14.0 SPECIFICATIONS

INDEX TO SPECIFICATIONS

PART 1 - GENERAL

1.1 Instructions to Bidders

.1 Supplementary Bid Form forming part of the tender front end documents must be submitted to CIMA+ (juli.cluett@cima.ca) and the Durham District School Board (roberto.brill@ddsb.ca) within four (4) hours after tender closing. Contractors shall identify all sub-contractors they intend to use and must complete all information requested. Contractor shall sign and date the last page and initial and date all other pages.

.2 The Stipulated Bid Sum shall be for the base bid manufacturer or supplier equipment only, unless otherwise indicated. Where a choice of this equipment is given, this Contractor shall indicate the supplier or manufacturer they intend to use. Where no choice is indicated, the base bid supplier or equipment shall be used.

.3 Equipment or materials manufactured by firms named in the following listing only shall be deemed equal to the equipment or material specified provided the equipment or material will have capacity, performance, rating, construction, physical dimensions, accessories and features which, in the opinion of the Consultant, are equal to those of the specified equipment or material. The Contractor shall not indicate equipment, materials or suppliers which are not listed.

.4 Where modification to the work of other trades are not required as a result or part of the alternative offered, include the cost of said modifications in the work.

END OF SECTION

INDEX TO SPECIFICATIONS

PART I – GENERAL

1.1 General Requirements

.1 The requirements of this section shall apply to all sections in Division 1.

.2 All material, labour, equipment, and services required under this section shall be the full responsibility of the Contractor including any material, labour, equipment, and services provided by their subcontractors.

1.2 Definitions

.1 “Supply” shall mean supply only.

.2 “Install” shall mean install and connect.

.3 “Provide” shall mean supply, install, and connect.

.4 “Drawings and Specifications” shall mean Contract Documents.

.5 “Authorities” or “Authorities having jurisdiction” shall mean all agencies that enforce the applicable laws, ordinances, rules, regulations, or codes of the Place of Work.

.6 “Work” shall mean all equipment, materials, labour, and permits to provide a complete and operational mechanical system as detailed in the drawings and specifications.

.7 “Owner” or “DDSB” shall mean Durham District School Board.

1.3 Related Work

.1 Division 15 – Mechanical

.2 Division 16 – Electrical

1.4 Intent

.1 The drawings and specifications are not a detailed set of installation instructions. Drawings and specifications are complementary to one another and that which is shown on one is as binding as that which is shown on both.

.2 The Consultant shall be immediately informed of any discrepancies between drawings and specifications leaving in doubt the true intent of the work.

.3 Supply all labour, equipment, and materials necessary to install a complete and operational mechanical system described herein and shown on the drawings.

.4 It is the intent of these drawings and specifications to provide for an installation complete and in operating condition. The responsibility for supplying and installing all material necessary to accomplish this, except where specifically noted that such work or materials is not included, shall be part of this section.

.5 Assess and be familiar with existing site conditions prior to pricing and construction and allow for same in tender price.

.6 All work must be done by qualified, certified and experienced persons in such line of work.

.7 All work shall be in accordance with standard industry practice accepted and recognized by the Consultant and the Trade.

.8 This Contractor shall coordinate with and cooperate with all other trades prior to installation. Where work interferes with other trades due to failure to coordinate or cooperate, the work shall be removed and relocated as approved by the Consultant at no extra cost to the Owner.

.9 The Consultant shall have the right to reject any work that does not conform to the Contract Documents and accepted standards of practice including but not limited to performance, quietness of operation and finish.

1.5 Codes, Bylaws, Standards, and Regulations

.1 The work shall comply with the latest editions and revisions of applicable codes, bylaws, standards, and regulations including but not limited to:

.1 Ontario Building Code
.2 Canadian Standards Association
.3 Local Building Bylaws
.4 Ontario Occupational Health and Safety Act

.2 Provide work in accordance with the requirements of all applicable government codes, local by-laws, underwriter's regulations base building standards, contract documents, and all authorities having jurisdiction.

.3 Where discrepancies occur between contract drawings and specifications and above codes and standards referred to herein, the Contractor is to notify the Consultant in writing and obtain clarification prior to proceeding with the work.

