltage and current readings to determine balance of panels and feeders under full load, and operation of each piece of equipment for correct operation.

.5 Supply meters, materials and personnel as required to carry out these tests.

.6 Test electrical work to standards and function of Specification and applicable codes in an approved manner. Replace defective equipment and wiring with new material and leave entire system in complete first class operating condition.

.7 Connect single phase loads so that there is the least possible unbalance of the supply phases.

.8 Submit all test results in report format.

.9 Trial Usage

.1 The Consultant reserves the right to use any system, 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, or for the purpose of learning operational procedures, before the final completion and acceptance of the work. Such tests shall not 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 above due to the aforementioned tests, where such injuries or breakage are caused by a weakness or inaccuracy of parts, or by defective materials or workmanship of any kind. Supply all labour and equipment required for such tests.

.2 Perform and pay for all costs associated with any testing required on the system components where, in the opinion of the Consultant the equipment manufacturer's ratings or specified performance is not being achieved.

1.24 CLOSEOUT PROCEDURES

.1 Refer to Section 01 77 00.

.2 The Consultant will carry out inspections and prepare deficiency list for action by the Contractor, during and on completion of project.

.3 Building Permit Compliance

.1 Provide a minimum of 10 business days notice to the Consultant for scheduling of Consultant’s occupancy inspection.

.2 Prior to requesting the Consultant’s letter “Review of General Conformance” for submission to the municipal building department to allow occupancy, the following items must be complete and submitted to the Consultant, as applicable:

.1 General

.1 Submit all applicable inspection reports from Authorities Having Jurisdiction.

.2 Continuity of fire separations at service penetrations must be complete.

.2 Electrical

.1 Provide Certificate of Acceptance from Electrical Inspection Department.

.2 Any devices not installed must have the wiring made safe and terminated in an outlet box complete with cover.

.3 All outlets must have cover plates installed. All electrical equipment not located in service rooms must have covers and/or doors installed complete.

.4 Emergency lighting system must be operational and tested by the Contractor. Where battery units and remote heads are indicated on the drawing, provide certification letter from equipment manufacturer indicating the system meets code requirements.

.5 Simulate normal power failure within the premises in the presence of the consultant and the owner’s representative. Test and verify exit lights and emergency lighting operations under emergency conditions. Submit letter of certification copy to the Consultant stating that the systems have been tested, witnessed by the Consultant or the Owner’s representative, etc., and the methods of installation and performance are satisfactory to all parties.

.6 All exit lights must be installed and operational.

.3 Electronic Safety and Security

.1 Fire alarm system and devices must be operational. Submit fire alarm verification report per CAN/ULC-S537, and submit audibility test. Indicate tap settings of all signalling devices.

.2 Functional testing of the fire alarm system per CAN/ULC-S1001 must be completed.

.3 If any of the above items have not been completed at the time of Consultant's Inspection, and the letter of "assurance of professional field review and compliance" cannot be issued, any costs for subsequent Inspections will be charged to the Contractor.

1.25 CLOSEOUT SUBMITTALS

.1 Refer to Section 01 78 00.

.2 Project Record Documents

.1 Provide extra sets of white prints on which to make, as the job progresses, all approved changes and deviations from the original drawings. Complete as-built drawings accurately marked up in red ink must be submitted for review by the Consultant before the contract is considered to be completed.

.2 Changes and deviations include those made by addenda, change orders, and supplemental instructions, and changes and deviations to be marked on the white print record drawings indicated on supplemental drawings issued with addenda, change orders, and supplemental instructions. Maintain the "as-built" white prints at the site for periodic inspection by the Consultant throughout the duration of the work.

.3 Upon substantial completion of the work, obtain a set of reproducible white prints of the drawings and neatly amend the print in accordance with the marked-up white prints to produce a true "as-built" set of drawings.

.4 As-built drawings are to indicate all circuiting as installed and all distribution junction box locations as well as conduit routes.

.5 Trace routing of existing panelboard feeders for all panelboards and indicate on as-built drawings.

.6 As-Built AutoCAD Drawings

.1 Request CAD release form from the Consultant, and submit completed form back to the Consultant.

.2 Transfer the information from the "as-built" white prints to the files, and submit to the Consultant for review.

.3 Employ a competent computer draftsperson to indicate changes on the electronic set of as-built drawings. Provide drawings in PDF and AutoCAD formats.

.4 Submit three (3) USB flash drives including as-built drawings in AutoCAD format, one with each O&M manual.

.5 Provide three (3) sets of full size as-built drawings in hard copy format, one with each O&M manual.

.7 As-built Single Line Diagram

.1 Provide in Main Electrical Room one wall mounted copy of as-built Single Line Diagram on 6 mm (1/4 in) foam board.

.2 As-built Single Line Diagram to indicate manufacturer name and catalogue numbers of as-installed products.

.3 Operations and Maintenance (O&M) Data

.1 Submit two complete sets of Operation and Maintenance instruction manuals in hard copy, and one in electronic format. Include in each copy of the manual:

.1 Verification certificates for installation of life safety systems by the manufacturer's representative.

.2 A copy of "reviewed" shop drawings.

.3 Complete explanation of operating principles and sequences.

.4 Recommended maintenance practices and precautions.

.5 Complete wiring and connection diagrams.

.6 Certificates of guarantees.

.2 Ensure that operating and maintenance instructions are specific and apply to the model and types of equipment provided.

.3 Include attendance records for each training session in the O&M manual.

.4 Warranties

.1 Submit a written guarantee to the Owner for one year from the date of acceptance. This guarantee shall bind the contractor to correct, replace or repair promptly any defective equipment workmanship without cost to the Owner.

.2 All equipment, materials and workmanship shall be unconditionally guaranteed for a minimum period of one year from the date of acceptance.

.3 Provide warranty certificates, wherever given or required, in excess of the normal warranty period showing the name of the firm giving the warranty, dated and acknowledged, on specific equipment and systems.

.4 Warranties for temperature controls and building automation systems will start on the date of verification of acceptance by the Consultant.

.5 Include these certificates with the maintenance and operating manuals in the appropriate sections.

2 Products – Not Used

3 Execution

3.1 DEMOLITION

.1 Refer to Section 26 05 05.

.2 Remove all electrical equipment and devices on redundant structures. Make safe all circuits, and provide continuity of remaining circuits.

.3 To make safe: Withdraw redundant wiring and remove unwanted conduit/wiring and accessories. Position breakers to OFF position and update panel schedules.

.4 Make safe any redundant mechanical devices as shown on mechanical drawings.

.5 Maintain continuity of existing services for other circuits/devices serving areas outside the Work area. Provide additional wiring/conduits/boxes etc. to suit existing services to be maintained and also implement new Work as detailed.

.6 Allow for this work in Tender Price.

.7 Turn over designated equipment to the Owner. Dispose of unwanted materials and equipment.

3.2 CONCRETE WORK

.1 Provide all concrete work required for the electrical work. Reinstall surfacing as per architectural requirements.

3.3 LINTELS

.1 Lintels for openings in masonry shall conform with requirements of by-laws, and as approved by the Structural Engineer.

.2 Pay all costs for lintels over openings, required solely by the electrical trades, not shown on architectural or structural drawings.

3.4 METALS

.1 Steel construction required solely for the work of this trade, and not shown on architectural or structural drawings shall be provided by this Division to the requirements of Division 05.

3.5 FLASHING AND SHEET METAL

.1 Refer to Section 07 62 00.

.2 Flash all conduits and systems passing through roof or built into an outside wall, or a waterproof floor.

.3 Provide copper flashing for sleeves passing through exterior walls or waterproof floors.

3.6 FIRESTOPPING

.1 Provide firestopping in accordance with Section 07 85 00.

.2 Ensure that fire ratings of floors and walls are maintained.

.3 Provide ULC classified firestopping products by 3M, Hilti, STI, or approved equal which have been tested in accordance with ULC-S115.

.4 Pack clearance spaces, fill all spaces between openings, pipes and ducts passing through fire separations and install firestopping systems in accordance with the appropriate ULC system number for the products and type of penetration.

.5 Install firestopping systems using personnel trained or instructed by the product manufacturer.

3.7 ACCESS DOORS

.1 Provide access doors in accordance with Section 08 31 00.

.2 Group conduit work to ensure the minimum number of access doors is required.

.3 Access doors are to be installed by the trade responsible for the particular type of construction in which the doors are required.

3.8 PAINTING AND FINISHES

.1 Refer to Division 09.

.2 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.

.3 Repair and finish factory finished equipment, damaged or scratched during installation, in an approved manner.

.4 All structural steel including hangers, brackets, supports and other ferrous metals shall be shop or factory prime painted wherever practicable. Wherever structural steel including hangers, brackets, supports, and other ferrous metals cannot be shop or factory prime painted, wire brush to remove all traces of rust, clean of all traces of dirt, oil, and grease, and apply one coat of an approved rust inhibiting primer in accordance with CGSB-GB-40d, and leave ready to receive finish paint.

.5 Primary and final painting for Work, other than items specified as factory primed or finished, will be performed as described in Division 09 – Finishes.

.6 All electrical fittings, supports, hanger rods, pull boxes, channel frames, conduit racks, outlet boxes, brackets, clamps etc., to have galvanized finish or paint finish over corrosion-resistant primer.

.7 All panelboards, motor starters etc., to be factory finished with baked on enamel. All enamel to be baked on gloss over corrosion resistant primer.

.8 Touch up minor damage to finish on factory finished equipment. Items suffering major damage to finish shall be replaced at the direction of the Consultant.

.9 Protect work so that finishes will not be damaged or marred during construction. Maintain the necessary protection until completion of the work.

.10 Provide all exposed ferrous metal work on equipment with at least one factory prime coat, or paint one prime coat on job. Clean up or wire brush all equipment, etc., before painting.

.11 For factory applied finishes, repaint or refinish surfaces damaged during shipment, erection or construction work.

3.9 LOCATION OF OUTLETS

.1 Refer to Architectural drawings for dimensions denoting exact locations.

.2 The Consultant reserves the right to change the location of outlets to within 3 m from the point indicated on the plans without extra charge providing the Contractor is advised before installation is made.

.3 Location of lighting, convenience, telephone, power and communication outlets shall be subject to change, without extra cost to Owners, provided information is given prior to installation. No extra amount will be paid for extra labour and materials for relocating outlets up to 3000 mm from their original location nor will credits be anticipated where relocation up to 3000 mm reduces materials and labour. Other cases will be considered on their individual merits.

3.10 MOUNTING HEIGHTS AND DEVICE LOCATIONS

.1 Refer to architectural drawings for exact location of electrical equipment and devices.

.2 Architectural elevations take precedence over electrical elevations. If there are conflicts between architectural and electrical, adjust locations of electrical equipment at no additional cost to the owner.

.3 Prior to roughing-in, the contractor is to mark locations of electrical equipment and devices for conflicts with architectural, studs, etc. If conflicts are noted, inform the Consultant for a decision prior to commencing the rough-in.

.4 Mounting heights of equipment and devices listed below is from finished floor to centreline of equipment, unless specified or indicated otherwise.

.5 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.

.6 Install electrical equipment at following heights above finished floor (AFF). Dimensions are to centre of device unless indicated otherwise.

.1 HVAC thermostats and manual HVAC controls: 1200 mm.

.2 Local switches, and manual lighting control devices:

.1 1100 mm.

.2 Locate on lock side of door.

.3 System furniture service fittings: to suit furniture layout.

.4 Wall receptacles:

.1 General: min. 400 mm AFF.

.2 Above top of counters: 175 mm.

.3 Above top of continuous baseboard heater, or mechanical heating/radiation units: 75 mm to bottom of device.

.4 In fan rooms, mechanical rooms, and electrical rooms: 1100 mm.

.5 For electric ranges: 130 mm.

.5 Outlets in raceways or millwork to be located as per Architectural details.

3.11 MANUFACTURER'S INSTRUCTIONS

.1 Where the specifications call for an installation to be made in accordance with Manufacturer's recommendations, a copy of such recommendations shall be at all times be kept on the job site and be available to the Owner's Representative.

.2 Follow manufacturer's instructions where they cover points now specifically indicated on the drawings and specifications. If they are in conflict with the drawings and specifications obtain clarification from the Consultant before starting work.

3.12 TESTS AND ACCEPTANCE

.1 The operation of the equipment and electrical system does not constitute an acceptance of the work by the Owner. The final acceptance is to be made after the Contractor has adjusted his equipment and demonstrated that it fulfills the requirements of the drawings and the specifications.

.2 Testing of all systems shall be performed in the presence of the Owner's designated representative. The contractor shall give 72 hours advance notice to the Owner before beginning the tests.

.3 Upon completion of the installation, the Contractor shall furnish certificates of approval from all authorities having jurisdiction, as applicable. Contractor shall demonstrate that work is complete and in perfect operating condition, with raceway and conduit systems properly grounded, wiring free from grounds, shorts, and that the entire installation is free for any physical defects.

.4 Provide labour and material to conduct the integrated systems testing of interconnected life safety systems in accordance with CAN/ULC-S1001-11.

3.13 CLOSEOUT ACTIVITIES

.1 In the presence of the Owner, demonstrate the proper operation of all systems.

.2 Instruct the Owner's designated representatives in all aspects of the operation and maintenance of systems and equipment listed in the trade sections governed by this Section. Obtain in writing from the Consultant a list of the Owner's representatives qualified to receive instructions.

.3 Arrange for and pay for the services of qualified service technicians and other manufacturer's representatives required for instruction of specialized portions of the installation.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Work in existing facilities.

.2 Electrical demolition.

1.2 SCHEDULING

.1 Refer to Section 01 10 00, and Section 01 70 00.

.2 All work in the existing building, other than minor works required to permit construction of the new Work, is to be performed in such a manner as to not disrupt the building operations.

.3 All systems are to be kept in full operation during normal building hours.

.4 Coordinate any noise generating works that disrupt the building operation to be carried out after/before normal operating hours.

2 Products

2.1 MATERIALS

.1 Materials and equipment for patching and extending work: As specified in individual sections.

3 Execution

3.1 EXAMINATION

.1 Verification of Conditions

.1 Verify field measurements and circuiting arrangements are as shown on Drawings.

.2 Verify that abandoned wiring and equipment serve only abandoned facilities.

.3 Demolition drawings are based on visual field observations and conditions derived from existing drawings, and do not assess the interiors of electrical equipment. Report discrepancies to the Consultant before disturbing existing installation.

.4 Beginning of demolition means installer accepts existing conditions.

.2 Tracing Existing Electrical Circuits

.1 Trace all circuits in the area of work listed as existing, and verify existing conditions prior to any modifications as indicated.

.2 Where drawings indicate “connect to existing circuit”, use a spare breaker, where available. Otherwise, verify existing load with a meter and advise the Consultant if the additional load will cause a circuit to trip.

.3 Where provided panelboard schedules indicate "Existing Circuit" or similar, provide the correct description for the circuit. Existing Circuit will not be acceptable in the final panelboard schedules submitted as part of closeout submittals.

.3 Existing Cabling in Return Air Plenums

.1 In ceilings being used as a return air-plenum, Contractor to review existing low-voltage cabling uncovered as part of the work.

.2 Immediately notify the Consultant if any cables identified are not plenum rated (i.e. CMP, or FT6 rated).

3.2 PREPARATION

.1 Coordinate utility service outages with utility company.

.2 Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

.3 Existing electrical service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switch overs and connections. Obtain permission from Owner at least 24 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

.4 Existing Telephone System: Maintain existing system in service. Notify Owner at least 24 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.

.5 Existing Fire Alarm System: Maintain existing system in service. Minimize outage duration. Provide fire watch as required. Make temporary connections to maintain service in areas adjacent to work area.

3.3 DEMOLITION

.1 Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.

.2 Demolish and extend existing electrical work.

.3 Remove, relocate, and extend existing installations to accommodate new construction.

.4 Remove abandoned wiring to source of supply.

.5 When relocating or removing equipment, should any circuits be abandoned, the conductors to these circuits must be removed or properly terminated as detailed in Ontario Electrical Safety Code (OESC) bulletin 12-25-5, or latest revision.

.6 Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

.7 Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.

.8 Disconnect and remove abandoned panelboards and distribution equipment.

.9 Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

.10 Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.

.11 Repair adjacent construction and finishes damaged during demolition and extension work.

.12 Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

.13 Maintain continuity of existing services for other circuits/devices serving areas outside the Work area. Provide additional wiring/conduits/boxes etc. to suit existing services to be maintained and also implement new Work as detailed.

.14 Should any conduit be embedded in concrete slab, cap and seal conduit if it cannot be removed (provided it meets ESA review and approval).

3.4 RESTORATION

.1 Install relocated materials and equipment under the provisions of Division 01.

3.5 CLEANING

.1 Clean and repair existing materials and equipment which remain or are to be reused.

.2 Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts, and broken electrical parts.

.3 Waste Management

.1 Turn over designated equipment to the Owner.

.2 Dispose of unwanted materials and equipment.

3.6 PROTECTION

.1 Maintain access to existing electrical installations which remain active. Modify installation or provide access panels as appropriate.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Building wire and cable.

.1 Armoured cable.

.2 Metal clad cable.

.3 Wiring connectors and connections.

.2 Permitted voltage drop for feeder and branch circuits.

.3 Conductor sizes are based on copper unless indicated as aluminum or "AL".

1.2 REFERENCES

.1 CSA Group:

.1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.

.2 Ontario Electrical Safety Code (28th edition/2021).

.3 CSA C22.2 No. 0.3-09 (R2019), Test methods for electrical wires and cables.

.4 CSA C22.2 No. 48-15, Nonmetallic sheathed cable.

.5 CSA C22.2 No. 51-14, Armoured cables.

.6 CSA C22.2 No. 52-15, Underground secondary and service-entrance cables.

.7 CSA C22.2 No. 65-13, Wire connectors.

.8 CSA C22.2 No. 75-17, Thermoplastic insulated wires and cables.

.9 CSA C22.2 No. 123-16, Aluminum sheathed cables.

.10 CSA C22.2 No. 131-14, Type TECK 90 cable.

.2 NECA (National Electrical Contractors Association) - Standard of Installation.

.3 NETA (International Electrical Testing Association) - ATS-2003 - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

.4 CAN/ULC-S139:2017 – Standard Method of Fire Test for Evaluation of Integrity of Electrical Power, Data and Optical Fibre Cables.

1.3 COORDINATION

.1 Where wire and cable destination is indicated, and routing is not shown, determine exact routing and lengths required.

1.4 CLOSEOUT SUBMITTALS

.1 Record Documents: Indicate as-constructed feeder sizes on single line diagram.

.2 Megger test results.

1.5 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

2 Products

2.1 MANUFACTURERS

.1 American Wire Group.

.2 BICC Phillips.

.3 General Cable.

.4 Nexans.

.5 Prysmian.

.6 Southwire.

2.2 REGULATORY REQUIREMENTS

.1 Provide products listed and classified by CSA Group as suitable for the purpose specified and indicated.

2.3 CONDUCTOR MATERIAL

.1 Submit bid based on copper conductors only.

2.4 BUILDING WIRE

.1 RW90:

.1 Single copper conductor.

.2 Minimum #12 AWG for branch circuit wiring.

.3 Minimum #14 AWG for 120 V control wiring.

.4 Chemically cross-linked polyethylene insulation.

.5 Rated for 90 degrees C, 1000 V.

.6 Suitable for handling to minus 40 degrees C.

.7 For interior installations in conduit.

.2 RWU90:

.1 Single copper conductor.

.2 Minimum 12 AWG for branch circuit wiring.

.3 Minimum 14 AWG for 120 V control wiring.

.4 Chemically cross-linked polyethylene insulation.

.5 Rated for 90 degrees C, 600 V.

.6 Suitable for handling to minus 40 degrees C.

.7 For exterior installations in conduit.

.3 T90 Nylon:

.1 Single copper conductor.

.2 Thin wall PVC insulation with nylon covering.

.3 Rated for 90 degrees C, 600 V.

.4 May be used up to size 10 AWG for interior installations.

.5 Base conduit fill on RW90 cable diameters.

2.5 ARMOURED CABLE

.1 General

.1 Connectors: standard as required, complete with anti-short rings.

.2 Runs to be limited to fixture drops, and runs to devices in walls and partitions, maximum horizontal runs in exposed areas and ceiling spaces to be 1.8 m (6 feet).

.3 Do not daisy chain (leap frog) luminaires with armoured cable.

.2 Type AC:

.1 Two, three or four copper conductors rated RW90, 1000 V.

.2 Bare copper ground wire.

.3 Insulation Voltage Rating: 600 volts.

.4 Insulation Temperature Rating: 90 degrees C (194 degrees F).

.5 Insulation Material: Thermoplastic.

.6 Overall interlocked aluminum tape armour.

.3 Type SPC90:

.1 Use for LED lighting, fluorescent dimming controls, and other SMART building applications.

.2 Colour coded cable with power, control and signal under one cable.

.3 12-2C Power with a 16-2C Control.

.4 Bare copper ground wire.

.5 Insulation Voltage Rating: 600 volts.

.6 Insulation Temperature Rating: 90 degrees C (194 degrees F).

.7 Insulation Material: Thermoplastic.

2.6 FIRE RATED CABLES

.1 General:

.1 2 hour fire rating to ULC S139 and to meet 2012 Ontario Building Code rule 3.2.7.10.

.2 Alternative means of compliance:

.1 Be protected by a fire rated assembly listed to achieve the minimum fire rating as indicated.

.2 Manufacturers:

.1 nVent Pyrotenax 1850 series Mineral Insulated (MI) cable.

.2 VITALink MC Brand Type MC, manufactured by Marmon Wire & Cable Inc. (listed by ULC under ULC category code ‘FHIT7’ or ‘FHJR7’, dated 19 May 2015).

.1 Request quotation from manufacturer or manufacturer's representative for field certification of installed Vitalink cables prior to requesting Consultant's construction field review.

.2 2-Hour rated Vitalink RC90 power cable must be installed according to UL protocol FHIT7.120 – Electrical circuit integrity systems certified in Canada.

.3 Substitution Limitations:

.1 "Lifeline" installed in conduit may only be considered if listed by ULC under ULC Category Codes 'FHIT7' or 'FHJR7'.

2.7 TECK90 CABLE

.1 Single, three, or four conductors as indicated on drawings.

.2 Cable to CSA C22.2 No. 131.

.3 Conductors:

.1 Grounding conductor: copper.

.2 Circuit conductors: copper, size as indicated.

.4 Insulation: Cross-linked polyethylene (XLPE), type RW90, rating: 600 V.

.5 Inner jacket: polyvinyl chloride.

.6 Armour: interlocking aluminum.

.7 Overall covering: thermoplastic.

.8 Fastenings:

.1 One-hole steel straps to secure surface cables 50 mm diameter and smaller. Two-hole steel straps for cables larger than 50 mm diameter.

.2 Channel type supports for two or more cables at 1500 mm centres.

.3 Threaded rods: 6 mm diameter to support suspended channels.

.9 Connectors: Watertight, approved for TECK cable.

2.8 CONDUCTOR PULLING LUBRICANT

.1 IDI Electric (Canada) Ltd., "Ideal Yellow 77" or "Wire Lube" as required.

2.9 CONNECTORS

.1 Armoured cable connectors must be proper squeeze type connectors and plastic anti-short bushings at terminations.

.2 Connectors for conductors connecting to devices as per local governing electrical requirements to be equal to IDI Electric (Canada) Ltd., "Ideal" No. 451, No. 452, and No. 453, "Wing-Nut", CSA certified, 600 volts, rated pressure type connectors.

.3 For conductors sized #3/0 and greater, provide long barrel double crimp, two (2) hole compression type lug connectors, unless otherwise noted.

2.10 WIRING TERMINATION

.1 Lugs, terminals, or screws used for termination of wiring to be suitable for copper conductors. Identify wiring with permanent indelible identifying markings, either numbered or coloured

plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring. Maintain phase sequence and colour coding throughout.

.2 Splice wire, up to and including No. 6 gauge, with nylon insulated expandable spring type connectors.

.1 Thomas & Betts – Marr Max Series

.3 Splice large conductors using compression type connections insulated with heat shrink sleeves.

.1 Thomas & Betts – 5400 Series lugs & heat shrink type #s series

3 Execution

3.1 EXAMINATION

.1 Verify that field measurements are as indicated.

.2 Wire and cable routing indicated is approximate unless dimensioned.

.3 Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.

.4 Voltage Drop

.1 Ensure voltage drop in power and control conductors is in accordance with the requirements of the OESC.

.2 Size conductors accordingly when sizes are not identified.

.1 Feeder conductors: maximum voltage drop of 2 per cent.

.2 Branch circuit conductors: maximum voltage drop of 3 per cent.

.5 Verify that mechanical work likely to damage wire and cable has been completed.

.6 Verify that raceway installation is complete and supported.

3.2 PREPARATION

.1 Completely and thoroughly swab raceway before installing wire.

3.3 INSTALLATION

.1 Route wire and cable as required to meet project conditions.

.2 Install cable to CSA C22.1 and per manufacturer's installation guidelines.

.3 Conduit and cable supports:

.1 All wiring to be installed in EMT at all exposed areas unless otherwise specified.

.2 All mechanical equipment to be connected with liquid tight flexible conduit.

.3 Support cables above accessible ceiling, using spring metal clips to support cables from structure. Do not rest cable on ceiling panels.

.4 Conductors

.1 Provide separate neutral for each circuit. Common neutrals not permitted.

.2 Use solid conductor for feeders and branch circuits 10 AWG and smaller.

.3 Use stranded conductors for control circuits.

.4 Use conductor not smaller than 12 AWG for power and lighting circuits.

.5 Use conductor not smaller than 16 AWG for control circuits.

.6 Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 25 m.

.5 Pulling conductors

.1 Pull all conductors into raceway at same time.

.2 Use suitable wire pulling lubricant for building wire 4 AWG and larger.

.3 Neatly train and lace wiring inside boxes, equipment, and panelboards.

.4 Protect exposed cable from damage.

.6 Connectors

.1 Use suitable cable fittings and connectors.

.2 Clean conductor surfaces before installing lugs and connectors.

.3 Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

.4 Use split bolt connectors for copper conductor splices and taps 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 per cent of insulation rating of conductor.

.5 Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.

.6 Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

.7 Identification

.1 Identify and colour code wire and cable to Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.

.2 Where colour-coded tape is utilized, apply a minimum of 50 mm (2 inches) at terminations, junction and pull boxes and conduit fittings. Do not paint conductors under any condition.

.3 Utilize colour coding on bussing in panels and, switchgear, disconnects, and metering cabinets to match conductor colour coding.

3.4 CONDUCTORS, WIRES, AND CABLES

.1 Indoor wiring installed in conduit, unless otherwise noted: 600 volt "RW90 XLPE".

.2 Wiring in channel back of fluorescent and LED lighting fixtures: 600 volt type GTF or TEW.

.3 Lighting and power branch circuit wiring:

.1 Copper, minimum No. 12 gauge.

.2 Home runs to lighting and receptacle panels, which exceed 22 m (75 feet) in length: minimum No. 10 gauge.

.4 Size wires for 2 per cent maximum voltage drop to farthest outlet on a maximum 80 per cent loaded circuit.

.5 Outdoor wiring: “RWU90 XLPE”.

.6 Conductors shall be colour coded. Conductors No. 10 gauge and smaller shall have colour impregnated into insulation at time of manufacture. Conductors size No. 8 gauge and larger may be colour coded with adhesive colour coding tape but only black insulated conductors shall be employed in this case, except for neutrals which shall be white wherever possible.

.7 Colour coding as follows:

.1 Phase "A" - Red

.2 Phase "B" - Black

.3 Phase "C" - Blue

.4 Control - Orange

.5 Ground - Green

.6 Neutral - White

.8 Neatly train circuit wiring in cabinets, panels, pull boxes and junction boxes and hold with nylon cable ties.

3.5 SITE TESTS AND INSPECTIONS

.1 Perform continuity tests of all feeders, motor circuits, and branch circuits.

.2 Perform insulation-resistance test (megger test) on each feeder. Submit report to the Consultant.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Low-voltage control cabling.

.2 Control-circuit conductors.

1.2 REFERENCES

.1 CSA Group:

.1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.

.2 Ontario Electrical Safety Code (28th edition/2021).

.3 CSA C22.2 No. 0.3-09 (R2019), Test methods for electrical wires and cables.

.4 CSA C22.2 No. 48-15, Nonmetallic sheathed cable.

.5 CSA C22.2 No. 51-14, Armoured cables.

.6 CSA C22.2 No. 65-13, Wire connectors.

.7 CSA C22.2 No. 75-17, Thermoplastic insulated wires and cables.

.8 CSA C22.2 No. 208-14, Fire alarm and signal cable.

.2 NECA (National Electrical Contractors Association) - Standard of Installation.

1.3 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

1.4 COORDINATION

.1 Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.

2 Products

2.1 REGULATORY REQUIREMENTS

.1 Conform to CSA C22.1.

.2 Provide products listed and classified by CSA Group as suitable for the purpose specified and indicated.

2.2 LOW VOLTAGE WIRING

.1 LVT:

.1 Multi conductor PVC insulated.

.2 Bare copper ground conductor.

.3 Overall PVC jacket.

.4 Rated 30 V.

.5 CMP (FT6) rated if cable is exposed.

.6 CMR (FT4) rated if cable is installed in conduit.

.2 Category 5e Network Cabling.

.1 CMP (FT6) rated if cable is exposed.

.2 CMR (FT4) rated if cable is installed in conduit.

2.3 TERMINATIONS AND SPLICES

.1 All terminations and splices shall be of an approved type for the conductors being used.

.2 Where conductors are terminated or spliced, it shall be done in the following manner:

.1 Where a single solid conductor is terminated in a device under one screw or clamping mechanism, no additional terminating hardware is required.

.2 Where multiple or stranded conductors are terminated in a device under one screw or clamping mechanism, self insulated crimp-on cable ends or approved equal shall be used up to and including No. 10 sized conductors. Approved compression lugs shall be used for larger conductor sizes.

.3 Where multiple conductors are spliced, properly sized Wing Nut connectors, or approved equal, shall be used for up to two No. 8 or three No. 10 AWG conductors. Pressure type sleeve cable connectors, splices, tee's, etc., shall be used for all larger size connections and terminations.

.4 Insulate all bare surfaces of splices with heat shrink sleeving or equivalent.

.5 Conductors connected to ground rods for service or equipment grounding or to building structural or architectural elements shall be terminated, connected and spliced using a thermoweld process or approved non-mechanical compression type connectors.

.3 Install all service and feeder conductors as continuous lengths without breaks, measured and cut based on site dimensions.

3 Execution

3.1 EXAMINATION

.1 Verify that mechanical work likely to damage wire and cable has been completed.

.2 Verify that raceway installation is complete and supported.

.3 Verify that field measurements are as indicated.

.4 Wire and cable routing indicated is approximate unless dimensioned.

3.2 PREPARATION

.1 Completely and thoroughly swab raceway before installing wire.

3.3 INSTALLATION

.1 Route control cabling as required to meet project conditions.

.2 Install cable to the CSA C22.1.

.3 Conduit and supports

.1 All wiring to be installed in EMT at all exposed areas and in partitions unless otherwise specified.

.2 All mechanical equipment to be connected with liquid tight flexible conduit.

.3 Support cables above accessible ceiling, using spring metal clips to support cables from structure. Do not rest cable on ceiling panels.

.4 Conductors

.1 Use stranded conductors for control circuits.

.2 Use conductor not smaller than 16 AWG for control circuits.

.5 Pulling conductors

.1 Pull all conductors into raceway at same time.

.2 Neatly train and lace wiring inside boxes, equipment, and panelboards.

.3 Neatly train circuit wiring in cabinets, panels, pull boxes and junction boxes and hold with nylon cable ties.

.4 Protect exposed cable from damage.

.6 Connectors

.1 Use suitable cable fittings and connectors.

.2 Clean conductor surfaces before installing lugs and connectors.

.3 Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.

.4 Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

.7 Identification

.1 Identify and colour code wire and cable to Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.

.2 Where colour coded tape is utilized, apply a minimum of 50 mm (2 inches) at terminations, junction and pull boxes and conduit fittings. Do not paint conductors under any condition.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Grounding electrodes and conductors.

.2 Equipment grounding conductors.

.3 Bonding.

.4 The terms “connect” and “bond” are used interchangeably in this Specification and have the same meaning.

1.2 REFERENCES

.1 CSA Group:

.1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.

.2 Ontario Electrical Safety Code (28th edition/2021).

.3 CSA C22.2 No.0.4-17, Bonding of electrical equipment.

.4 CSA C22.2 No. 41-13, Grounding and bonding equipment.

.5 CSA C22.2 No. 75-17, Thermoplastic insulated wires and cables.

.2 ANSI/TIA/EIA J-STD-607-A - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.

.3 Institute of Electrical and Electronics Engineers, Inc.

.1 IEEE 81-1983 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

1.3 ACTION SUBMITTALS

.1 Product Data: Provide for grounding electrodes and connections.

1.4 INFORMATIONAL SUBMITTALS

.1 Test Reports: Indicate overall resistance to ground and resistance of each electrode.

.2 Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.5 CLOSEOUT SUBMITTALS

.1 Project Record Documents: Record actual locations of components and grounding electrodes.

.2 Certificate of Compliance: Indicate approval of installation by authority having jurisdiction.

1.6 QUALIFICATIONS

.1 Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years’ experience.

1.7 REGULATORY REQUIREMENTS

.1 Products: Listed and classified testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

2 Products

2.1 MANUFACTURERS

.1 B-Line by Eaton.

.2 Hubbell (Burndy).

.3 Panduit.

.4 Thomas & Betts.

2.2 PERFORMANCE CRITERIA

.1 Grounding System Resistance: 5 ohms.

.2 Provide all equipment grounding as required regardless of whether it has been shown on drawings or called for in this specification. Arrange grounds so that under normal operating conditions no injurious amount of current will flow in any grounding conductor.

2.3 GROUNDING AND BONDING CONDUCTORS

.1 Electrical grounding conductors shall be CSA C22.2 No. 75 insulated stranded copper, except that sizes #10 AWG and smaller shall be solid copper. Insulation colour shall be continuous green for all equipment grounding conductors.

.2 Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes #10 AWG and smaller shall be ASTM B1 solid bare copper wire.

2.4 ROD ELECTRODES

.1 Material: Copper-clad steel.

.2 Diameter: 19 mm.

.3 Length: 3000 mm.

2.5 GROUND RODS

.1 Copper clad steel, 19 mm (3/4 inch) diameter by 3000 mm (10 feet) long, conforming to CSA C22.2 No. 41.

.2 Quantity of rods shall be as required to obtain the specified ground resistance.

2.6 SPLICES AND TERMINATION COMPONENTS

.1 Components shall meet or exceed CSA C22.2 No. 41, and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).

2.7 GROUND CONNECTIONS

.1 Below Grade: Exothermic-welded type connectors.

.2 Above Grade:

.1 Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lockwashers.

.2 Ground Busbars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.

2.8 GROUND TERMINAL BLOCKS

.1 At any equipment mounting location (e.g. backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks.

2.9 SPLICE CASE GROUND ACCESSORIES

.1 Splice case grounding and bonding accessories shall be supplied by the splice case manufacturer when available. Otherwise, use 6 AWG insulated ground wire with shield bonding connectors.

2.10 MECHANICAL CONNECTORS

.1 Material: Bronze.

2.11 WIRE

.1 Material: Stranded copper.

.2 Foundation Electrodes: 2/0 AWG.

.3 Grounding Electrode Conductor: Size to meet Ontario Electrical Safety Code requirements.

2.12 GROUNDING WELL COMPONENTS

.1 Well Pipe: 200 mm by 600 mm long concrete pipe with belled end.

.2 Well Cover: Cast iron with legend "GROUND" embossed on cover.

3 Execution

3.1 EXAMINATION

.1 Verify that final backfill and compaction has been completed before driving rod electrodes.

3.2 INSTALLATION

.1 General

.1 Ground in accordance with the Ontario Electrical Safety Code, as shown on drawings, and as hereinafter specified.

.2 System Grounding:

.1 Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.

.2 Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.

.3 Equipment Grounding: Metallic structures (including ductwork and building steel), enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be bonded and grounded.

.4 Ground electrical equipment and wiring in accordance with Ontario Electrical Safety Code and Local Inspection Authority's Rules and Regulations.

.5 Install grounding conductors, outside Electric Rooms and Electrical Closets in conduit and conceal where possible. Make connections to water mains, all metallic piping systems, neutral and equipment with brass, copper or bronze bolts and connectors or weld using Cadweld or Thermoweld processes.

.6 Provide grounding conductors, sized as per Code, and connect to grounding bus or water main wherever non-raceways are installed.

.2 Provide grounding electrode conductor and connect to reinforcing steel in foundation footing. Bond steel together.

.3 Provide bonding to meet Regulatory Requirements.

.4 Bond together metal siding not attached to grounded structure; bond to ground.

.5 Install ground grid under access floors indicated.

.6 Bond together each metallic raceway, pipe, duct and other metal object entering space under access floors. Bond to underfloor ground grid. Use #6 AWG bare copper conductor.

.7 Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

.8 Ground Resistance

.1 Grounding system resistance to ground not to exceed 5 ohms. Make necessary modifications or additions to the grounding electrode system for compliance without additional cost to the Owner. Final tests shall assure that this requirement is met.

.2 Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

.3 Services at power company interface points shall comply with the power company ground resistance requirements.

.9 Ground Rod Installation

.1 Drive each rod vertically in the earth, not less than 3000 mm (10 feet) in depth.

.2 Where permanently concealed ground connections are required, make the connections by the exothermic process to form solid metal joints. Make accessible ground connections with mechanical pressure type ground connectors.

.3 Where rock prevents the driving of vertical ground rods, install angled ground rods or grounding electrodes in horizontal trenches to achieve the specified resistance.

.10 Inaccessible Grounding Connections

.1 Make grounding connections, which are buried or otherwise normally inaccessible (except connections for which periodic testing access is required) by exothermic weld.

.11 Secondary Equipment and Circuits

.1 Main Bonding Jumper: Bond the secondary service neutral to the ground bus in the service equipment.

.2 Metallic Piping, Building Steel, and Supplemental Electrode(s):

.1 Provide a grounding electrode conductor sized per code between the service equipment ground bus and all metallic water and gas pipe systems, building steel, and supplemental or made electrodes. Jumper insulating joints in the metallic piping. All connections to electrodes shall be made with fittings that conform to CSA C22.2 No 41.

.2 Provide a supplemental ground electrode and bond to the grounding electrode system.

.3 Conduit Systems:

.1 Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.