.4 Contractors shall not reduce the requirements on the contract drawings and specifications by applying any codes and standards referred to herein.

1.6 Permits and Fees

.1 Where applicable, the Consultants will apply for the Building Permit on behalf of DDSB. The Contractor shall arrange for all building inspections.

.2 The Contractor shall apply for, obtain, and pay for all other required permits, fees, connections, inspections, licenses, certificates or charges necessary including all taxes.

.3 Coordinate all required inspections and give necessary notice to all authorities.

.4 Upon completion of project, provide inspection certificates confirming acceptance by all authorities having jurisdiction for all applicable disciplines.

1.7 Shop Drawings

.1 Within two (2) weeks of award, the Contractor shall submit shop drawings of all equipment for the project.

.2 Prior to ordering of products or delivery of any products to job site, submit shop drawings electronically in PDF format to the Consultant for review and comments. Submit sufficiently in advance of construction to allow ample time for review. Size of shop drawings shall be 8.5x11. 11x17 will be acceptable where appropriate for content and scale.

.3 Submittals shall contain but not be limited to construction information, product data and dimensional layout.

.4 Clearly mark each sheet of printed submittal material, using arrow, underlining or circling, to show particular sizes, dimensions, model numbers, ratings and options actually being proposed. Cross out non-applicable material.

.5 **Prior to submission to the Consultant, the Contractor shall review all shop drawings. By this review the Contractor represents that they have determined and verified all field measurements, field construction criteria, materials, catalogue numbers and similar data or will do so and that he has checked and coordinated each shop drawing with the requirements of the Work and of the Contract Documents.**

.6 **The Contractor's review of each shop drawing shall be indicated by their approval stamp, date and signature on the front of each page. Drawings will not be considered if not previously checked by the Contractor.**

.7 Review comments from the Consultant. If shop drawings are modified, confirm changes before proceeding. If shop drawings are not approved, revise and resubmit changes for approval within one (1) week.

.8 Review of the shop drawings by the Consultant does not relieve the Contractor or his Supplier of the responsibility to provide the correct and complete equipment, material or installation.

.9 Keep one complete set of shop drawings at the job site during construction.

1.8 Warranty

.1 Provide a one (1) year full parts and labour warranty for the new system from date of substantial completion.

.2 Submit warranty letter on Company letterhead signed by Company representative stating warranty terms including warranty period from date of substantial completion.

PART 2 - PRODUCTS

2.1 Materials

.1 All material used shall be new, free from defects, of quality specified, and installed in accordance with manufacturer's instructions.

.2 The same manufacturer shall be used for types of equipment used in similar applications.

.3 It is the responsibility of the Contractor to store and protect materials supplied by this scope.

.4 Materials shall be stored in original containers.

.5 Remove all redundant materials from site and dispose of in an environmentally friendly manner.

2.2 Selected Products and Equivalents

.1 Selected products are specified and/or shown on the drawings, and identified by manufacturer's name, type and catalogue number.

.2 Equivalent products may be considered if sufficient information is submitted at least ten (10) working days prior to tender close to the Consultant to enable the Consultant to determine acceptability of such products.

.3 Where a manufacturer of materials, equipment or products is not specified, they shall meet the requirements and be of quality as specified herein.

2.3 Quality of Product

.1 All products provided shall be listed where applicable.

.2 All products provided shall be new including those not specified and shall be of a quality best suited to the purpose required and their use subject to approval by the Consultant.

2.4 Product Finishes

.1 Shop drawings shall indicate finishes. Use standard finish unless otherwise specified.

.2 Apply primer on all items which are to be finished on the job.

.3 Repair dents and touch up all damaged finishes with matching lacquer, or, if required by the Consultant, completely repaint or replace damaged surface at no extra cost to the Contract.

PART 3 - EXECUTION

3.1 Site Examination

.1 Examine the site of work and become familiar with all features and characteristics affecting this work before submitting tender.

.2 No additional compensation will be given for extra work due to existing conditions which such examination should have disclosed.

.3 Report to the Consultant any unsatisfactory conditions which may adversely affect the proper completion of this work.

3.2 Coordination with Other Divisions

.1 Examine the drawings and all divisions of the specifications. Before commencing any work, obtain a ruling from the Consultant if any conflict exists, otherwise no additional compensation will be made for any necessary adjustments.

.2 Lay out the work and equipment with due regard to architectural, structural and electrical features.

.3 Examine previously constructed work and notify the Consultant of any conditions which prejudice the proper completion of this work. Commencement of this work without such notification shall constitute acceptance of other work.

3.3 Workplace Safety

.1 The workplace must be kept safe at all times.

.2 Conform to all ministries of labour, and health and safety regulations at all times.

.3 Use ladders and proper techniques as approved by the ministry of labour to perform all work.

.4 Cover all holes/openings and provide barriers around hazards, etc. to ensure occupants and workers are not at risk.

.5 Where work does not conform to such regulations, stop work immediately and report the situation to the Owner's representative or Consultant or rectify the situation immediately.

.6 Report any hazards or concerns to the Owner's representative immediately.

.7 Conform to Owner's safety requirements and construction regulations.

3.4 Welding, Grinding, Noisy Work, Odours

.1 No welding, grinding, other noisy work or work generating odours shall be done during regular operating/school hours.

.2 All above work shall be done after hours or on weekends outside of regular hours.

.3 Submit hot work permit prior to any welding. Coordinate any specific requirements in conformance with Client standards.

3.5 Cutting, Coring and Patching

.1 All cutting, coring and patching as it relates to work under this division is the responsibility of this Contractor in a manner acceptable by the Consultant and Owner. Coordinate any cutting or coring with the Owner prior to construction.

.2 Structural members shall not be cut.

.3 Use fire rated materials at all fire separations.

.4 Patching shall match existing surroundings and shall be approved by the Consultant and Owner. Patching shall leave a completely smooth finish.

3.6 Finishing and Painting

.1 All final finishing and painting as it relates to the contract work is the responsibility of this Contractor in a manner acceptable by the Consultant and the Owner.

.2 Protect and clean all surroundings from sanding residue.

.3 Painting shall include two (2) coats of colour approved by the Consultant or the Owner.

.4 Match existing finishes unless otherwise noted.

3.7 Mobilization, Demolition and Security

.1 Supply and erect all signs, barricades and such other protection as may be required to protect the public during construction.

.2 Provide security protection for Contractor's office, plant and stored materials.

.3 Move onto site and set up storage facilities and temporary hoarding as required.

.4 Move off site and remove storage facilities and all temporary facilities and leave the site clean and tidy.

3.8 Damage to Existing Services and Structures

.1 Obtain the necessary drawings and perform any necessary sub-surface, wall and floor investigations in order to determine the exact number and location of all existing services, structures, underground pipes, cables, and other similar items.

.2 The location for existing structures and services shown on the Contract Drawings do not relieve the Contractor of this responsibility.

.3 Take the necessary steps to ensure that no damage is caused to existing structures, buildings, foundations, roads, sidewalks, property, utility services, and other similar items during the progress of the Work.

.4 If any damage is caused, repair and make good such damage at no additional cost within a reasonable time and to the complete satisfaction of the Consultant and Owner.

3.9 Occupying the Site

.1 Use only those areas designated by the Owner for the access, except in so far as is necessary for the execution of the Works, and in so doing, do not unnecessarily obstruct the normal traffic of, to, from or about the Site; and do not unreasonably allow any vehicles or materials to stand in front of, or near to, any buildings on the Site or any access thereto, or any access into any private properties.

.2 Confine operations within areas designated for construction, storage and access as shown on the Contract Drawings and/or as directed by the Consultant/Owner.

.3 Limit access to and from the site as instructed by the Consultant.

.4 Maintain safe access to any existing facilities for the operations staff at all times.

3.10 Contractor Use of Premise

.1 Arrange with the Owner and Consultant for storage areas and access to the Works.

.2 Make arrangements with property owners if additional areas are required. Obtain written agreements and submit copies to the Consultant.

.3 Confine operations within working limits for construction, storage and access.

.4 Carry out the construction of the Works in such a manner that a minimum of inconvenience is caused to the Owners and occupants of properties adjacent to the Works.