.2 Non-metallic conduit systems shall contain an equipment grounding conductor, except that non-metallic feeder conduits which carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment need not contain an equipment grounding conductor.

.3 Conduit containing only a grounding conductor, and which is provided for mechanical protection of the conductor, shall be bonded to that conductor at the entrance and exit from the conduit.

.4 Feeders and Branch Circuits: Install equipment grounding conductors with all feeders and power and lighting branch circuits.

.5 Boxes, Cabinets, Enclosures, and Panelboards:

.1 Bond the equipment grounding conductor to each pull box, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes (except for special grounding systems for intensive care units and other critical units shown).

.2 Provide lugs in each box and enclosure for equipment grounding conductor termination.

.3 Provide ground bars in panelboards, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.

.6 Receptacles shall not be grounded through their mounting screws. Ground with a jumper from the receptacle green ground terminal to the device box ground screw and the branch circuit equipment grounding conductor.

.7 Raised Floors: Provide bonding of all raised floor components.

.12 Corrosion Inhibitors

.1 When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

.13 Conductive Piping

.1 Bond all conductive piping systems, interior and exterior, to the building to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.

3.3 FIELD QUALITY CONTROL

.1 Perform inspections and tests listed in NETA ATS, Section 7.13.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Conduit and equipment supports.

.2 Anchors and fasteners.

1.2 REFERENCES

.1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.

.2 Ontario Electrical Safety Code (28th edition/2021).

.3 CECA - Canadian Electrical Contractors Association.

1.3 CLOSEOUT SUBMITTALS

.1 Submit the following in the Operation and Maintenance Manual for products used over the course of the project:

.1 Product Data: Provide manufacturer's catalogue data for fastening systems.

.2 Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.4 REGULATORY REQUIREMENTS

.1 Provide products listed and classified by Canadian Standards as suitable for purpose specified and shown.

2 Products

2.1 MANUFACTURERS

.1 B-line by Eaton.

.2 Burndy Canada Ltd. (Hubbell).

.3 Erico Caddy.

.4 E. Myatt & Co. Inc.

.5 Hilti Canada.

.6 Thomas & Betts.

.7 Unistrut.

.8 Approved equal.

2.2 GENERAL

.1 All supporting devices, strut channel, threaded rod, anchors, etc. to be used shall be of the “hot dipped” galvanized type. Electrogalvanized components will not be accepted.

.2 Materials and Finishes: Provide adequate corrosion resistance.

.3 Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products.

.4 Anchors and Fasteners:

.1 Concrete Structural Elements: Use expansion anchor sand preset inserts.

.2 Steel Structural Elements: Use beam clamps and welded fasteners.

.3 Concrete Surfaces: Use self-drilling anchors and expansion anchors.

.4 Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts and hollow wall fasteners.

.5 Solid Masonry Walls: Use expansion anchors and preset inserts.

.6 Sheet Metal: Use sheet metal screws.

.7 Wood Elements: Use wood screws.

2.3 ANCHORS AND HANGERS

.1 Hangers for electrical conduit shall be galvanized after fabrication.

.2 Perforated strapping: not permitted.

2.4 INSERTS

.1 Use only factory-made threaded or toggle type.

.2 Where inserts cannot be placed, use factory-made expansion shields for light weights, where approved by the Consultant.

.3 Do not use powder-activated tools except with the written permission of the Consultant.

2.5 SLEEVES

.1 Through interior walls, use standard weight steel pipes, conduit, or 18 gauge galvanized steel. Cut flush with finished surfaces. Check room finish schedules.

.2 Through exterior walls above grade, floors, and roof use standard weight steel pipes, machine cut, flush with finished surface inside and to suit flashing outside.

.3 Through exterior walls below grade, water-proofed floors, and other water-proof walls, use heavy weight cast iron pipes, machine cut. Extend sleeves 100 mm (4 inch) above finished floors, and cut flush with underside of floor.

2.6 STEEL CHANNEL

.1 Description: Painted steel.

2.7 SUPPORTS

.1 Steel supports in wet or dry locations to be galvanized after fabrication.

.2 Where galvanized members are bolted together use cadmium plated bolts.

.3 For hanger rods use minimum 10 mm (3/8 inch) diameter steel threaded rod. Use clevis type attachment.

.4 Provide minimum 100 mm (4 inch) high concrete bases for all floor mounted equipment.

2.8 SUPPORTS AND BASES

.1 Submit proposed method of attachment of hangers and beam clamps, to cellular steel deck for approval before proceeding with Work.

.2 Supply and erect special structural Work required for the installation of electrical equipment. Provide anchor bolts and other fastenings unless noted otherwise. Mount equipment required to be suspended above floor level, where details are not shown, on a frame or platform bracketed

from the wall or suspended from the ceiling. Carry supports to either the ceiling or the floor, or both as required, at locations where, because wall thickness is inadequate, it is not permitted to use such brackets.

.3 Electrical panels, switches or other electrical equipment shall be complete with suitable bases or mounting brackets.

.4 Provide channel or other metal supports where necessary, to adequately support lighting fixtures. Do not use wood unless wood forms part of the building structure.

.5 Support hangers, in general, from inserts in concrete construction or from building structural steel beams, using beam clamps. Provide additional angle or channel steel members, required between beams for supporting conduits and cables.

.6 Provide any additional supports required from existing concrete construction for any piping or equipment, by drilling same and installing expansion bolt cinch anchors.

.7 Do not use explosive drive pins in any section of Work without obtaining prior approval.

2.9 CONCRETE BASES AND HOUSEKEEPING PADS

.1 Provide concrete bases of dimensions where indicated, but not less than 100 mm (4 inches) larger in both directions than supported unit, and 100 mm (4 inches) high, and so anchors will be a minimum of 10 bolt diameters from edge of the base. Chamfer edges.

.2 Use 20 MPa (3000 psi) 28-day compressive-strength concrete.

.3 Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 450 mm (18 inch) centres around full perimeter of base.

.4 Anchor equipment to concrete base.

.5 Provide a housekeeping pad for floor mounted equipment, including but not limited to the following:

.1 Transformers.

.2 Switchgear and switchboards.

.3 Distribution panelboards.

.4 Engine Generators.

.5 Uninterruptible Power Supplies and batteries.

.6 Transfer Switches.

2.10 CONCRETE ANCHORS

.1 Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

.2 Drilled expansion anchors for anchors set in concrete block or poured concrete after the concrete has set. Size the insert and number of anchors so that the maximum load per anchor does not exceed the manufacturer's recommendation.

.3 U-channel concrete inserts shall be 12 gauge steel 1-5/8 in. square with insert anchors 1 3/8 in. long and 4 in. on centre.

.4 Install anchor bolts to elevations required for proper attachment to supported equipment.

2.11 PLYWOOD EQUIPMENT BOARDS

.1 Plywood Equipment Boards: preservative treated, and kiln dried; thickness as indicated, or if not indicated, not less than 19 mm (3/4 inches) deep. Provide marine grade plywood where subject to moisture conditions.

.2 Paint plywood board white, or to match adjacent finishes. Leave the fire-retardant label unpainted for verification by the Consultant and by Authority Having Jurisdiction (AHJ).

.3 Unless otherwise noted, boards shall be painted with two coats of good grade weatherproof flat gray non-conductive fire-retardant paint on all sides and edges (prior to mounting) and plumbed in a true vertical position. Provide nominal 13 mm (1/2 in) rustproof spacers between back of plywood and wall. Cut, fit, and place plywood equipment boards accurately in location, alignment, and elevation to support and anchor electrical materials and equipment. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members. Attach to substrates as required to support applied loads. Maintain at least 100 mm (4 inches) from bottom of plywood equipment boards and the finished floor surface.

.4 Unless directed otherwise in field, plywood equipment boards shall be 2440 mm (8 feet) high by 19 mm (3/4 inches) deep by length shown on drawings (as dimensioned or as scaled) or length as required to accommodate equipment if not indicated on drawings. Unless directed otherwise in field, provide plywood equipment boards for all indoor surface mounted panelboards and systems "head-end" equipment for all applications where located in mechanical or electrical rooms/areas and only where specifically shown on drawings for all other applications.

2.12 ROOF SUPPORTS

.1 High-density polyethylene platform and base, height adjustable with rounded corners and edges to reduce likelihood of roof penetration.

.2 Large surface area to spread the weight of supported objects including conduits, and cable trays over a large surface footprint.

.3 No penetration of the waterproof membrane.

.4 Self drains water, rot proof, and sunlight resistant.

.5 Manufacturers:

.1 Thomas & Betts Superstrut Adjustable Universal Support.

.2 Eaton Dura-Blok series.

.3 Approved equal.

3 Execution

3.1 INSTALLATION

.1 Obtain permission from the Consultant before drilling or cutting structural members.

.2 Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

.3 Install surface-mounted cabinets and panelboards with minimum of four anchors.

.4 In wet and damp locations use steel channel supports to stand cabinets and panelboards 25 mm (1 inch) off wall.

.5 Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

.6 Provide inserts, sleeves, equipment supports and hangers, sealing of sleeves and openings, as required for all electrical work. Ensure that the load onto structures does not exceed the maximum loading per square metre as shown on Structural Drawings or as directed by the Consultant.

.7 Provide insets, holes, anchor bolts and sleeves in time when walls, floors, and roof are erected.

.8 Place insets only in structural members and not in the finishing material.

.9 Secure all supports and hangers to the structure unless noted otherwise.

.10 Suspend hanger rods from approved concrete inserts and from beam clamps. Obtain Consultant's approval before welding to steel structural members.

.11 Secure supports to precast concrete members to inserts originally cast into the members or by rods passing between the members and connected to a steel plate bearing.

.12 Sealing of Sleeves and Openings to Maintain Fire Rating

- .1 Use Dow-Corning #3-6548 'Silicone RTV' foam, Thomas & Betts "Flamesafe' firestopsystem, Electrovert 'Flameseal" firestop putty, or approved equal materials installed in accordance with the manufacturer's specifications and recommendations.
- .2 Submit data sheets for review prior to installation.

.13 Supports

- .1 All conduits, panels, etc. to be securely and adequately supported.
- .2 Where more than three conduits run together, conduit racks to be used.
- .3 Single runs of conduit to be supported by galvanized conduit straps or ring bolt type hangers. Tie wire or perforated metal strap hangers will NOT be accepted.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Rigid steel conduit.

.2 Flexible metal conduit.

.3 Liquid tight flexible metal conduit.

.4 Electrical metallic tubing (EMT).

.5 Rigid PVC conduit.

.6 Fittings and conduit bodies.

1.2 REFERENCES

.1 Canadian Standards Association

.1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.

.2 Ontario Electrical Safety Code (28th edition/2021).

.3 CAN/CSA-C22.2 No. 18 – Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.

.4 CSA C22.2 No. 45 – Rigid Metal Conduit.

.5 CSA C22.2 No. 45.1 – Rigid Metal Conduit - Steel.

.6 CSA C22.2 No. 56-17, Flexible metal conduit and liquid-tight flexible metal conduit.

.7 CSA C22.2 No. 83.1 – Electrical Metallic Tubing - Steel.

.8 CSA C22.2 No. 211.1 – Rigid Types EB1 and DB2/ES2 PVC Conduit.

.9 CSA C22.2 No. 211.2 – Rigid PVC (Unplasticized) Conduit.

.10 CSA C22.2 No. 211.3 – Reinforced Thermosetting Resin Conduit (RTRC) on Fittings.

.11 CSA C22.2 No. 227.1 – Electrical Nonmetallic Tubing.

.12 CSA C22.2 No. 227.2.1 – Liquid-Tight Flexible Nonmetallic Conduit.

1.3 RECORD DOCUMENTATION

.1 Accurately record actual routing of conduits larger than 51 mm.

.2 Accurately record actual routing of all conduits installed below grade, regardless of size, including whether direct buried or installed in concrete duct bank.

1.4 REGULATORY REQUIREMENTS

.1 Provide products listed and classified by CSA (Canadian Standards Association) as suitable for purpose specified and shown.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Accept conduit on site. Inspect for damage.

.2 Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

1.6 PROJECT CONDITIONS

.1 Verify that field measurements are as shown on drawings.

.2 Verify routing and termination locations of conduit prior to rough-in.

.3 Conduit routing, if shown on drawings, is approximate unless dimensioned. Route as required to provide a complete wiring system.

2 Products

2.1 MANUFACTURERS

.1 Where products are listed in this section based on a single manufacturer, the equivalent product from the following manufacturers is acceptable:

.1 Appleton.

.2 Columbia-MBF.

.3 Crouse-Hinds by Eaton.

.4 Hubbell.

.5 Thomas & Betts Ltd.

2.2 RIGID METAL CONDUIT

.1 Rigid metal conduit: to CSA C22.2 No. 45, hot dipped galvanized steel, threaded.

.2 Epoxy coated conduit: to CSA C22.2 No. 45, with zinc coating and corrosion resistant epoxy finish inside and outside.

.3 Fittings and conduit bodies: Material to match conduit.

2.3 FLEXIBLE METAL CONDUIT

.1 Flexible metal conduit: to CSA C22.2 No. 56, interlocked steel construction.

.2 Fittings: CSA C22.2 No. 56.

2.4 LIQUID TIGHT FLEXIBLE METAL CONDUIT

.1 Description: Interlocked steel construction with PVC jacket.

.2 Fittings: CSA C22.2 No. 56.

2.5 ELECTRICAL METALLIC TUBING (EMT)

.1 Description: CSA C22.2 No. 83.1; galvanized tubing.

.2 Fittings and Conduit Bodies: CSA C22.2 No. 83.1; steel type.

2.6 ELECTRICAL NON-METALLIC TUBING (ENT)

.1 To CSA C22.2 No. 227.1.

2.7 CONDUIT, FITTINGS, AND ACCESSORIES

.1 Conduit accessories, conduits and fittings conforming to CSA Standard C22.2 No. 18-1972.

.2 Provide rain tight connectors, couplings, fittings, junction boxes, pull boxes and surface outlet boxes shall be used for surface conduit installations exposed to moisture or in sprinklered buildings.

.3 Rigid conduit bushings:

.1 Thomas & Betts Ltd. - Series 5031.

.4 EMT Connectors:

.1 Thomas & Betts Ltd. - Steel City TC121A series.

.5 Ground Bushings:

.1 Thomas & Betts – Blackjack or 1220 series.

.6 Flexible conduit connectors:

.1 Thomas & Betts Ltd. - Series 3110.

.2 EMT couplings: steel concrete tight to match connectors.

.7 Terminate rigid conduit entering boxes or enclosures with nylon insulated steel threaded bushings.

.1 Thomas & Betts – 8125 series.

.8 Terminate EMT entering boxes or enclosures with nylon insulated steel concrete tight connectors.

.9 Terminate flexible conduit entering boxes or enclosures with nylon insulated steel connectors.

.1 Thomas & Betts – 5332 series.

3 Execution

3.1 PREPARATION

.1 Produce layout sketches of conduit runs through mechanical and electrical service areas, through corridors, and other congested areas in order to resolve any interferences with other work, and to determine the most efficient route to run the conduit.

3.2 INSTALLATION

.1 Minimum size: 21 mm (3/4 inch) unless otherwise specified.

.2 All conduit shall be concealed except in mechanical rooms and electrical rooms, or unless otherwise indicated in this specification, or noted on the drawings. Surface conduit work is not permitted unless specifically noted.

.3 Install wiring in conduit unless otherwise specified. Where conduit sizes are not shown on drawings, provide conduits sized in accordance with Ontario Electrical Safety Code, CSA C22.1. When conduits are indicated, they are the minimum size required, and must be increased to suit the length of run or voltage drop requirements.

.4 Conduit use:

.1 Unless otherwise specified below or shown on the drawings, all systems shall be installed in electrical metallic tubing (EMT).

.2 Equipment subject to vibration:

.1 Use liquid tight flexible metal conduit for connections to transformers, motors, and equipment, subject to vibration and movement.

.3 Outdoor locations, above grade: use rigid steel.

.4 Underground: Use rigid PVC conduit for wiring in slabs on grade and wiring below grade.

.5 Wet and damp locations:

.1 Use rigid steel.

.2 Use liquid tight flexible metal conduit for connections to transformers, motors, and equipment, subject to vibration and movement.

.6 Dry locations:

.1 Concealed in metal stud partitions:

.1 Use electrical metallic tubing.

.2 Use of AC90 (Bx) as described in Section 26 05 19.

.2 Concealed in concrete: Use electrical non-metallic tubing or rigid PVC.

.3 Exposed areas: Use electrical metallic tubing.

.4 Use liquid tight flexible metal conduit below raised floors for connections to all devices.

.5 Aluminium conduit may be used, in lieu of steel conduit, in clean and dry locations, but shall not be used in poured concrete, or for signal and intercommunication systems wiring.

.6 Raceways installed less than 2 m above grade in an area where they are subject to mechanical damage, shall be of the rigid steel type or protected by a steel guard of not less than no. 10 MSG, adequately secured in place.

.7 Use epoxy coated conduit in corrosive areas.

.7 Equipment in sprinklered spaces:

.1 Provide CSA certified sealing rings for rigid steel galvanize conduit and CSA certified raintight connectors for steel galvanized electrical metallic tubing (EMT) where conduits enter the top or the sides of enclosures.

.5 Arrangement and supports

.1 Arrange supports to prevent misalignment during wiring installation.

.2 Arrange conduit to maintain headroom and present neat appearance.

.3 Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

.4 Group related conduits; support using conduit rack.

.5 Construct rack using steel channel; provide space on each for 25 per cent additional conduits.

.6 Fasten conduit supports to building structure and surfaces to Section 26 05 29.

.7 Do not support conduit with wire or perforated pipe straps.

.8 Remove wire used for temporary supports

.9 Do not attach conduit to ceiling support wires.

.10 Route exposed conduit parallel and perpendicular to walls.

.11 Route conduit installed above accessible ceilings parallel and perpendicular to walls.

.12 Route conduit in and under slab from point-to-point.

.13 In damp and unheated areas, avoid moisture traps; provide junction box with drain fitting at low points in conduit system.

.14 Provide suitable fittings to accommodate expansion and deflection where conduit crosses expansion joints.

.6 Clearances

.1 Maintain adequate clearance between conduit and piping.

.2 Maintain 300 mm (12 inch) clearance between conduit and surfaces with temperatures exceeding 40 degrees C.

.7 Conduit bends

.1 Install no more than equivalent of three 90 degree bends between boxes.

.1 Use conduit bodies to make sharp changes in direction, as around beams.

.2 Use hydraulic one-shot bender to fabricate bends in metal conduit larger than 50 mm size or provide prefabricated conduit bends.

.8 Install wall entrance seals where conduits pass through exterior walls below grade.

.9 Provide expansion coupling in conduit runs at building expansion joints and in long runs subject to thermal expansion, all in accordance with manufacturer recommendations.

.10 Cut conduit square using saw or pipe cutter; de-burr cut ends.

.11 Bring conduit to shoulder of fittings; fasten securely.

.12 Use suitable caps to protect installed conduit against entrance of dirt and moisture.

.13 Use conduit hubs or sealing locknuts to fasten conduit and to cast boxes.

.14 Provide suitable pull string in each empty conduit except sleeves and nipples.

.15 Ground and bond conduit to Section 26 05 26.

.16 Identify conduit to Section 26 05 53.

.17 Flexible conduit and armoured cable will be accepted for a maximum length of 1500 mm for final connection to lighting fixtures. Do not connect from fixture to fixture.

3.3 CLEANING

.1 Conduit manufacturer's touch-up enamel shall be used to repair all scratches and gouges on epoxy-coated conduit.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Wall and ceiling outlet boxes.

.2 Pull and junction boxes.

1.2 RELATED REQUIREMENTS

.1 Section 26 27 26 – Wiring Devices.

1.3 REFERENCES

.1 CSA Group:

.1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.

.2 Ontario Electrical Safety Code (28th edition/2021).

.3 CSA C22.2 No. 18.1-13 (R2018) – Metallic Outlet Boxes (Tri-national standard, with UL 514A and ANCE NMX-J-023/1).

.4 CSA C22.2 No. 40-17 - Junction and Pull Boxes.

.5 CSA C22.2 No. 85-14 (R2018) – Rigid PVC Boxes and Fittings.

1.4 CLOSEOUT SUBMITTALS

.1 Record actual locations and mounting heights of outlet, pull, and junction boxes on project record documents.

1.5 REGULATORY REQUIREMENTS

.1 Provide products listed and classified by CSA (Canadian Standards Association) as suitable for the purpose specified and indicated.

2 Products

2.1 OUTLET BOXES

.1 Sheet Metal Outlet Boxes: CSA C22.2 No. 18.1, galvanized steel.

.1 Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 13 mm male fixture studs where required.

.2 Concrete Ceiling Boxes: Concrete type.

.2 Non-metallic Outlet Boxes: CSA C22.2 No. 18.1.

.3 Cast Boxes: CSA C22.2 No. 18.1, Type FD, aluminum. Provide gasketed cover by box manufacturer. Provide threaded hubs.

.4 Wall Plates for Finished Areas: As specified in Section 26 27 26.

2.2 PULL BOXES AND JUNCTION BOXES

.1 Sheet Metal Boxes: CSA C22.2 No. 18.1, galvanized steel.

.2 Surface Mounted Cast Metal Box: CSA C22.2 No. 18.1, Type 4; flat-flanged, surface mounted junction box:

.1 Material: Cast aluminum.

.2 Cover: Provide with ground flange, neoprene gasket, and stainless steel cover screws.

2.3 OUTLET BOXES

.1 Conform to CSA C22.2 No. 18.1.

.2 Ceiling boxes: 103 mm (4 inch) octagon or square, complete with fittings, where required to support fixtures.

.3 Switch and receptacle boxes:

.1 103 mm (4 inch) square with plaster ring, where flush mounted in plaster walls.

.2 Iberville 1104 series box, or equal, where flush mounted in wood or drywall, with stud fasteners as required.

.3 Masonry boxes in masonry walls.

.4 Where boxes are surface mounted in unfinished areas they shall be FS conduits.

.5 Standard outlet boxes manufactured from code gauge galvanized steel.

.6 Provide a suitable outlet box for each light, switch, receptacle or other outlet, approved for the particular area it is to be installed.

.7 Support outlet boxes independently of conduit and cable.

.8 Locate outlet boxes, mounted in hung ceiling space, so they do not obstruct or interfere with the removal of lay-in ceiling tiles.

.9 Offset outlet boxes, shown back to back in partitions, horizontally a minimum 150 mm (6 inch) to minimize noise transmission between adjacent rooms.

.10 Use gang boxes at locations where more than one device, of the same system only, is to be mounted. Utilize separate boxes for each system.

.11 Use tile wall covers where 103 mm (4 inch) square outlet boxes are installed in exposed concrete or cinder block in finished areas.

.12 Provide flush mount boxes, panels, cabinets and electrical devices, which are installed in finished areas, with suitable flush trims and doors or covers, unless specifically noted otherwise.

.13 Provide pre-formed polyethylene vapour barriers for all boxes located in walls with internal vapour barriers.

3 Execution

3.1 EXAMINATION

.1 Verify locations of floor boxes prior to rough-in.

3.2 INSTALLATION

.1 Install boxes to CSA C22.1.

.2 Install in locations as shown on drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.

.3 Set wall mounted boxes at elevations to accommodate mounting heights indicated.

.4 Electrical boxes are shown on drawings in approximate locations unless dimensioned. Adjust box location up to 3 m (10 feet) if required to accommodate intended purpose.

.5 Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26.

.6 Maintain headroom and present neat mechanical appearance.

.7 Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

.8 Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 150 mm (6 inch) from ceiling access panel or from removable recessed luminaire.

.9 Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods.

.10 Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

.11 Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.

.12 Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

.13 Use flush mounting outlet box in finished areas.

.14 Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

.15 Do not install flush mounting box back-to-back in walls; provide minimum 150 mm (6”) separation. Provide minimum 600 mm (24”) separation in acoustic rated walls.

.16 Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

.17 Use stamped steel bridges to fasten flush mounting outlet box between studs.

.18 Install flush mounting box without damaging wall insulation or reducing its effectiveness.

.19 Use adjustable steel channel fasteners for hung ceiling outlet box.

.20 Do not fasten boxes to ceiling support wires.

.21 Support boxes independently of conduit.

.22 Use gang box where more than one device is mounted together. Do not use sectional box.

.23 Use gang box with plaster ring for single device outlets.

.24 Use cast outlet box in exterior locations exposed to the weather.

.25 Use cast outlet box in wet locations.

.26 Set floor boxes level.

.27 Large pull boxes: Use hinged enclosure in interior dry locations, surface-mounted cast metal box in other locations.

3.3 ADJUSTING

.1 Adjust floor box flush with finish flooring material.

.2 Adjust flush-mounting outlets to make front flush with finished wall material.

.3 Install knockout closures in unused box openings.

3.4 CLEANING

.1 Clean interior of boxes to remove dust, debris, and other material.

.2 Clean exposed surfaces and restore finish.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Metal Raceway is an enclosed pathway used for surface distribution of branch circuit electrical wiring, and cabling for voice, data, multi-media, low voltage, and optical fiber. Raceway is typically installed in existing building structures, or after construction is complete. A complete raceway system includes raceway, covers, mounting hardware, various fittings, and outlet boxes installed at specific locations. Specific codes and standards apply to electrical wires and telecommunications cables that are deployed within metal raceway. Compliance to codes and standards is required for installation, grounding and bonding, and cable deployment.

1.2 RELATED REQUIREMENTS

.1 Section 26 05 33.13 – Conduit for Electrical Systems.

.2 Section 26 05 33.16 – Boxes for Electrical Systems.

1.3 QUALITY ASSURANCE

.1 Product free from defects in material or workmanship.

.2 Materials and work specified in this document shall comply with, and are not limited to the codes, standards, and regulations listed below.

.1 CSA C22.1 - Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.

.2 National Electrical Manufacturer's Association (NEMA)

.1 ANSI/NEMA WD-6-2002: Wiring Devices – Dimensional Requirements

.2 NEMA 250-2003: Enclosures for Electrical Equipment.

.3 Performance Requirements:

.1 Metal raceway and fittings UL Listed and CSA certified.

1.4 SUBMITTALS

.1 Product Data Sheet.

.2 Manufacturer's Instructions.

.3 Product Catalog Literature.

.4 Product Drawings.

1.5 WARRANTY

.1 Product is warranted free of defects in material or workmanship.

.2 Product is warranted to perform the intended function within design limits.

2 Products

2.1 MANUFACTURERS

.1 Wiremold Legrand.

.2 Hubbell.

.3 Thomas & Betts Canada.

2.2 SURFACE MOUNTED RACEWAY, GENERAL

.1 The raceway and all system components must be UL Listed and exhibit non-flammable self-extinguishing characteristics tested to comparable specifications of UL94V-0. The raceway base

and cover shall be manufactured by rigid compound, available in ivory or white colours, and allow for field painting.

2.3 SINGLE CHANNEL METAL RACEWAY

.1 Raceway:

.1 Metal raceway shall be a one-piece design with base and cover, factory assembled, with mounting hardware and instructions included.

.2 Metal raceway, cover, surface boxes, shall be a formed steel construction with a thickness of 0.040”, and zinc plated. Related fittings shall be galvanized on all surfaces.

.3 Metal raceway, cover, and related fittings shall have an Ivory color powder coat paint finish on all external surfaces.

.4 Have tools available for field cutting and bending.

.5 Assembly and disassembly of raceway base, cover, and fittings requiring no special tools.

.6 Available fittings including couplings, internal and external elbows, tees, entrance fittings, conduit adapters and bushings.

.7 Available fittings including internal, external and flat elbows, and tee fitting, with a 1 ½” radius to accommodate communications UTP and fiber cabling minimum bend radius requirements.

.8 Installed fittings designed to overlap the raceway to cover exposed or uneven edges from field cutting.

.2 Device Boxes

.1 Compatible device boxes shall have a removable knockout portion to permit metal raceway entry and exit.

.2 Device boxes available in standard NEMA single- and double-gang, and multiple gang up to six-gang. Device box depth shall range from 1.125” to 2.75”.

.3 Device boxes shall have a single seam construction with rounded corners to eliminate sharp edges.

.4 Assembled device box front face design to permit flush mounting of standard wall plates to minimize perimeter profile exposure.

.5 Device boxes shall have threaded standoff posts attached to the base, to facilitate mounting of covers with short screws for ease of alignment during installation.

.3 Basis of Design: Wiremold 500 and 700 series.

2.4 TWO-CHANNEL METAL RACEWAY

.1 Surface metal raceway, single or complete with snap-in divider to form 2 compartments for power and data, with removable cover. Width to suit application while keeping code and telecommunication standard filling ratios.

.2 Elbows, couplings, end caps, device brackets and faceplates for power, data and voice, and fittings manufactured as accessories for wireway supplied. 120 V power receptacles and mounting for voice/data.

.3 Finish: Designer Grey.

.4 Basis of Design: Wiremold DS4000 series.

3 Execution

3.1 PREPARATION

.1 Submit layout drawings of the raceway system for reviewed prior to installation.

.2 Installation of metal raceway in wet areas is not permitted.

.3 Manufacturer's instructions for installing raceway and fittings shall be followed by the installer.

.4 All wall surfaces, or other permanent structures to which raceway is mounted shall be finished complete.

3.2 INSTALLATION

.1 Mount base and cover together to wall or structure using the appropriate fasteners and clips, per manufacturer's instructions.

.2 Securely support raceway in intervals not exceeding 3 m (10 feet) or per manufacturer's instructions.

.3 Install fittings and device boxes in the specified locations, per manufacturer's instructions and per contract drawing specifications.

.4 Completed raceway installation shall be mechanically continuous and connected to all electrical outlets, device boxes, and enclosures with no gaps or exposed cuts.

.5 Provide insulated ground wire for power raceways per OESC requirements. Raceway shall not be used as the primary ground path.

.6 Prior to wire and cable installation, the raceway system shall be installed complete, including insulating bushings, adapters, fittings, outlets, boxes, and enclosures. Unused raceway openings shall be closed.

.7 Make wiring connections with the proper approved insulated wire connectors or lugs. Exposed conductors at harness wiring junctions are not permitted regardless of connection method.

.8 Provide a physical barrier in raceway and boxes to separate power and communication wiring.

.9 Install covers on raceway, boxes and fittings after wiring is complete, or if wire and cable installation is to be done at a later date.

3.3 FIELD QUALITY CONTROL

.1 Verify layout of system to contract drawings.

.2 Raceway system shall be free of dents, scratches, bare metal edges, and exposed uneven cuts.

.3 Securely fasten all outlets, boxes, and enclosures walls or permanent structures.

.4 Verify that all wiring junctions or connections have no exposed conductors prior to energizing the circuits.

.5 Verify that all bonding locations are code and standards compliant.

.6 Verify that power and communications wiring are separated by a physical barrier in raceway and boxes.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Sleeves, sealing of sleeves and openings, as required for all electrical work.

1.2 SUBMITTALS

.1 Submit data sheets for firestopping in accordance with Section 01 30 00.

.2 Submit copies of firestopping drawings with ULC certificate and system number for each specific installation.

.3 Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance ratings.

.4 Submit dimensioned location drawings indicating required sleeves and formed openings in structural poured concrete or precast concrete construction or in roofing, and locations of cutting or drilling required for Electrical work.

2 Products

2.1 SLEEVES

.1 Galvanized steel sleeves:

.1 No. 24 gauge with an integral flange at one (1) end to secure sleeve to formwork construction.

.2 Schedule 40 pipe.

.2 Schedule 40 PVC sleeves.

2.2 SLEEVE SEALS

.1 Manufacturers

.1 Hilti Canada.

.2 Specified Technologies Inc.

.3 3M Canada Inc.

.4 Tremco.

.5 A/D Fire Protection Systems.

.6 Nelson.

.7 Approved equal.

.2 Asbestos-free, elastomeric materials and intumescent materials, tested, listed and labelled by ULC in accordance with CAN/ULC-S115, and CAN/ULC-S101 for installation in ULC designated firestopping, and smoke seal systems to provide a positive fire, water and smoke seal and a fire resistance rating (flame, hose stream and temperature) no less than fire rating for surrounding construction.

.3 Materials are to be compatible with abutting dissimilar materials and finishes and complete with primers, damming and back-up materials, supports, and anchoring devices in accordance with firestopping manufacturer's recommendations and ULC tested assembly. Coordinate material requirements with trades supplying abutting areas of materials.

.4 Maintain fire rating of separation in accordance with architectural drawings.

3 Execution

3.1 INSTALLATION

.1 Where conduits and conductors pass through structural poured concrete, provide sleeves of type suitable for application, and approved by local governing codes.

.2 Sleeves in concrete slabs, except as noted below, are to be No. 24 gauge or equivalent, with an integral flange to secure sleeves for formwork construction.

.3 Sleeves in waterproof concrete slabs and in other slabs where waterproof sleeves are required are to be lengths of Schedule 40 pipe sized to extend 100 mm (4") above floor.

.4 Sleeves in poured concrete walls and foundation are to be Schedule 40 pipe.

.5 Through interior walls, use standard weight steel pipes, conduit, or galvanized steel. Cut flush with finished surfaces. Check room finish schedules.

.6 Through exterior walls above grade, floors, and roof use standard weight steel pipes, machine cut, flush with finished surface inside and to suit flashing outside.

.7 Through exterior walls below grade, water-proofed floors, and other water-proof walls, use heavy weight cast iron pipes, machine cut. Extend sleeves 100 mm (4") above finished floors, and cut flush with underside of floor.

.8 Size sleeves, unless otherwise noted, to leave 13 mm (1/2") clearance around conduit, duct, conductor, etc. Void between sleeves and conduit, duct, conductors, etc., to be packed and sealed for length of sleeves as in accordance with article entitled “Sleeve Seals” specified in this Section. Pack and seal sleeves set in exterior walls with governing authority approved materials suitable for application and pack both ends of sleeves watertight with approved permanently flexible and water tight materials. Coordinate exact responsibility of work with General Trades Contractor.

.9 Submit to concrete reinforcement detailer at proper time, drawings indicating required sleeves, recesses and formed openings in poured concrete work. Completely and accurately dimension such drawings and relate sleeves, recesses and formed openings to suitable grid lines and elevation datum.

.10 Supply sleeves of a water protecting type in accordance with detail found on drawings for installation in following locations:

.1 in Mechanical and Fan Room floor slabs, except where on grade;

.2 in slabs over Mechanical, Fan, Electrical and Telephone Equipment Rooms or closets;

.3 in floors equipped with waterproof membranes.

.11 "Gang" type sleeving to be permitted only with approval of Owner and reviewed with the Consultant.

.12 Terminate sleeves for work which is exposed, so that sleeve is flush at both ends with wall, partition, or slab surface such that sleeve may be covered completely by escutcheon plates.

.13 Sleeves are not required in interior walls and dry area floors where conduit is installed ahead of floor construction.

.14 Seal all openings and sleeves after installation of equipment:

.1 With an approved material to maintain fire rating where sleeves and openings pass through fire separations and floors.

.2 With an approved material to maintain fire rating for sleeves and openings provided for future equipment.

.3 Flash all conduits and systems passing through roof or built into an outside wall, or a waterproof floor.

.4 Provide copper flashing for sleeves passing through exterior walls or waterproof floors.

.15 Provide all flashing and waterproofing for sleeves through roof and exterior walls to the requirements of Division 07.

.16 Firestop sleeves in accordance with the manufacturer's specifications and recommendations.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Tested firestop systems used in penetrations for the passage of cables, conduit, and other electrical equipment through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.

1.2 RELATED REQUIREMENTS

.1 Coordinate work of this section with work of other sections as required to properly execute the work and as necessary to maintain satisfactory progress of the work of other sections, including:

.1 Section 07 85 00 – Firestopping and Smoke Seals.

1.3 REFERENCES

.1 Underwriter's Laboratories (UL) and Underwriters Laboratories of Canada (ULC):

.1 Test Requirements: CAN/ULC-S115:2018, Standard Method of Fire Tests of Firestop Systems.

.2 Underwriters Laboratories of Canada (ULC) runs CAN/ULC-S115:2018 under their designation of ULC-S115:2018 and publishes the results in their "FIRE RESISTANCE RATINGS DIRECTORY" that is updated annually.

.3 Underwriters Laboratories (UL) of Northbrook, IL runs ASTM E-814 under their designation of UL 1479 and publishes the results in their "FIRE RESISTANCE DIRECTORY" that is updated annually. UL tests that meet the requirements of ULC-S115-M are given a cUL listing and are published by UL in their "Products Certified for Canada (cUL) Directory.

.4 CAN/ULC-S102:2018, Standard Test Method for Surface Burning Characteristics of Building Materials and CAN/ULC-S101 Fire Endurance Tests of Building Construction and Materials.

.2 ASTM:

.1 Omega Point Laboratories runs ASTM E-814 and publishes the results annually in their "Omega Point Laboratories Directory".

.2 Inspection Requirements: ASTM E 2174, "Standard Practice for On-site Inspection of Installed Fire Stops.", and ASTM E2393 Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers.

.3 Test Requirements: ASTM E 2307, "Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-story Test Apparatus".

.4 ASTM D6904, "Standard Practice for Resistance to Wind Driven Rain for Exterior Coatings Applied on Masonry".

.5 ASTM C 679, "Standard Test Method for Tack-Free Time of Elastomeric Sealants".

.3 International Firestop Council Guidelines for Evaluating Firestop Systems Engineering Judgments.

.4 Ontario Building Code.

.5 Ontario Electrical Safety Code.

1.4 DEFINITIONS

.1 Firestopping: Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in fire rated wall and floor assemblies.

1.5 SUBMITTALS

.1 Submit Product Data: Manufacturer's specifications and technical data for each material including the composition and limitations, documentation of ULC or cUL firestop systems to be used and manufacturer's installation instructions to comply with Section 01 30 00.

.2 Manufacturer's engineering judgment identification number and drawing details when no ULC or cUL system is available for an application. Engineered judgment must include both project name and contractor’s name who will install firestop system as described in drawing.

.3 Submit material safety data sheets provided with product delivered to job-site.

.4 Submit shop drawings in accordance with Section 01 30 00:

.1 Submit complete cUL, ULC, or equivalent approved systems for all applications. Ensure the listing is clearly noted on the submittal.

1.6 CLOSEOUT SUBMITTALS

.1 On completion of firestopping and smoke sealing installation, submit a Letter of Assurance to the Consultant certifying the firestopping and smoke sealing installation has been carried out throughout the building to electrical service penetrations and that installation has been done in strict accordance with requirements of the Ontario Building Code, any applicable municipal bylaws, ULC requirements, and manufacturer’s instructions.