.5 Store materials separately on the Site at locations agreed upon with the Consultant, suitably protected to prevent their deterioration or the intrusion of foreign matter. In the opinion of the Consultant, remove any material which has deteriorated or been damaged immediately from the Site at no additional cost to the Owner.

.6 During construction, liaise with the Consultant and the Owner to schedule work to minimize impacts on building operations.

3.11 Equipment and System Protection

.1 Protect equipment and materials from damage in storage and on site before, during, and after installation until final acceptance.

.2 Protect equipment and system openings from dust and debris with appropriate covers that will withstand through the construction.

.3 Where equipment and system components become dirty or damaged, clean and repair to new condition to the satisfaction of the Consultant and Owner at no expense to the Owner.

3.12 Protective Coatings and Painting

.1 Prime and touch up finished paintwork or coatings that have been damaged.

.2 Where damage is beyond minor repair, restore finishes to new condition.

3.13 Owner Occupancy

.1 The Owner and its operators will occupy premises during entire construction period for execution of normal operations.

.2 Cooperate with the Owner in scheduling operations to minimize conflict and to facilitate the Owner usage.

.3 Maintain free access and parking for the Owner’s staff.

3.14 Field Review and Deficiencies

.1 The Contractor shall notify the Consultant when the job is ready for field review at various stages including rough-in stages.

.2 During the course of construction, the Consultants will monitor construction and provide written reports of work progress, discussions and deficiencies.

.3 The Contractor shall correct all deficiencies within the work period prior to the next review.

.4 The Contractor shall not conceal any work until inspected. Where work was concealed, the Contractor shall remove and replace tiles, coverings or other obstructions to allow proper inspection at the Contractor's expense.

.5 Upon completion of the project the Consultant will do a final review. Upon receiving the final inspection report, the Contractor must correct and sign back the inspection report indicated all deficiencies are completed. A re-inspection will only be done once the Consultant receives this in writing. Where the Consultant performs the re-inspection and the work is not complete, the Contractor is responsible for reimbursing the Consultant for the field review. The fee for additional reviews will be at the Consultant's hourly rates plus mileage and applicable taxes to be paid directly to the Consultant prior to performing the next field review.

END OF SECTION

PART I – GENERAL

1.1 Section Includes

.1 Coordination of work between the Contractor and the Owner under administration of the Consultant

.2 Pre-construction, construction progress and special meetings

.3 On-site documents

1.2 Start-up Meeting

.1 Within two (2) weeks after award of Contract, the Contractor shall arrange a pre-construction meeting to discuss and resolve administrative procedures and responsibilities.

.2 Representatives of the Owner, the Consultant and the Contractor shall be in attendance. The Contractor representatives shall include, at a minimum, the project representatives of the Mechanical (Prime) Contractor.

.3 The Agenda for the meeting is to include the following:

.1 Appointment of official representative for participants in Work.
.2 Typical day and time for weekly meetings.
.3 Schedule and sequence of work.
.4 Schedule of submission of shop drawings.
.5 Requirements for storage areas.
.6 Delivery schedule of specified equipment.
.7 Site security.
.8 Proposed changes, change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, and administrative requirements.
.9 Owner supplied Products.
.10 Record drawings.
.11 Operation and maintenance information.
.12 Take-over procedures, acceptance, and warranties.
.13 Monthly progress claims, administrative procedures and holdbacks.

1.3 Construction Progress Meetings

.1 The Contractor will schedule and administer bi-weekly meetings throughout progress of the Works as required. Bi-weekly meetings will be scheduled for a typical day and time for each week and shall be determined at the pre-construction meeting to suit all parties.

.2 Attend all meetings and have project manager and representatives from major subcontractors attend. All sub-contractors shall attend all meetings unless otherwise pre-approved by the Consultant. The Contractor shall provide written

request at least 72 hours before each meeting to obtain approval for absence of any sub-contractor.

.3 Provide any schedule updates.

.4 The Agenda for the meeting is to include the following:

.1 Review and approval of minutes from previous meeting.
.2 Review of Work progress since previous meeting.
.3 Field observations, problems, conflicts.
.4 Problems that impede construction schedule.
.5 Review of delivery schedules.
.6 Corrective measures and procedures to regain projected schedule.
.7 Revision to construction schedule.
.8 Progress schedule, during succeeding work period.
.9 Review of submittal schedules.
.10 Review proposed changes for affect on construction schedule and on completion date.
.11 Review of marked up record drawings and other business.

.5 The Contractor shall record minutes and include significant proceedings and decisions, as well as identifying “action by” and “due date”.

.6 The Contractor shall distribute electronic file of minutes via email within four (4) working days after each meeting and transmit to meeting participants, affected parties not in attendance, and the Owner.

.7 Site meeting frequency shall be twice weekly if performance and schedule are not to the satisfaction of the Consultant or the Owner, at no additional cost to the Contract.

1.4 On-Site Documents

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

.1 Contract or Issued for Construction Drawings
.2 Specifications
.3 Addenda
.4 Reviewed shop drawings
.5 Contract Change Orders
.6 Other modifications to Contract
.7 Marked up As-Built Drawings
.8 Field test reports
.9 Copy of approved Work schedule
.10 Manufacturers’ installation and application instructions

1.5 Construction Coordination

.1 Comply with Owner’s allocation of mobilization areas, storage, access and parking facilities.

.2 During construction coordinate use of site and facilities with the Consultant and Owner.

.3 Comply with instructions of the Consultant and Owner for use of site facilities.

1.6 Schedules Management

.1 Submit to the Consultant within two (2) weeks of award of the Contract, the preliminary construction progress schedule, based on the tender and all required schedules, in accordance with Section 01320.

.2 After review by the Consultant, revise and resubmit all schedules to comply with revised project schedule.

.3 Identify and track all critical items on all schedules and advise the Consultant of any changes to the schedules.

.4 Actively manage and coordinate the work to avoid delays against reviewed schedules.

.5 Revise schedules, reorganize and replace construction to minimize the impact of any identified delays.

1.7 Coordination of Construction

.1 This is a lump sum contract to be completed in its entirety by the Contractor using the Contractor's own forces and the forces of individual subcontractors and subtrades.

.2 All of the specifications and drawings are interpreted as one contract. Be wholly responsible for coordination of all work by own forces, subtrades or subcontractors to complete the work.

.3 No Section or Division of these specifications shall be construed or interpreted as being the responsibility of any subtrade, subcontractor or supplier.

.4 Examine the work of all trades and ensure that conditions are satisfactory for the completion of any subsequent work.

.5 Notify the Consultant immediately of any adverse conditions which may affect subsequent work and do not proceed with any subsequent work until such conditions are rectified.

1.8 Submittals

.1 Make all necessary submittals to the Consultant for review and approval.

.2 Submit all requests for payment to the Consultant.

.3 Submit requests for interpretation of Contract Documents and obtain instructions from the Consultant.

.4 Submit requests for Contract Change Orders to the Consultant.

.5 Deliver all closeout submittals to the Consultant.

.6 Allow five (5) days for Consultant to respond to Request for Interpretation.

1.9 Closeout Procedures

.1 Notify the Consultant in writing when the works are considered ready for Substantial Completion.

.2 Accompany the Consultant on a preliminary field review of the work to identify and confirm items for completion or correction.

.3 Allow five (5) working days from the date of notification to the first day of joint preliminary field review.

.4 Comply with the Consultant's written instructions for completion or correction of items prior to issuance of Certificate of Substantial Completion.

.5 Complete all outstanding items of work or deficiencies identified in the Certificate of Substantial Completion in a timely manner.

END OF SECTION

PART I – GENERAL

1.1 Description

.1 This section specifies requirements and procedures for preparing and updating construction schedules and reports for planning, coordinating, executing and monitoring the progress of the work.

1.2 Related Work

.1 All Divisions and Sections are related to this Section.

1.3 Schedules

.1 The Contractor shall perform and complete all of the work as set forth on the drawings and in the specifications by the completion date specified in the tender and contract documents.

.2 Prepare construction schedule and submit to Consultant for review and approval. Modify and implement schedules and sequences as modified and approved by the Consultant at no extra cost to the Contract.