1.7 QUALITY ASSURANCE

.1 Fire-Test-Response Characteristics: Provide through-penetration fire stop systems and fire-resistive joint systems that comply with specified requirements of tested systems.

.2 Firestop System installation must meet requirements of CAN/ULC-S115 tested assemblies that provide a fire rating as shown in Section 2.1 Clauses 4, 5, 6, and 7 below.

.3 Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.

.4 Firestop Systems do not re-establish the structural integrity of load bearing partitions/assemblies, or support live loads and traffic. Installer shall consult the structural engineer prior to penetrating any load bearing assembly.

.5 For those firestop applications that exist for which no ULC or cUL tested system is available through a manufacturer, a manufacturer's engineering judgment derived from similar ULC or cUL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineering judgment drawings must follow requirements set forth by the International Firestop Council.

1.8 INSTALLER QUALIFICATIONS

.1 Engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having the necessary training to install manufacture’s products per specified requirements. A supplier’s willingness to sell its firestopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.

.2 Installation Responsibility: assign installation of through-penetration fire stop systems and fire-resistive joint systems in Project to a single sole source firestop specialty contractor.

.3 The work is to be installed by a contractor with at least one of the following qualifications:

.1 FM 4991 approved contractor.

.2 UL approved contractor.

.3 Manufacturer's accredited fire stop specialty contractor.

.4 Installer: Minimum 3 years experience with fire stop installation.

1.9 DELIVERY, STORAGE, AND HANDLING

.1 Deliver materials undamaged in manufacturer's clearly labeled, unopened containers, identified with brand, type, and ULC or cUL label where applicable.

.2 Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job-site.

.3 Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements.

.4 Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.

.5 Do not use damaged or expired materials.

1.10 PROJECT CONDITIONS

.1 Do not use materials that contain flammable solvents.

.2 Scheduling

.1 Schedule installation of CAST IN PLACE firestop devices after completion of floor formwork, metal form deck, or composite deck but before placement of concrete.

.2 Schedule installation of Drop-In firestop devices after placement of concrete but before installation of the pipe penetration. Diameter of sleeved or cored hole to match the listed system for the device.

.3 Schedule installation of other firestopping materials after completion of penetrating item installation but prior to covering or concealing of openings.

.3 Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.

.4 Weather conditions: Do not proceed with installation of firestop materials when temperatures exceed the manufacturer's recommended limitations for installation printed on product label and product data sheet.

.5 During installation, provide masking and drop cloths to prevent firestopping materials from contaminating any adjacent surfaces.

2 Products

2.1 PERFORMANCE REQUIREMENTS

.1 Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.

.2 Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

.3 Provide a round fire-rated cable management device whenever cables penetrate fire rated walls, where frequent cable changes and additions may occur. The fire-rated cable management device shall consist of a corrugated steel tube with zinc coating, contain an inner plastic housing, intumescent material rings, and inner fabric smoke seal membrane. The length of the sleeve shall be 315 mm (12.4 inches). The fire-rated cable management device shall contain integrated intumescent firestop wrap strip materials sufficient to maintain the hourly rating of the barrier being penetrated. The fire-rated cable management device shall contain a smoke seal fabric membrane or intumescent firestop plugs sufficient to achieve the L-Rating requirements of the barrier type. Install device per the manufacturer's published installation instructions.

.4 Penetrations in Horizontal Assemblies: Provide firestopping with ratings determined in accordance with CAN/ULC-S115. For penetrations through a Fire Wall or horizontal Fire Separation provide a firestop system with a "FT" Rating as determined by ULC or cUL which is equal to the fire resistance rating of the construction being penetrated.

.5 W-ratings: in accordance with Section 07 85 00.

.6 Provide a firestop system with an Assembly Rating as determined by CAN/ULC-S115 which is equal to the time rating of construction joint assembly.

.7 Penetrations in Smoke Barriers: Provide firestopping with ratings determined in accordance with CAN/ULC-S115.

.1 L-Rating: Not exceeding 5.0 CFM/sqft of penetration opening at both ambient and elevated temperatures.

.8 Mold Resistance: Provide penetration firestopping with mold and mildew resistance rating as determined by ASTM G21.

.9 Rain and water resistance: provide perimeter joint sealant tested in accordance with ASTM D 6904 with less than 1 hour tack free time as tested in accordance with ASTM C 679.

2.2 MANUFACTURERS

.1 Manufacturer List:

.1 AD Fire Protection Systems.

.2 Hilti (Canada) Corporation

.3 3M.

.4 Specified Technologies, Inc. (STI).

.5 Tremco, Inc.

.6 Approved equal.

.2 Substitutions: Where a specific manufacturer is noted in this Section, equivalent products from the manufacturers listed above may be used, subject to compliance with through penetration firestop systems and joint systems listed in the ULC Fire Resistance Directory – Volume III, or UL Products Certified for Canada (cUL) Directory.

2.3 MATERIALS

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

.2 Accessories: provide components for each firestopping and smoke seal systems that are needed to install fill materials. Use only components specified by firestopping material manufacturer, and approved by the qualified testing agency. Accessories include, but are not limited to, the following items:

.1 Permanent forming, damming, and backing material.

.2 Temporary forming material.

.3 Pre-formed firestop devices for use with non-combustible and combustible pipes (closed and open systems), conduit and/or cable bundles penetrating concrete floors and/or gypsum walls:

.1 Hilti Tub Box Kit (CP 681) for use with tub installations.

.2 Hilti Cast-In Place Firestop Device (CP 680-PX) for use with XFR pipe.

.3 Hilti Cast-In Place Firestop Device (CP 680-M) for use with non-combustible penetrants.

.4 Hilti Speed Sleeve (CP 653) for use with cable penetrations.

.5 Hilti Firestop Drop-In Device (CFS-DID) for use with non-combustible and combustible penetrants.

.6 Hilti Cast-in Firestop sleeve (CFS-CID MD P) and (CFS-CID MD M) for use with combustible and non-combustible pipes through metal deck.

.7 Hilti Firestop Block (CFS-BL).

.8 STI SpecSeal series SSC Firestop Collars.

.9 STI SpecSeal series LCC Firestop Collars.

.4 Sealants or caulking materials for use with non-combustible items including steel pipe, copper pipe, rigid steel conduit and electrical metallic tubing (EMT).

.1 Hilti Intumescent Firestop Sealant (FS-ONE MAX).

.2 Hilti Fire Foam (CP 620)/CP 660.

.3 Hilti Flexible Firestop Sealant (CP 606).

.4 Hilti Firestop Silicone Sealant Gun Grade (CFS-S SIL GG).

.5 Hilti Firestop Silicone Sealant Self Leveling (CFS-S SIL SL).

.5 Intumescent sealants or caulking materials for use with combustible items (penetrants consumed by high heat and flame) including insulated metal pipe, PVC jacketed, flexible cable or cable bundles and plastic pipe.

.1 Hilti Intumescent Firestop Sealant (FS-ONE MAX).

.6 Foams, intumescent sealants, or caulking materials for use with flexible cable or cable bundles.

.1 Hilti Intumescent Firestop Sealant (FS-ONE MAX).

.2 Hilti Fire Foam (CP 620)/660.

.3 Hilti Flexible Firestop Sealant (CP 606).

.4 Hilti Firestop Silicone Sealant Gun Grade (CFS-S SIL GG).

.5 Hilti Firestop Silicone Sealant Self Leveling (CFS-S SIL SL).

.7 Firestop Putty Pads: Intumescent, non-hardening putty pads to be installed on metallic and non-metallic electrical switch and receptacle boxes to reduce horizontal separation between boxes to less than 610 mm (24 in):

.1 STI SpecSeal Series SSP Firestop Putty Pads.

.2 Hilti Firestop Putty Pad (CP 617).

.8 Materials used for large size/complex penetrations made to accommodate cable trays, multiple steel and copper pipes, electrical busways in raceways.

.1 Hilti Firestop Block (CFS-BL).

.2 Hilti Composite Sheet (CFS-COS).

.3 Hilti Firestop Mortar (CP 637).

.4 Hilti Fire Foam (CP 620)/660.

.5 Hilti Firestop Board (CP 675T).

.9 Non-curing, re-penetrable materials used for large size/complex penetrations made to accommodate cable trays, multiple steel and copper pipes, electrical busways in raceways.

.1 Hilti Firestop Block (CFS-BL).

.2 Hilti Firestop Board (CP 675T).

.10 Re-penetrable, round cable management devices for use with new or existing cable bundles penetrating gypsum or masonry walls.

.1 Hilti Speed Sleeve (CP 653) with integrated smoke seal fabric membrane.

.2 Hilti Firestop Cable Collar (CFS-CC).

.3 Hilti Firestop Sleeve (CFS-SL SK).

.4 Hilti Retrofit Sleeve (CFS-SL RK) for use with existing cable bundles.

.5 Hilti Gangplate (CFS-SL GP) for use with multiple cable management devices.

.6 Hilti Gangplate Cap (CFS-SL GP CAP) for use at blank openings in gangplate for future penetrations.

.11 For blank openings made in fire-rated wall or floor assemblies, where future penetration of pipes, conduits, or cables is expected.

.1 Hilti CFS-BL Firestop Block (for walls and floors).

.2 Hilti CFS-PL Firestop Plug (for walls and floors).

.12 Cast-In-Place Firestop Device: Single component molded firestop device installed on forms prior to concrete placement with totally encapsulated, tamper-proof integral firestop system and smoke sealing gasket. Device shall allow for a concrete floor thickness of minimum 63 mm (2-1/2 in) up to 914 mm (36 in) without the use of field applied extension tubing:

.1 STI SpecSeal CID Cast-In Firestop Device.

.2 Hilti CP 680 Cast-In Place Firestop Device (for floors only).

.13 For single or cable bundles up to one inch diameter penetrating gypsum, masonry, concrete walls or wood floor assemblies.

.1 Hilti CFS-D Firestop Cable Disc.

3 Execution

3.1 INSTALLERS

.1 Labour Use to Install Firestop Systems

.1 To ensure complete harmony on the project site, the installation of each scope of work is to be performed jurisdictionally correct per existing trade agreements.

3.2 PREPARATION

.1 Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.

.1 Verify penetrations are properly sized and in suitable condition for application of materials.

.2 Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.

.3 Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.

.4 Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.

.5 Do not proceed until unsatisfactory conditions have been corrected.

3.3 COORDINATION

.1 Coordinate construction of openings, penetrations to ensure that the fire stop systems are installed according to specified requirements.

.2 Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration fire stop systems.

.3 Coordinate fire stopping with other trades so that obstructions are not placed in the way prior to the installation of the fire stop systems.

.4 Do not cover up through-penetration fire stop and joint system installations that will become concealed behind other construction until each installation has been examined by the building inspector.

3.4 INSTALLATION

.1 Regulatory Requirements: Install firestop materials in accordance with ULC Fire Resistance Directory or UL Products Certified for Canada (cUL) Directory or Omega Point Laboratories Directory.

.2 Manufacturer's Instructions: Comply with manufacturer's instructions for installation of through-penetration and construction joint materials.

.1 Seal all holes or voids made by penetrations to ensure an air and water-resistant seal.

.2 Consult with mechanical engineer, project manager, and damper manufacturer prior to installation of ULC or cUL firestop systems that might hamper the performance of fire dampers as it pertains to duct work.

.3 Protect materials from damage on surfaces subjected to traffic.

3.5 FIELD QUALITY CONTROL

.1 Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.

.2 Keep areas of work accessible until inspection by applicable code authorities.

.3 Inspection of through-penetration firestopping shall be performed in accordance with ASTM E 2174, “Standard Practice for On-Site Inspection of Installed Fire Stops”, or other recognized standard.

.4 Perform under this section patching and repairing of firestopping caused by cutting or penetrating of existing firestop systems already installed by other trades.

.5 Manufacturer’s Field Services: During Installation, provide periodic destructive testing inspections to assure proper installation/application. After installation is complete, submit findings in writing indicating whether or not the installation of the tested system identified was installed correctly.

3.6 IDENTIFICATION AND DOCUMENTATION

.1 The firestop contractor is to supply documentation for each single application addressed. This documentation is to identify each penetration location on the entire project.

.2 The Documentation Form for through penetrations is to include:

.1 A Sequential Location Number.

.2 The Project Name.

.3 Date of Installation.

.4 Detailed description of the penetration location.

.5 Tested System or Engineered Judgment Number.

.6 Type of assembly penetrated.

.7 A detailed description of the size and type of penetrating item.

.8 Size of opening.

.9 Number of sides of assemblies addressed.

.10 Hourly rating to be achieved.

.11 Installer’s Name.

.3 Copies of these documents are to be provided to the general contractor at the completion of the project.

.4 Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels:

.1 The words: "Warning-Through Penetration Firestop System-Do Not Disturb. Notify Building Management of Any Damage."

.2 Contractor's Name, address, and phone number.

.3 Through-Penetration firestop system designation of applicable testing and inspecting agency.

.4 Date of Installation.

.5 Through-Penetration firestop system manufacturer's name.

.6 Installer's Name.

3.7 ADJUSTING AND CLEANING

.1 Remove equipment, materials and debris, leaving area in undamaged, clean condition.

.2 Clean all surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Switches, receptacles, wiring devices, cover plates and their installation.

1.2 RELATED REQUIREMENTS

.1 Section 26 27 26 – Wiring Devices.

1.3 REFERENCES

.1 CSA Group:

.1 CSA C22.2 No. 42-10 (R2020), General Use Receptacles, Attachment Plugs and Similar Devices.

.2 CSA C22.2 No. 42.1-13 (R2017), Cover plates for flush-mounted wiring devices (Bi-national standard, with UL 514D).

.3 CSA C22.2 No. 55-15 (R2020), Special Use Switches.

.4 CSA-C22.2 No. 111-18, General-Use Snap Switches (Bi-national standard, with UL 20).

1.4 SUBMITTALS

.1 Submit shop drawings and product data in accordance with Section 01 30 00.

2 Products

2.1 OUTDOOR RECEPTACLE PEDESTALS

.1 Aluminum pedestal complete with pedestal cap, gaskets, grounding lug, and all require accessories.

.2 Minimum 75 mm by 75 mm (3 inch by 3 inch) cross section.

.3 Drain hole.

.4 Final mounting height of wiring device shall be no greater than 1200 mm above finished grade, including concrete base.

.5 Pedestal will be approved using field evaluation or special inspection and marked by a certification organization accredited by (SCC) standards council of Canada such as "CSA" or "QPS" or "ESA" or "ENTELA" or "UL".

.6 Complete with base flange for concealing anchor bolts.

.7 Receptacles to be oriented minimum 45 degrees down from horizontal to minimize cable strain.

.8 Provide bracket for management of cables, or coiling of excess cable length.

2.2 FOUNDATIONS FOR PEDESTALS

.1 Provide foundations for lighting standards in accordance with manufacturer's recommendations. Submit Equipment Foundation Data in accordance with referenced standards in this section.

.2 Anchor Bolts

.1 Provide concealed galvanized high strength steel rod anchor bolts, in accordance with manufacturer’s instructions.

2.3 SPECIAL RECEPTACLES

.1 Voltage and configurations as indicated on drawings.

.2 Receptacles of one manufacturer throughout project.

2.4 RECEPTACLE COVER PLATES

.1 Cover plates for wiring devices to: CSA C22.2 No. 42.1.

.2 Cover plates from one manufacturer throughout project.

.3 While-in-use weatherproof cover spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches for outdoor applications. Cover shall be suitable for wet locations whether or not a plug is inserted in the receptacle.

.4 All outdoor wiring device cover plates to be labeled with riveted 3-ply engraved laminated nameplate identifying panel and circuit number for each device, and receptacle configuration.

3 Execution

3.1 INSTALLATION

.1 Receptacle Pedestal

.1 Cut opening required on gasket for wiring access and concrete screw holes.

.2 Install galvanized steel concrete screws to secure pedestal to concrete base.

.3 Apply a bead of sealant at top of pedestal for weatherproofing.

.4 Ground pedestal in accordance with Section 26 05 29.

.5 Install receptacles as indicated.

.2 Receptacles:

.1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.

.2 Mount receptacles at height in accordance with Section 26 05 00 as indicated.

.3 Cover plates:

.1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.

.2 Install suitable common cover plates where wiring devices are grouped.

.3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

3.2 WASTE MANAGEMENT

.1 Separate and recycle waste materials in accordance with Section 01 74 00.

.2 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Owner’s Representative.

End of Section

1 General

1.01 Section Includes

.1 This section provides minimum acceptance requirements for vibration isolation for all electrical equipment, conduit, and piping.

1.02 Related Requirements

.1 Section 26 22 13 – Low-Voltage Distribution Transformers.

1.03 Submittals

.1 All vibration isolation systems shall be by one manufacturer.

.2 All outdoor mounted equipment shall be restrained for the highest wind speed as specified by the project's structural engineer, the governing building code(s) or the authority having jurisdiction.

.3 Submit shop drawings for all devices specified herein and as indicated and scheduled on the drawings. Submittals shall indicate full compliance with the device specification in Part 2. Any deviation shall be specifically noted and subject to engineer approval. Submittals shall include device dimensions, placement, attachment, and anchorage requirements.

1.04 Quality Assurance

.1 Unless otherwise directed by the local authority having jurisdiction, the following codes and standards will apply:

.1 International Building Code 2009.

.2 American Society of Civil Engineers 7-05.

.3 Ontario Building Code, Latest Edition.

.2 Manufacturer's Qualifications: Firms regularly engaged in manufacture of vibration control products of type, size, and capacity required, whose products have been in satisfactory use in similar service for not less than 5 years.

2 Products

2.01 Manufacturers

.1 Vibro-Acoustics.

.2 Kinetics Noise Control.

.3 BVA Systems.

.4 Vibron Limited.

.5 Mason Industries.

2.02 Vibration Isolation

.1 Springs: All springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. All springs except internal nested springs shall have an outside diameter not less than 0.8 of the compressed height of the spring. Ends of springs shall be square and ground for stability. Laterally stable springs shall have kx/ky ratios of at least 0.9. All springs shall be fully colour-coded to indicate capacity – colour striping is not considered adequate.

.2 Corrosion Protection: All springs shall be powder-coated enamel. Housings shall be hot dipped galvanized, powder-coated enamel, or painted with rust-resistant paint.

.3 Isolators:

.1 Vibration Isolation Pads: Type N – Neoprene pad type isolators, 10 mm (3/8”) minimum thick, ribbed on both sides.

.1 Type NSN – Sandwich neoprene pad type isolators, with 10 mm (3/8”) minimum thick ribbed neoprene pads bonded to each side of a 3.5 mm (10 ga) minimum galvanized metal plate. Isolator pads shall be selected to ensure that deflection does not exceed 20% of isolator free height.

.2 Rubber-in-Shear Floor Mounts: Type RD – “Double-deflection” neoprene isolators, with neoprene-coated metal surfaces, and top and bottom surfaces ribbed. Isolators shall have bolt holes in the base.

.3 Restrained Spring Floor Mounted Isolators: Type CSR – Laterally stable, vertically restrained spring isolators with welded steel housings and heavy top plates for supporting equipment. Springs shall be supported either with a neoprene cup or a metal base plate complete with a ribbed neoprene pad, minimum 6 mm (1/4”) thick, bonded to the base plate. Housings shall include vertically restraining limit stops. Minimum clearance around the restraining bolts and between the housing and the spring shall be 13 mm (1/2”). Top plate and restraining bolts shall be out of contact with the housing during normal operation and neoprene grommets shall be incorporated to minimize short-circuiting of restraining bolts. For outdoor applications, housing must be hot-dip galvanized. For indoor applications, powder-coated finish for the housing is acceptable.

3 Execution

3.01 General

.1 Coordinate size, doweling, and reinforcing of concrete equipment housekeeping pads and piers with vibration isolation manufacturer to ensure adequate space and prevent edge breakout failures. Pads and piers must be adequately doweled into structural slab.

.2 Coordinate locations and sizes of structural supports with locations of vibration isolators (e.g., roof curbs, cooling towers, air-cooled chillers, etc.).

.3 Isolated equipment, duct and piping located on roofs must be attached to the structure. Intermediate supports between the restraint and structure that are not attached to the structure must be approved by the restraint manufacturer.

3.02 Vibration Isolation

.1 Ensure housekeeping pads have adequate space to mount equipment and isolator housings and shall also be large enough to ensure adequate edge distance for isolator anchors.

.2 Select and locate vibration isolation equipment to give uniform loading and deflection, according to weight distribution of equipment.

.3 Engine-generator set silencers and associated exhaust piping shall be supported with Type SHR isolators with a minimum 40 mm (1-1/2 inch) static deflection.

.4 Equipment Isolation:

			Floor Span											
			Slab on Grade			Up to 6 m (20 ft)			6 m to 9 m (20 ft to 30 ft)			9 m to 12 m (30 ft to 40 ft)		
Eqpm Type	**HP and Other**	**RPM**	**Base Type**	**Isolator Type**	**Min. Defl.**	**Base Type**	**Isolator Type**	**Min. Defl., in.**	**Base Type**	**Isolator Type**	**Min. Defl., in.**	**Base Type**	**Isolator Type**	**Min. Defl., in.**
Transformers and UPS's														
All	All	All	N/A	NSN	3 mm (0.12")	N/A	NSN	3 mm (0.12")	N/A	NSN	3 mm (0.12")	NM	RD/NSN	6 mm (0.25")
Engine-Driven Generators														
All	All	All	N/A	CSR	19 mm (0.75")	N/A	CSR	38 mm (1.50")	N/A	CSR	64 mm (2.50")	N/A	CSR	89 mm (3.50")
Notes: (1) Units that are suspended overhead shall use isolation hangers in place of floor mounted isolators with equal or greater deflection. (2) Floor spans are defined as the distance between structural support columns or walls.														

.5 There shall be no rigid contact of isolated equipment with shaft walls, floor slabs, partitions, or non-flexible conduits connections.

.6 Where recommended by the manufacturer, isolator base plates shall be bolted to the structure or foundation. Bolting shall incorporate neoprene bushings and washers.

3.03 Site Tests and Inspections

.1 After installation, arrange and pay for the vibration isolation product manufacturer, or representative, to visit the site to verify that the vibration isolation systems are installed and operating properly, and shall submit a certificate so stating. Verify that isolators are adjusted, with springs perpendicular to bases or housing, adjustment bolts are tightened up on equipment mountings, and hangers are not cocked.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Nameplates and labels.

.2 Wire and cable markers.

.3 Conduit markers.

.4 Receptacle labels.

.5 Signage.

1.2 SUBMITTALS

.1 Product Data: Provide catalogue data for nameplates, labels, and markers.

.2 Provide shop drawings of nameplates for Consultant's review prior to fabrication (scale 1:1).

.3 Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.3 REGULATORY REQUIREMENTS

.1 Provide products listed and classified by CSA (Canadian Standards Association) as suitable for the purpose specified and indicated.

2 Products

2.1 NAMEPLATES AND LABELS

.1 Nameplates:

.1 Engraved three-layer laminated plastic, letters on contrasting background.

.2 Colours to match existing building system, where applicable. If no building system exists, use the following:

.1 347/600 Volt system: White text on Blue Background.

.2 120/208 Volt system: Black text on White Background.

.3 Fire Detection system: White text on Red Background.

.4 Emergency Lighting system: Red text on White Background.

.5 LV systems: White text on Green Background.

.6 120/208 Volt Uninterruptable Power Supply (UPS): White text on Orange Background.

.3 Confirm colours with the Consultant prior to ordering nameplates.

.2 Equipment Nameplates to indicate:

.1 Equipment/Panelboard ID

.2 Ampacity.

.3 Voltage

.4 Number of Phases

.5 Number of wires in system

.6 Interrupting Capacity

.7 Size, number of poles, Panelboard ID, and circuit number of upstream overcurrent protection device.

.1 Location of upstream device if not in the same room.

.3 Locations:

.1 Distribution panelboards, and individual distribution panelboard branch breakers.

.2 Receptacle panelboards.

.3 Each electrical distribution and control equipment enclosure.

.4 Uninterruptible Power Supply.

.5 Mechanical Equipment.

.6 UPS Receptacles.

.7 Disconnects, starters and contactors: indicate equipment being controlled and voltage.

.8 Terminal cabinets, junction boxes, and pull boxes: indicate system and voltage.

.9 Transformers: indicate capacity, primary and secondary voltages.

.4 Letter Size:

.1 Use 3 mm letters for identifying individual equipment and loads.

.2 Use 6 mm letters for identifying grouped equipment and loads.

.5 Labels:

.1 Mechanically fastened with sheet metal screws, with 5 mm white letters on black background.

.2 White letters on red background for UPS and equipment, and devices downstream of UPS.

.3 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.

.4 Wording on nameplates and labels to be reviewed by the Consultant prior to manufacturing.

.5 Allow for minimum of twenty-five (25) letters per nameplate and label.

.6 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.

.7 Terminal cabinets and pull boxes: indicate system and voltage.

2.2 WIRING IDENTIFICATION

.1 Identify wiring with permanent indelible identifying markings, numbered, on both ends of phase conductors of feeders and branch circuit wiring.

.2 Maintain phase sequence and colour coding throughout.

.3 Colour coding: to CSA C22.1.

.4 Use colour coded wires in communication cables, matched throughout system.

2.3 WIRE MARKERS

.1 Description: tape, split sleeve, or tubing type wire markers.

.2 Locations: Each conductor at panelboard gutters, pull boxes, outlet and junction boxes and each load connection.

.3 Legend:

.1 Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.

.2 Control Circuits: Control wire number indicated on shop drawings.

2.4 CONDUIT AND BOX MARKERS

.1 Colour code conduits, boxes and metallic sheathed cables.

.2 Location: Provide markers for each conduit longer than 2 m.

.3 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.

.4 Colours to match equipment nameplate background colour:

.1 347/600 Volt system: Blue.

.2 120/208 Volt system: Black.

.3 Fire Alarm system: Red.

.4 Emergency Lighting system: Red/White.

.5 LV Systems (EPO, Remote Monitoring, Generator Control, Communications): Green.

.6 120/208 Volt Uninterruptable Power Supply (UPS): Orange

.5 Confirm colours with the Consultant prior to commencing rough-in.

2.5 JUNCTION AND PULL BOXES

.1 Clearly identify main pull or junction boxes (excluding obvious outlet boxes) by painting outside of covers.

.2 Spray painting: not permitted.

.3 Paint colours to be in accordance with following schedule:

.1 Lighting: yellow.

.2 Normal power: blue.

.3 Emergency power: orange.

.4 Fire alarm: red.

.5 Communications systems including telephone and data: green.

.6 Miscellaneous signals: brown.

.4 In addition to painting miscellaneous signal boxes, clearly identify specific system in which box is installed. Identify source panelboard for power circuits.

2.6 BRANCH BREAKER LABELS

.1 General:

.1 Legibly identify every circuit and circuit modification as to its clear, evident, and specific purpose or use. Include sufficient detail to allow each circuit to be distinguished from all others.

.2 Label spare positions that contain unused overcurrent devices or switches.

.3 Do not describe any circuit in a manner that depends on transient conditions of occupancy.

.2 Switchboards, distribution panelboards, enclosed breakers, and disconnect switches:

.1 Locate identification at each switch.

.2 Branch breaker nameplates on switchboards, distribution panelboards and switchboards, and generator load breakers to indicate:

.1 Locate identification at each switch on a switchboard.

.2 Identification of downstream equipment fed from the breaker.

.1 Location of downstream device if not in the same room.

.3 Breaker size and number of poles.

.4 Interrupting Capacity.

.5 Circuit number (where applicable).

.6 Do not describe any circuit in a manner that depends on transient conditions of occupancy.

.3 Lighting and Receptacle Panelboards:

.1 Provide a circuit directory that is located on the face or inside of the panel door.

.2 Do not describe any circuit in a manner that depends on transient conditions of occupancy.

2.7 RECEPTACLE LABELS

.1 Label all receptacles with the panelboard ID and circuit number.

.2 Use receptacle labels by electronic labeller Brother P-Touch, model PT-20/25, Dymo-Tape or approved equal.

.3 Location: On receptacle wall plate.

3 Execution

3.1 EQUIPMENT NAMEPLATES FROM MANUFACTURERS

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

.2 Manufacturers' nameplates and CSA labels are to be visible and legible after equipment is installed. Provide warning signs, as specified, or to meet requirements of Inspection Department, Health and Safety, and the Consultant.

.3 Label power outlets with circuit identification on visible portion of faceplate or surface mounted outlet box.

3.2 CONDUIT AND BOX IDENTIFICATION

.1 Locate labels as follows:

.1 At every end of every conduit, duct or cable run, adjacent to item of equipment serviced.

.2 On each exposed conduit, duct or cable passing through a wall, partition or floor (one on each side of such wall partition or floor).

.3 At intervals of 15 m (50'-0") along every exposed conduit, duct or cable run exceeding 15 m (50 feet) in length.

.4 At every access point on concealed conduit duct or cable.

.5 At each junction box.

.2 Place labels so as to be visible from 1500 mm (5'-0") above adjacent floor platform.

3.3 PREPARATION

.1 Degrease and clean surfaces to receive nameplates and labels.

3.4 APPLICATION

.1 Confirm colours prior to start of work.

.2 Install nameplate and label parallel to equipment lines.

.3 Secure nameplate to equipment front using adhesive.

.4 Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

.5 Identify conduit using field painting.

.6 Paint coloured band on each conduit longer than 2 m.

.7 Paint bands 6 m on centre.

3.5 LABELLING

.1 Colour code wiring consistently throughout the installation and generally match colour coding of internal wiring of pre-wired components.

.2 Label wiring with point name using Thomas & Betts 12 character polestar metalized labels with 3 rows of characters per label, or equal by Brady. Label to occur as a minimum at both ends and at pull boxes of the wiring run.

.3 Identify all pull boxes, junction boxes, etc. (installed as part of this project or used by this project) with the exact use of the box. Indelible felt pen marker is acceptable.

.4 Label light control items with point name using Thomas & Betts 12 character label, or equal by Brady. Label to be black lettering on clear backing.

.5 Label relays and controllers inside panels using Thomas & Betts 12 character label, or equal by Brady.

.6 Provide red, 13 mm (1/2 inch) diameter, sticker on emergency light fixture frame. Include circuit number on sticker with thin permanent black mark pen.

3.6 LABELS AND SIGNS

.1 Manufacturers' nameplates and CSA labels are to be visible and legible after equipment is installed. Provide warning signs, as specified, or to meet requirements of Inspection Department, Health and Safety, and the Consultant.

.2 Label power outlets with circuit identification on visible portion of faceplate or surface mounted outlet box.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Electrical connections to equipment specified in other sections.

1.2 RELATED REQUIREMENTS

.1 Division 20 – Common Mechanical Requirements.

.2 Division 23 – Heating, Ventilating, and Air Conditioning.

.3 Division 25 – Integrated Automation.

1.3 REFERENCES

.1 NEMA WD 1 - General Colour Requirements for Wiring Devices.

.2 NEMA WD 6 - Wiring Devices - Dimensional Requirements.

1.4 COORDINATION

.1 Coordinate work to Section 01 30 00.

.2 Obtain and review shop drawings, product data, and manufacturer's instructions for equipment provided under other sections.

.3 Determine connection locations and requirements.

.4 Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.

.5 Sequence electrical connections to coordinate with start-up schedule for equipment.

1.5 SUBMITTALS

.1 Submit to Section 01 30 00.

.2 Product Data: Provide wiring device manufacturer's catalogue information showing dimensions, configurations, and construction.

.3 Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.6 REGULATORY REQUIREMENTS

.1 Provide products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

2 Products

2.1 COMMON MOTOR REQUIREMENTS

.1 Motors up to and including 1/3 HP, shall be 1 phase, 60 Hz, 120 volts.

.2 Motors 1/2 HP and above shall be 3 phase, 60 Hz, 575 volts or 208 volts.

2.2 CORDS AND CAPS

.1 Attachment Plug Construction: Conform to NEMA WD 1.

.2 Configuration: NEMA WD 6; match receptacle configuration at outlet provided for equipment.

.3 Cord Construction: NFPA 70, Type SJO multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.

.4 Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

3 Execution

3.1 WIRING OF EQUIPMENT PROVIDED UNDER OTHER DIVISIONS

.1 Use the following procedure with regards to wiring of motors and equipment provided under other Divisions.

.2 The following equipment shall be responsibility of the trade supplying the equipment unless otherwise noted, in accordance with the requirements laid out in the individual section, or this division:

.1 Motors.

.2 Starters.

.3 Variable Frequency Drives.

.4 Motor Control Centres.

.5 Control wiring.

.3 In every instance, install starter, motor control centre, variable frequency drivers (VFD), etc. and wire to line side of the starter, the Motor Control Centre, or VFD. Extend wiring from starter, motor control centre or VFD to motor as indicated.

.4 Provide all wiring for starters and VFD's from supply to starter to VFD and to motor. Coordinate requirements with the appropriate trade.

.5 Provide 500 mm of liquid tight flexible metal conduit for final connection to motor. Provide disconnect switches where required by code, and as indicated on the drawings.

.6 Where individual starters and controls are grouped together provide a panel for mounting this equipment. Provide a feeder, main fused disconnect and a splitter of adequate size and capacity and wire to line side of the starters on this panel and from starters to motors.

.7 Equipment, General

.1 Ascertain exact locations of starters, motor control centres, motors, etc. from drawings and coordinate exact locations with the supplying trade.

.2 Control wiring shall be the responsibility of the supplying trade.

.1 Control wiring shall be in accordance with Section 26 05 19, and Section 26 05 23.

.2 Control wiring shall be installed in conduit in accordance with Section 26 05 33.13.

.8 HVAC Equipment

.1 Ascertain exact locations of starters, motor control centres, motors, motorized dampers, VAV boxes, and heating control valves from HVAC drawings and coordinate exact locations with HVAC Division.

.2 In the case of unit heaters, reheat coils and cabinet unit heaters, terminate wiring on terminals provided. Control wiring, thermostats, or other control devices shall be the responsibility of the HVAC trade, as described above.

.3 Provide branch circuit wiring and an outlet for each motorized damper, variable air volume (VAV) box, or heating control valve. Control wiring shall be the responsibility of the HVAC trade, as described above.

.9 Integrated Automation (Building Automation System)

.1 From equipment as noted on drawings, extend suitable wiring in conduit from equipment contacts to designated BMS panel swerving area, terminating wiring and conduit in a junction box. Leave wiring un-terminated with slack coiled length of minimum 2 m (6') long. Clearly label junction box and wiring end for termination onto BMS panel by respective Mechanical Trade.

3.2 EXAMINATION

.1 Verify that equipment is ready for electrical connection, wiring, and energization.

3.3 ELECTRICAL CONNECTIONS

.1 Provide a local disconnect switch for all equipment, regardless of if a disconnect switch is shown or not shown on the plans.

.2 Make electrical connections to equipment manufacturer's instructions.

.3 Make conduit connections to equipment using flexible conduit. Use liquid-tight flexible conduit with watertight connectors in damp or wet locations.

.4 Make wiring connections using wire and cable with insulation suitable for temperatures encountered in heat producing equipment.

.5 Provide receptacle outlet where connection with attachment plug is indicated. Provide cord and cap where field-supplied attachment plug is indicated.

.6 Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

.7 Install disconnect switches, controllers, control stations, and control devices as indicated.

.8 Modify equipment control wiring with terminal block jumpers as indicated.

.9 Provide interconnecting conduit and wiring between devices and equipment where indicated.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Materials and components for dry type transformers up to 600 V primary, equipment identification and transformer installation.

1.2 REFERENCES

.1 ANSI/ASHRAE/IES Standard 90.1-2013 – Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 CSA Group:

.1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.

.2 Ontario Electrical Safety Code (28th edition/2021).

.3 CSA C22.2 No. 47-13 (R2018), Air-cooled transformers (dry type).

.4 CSA C9-17, Dry-type transformers.

.5 CSA C802.2-18, Minimum Efficiency Values for Dry-Type Transformers.

.3 National Electrical Manufacturers Association (NEMA):

.1 NEMA ST-20-2014, Dry-Type Transformers for General Applications: sound levels.

.4 NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).

.5 Ontario Building Code and its referenced standards.

1.3 ACTION SUBMITTALS

.1 Product Data: Provide outline and support point dimensions of enclosures and accessories, unit weight, voltage, power, and impedance ratings and characteristics, tap configurations, insulation system type, and rated temperature rise.

1.4 INFORMATIONAL SUBMITTALS

.1 Test Reports: Indicate loss data, efficiency at 25, 50, 75, and 100 per cent rated load, and sound level.

.2 Submit manufacturer's installation instructions.

.1 Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements.

.2 Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.5 CLOSEOUT SUBMITTALS

.1 Record actual locations of transformers in project record documents.

1.6 DELIVERY, STORAGE, AND HANDLING

.1 Store and handle in strict compliance with manufacturer’s instructions and recommendations. Protect from potential damage from weather and construction operations.

.2 Store so condensation will not form on or in the transformer housing and if necessary, apply temporary heat where required to obtain suitable service conditions. Store in a clean, dry space.

Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

.3 Handle to manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

.4 Handle transformer using proper equipment for lifting and handling, use when necessary lifting eye and/or brackets provided for that purpose.

1.7 WARRANTY

.1 The transformer shall carry a 1 year warranty from the time of substantial performance.

2 Products

2.1 GENERAL

.1 Transformers shall be standard general purpose dry type unless otherwise indicated on drawings as K-Rated or Harmonic Mitigation type.

.2 Use transformers of one manufacturer throughout project and in accordance with CSA C22.2 No. 47 and CSA C9.

2.2 MANUFACTURERS

.1 Manufacturer List:

.1 Bemag.

.2 Delta Transformer.

.3 Eaton.

.4 Hammond.

.5 Powersmiths.

.6 Rex Power Magnetics.

.7 Siemens.

.8 Schneider Electric.

.9 STI.

.2 Substitutions: permitted if approved by the Consultant prior to Tender closing date.

2.3 REGULATORY REQUIREMENTS

.1 Products: Listed and classified by CSA (Canadian Standards Association).

.2 Efficiency ratings:

.1 Meet or exceed the efficiency levels indicated in CSA C802.2-12, and ASHRAE 90.1-2013, Table 8.4.4.

2.4 GENERAL PURPOSE TRANSFORMERS

.1 NEMA ST-20, factory-assembled, air cooled low-inrush dry type transformer, ratings and voltages as indicated on drawings.

.2 Single or three phase as indicated on drawings.

.3 Type: AN/AA ventilated self-cooled.

.4 Copper or Aluminum windings.