.3 The construction schedule shall be provided at or before the pre-construction meeting as specified under Section 01310.

1.4 Welding, Grinding, Noisy Work, Odours

.1 No welding, grinding, other noisy work or work generating odours shall be done during regular operating/school hours.

.2 All above work shall be done during summer break or after hours or on weekends outside of regular school hours.

1.5 Progress of the Work

.1 The work shall be started on the date indicated in the written order for commencement of the works and shall be executed with such progress as may be required to prevent delay to the general completion of such parts of the project, and with such forces, material and equipment, as to assure completion of the work in the time established in the Form of Tender. Additionally, the Contractor shall, at all times, schedule and direct his work so that it provides an orderly progression of the work to completion within the specified time for completion.

.2 The Contractor agrees that whenever it becomes apparent from the current regular schedule update that delays to the approved schedule have resulted and these delays are through no fault of the Owner or Owner's representatives, and hence, that the Contract completion date will not be met, or when so directed by

the Owner, he will take whatever action is necessary to achieve the specified milestone and contract completion dates.

.3 With each schedule update, the Contractor shall submit for review a written statement of the steps he intends to take, to address, to remove or arrest any delay to the schedule. If the Contractor fails to submit a written statement of the steps he intends to take or fails to take such steps as required by the Contract, the Owner may direct the level of effort in manpower (trades), equipment and work schedule overtime to remove or arrest the delay to the critical path in the accepted schedule, and the Contractor shall promptly provide such level of effort at no additional cost to the Owner. In addition, should schedule delays persist, the Contractor's bonding agent may be asked to attend meetings to update the schedule.

.4 Failure of the Contractor to comply with the requirements of this provision shall subject him to, at the Owner's Sole discretion, a withholding, in partial or in total of payments otherwise due to the Contractor for work performed under this Contract. The Contractor agrees that any withholding of money is not a penalty for noncompliance, but is an assurance for the Owner that funds will be available to implement these requirements should the Contractor fail to do so, since failure of the Contractor to comply with these requirements shall mean that the Contractor failed to execute the work with such diligence as to ensure its completion within the time for completion.

PART 2 – CONSTRUCTION SCHEDULE

2.1 Requirements

.1 The schedule shall show the order and interdependence of activities and the sequence in which the work is to be accomplished as planned by the Contractor.

.2 The scheduled activities shall be developed into four major groups:

.1 Procurement Activities

Each of the following procurement items should be tied logically to the correct construction activity in the overall construction schedule:

.1 Permits and Approvals
.2 Submittal Items
.3 Approval of Submittal Items
.4 Fabrication and Delivery of Submittal Items

.2 Construction Activities

.1 Construction activities are the physical work activities that describe how the job will be constructed.

.3 Shutdowns and Tie-ins

.1 Work by Contractor

.4 Testing, Start-up, Training and Closeouts

.1 Activities for this group shall include all work required to satisfy the appropriate specification sections and meet the requirements of substantial performance and contract completion.

.3 Failure to include in the schedule any element of work required for the performance of this Contract shall not excuse the Contractor from completing all the work required within the applicable completion time, notwithstanding the Owner's network review.

.4 A schedule which shows the completion of any milestone or substantial performance prior to the contractual completion dates stipulated may be accepted by the Consultant but shall in no event form the basis of a claim for delay against the Owner by the Contractor.

.5 Schedule of Values

.1 Each activity on the construction schedule shall be allocated a dollar value. Each activity's assigned cost shall consist of labour, equipment, and materials costs. The sum of all activity costs shall be equal to the total contract price. In submitting cost data the Contractor certifies that they are not unbalanced and that the values assigned to each activity represents the Contractor's estimate of the actual costs of performing that activity. The listing of cost loaded activities will become the schedule of values and will serve as a basis for progress payments to the contractor.

.2 The accepted schedule of values shall represent a fair, reasonable and equitable dollar cost allocation for each activity on the Contractor's construction schedule. These values shall be represented in all progress draws.

.3 If it is determined that the cost data do not meet the requirements for a balanced bid breakdown, the Contractor will present documentation substantiating any cost allocation on the cost data. Cost allocations shall be considered unbalanced if an activity on the construction schedule has been assigned a disproportionate allocation of cost.