.5 Finish: Final coating to be ANSI 61 Grey Epoxy Powder.

.6 T-connected transformers are not acceptable.

.7 Isolate core and coil from enclosure using vibration-absorbing mounts.

.8 Impedance: standard (3% to 5% nominal for up to 75 kVA, 4% to 6% for transformers 112.5 kVA and greater).

2.5 PRIMARY VOLTAGE

.1 600 volts delta, 3 phase;

2.6 SECONDARY VOLTAGE

.1 120/208 volts, 3 phase wye.

2.7 INSULATION SYSTEM AND AVERAGE WINDING TEMPERATURE RISE

.1 1-15 kVA: Class 185 with 150 degrees C rise.

.2 16-500 kVA: Class 220 with 150 degrees C rise.

.3 Above 500 kVA: Class 220 with 150 degrees C rise.

2.8 CASE TEMPERATURE

.1 Limits in accordance with CSA C22.2 no. 47.

2.9 WINDING TAPS

.1 To NEMA ST-20.

.2 Four full capacity 5 per cent adjustment taps, 2 at 2.5 per cent FCBN (full capacity below nominal) and 2 at 2.5 per cent FCAN (full capacity above nominal).

2.10 BASIC IMPULSE LEVEL

.1 10 kV BIL.

2.11 GROUNDING

.1 Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

2.12 MOUNTING

.1 1-15 kVA: suitable for wall mounting.

.2 16-75 kVA: suitable for wall, or floor, as shown.

.3 Larger than 75 kVA: suitable for floor mounting.

2.13 COIL CONDUCTORS

.1 Continuous windings with terminations brazed or welded.

2.14 ENCLOSURE

.1 NEMA ST-20, CSA type 2 ventilated, sprinkler-proof. Provide lifting eyes or brackets.

2.15 SOUND LEVELS

.1 To NEMA ST-20 for transformers up to 300 kVA:

.1 Up to 9 kVA: 40 dB.

.2 10 – 50 kVA: 45 dB.

.3 51 – 150 kVA: 50 dB.

.4 151 – 300 kVA: 55 dB.

.2 Sound levels 3 dB less than NEMA ST-20 for transformers 301 kVA and greater:

.1 301 – 500 kVA: 57 dB.

.2 501 – 700 kVA: 59 dB.

.3 701 – 1000 kVA: 61 dB.

.4 Above 1000 kVA: 3 dB less than NEMA ST-20.

2.16 NAMEPLATE

.1 Transformer shall have embossed aluminum or stainless steel nameplate indicating, but not restricted to the following:

.1 kVA rating.

.2 Voltage rating.

.3 Impedance.

.4 Type.

.5 Insulation class.

.6 Temperature rise.

.7 Connection diagram.

.8 Serial number.

2.17 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 53.

2.18 SOURCE QUALITY CONTROL

.1 Production test each unit according to NEMA ST-20.

3 Execution

3.1 INSTALLATION

.1 Mounting:

.1 Mount dry type transformers up to 75 kVA, on floor, wall, or suspended from celling, as indicated on plans.

.2 Maintain clear space as described in 2021 OESC Rule 2-312.

.3 Mount dry type transformers rated above 75 kVA on floor.

.4 For wall mounted transformers, provide rubber-in-shear isolation mounts above bracket-supported rails secured from the wall.

.5 For ceiling mounted transformers, provide trapeze hangers and provide rubber-in-shear isolation mounts.

.6 Mount floor mounted transformers on concrete housekeeping pads, minimum 100 mm (4”) thick, and extending a minimum of 150 mm (6”) beyond the footprint of the transformer.

.7 Mount vibration isolating pads suitable for isolating the transformer noise from the building structure in accordance with Section 26 05 48.13.

.2 Set transformer plumb and level.

.3 Use flexible conduit, under the provisions of Section 26 05 33.13, 600 mm minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

.4 Provide grounding and bonding to Section 26 05 26.

.5 Ensure adequate clearance around transformer for ventilation.

.6 Install transformers in level upright position.

.7 Remove shipping supports only after transformer is installed and just before putting into service.

.8 Loosen isolation pad bolts until no compression is visible.

.9 Make primary and secondary connections in accordance with wiring diagram.

.10 Energize transformers after installation is complete.

3.2 FIELD QUALITY CONTROL

.1 Section 01 40 00: Field Inspection, Testing, Adjusting.

.2 Perform inspections and tests listed in NETA ATS, Section 7.2.

3.3 ADJUSTING

.1 Measure primary and secondary voltages and make appropriate tap adjustments.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Power distribution panelboards – Circuit breaker type.

.2 Lighting and appliance branch circuit panelboards.

1.2 RELATED REQUIREMENTS

.1 Section 26 28 16.02 – Molded Case Circuit Breakers.

1.3 REFERENCES

.1 CSA Group:

.1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.

.2 Ontario Electrical Safety Code (28th edition/2021).

.3 CSA C22.2 No. 5-16 – Molded Case Circuit Breakers, molded-case switches, and circuit-breaker enclosures.

.4 CSA C22.2 No. 29-15 – Panelboards and Enclosed Panelboards.

.2 NEMA:

.1 NEMA ICS 2-2000 (R2020) – Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.

.2 NEMA KS 1-2013 – Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).

.3 NEMA PB 1-2011 – Panelboards.

.4 NEMA PB 1.1-2013 – General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

.3 NETA ATS – Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).

1.4 SUBMITTALS

.1 Submit in accordance with Section 01 30 00.

.2 Shop drawings shall contain overall panelboard dimensions, interior mounting dimensions, and wiring gutter dimensions. The location of the main, branches, and solid neutral shall be clearly shown. In addition, the drawing shall illustrate one line diagrams with applicable voltage systems.

.3 Shop drawings:

.1 Indicate the following:

.1 Outline and support point dimensions.

.2 Voltage.

.3 Main bus ampacity.

.4 Integrated short circuit ampere rating.

.5 Circuit breaker arrangement, types, and sizes.

.2 The following information shall be submitted to the Consultant:

.1 Breaker layout drawing with dimensions indicated and nameplate designation.

.2 Component list.

.3 Conduit entry/exit locations.

.4 Assembly ratings including:

.1 Short-circuit rating.

.2 Voltage.

.3 Continuous current.

.5 Cable terminal sizes.

.6 Product data sheets.

.3 Where applicable, the following additional information shall be submitted to the Consultant:

.1 Key interlock scheme drawing and sequence of operations.

.4 Submittals for Construction

.1 The following information shall be submitted for record purposes:

.1 Installation information

1.5 CLOSEOUT SUBMITTALS

.1 Refer to Section 01 78 00.

.2 Record actual locations of panelboards and record actual circuiting arrangements in project record documents.

.3 Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

.4 Final as-built drawings and information shall incorporate all changes made during the manufacturing and installation process.

.5 Include a copy of each panelboard schedule in the Operation and Maintenance manual.

1.6 MAINTENANCE MATERIAL SUBMITTALS

.1 Manufacturer shall provide installation instructions and NEMA Standards Publication PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

.2 Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins and renewal parts lists where applicable, for the complete assembly and each major component.

.3 Provide two of each panelboard key.

.4 Provide final panelboard schedules indicating panelboard data, phasing, breaker sizes, and loads served.

1.7 QUALITY ASSURANCE

.1 Regulatory Requirements

.1 Products: Listed and classified by CSA (Canadian Standards Association).

.2 Qualifications

.1 Company specializing in manufacturing of panelboard products with a minimum of 20 years' experience.

.2 The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

.3 For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

.4 The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Consultant, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.8 DELIVERY, STORAGE, AND HANDLING

.1 Inspect and report concealed damage to carrier within their required time period.

.2 Handle carefully to avoid damage to panelboard internal components, enclosure, and finish.

.3 Store in a clean, dry environment. Maintain factory packaging and, if required, provide an additional heavy canvas or heavy plastic cover to protect enclosure(s) from dirt, water, construction debris, and traffic.

.4 Equipment shall be handled and stored in accordance with manufacturer's instructions. One copy of these instructions shall be included with the equipment at time of shipment.

1.9 WARRANTY

.1 Warrant specified equipment to be free from defects in materials and workmanship for eighteen (18) months from the date of purchase.

2 Products

2.1 GENERAL

.1 Description: CSA C22.2 No. 29, circuit breaker type.

2.2 DISTRIBUTION PANELBOARDS – CIRCUIT BREAKER TYPE

.1 Manufacturers:

.1 Square D by Schneider Electric, I-LINE Series.

.2 Eaton Cutler-Hammer, PRL 3 and PRL4 Series.

.3 Equal by Siemens.

.2 The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Consultant ten days prior to bid date.

.3 Panelboard Bus:

.1 Copper, ratings as indicated.

.2 Provide copper neutral bus for panelboards indicated for 4-wire systems.

.3 Provide copper ground bus in each panelboard.

.4 Short Circuit Ratings:

.1 Panelboards rated 600 V shall have minimum integrated short-circuit ratings as shown on the drawings or as herein scheduled, but not less than 65 000 amperes RMS symmetrical.

.2 Distribution panelboards with bolt-on devices contained therein shall have interrupting ratings as specified herein or indicated on the drawings.

.3 Panelboards shall be fully rated.

.4 Where indicated, provide circuit breakers ULC listed for application at 100 per cent of their continuous ampere rating in their intended enclosure.

.5 Minimum integrated short circuit rating: Panelboards rated 240 V shall have minimum integrated short-circuit ratings as shown on the drawings or as herein scheduled, but not less than 10 000 amperes RMS symmetrical.

.6 Molded Case Circuit Breakers: To Section 26 28 16.02.

.7 Circuit Breaker Accessories: Trip units and auxiliary switches as indicated.

.8 Cabinet Front: Surface type, fastened hinge and latch, metal directory frame, finished in manufacturer's standard gray enamel.

.9 Enclosures: CSA type 2 sprinklerproof complete with drip hood, or as noted.

.10 Trims shall be equipped with a flush lock.

.11 Breaker positions labeled as “Spare” or “Space” shall constitute no less than 20 per cent of available breaker positions, whether indicated or not in panelboard schedules.

.12 Each panel shall be complete with a directory which shall be mounted inside door in a metal frame with clear plastic cover and copy in each Data Book. Use final Room Numbers for directories.

2.3 BRANCH CIRCUIT PANELBOARDS

.1 Manufacturers:

.1 Square D by Schneider Electric, NQ or NQOD Series.

.2 Eaton Cutler-Hammer, POW-R-LINE 1, POW-R-LINE 2, POW-R-LINE 3 Series.

.3 Equal by Siemens.

.2 Description: CSA C22.2 No.29, circuit breaker type, lighting and appliance branch circuit panelboard.

.3 Panelboard Bus:

.1 Copper, ratings as indicated.

.2 Provide copper neutral bus in each panelboard.

.3 Provide copper ground bus in each panelboard.

.4 Provide insulated ground bus where scheduled.

.4 Minimum Integrated Short Circuit Rating: 10 000 amperes RMS symmetrical for 240 volt panelboards, or as indicated.

.5 Molded Case Circuit Breakers: NEMA AB 1, plug-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits, Type HACR for air conditioning equipment circuits, Class A ground fault interrupter circuit breakers where scheduled. Do not use tandem circuit breakers.

.6 Current Limiting Molded Case Circuit Breakers where indicated: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.

.7 Cabinet Front: Surface cabinet front with concealed trim clamps, concealed hinge, metal directory frame, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.

.8 Enclosure shall be CSA type 2 sprinklerproof complete with drip hood, or as noted.

.9 Trims shall be equipped with a flush lock.

.10 Breaker positions labeled as “Spare” or “Space” shall constitute no less than 20 per cent of available breaker positions, whether indicated or not in panelboard schedules.

.11 Panelboards: to CSA C22.2 No.29 and product of one manufacturer.

.1 Install circuit breakers in panelboards before shipment.

.2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.

.12 Panelboards rated 240 Vac or less shall have short-circuit ratings as shown on the drawings or as herein scheduled, but not less than 10,000 amperes RMS symmetrical.

.13 Bus and breakers rated for symmetrical interrupting capacity, as indicated.

.14 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.

.15 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.

.16 Two keys for each panelboard and key panelboards alike.

.17 Copper bus with neutral of same ampere rating as mains.

.18 Mains: suitable for bolt-on breakers.

.19 Trim with concealed front bolts and hinges.

.20 Trim and door finish: baked grey enamel.

.21 The minimum short-circuit rating for branch circuit panelboards shall be as specified herein or as indicated on the drawings. Panelboards shall be fully rated.

.22 Bolt-on type, heavy-duty, quick-make, quick-break, single- and multi-pole circuit breakers of the types specified herein, shall be provided for each circuit with toggle handles that indicate when unit has tripped.

.23 Circuit breakers shall be thermal-magnetic type with common type handle for all multiple pole circuit breakers. Circuit breakers shall be minimum 100-ampere frame and through 100-ampere trip sizes shall take up the same pole spacing. Circuit breakers shall be ULC listed as type SWD for lighting circuits.

.1 Circuit breaker handle locks shall be provided for all circuits that supply exit signs, emergency lights, energy management, and control system (EMCS) panels and fire alarm panels.

.24 Circuit breakers shall have a minimum interrupting rating of 10 000 amperes symmetrical at 240 volts, and 14 000 amperes symmetrical at 480 volts, unless otherwise noted on the drawings.

.25 Each panel shall be complete with a directory which shall be mounted inside door in a metal frame with clear plastic cover and copy in each Data Book. Use final Room Numbers for directories.

.26 Lighting and receptacle panels shall be surface or flush-mounting type, as shown.

.27 Panels shall be dead front type in code gauge steel enclosures. All panels shall be sprinkler proof c/w drip hoods as required.

.28 Panels shall have mains of voltage and capacity, and main and branch breakers, as shown on the drawings. Spaces shall include necessary bus work such that Owners, at a later date, need buy only the breakers.

.29 Where panels exceed 42 circuits, use multi-section panel with main cross-over solid bus bars unless noted otherwise on drawings. Main bus capacity of each section shall be full size to match cross-over bus.

.30 Breakers shall have bolted type connections. Multi-pole breakers shall be common trip type with a single handle, suitable for voltage applied and of same manufacture as single pole breakers.

.31 Panels for 120/208 volt, 3-phase, 4-wire systems shall be complete with full size breakers.

.32 Where shown on drawings or required by code, certain breakers shall include ground fault interrupter.

.33 Provide lighting and receptacle panels suitable for surface, or flush-mounting type, as shown.

.34 Provide locking bars on non-switched circuits where panels are used for switching lighting circuits.

.35 Panels for non-linear loads shall be complete with lugs for double neutrals.

.36 Panels shall be given a rust-resistant treatment to both tub and trim.

.37 Flush panels shall have concealed hinges and flush type combination lock latch. Locks shall be chrome plated. Doors shall open minimum 135 degrees. Trims shall have fasteners concealed and shall be prime coated to receive room finish paint.

.38 Surface mounted panels shall have manufacturer's standard surface door trim complete with lock and latch. Finish shall be grey.

.39 Recessed panels shall have standard flush trims.

.40 Co-ordinate panel finish with Room Finish Schedule.

2.4 MOLDED CASE CIRCUIT BREAKERS

.1 Breakers: to Section 26 28 16.02.

.2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.

.3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.

.4 Lock-on devices for 10 per cent of 15 A to 30 A breakers installed as indicated. Turn over unused lock-on devices to Owner.

.5 Lock-on devices for fire alarm, security, and sprinkler circuits.

.6 Provide shunt trips, bell alarms, and auxiliary switches as shown on the contract drawings.

2.5 CONSTRUCTION

.1 General:

.1 Interiors shall be completely factory assembled. They shall be designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.

.2 Surface trims shall be same height and width as box. Flush trims shall overlap the box by 3/4 of an inch on all sides.

.3 A temporary directory card with a clear plastic cover shall be supplied and mounted on the inside of each door.

.4 All locks shall be keyed alike. Key same as existing.

.2 Branch Circuit Panelboards:

.1 Trims for branch circuit panelboards shall be supplied with a hinged door over all circuit breaker handles. Doors in panelboard trims shall not uncover any live parts. Doors shall have a semi flush cylinder lock and catch assembly. Door-in-door trim shall be provided. Both hinged trim and trim door shall utilize three point latching. No tools shall be required to install or remove trim. Trim shall be equipped with a door-actuated trim locking tab. Equip locking tab with provision for a screw such that removal of trim requires a tool, at the owner's option. Installation shall be tamper resistant with no exposed hardware on the panelboard trim.

.3 Distribution Panelboards:

.1 Distribution panelboard trims shall cover all live parts. Switching device handles shall be accessible.

2.6 BUS

.1 Lugs: Copper and listed by CSA, or cUL, for use with copper conductors and sized to accept copper conductors of the ampacity specified.

.2 Main bus bars shall be copper sized in accordance with CSA standards to limit temperature rise on any current carrying part to a maximum of 65 degrees C above an ambient of 40 degrees C maximum.

.3 A copper system ground bus shall be included in all panelboards.

.4 Full-size (100 per cent rated) insulated copper neutral bars shall be included for panelboards shown with neutral. Bus bar taps for panels with single-pole branches shall be arranged for sequence phasing of the branch circuit devices. Neutral busing shall have a suitable lug for each outgoing feeder requiring a neutral connection. 200 per cent rated neutrals shall be supplied for panels designated on drawings with oversized neutral conductors.

2.7 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 53.

.2 Nameplate for each panelboard size 4 engraved.

.3 Nameplate for each branch circuit in distribution panelboards size 2 engraved.

.4 Complete circuit directory with typewritten legend showing location and load of each circuit.

.5 Provide an engraved nameplate for each panelboard section.

.6 Provide copies of all circuit directories in manuals.

2.8 SOURCE QUALITY CONTROL

.1 The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of NEMA and CSA standards.

3 Execution

3.1 INSTALLATION

.1 Install panelboards to CSA C22.1.

.2 Install panelboards plumb.

.3 Height: 1800 mm to top of panelboard; install panelboards taller than 1800 mm with bottom no more than 100 mm above floor.

.4 Provide filler plates for unused spaces in panelboards.

.5 Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.

.6 Provide engraved plastic nameplates under the provisions of Section 26 05 53.

.7 Ground and bond panelboard enclosure according to Section 26 05 26.

.8 Locate panelboards as indicated and mount securely, plumb, true, and square, to adjoining surfaces.

.9 Install surface mounted panelboards on fire rated plywood backboards in accordance with Section 26 05 29. Where practical, group panelboards on common backboard.

.10 Connect loads to circuits.

.11 Connect neutral conductors to common neutral bus with respective neutral identified.

.12 Deliver five (5) duplicate keys for each panel lock to the Owner.

.13 Mount electrical panels, where possible, with top of trim at uniform height of 2000 mm.

.14 Cap ends of conduits in accessible locations in ceiling spaces above panels, to allow for future wiring.

.15 The Contractors shall install all equipment per the manufacturer’s recommendations and the contract drawings.

.16 Install panelboards in accordance with manufacturer's written instructions, NEMA PB 1.1 and Electrical Code requirements.

.17 After completion of wiring, type directory showing a clear description of each circuit being controlled from panel and place in metal frame inside door.

.18 Provide revised directories for existing panels if revised.

.19 Provide circuit breaker handle locks for all circuits that supply exit signs, emergency lights, energy management, and control system (EMCS) panels and fire alarm panels.