2.2 Schedule Updates

.1 The Schedule may be reviewed at each construction meeting. The Contractor shall update their schedule as requested by the Owner or Consultant.

PART 3 – CONTRACT COMPLETION TIME

3.1 Causes for Extension of Time

.1 In the event the Contractor requests an extension of any contract completion date, he shall furnish justification and supporting evidence. The Consultant will, after receipt of such justification and supporting evidence, make findings of fact and will advise the Contractor in writing thereof. If the Consultant finds that the Contractor is entitled to an extension of the Contract completion date under the provisions of the contract, the Consultant's determination as to the total number of day's extension shall be based upon the current accepted and updated schedule and on all data relevant to the extension. Such data shall be included in the next updating of the schedule. The Contractor acknowledges and agrees that actual delays in activities which, according to the schedule, do not affect any contract completion date shown by the critical path in the network do not have any effect on the contract completion date or dates and therefore will not be the basis for a change in Contract completion time.

END OF SECTION

PART 1 - GENERAL

1.1 Construction Safety Measures

.1 Contractor shall implement all required health and safety requirements of the Health and Safety Acts.

.2 Meet the requirements of the following:

1. Occupational Health and Safety Act, Regulations for construction projects, O. Reg. 213/91 (as am. By O. Reg. 631/94), Part II General Construction
2. Occupational Health and Safety Act, Industrial Establishments Regulation, R.R.O. 1990, Reg. 851 (as amended by O. Reg. 516/92; 630/94; 230/95; and 450/97), Part I Safety Regulations.
3. Revised Statutes of Ontario 1980, Chapter 321, Revised Regulation of Ontario1980, Regulation 691 as amended by O. Reg. 156/84 and O. Reg. 645/86, and Ontario Regulation 714/82
4. Canada Labour Code, Canada Occupational Safety and Health Regulations, SOR/86-304 (as amended by SOR/87-623; 88-44; 88-68; 88-632; 89-479; 89-515; 90-180; 91-448; 92-544; 94-33; 94-263; 95-286; 95-533; 96-294; 96-400; and 96-525), Part XI – Confined Spaces
5. Workers Safety & Insurance Board (WSIB) and municipal statutes and authorities.

.3 In event of conflict between any provisions of above authorities, the most stringent provision governs.

.4 Where applicable, the Contractor shall be designated “Constructor” as defined by Ontario Act.

1.2 Overloading

.1 Ensure no part of work is subjected to a load which will endanger its safety or will cause permanent deformation.

1.3 Special Protection and Precautions

.1 Comply with the requirements of the Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage and disposal of hazardous materials and regarding labelling and the provision of safety data sheets (SDS) acceptable to Labour Canada.

.2 Comply with the requirements of the current CAN/CGA B-105-M-93 when working in and around hazardous locations/confined spaces.

.3 Conform to Ministry of Labour requirements for work in hazardous locations. Establish and implement written procedures to assure compliance.

.4 Smoking is not permitted anywhere on the site or on the property.

END OF SECTION

PART 1 – GENERAL

1.1 Section Includes:

.1 Construction aids

.2 Parking

1.2 Installation and Removal

.1 Provide construction facilities in order to execute work expeditiously.

.2 Remove all such work from site after use.

.3 Make all necessary applications, obtain permits and pay for all fees.

1.3 Scaffolding and Supports

.1 Provide and maintain scaffolding, ladders and platforms required to complete the work.

1.4 Fire Protection

.1 Provide and maintain temporary fire protection equipment during performance of the Works required by governing codes, regulations and bylaws.

.2 Burning rubbish and construction waste materials is not permitted on site.

.3 Confine work and operations of employees as required by Contract Documents. Do not unreasonably encumber premises with products.

.4 Do not load or permit the loading of any part of the Works with a weight or force that will endanger the Works.

1.5 Construction Parking

.1 Parking will be permitted in areas as approved by the Owner, provided it does not disrupt maintenance vehicles or the performance of operations staff.

.2 Provide and maintain adequate access to project site.