3.2 FIELD QUALITY CONTROL

.1 Perform inspections and tests listed in NETA ATS, Section 7.4 for switches, Section 7.5 for circuit breakers.

.2 Inspect complete installation for physical damage, proper alignment, anchorage, and grounding.

.3 Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads within 20 per cent of each other. Maintain proper phasing for multi-wire branch circuits.

.4 Check tightness of bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written specifications.

3.3 ADJUSTING

.1 Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other.

.2 Maintain proper phasing for multi-wire branch circuits.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Switches, receptacles, wiring devices, cover plates and their installation.

1.2 REFERENCES

.1 CSA Group:

.1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.

.2 Ontario Electrical Safety Code (28th edition/2021).

.3 CSA C22.2 No. 14-13, Industrial control equipment.

.4 CSA C22.2 No. 42-10 (R2015), General use receptacles, attachment plugs, and similar devices.

.5 CSA C22.2 No. 42.1-13, Cover plates for flush-mounted wiring devices.

.6 CSA C22.2 No. 55-15 (R2020), Special use switches.

.7 CSA C22.2 No.111-10 (R2015), General-use snap switches.

.8 CSA C22.2 No. 182.1-17, Plugs, receptacles, and cable connectors of the pin and sleeve type.

1.3 INFORMATIONAL SUBMITTALS

.1 Submit shop drawings and product data in accordance with Section 01 30 00.

.2 Product Data: Provide manufacturer's catalogue information showing dimensions, colours, and configurations.

.3 Submit manufacturer's installation instructions.

2 Products

2.1 MANUFACTURERS

.1 Eaton.

.2 Hubbell Bryant.

.3 Leviton.

.4 Molex.

.5 Pass & Seymour (Legrand).

2.2 RECEPTACLES

.1 General

.1 Description: CSA C22.2 No. 42, Commercial Spec Grade general use receptacles.

.2 Device Body: white plastic.

.3 Configuration: Type as specified and indicated.

.4 Convenience Receptacle: Type 5-15, 5-20 where indicated.

.5 GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.

.6 Data Room Receptacle Types: As indicated on drawings.

.7 Receptacles of one manufacturer throughout project.

.2 Receptacles shall be white coloured, specification grade, unless noted otherwise.

.3 Receptacles shall be as listed below:

.1 15 ampere, 120 volt, single phase grounded duplex receptacle shall be NEMA-U- ground type CSA Configuration 5-15R.

.2 20 ampere, 120 volt, single phase grounded duplex receptacle shall be NEMA-U-ground type CSA Configuration 5-20RA

.3 15 ampere, 120 volt, weatherproof receptacles shall be equal to those above but complete with gasketed cast plate and hinged covers.

.4 Other types of receptacles shall be provided as shown on Drawings.

.5 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA-C22.2 No. 42 with following features:

.1 White urea moulded housing.

.2 Suitable for No. 10 AWG for back and side wiring.

.3 Break-off links for use as split receptacles.

.4 Eight back wired entrances, four side wiring screws.

.5 Triple wipe contacts and riveted grounding contacts.

.6 Single receptacles CSA type 5-15 R, 125 V, 15 A, U ground with following features:

.1 White urea moulded housing.

.2 Suitable for No. 10 AWG for back and side wiring.

.3 Four back wired entrances, 2 side wiring screws.

.7 Other receptacles with ampacity and voltage as indicated.

.8 Example Products (Decorator style duplex 5-15R):

.1 Pass & Seymour 26252 Series.

.2 Hubbell HBL2152 Series.

.9 Ground Fault Circuit Interrupter (GFCI or GFI) Receptacles

.1 Protected by a ground fault circuit interrupter of the Class A type.

.2 Any receptacle within 1.5 m of a sink must be GFCI protected.

.3 Any receptacle located outdoor must be GFCI protected.

.10 Isolated Ground (IG) Receptacles:

.1 Marked as such (green triangle).

.2 Example Products:

.1 Hubbell IG2152 (15A duplex decorator style, orange faceplate).

.11 Tamper-resistant receptacles.

.1 Marked as such (for example “TR”).

.2 To be used in the following spaces:

.1 Child care facilities and kindergarten classrooms.

.2 Guest rooms and suites of hotels and motels.

.3 Preschools and elementary education facilities, including kindergarten facilities.

.4 Dwelling units.

.3 Example Products:

.1 Hubbell BR15WHITR (15A duplex decorator style).

.2 Hubbell BR20WHITR (20A duplex decorator style).

.12 USB Charger receptacles: duplex tamper resistant device.

.1 USB ports: one type A and one type C USB charging port, 5 amp, 5 volt.

.2 Example: Hubbell USB15AC5WWR.

.13 Wet location and weatherproof devices:

.1 Receptacles and cover plates suitable for wet locations, cover plates to provide shielding with and without a plug inserted into the receptacle in accordance with OESC rule 26-702. Cover plates to be marked “Extra Duty”.

.2 Receptacles shall be 20 A rated, GFI.

2.3 PENDANT RECEPTACLES

.1 Pendant cord mounted single receptacles complete with strain relief device.

.2 Strain relief system: Hubbell Kellems Grips, Molex, or equal.

2.4 SPECIAL WIRING DEVICES

.1 Pilot lights as indicated, with neon type 0.04 W, 125 V lamp and red plastic jewel flush type.

2.5 PIN AND SLEEVE DEVICES

.1 Manufacturers:

.1 Crouse-Hinds by Eaton.

.2 Hubbell.

.3 Meltric.

.4 Mennekes.

.5 Russellstoll (Thomas & Betts).

.6 Walther Electric.

.2 Refer to equipment schedule and plans for locations and specific requirements.

2.6 REGULATORY REQUIREMENTS

.1 Provide products listed and classified by CSA (Canadian Standards Association).

3 Execution

3.1 EXAMINATION

.1 Verify that outlet boxes are installed at proper height.

.2 Verify that wall openings are neatly cut and will be completely covered by wall plates.

.3 Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

.1 Provide extension rings to bring outlet boxes flush with finished surface.

.2 Clean debris from outlet boxes.

3.3 INSTALLATION

.1 Install to CSA C22.1.

.2 Mounting heights in accordance with Section 26 05 00.

.3 Install devices plumb and level.

.4 Install switches with OFF position down.

.5 Install wall dimmers to achieve full rating specified and indicated after de-rating for ganging as instructed by manufacturer.

.6 Do not share neutral conductor on load side of dimmers.

.7 Install receptacles with grounding pole on bottom.

.8 Connect wiring device grounding terminal to outlet box with bonding jumper.

.9 Install decorative plates on switch, receptacle, and blank outlets in finished areas.

.10 Connect wiring devices by wrapping conductor around screw terminal.

.11 Use jumbo size plates for outlets installed in masonry walls.

.12 Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

.13 Switches:

.1 Install single throw switches with handle in "UP" position when switch closed.

.2 Install switches in gang type outlet box when more than one switch is required in one location.

.14 Receptacles:

.1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.

.2 Where split receptacle has one portion switched, mount vertically and switch upper portion.

.3 Connect receptacle grounding terminal to the outlet box with an insulated green ground strap.

.4 Receptacles for maintenance of HVAC and similar equipment located on rooftops.

.1 Provide weatherproof GFI 5-20R receptacles on roof, installed at 750 mm (30 inches) above finished roof level, complete with wet location cover plate.

.2 Locate within 7500 mm (25 feet) of new HVAC equipment, and at least 2000 mm (6.5 feet) away from roof line.

.3 Refer to 2021 OESC rules 2-316, 26-708, and 26-710, and OESC bulletin 26-27-0, or latest edition.

.15 Cover plates:

.1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.

.2 Install suitable common cover plates where wiring devices are grouped.

.3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

.4 Do not install plates until final painting of room or area is completed. Remove protective covering.

3.4 FIELD QUALITY CONTROL

.1 Inspect each wiring device for defects.

.2 Operate each wall switch with circuit energized and verify proper operation.

.3 Verify that each receptacle device is energized.

.4 Test each receptacle device for proper polarity.

.5 Test each GFCI receptacle device for proper operation.

3.5 ADJUSTING

.1 Adjust devices and wall plates to be flush and level.

3.6 CLEANING

.1 Clean exposed surfaces to remove splatters and restore finish.

End of Section

1 General

1.1 REFERENCES

.1 CSA C22.2 No. 248 series.

1.2 SUBMITTALS

.1 Provide submittals in accordance with Section 01 30 00.

.2 Product Data:

.1 Provide fuse performance data characteristics for each fuse type and size above 200 amps. Performance data to include: average melting time-current characteristics.

.3 Shop Drawings:

.1 Provide shop drawings in accordance with Section 01 30 00.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Ship fuses in original containers.

.2 Do not ship fuses installed in switchboard.

.3 Store fuses in original containers in storage cabinet.

.4 Waste Management and Disposal:

.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 00.

1.4 MAINTENANCE MATERIAL SUBMITTALS

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

.2 3 spare fuses of each type and size installed above 600 A.

.3 6 spare fuses of each type and size installed up to and including 600 A.

2 Products

2.1 MANUFACTURERS

.1 Bussman by Eaton.

.2 GEC.

.3 Littelfuse.

.4 Mersen.

.5 Substitutions: not permitted.

2.2 FUSES - GENERAL

.1 Fuse type references L1, L2, J1, R1, etc. have been adopted for use in this specification.

.2 Fuses: product of one manufacturer.

.3 Fuses shall be sized as shown, time delay type, and of the same type throughout.

.4 Fuses shall be CSA certified Class-J for 1-600A or Class-L for 650 Amps and above.

.5 Provide the following accessories where indicated or where required to complete installation:

.1 Fuseholders: Compatible with indicated fuses.

.2 Fuse Reducers: For adapting indicated fuses to permit installation in switch designed for uses with larger ampere ratings.

2.3 FUSE TYPES

.1 Class J fuses.

.1 Type J1, time delay, capable of carrying 500 per cent of its rated current for 10 seconds minimum.

.2 Type J2, fast acting.

.2 Class L fuses.

.1 Type L1, time delay, capable of carrying 500 per cent of its rated current for 10 seconds minimum.

.2 Type L2, fast acting.

.3 Class R fuses.

.1 Type R1, (UL Class RK1), time delay, capable of carrying 500 per cent of its rated current for 10 seconds minimum, to meet UL Class RK1 maximum let-through limits.

.2 Type R2, time delay, capable of carrying 500 per cent of its rated current for 10 seconds minimum.

.3 Type R3, (UL Class RK1), fast acting Class R, to meet UL Class RK1 maximum let-through limits.

2.4 FUSE REQUIREMENTS

.1 Dimensions and Performance: CSA C22.2 No. 248 Series, Class as specified or indicated.

.2 Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.

.3 Power Load Feeder Switches: HRC-1 Class J time delay type.

.4 Other Feeder Switches: HRC-1 Class J time delay type.

2.5 SPARE FUSE CABINET

.1 Description: Wall-mounted sheet metal cabinet, suitably sized to store spare fuses and fuse pullers specified.

.2 Doors: Hinged, with hasp for Owner's padlock.

.3 Finish: Prime finish for field painting.

.4 Dimensions: Minimum 914 mm by 914 mm by 305 mm (3 foot by 3 foot by 1 foot).

3 Execution

3.1 INSTALLATION

.1 Install fuses to manufacturer's instructions.

.2 Install fuse with label oriented such that manufacturer, type, and size are easily read.

.3 Install spare fuse cabinet in electrical room.

.4 Provide a complete set of fuses in each fusible device supplied under this Division and provide 3 spare fuses for each size used in spare fuse cabinet.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Materials for Molded-Case Circuit Breakers (MCCB).

.2 Accessories

1.2 RELATED REQUIREMENTS

.1 Section 26 24 16 – Panelboards.

1.3 REFERENCES

.1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.

.2 Ontario Electrical Safety Code (28th edition/2021).

.3 CSA C22.2 No. 5-16, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures.

.4 NEMA AB1 - Molded Case Circuit Breakers, Molded Case Switches, and Circuit - Breaker Enclosures.

.5 NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).

1.4 SUBMITTALS

.1 Submit product data in accordance with Section 01 30 00.

.2 Include time-current characteristic curves for breakers with ampacity of 400 A and above, or with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage.

.3 Include termination temperature rating in degrees C.

.4 Certificate of Origin

.1 Prior to any installation of circuit breakers in either a new or existing installation, Contractor must submit three (3) copies of a certificate of origin from the manufacturer, duly signed by the factory and the local manufacturer's representative, certifying that all circuit breakers come from this manufacturer, they are new and they meet standards and regulations. These certificates must be submitted to the Consultant for review.

.2 A delay in the production of the certificate of origin won't justify any extension of the contract and additional compensation.

.3 Any work of manufacturing, assembly or installation should begin only after acceptance of the certificate of origin by the Consultant. Unless complying with this requirement, Consultant reserves the right to mandate the manufacturer listed on circuit breakers to authenticate all new circuit breakers under the contract, and that, to Contractor's expense.

.4 In general, the certificate of origin must contain:

.1 The name and address of the manufacturer, and the person responsible for authentication. The responsible person must sign and date the certificate;

.2 The name and address of the licensed dealer, and the person of the distributor responsible for the Contractor's account.

.3 The name and address of the Contractor, and the person responsible for the project.

.4 The name and address of the local manufacturer's representative. The local representative must sign and date the certificate.

.5 The name and address of the building where circuit breakers will be installed:

.1 Project title.

.2 End user's reference number.

.3 The list of circuit breakers.

2 Products

2.1 GENERAL

.1 Molded-case circuit breakers, Circuit breakers, and Ground-fault circuit-interrupters, Fused circuit breakers, and Accessory high-fault protectors: to CSA C22.2 No. 5.

.2 Bolt-on Molded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.

.3 Plug-in Molded case circuit breakers: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.

.4 Common-trip breakers: with single handle for multi-pole applications.

.5 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.

.1 Trip settings on breakers with adjustable trips to range from 3-8 times current rating.

.6 Circuit breakers with interchangeable trips.

2.2 INTERRUPTING CAPACITY

.1 Protective devices shall be fully rated, for required available fault current. Series rated shall not be used on this installation.

.2 Refer to Section 26 24 16.

2.3 MOLDED CASE CIRCUIT BREAKERS – GENERAL

.1 Molded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

.2 NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole.

.3 Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.

.4 1-, 2-, or 3-pole bold on, single-handle common trip voltage as indicated on drawings.

.5 Overcentre toggle-type mechanism, quick-make, quick-break action. Trip indication is by handle position.

.6 Calibrate for operation in 40 degree C ambient temperature.

2.4 MOLDED CASE CIRCUIT BREAKERS – UP TO 150 AMPERE

.1 Permanent trip unit containing individual thermal and magnetic trip elements in each pole, unless noted otherwise on drawings.

2.5 MOLDED CASE CIRCUIT BREAKERS – 151 TO 224 AMPERE

.1 Variable magnetic trip elements. Provide push-to-trip button on cover of breaker for mechanical tripping.

2.6 MOLDED CASE CIRCUIT BREAKERS – 225 AMPERE AND ABOVE

.1 Electronic trip type with adjustments for long-time, instantaneous, and short-time functions.

.2 Provide ground fault function for breakers greater than 400 Amps.

.3 1000 Amp and Above:

.1 Modbus Communications

.1 Breaker status.

.1 Open.

.2 Closed.

.3 Tripped.

.2 Cause of trip.

.3 Time of trip.

.4 Current at time of trip.

.5 RMS currents per phase and ground.

.6 Peak demand.

.7 Present demand.

.8 Energy consumption.

.4 1200 Amp and Above:

.1 Provide handle mechanisms that are lockable in the open (off) position.

2.7 ADDITIONAL FEATURES

.1 Provide as indicated on drawings:

.1 Shunt trip.

.2 Auxiliary switch.

.3 Motor-operated mechanism.

.4 Under-voltage release.

.5 On-off locking device.

.6 Handle mechanism.

2.8 ENCLOSED BREAKERS

.1 Molded case, front operated, automatic circuit breakers sized as specified on drawings each secured in a NEMA 1, flush wall mounting enclosure with steel front panel.

.2 Voltage rating suitable for circuit phase to phase voltage as indicated on drawings.

.3 Units to include solid state adjustable trip units and contactors. Contactors to be of rating and type to suit application.

2.9 CIRCUIT BREAKERS FOR EXISTING DISTRIBUTION EQUIPMENT

.1 Products to be of types from existing equipment manufacturers.

.2 Additional breakers for existing panelboards are to match existing device standards and be completely compatible to equipment in which they are installed.

.3 During Bidding period, check and verify exact requirements of existing equipment to ensure that additional devices are accommodated.

.4 Make necessary modifications to equipment to accommodate device and feeder installation.

.5 Provide suitable engraved lamacoid identification nameplate on additional components.

.6 Revise typed circuit directory cards on branch circuit panelboards.

.7 Mount additional devices to standards of existing equipment manufacturer.

.8 Refer to notes on drawings.

.9 Provide additional retrofit work to existing equipment as noted on drawings.

3 Execution

3.1 INSTALLATION

.1 Install circuit breakers as per related sections.

End of Section

1 General

1.1 SECTION INCLUDES

.1 Fusible and non-fusible enclosed low-voltage disconnect switches from 30 to 800 amps.

1.2 RELATED REQUIREMENTS

.1 Section 26 28 13 – Fuses.

1.3 REFERENCES

.1 CSA Group:

.1 CSA C22.1:21, Canadian Electrical Code, Part 1 (25th Edition), Safety Standard for Electrical Installations.

.2 Ontario Electrical Safety Code (28th Edition/2021).

.3 CAN/CSA-C22.2 No. 4-16 – Enclosed and Dead-Front Switches.

.4 CSA C22.2 No. 248 series – Low-voltage fuses.

.2 NETA (International Electrical Testing Association) ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.4 SUBMITTALS

.1 Product Data: Provide switch ratings, and enclosure dimensions.

1.5 CLOSEOUT SUBMITTALS

.1 Record actual locations of enclosed switches in project record documents.

2 Products

2.1 MANUFACTURERS

.1 Eaton Cutler-Hammer.

.2 Siemens.

.3 Square D by Schneider Electric.

2.2 REGULATORY REQUIREMENTS

.1 Products: Listed and classified by CSA or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

2.3 DISCONNECT SWITCHES

.1 Provide dedicated disconnect switches at electrical equipment.

.2 Fused or un-fused disconnect or safety switches: Type "A", quick-make, quick-break construction with provision for padlocking switches in either "ON" or "OFF" position.

.1 Quick-make, quick-break.

.2 Heavy duty industrial type.

.3 Lockable with up to 3 padlocks.

.4 Cover interlocked with switch mechanism.

.5 Viewing window for viewing blades.

.3 Fused switches equipped with fuse clips designed for Class "J" fuses and designed to reject standard NEC fuses.

.4 Enclosure: CSA Type 1 sprinkler-proof, or as noted.

.5 Switches throughout project of same manufacturer.

3 Execution

3.1 INSTALLATION

.1 Provide fused or un-fused safety or disconnect switches as shown and as required by Code.

.2 Install disconnect switches complete with fuses, if applicable, to CSA C22.1.

.3 Apply neatly typed adhesive tag on inside door of each fusible switch indicating NEMA fuse class and size installed.

.4 Coordinate fuse ampere rating with installed equipment. Fuse ampere rating variance between original design information and installed equipment, size in accordance with Bussmann Fusetron 40 degree C recommendations. Do not provide fuses of lower ampere rating than motor starter thermal units.

End of Section