.3 Any damages resulting from Contractors negligence will be the responsibility of the Contractor.

1.6 Equipment, Tools and Materials Storage

.1 Provide and maintain, in a clean and orderly condition, lockable sheds/boxes for storage of tools, equipment and materials.

.2 Locate materials on site in a manner to cause least interference with work activities and normal operation of the existing facility.

1.7 Sanitary Facilities

.1 Utilize facilities on site where approved by the Owner.

.2 Leave site in a clean sanitary condition.

END OF SECTION

PART 1 – GENERAL

1.1 Description

.1 This section specifies requirements for environmental controls including control of noise, dust, surface water and erosion, various pollution control methods and handling of Designated Substances as well as compliance with the Occupational Health and Safety Act and Site Safety.

1.2 General

.1 Establish and maintain site procedures such that noise levels from construction areas are minimized.

.2 Control noise level in accordance with local by-laws and Ministry of the Environment (MOE) Standards.

.3 Prevent dust nuisance resulting from construction operations at all locations on the site and roads used by Contractor's activities.

.4 Protect existing services, land, water courses.

1.3 Measures

.1 Noise Controls:

.1 Use vehicles and equipment with efficient muffling devices.
.2 Provide and use devices that will minimize noise levels in construction areas.

.2 Dust Controls:

.1 Use water, brine or calcium chloride to control dust.
.2 Minimize use of calcium chloride and brine, particularly in close proximity to water courses, aquifers or agricultural lands.
.3 Transport dusty materials in covered haulage vehicles.

.3 Mud Control:

.1 Keep sites and public roadways clean and free from mud at all times.

1.4 Refuelling Areas

.1 Review all proposed construction areas to plan access routes and fuelling areas.

.2 Do not refuel or maintain equipment adjacent to or in watercourse or over water supply aquifers unless non-spill facilities are used.

.3 Do not fuel equipment within 30 metres of any watercourse unless otherwise non-spill facilities are used.

1.5 Cleaning Equipment

.1 Do not clean equipment in streams, lakes, ditches, swales, etc.

.2 Clean construction equipment prior to entering roadways.

.3 Do not clean equipment in locations where debris can gain access to sewers, watercourses or aquifers.

1.6 Spills

.1 Submit procedures for interception, rapid clean-up and disposal of any spillage that may occur, for the Engineer's review, prior to commencing work.

.2 Be prepared at all times to intercept, clean-up and dispose of any spillage that may occur whether on land or water.

.3 Keep all materials required for clean up of spillages readily accessible on site.

.4 Report immediately any spills causing damage to the environment to the MOE Spills Centre.

1.7 Sensitive Areas

.1 Avoid encroachment on unique natural areas and establish boundary protection and signage to avoid such encroachment.

1.8 Management and Disposal of Excess Materials

.1 The requirements of OPSS 180 shall apply except for the following revision/ amendments:

.1 Subsection 180.07.02, Conditions on management by Reuse, shall be amended by the addition of the following:

.1 "Recycled hot mix asphalt or excess bituminous pavement shall not be used as trench backfill or bedding."

.2 Subsection 180.07.04, Conditions on Management by Open Burning, shall be deleted. No open burning will be permitted.

1.9 Removal and Disposal of Hazardous Materials

.1 Hazardous materials shall be removed from the site and handled in accordance with MOE Regulations current at the time of construction.

.2 Comply with the governing Ministry of Labour Regulations respecting protection of works, remedial handling and disposition of the Designated Substances encountered.

.3 Prior to commencement of work on or about any Designated Substance, provide written notification to the MOE of the location(s) proposed for disposal of Designated Substances. Provide a copy of said notification to the Engineer a minimum of 10 working days in advance of starting work on or about any Designated Substance.

.4 In the event that the MOE has concerns with any proposed disposal location, further notification shall be provided until the MOE's concerns have been addressed.

.5 Do not empty fuel, lubricants, paint materials, solvents or other chemicals into sewers or watercourses.

1.10 Compliance with the Occupational Health and Safety Act

.1 It is specifically drawn to the attention of the Contractor that the Occupational Health and Safety Act provides, in addition to other items that:

.1 A Constructor shall ensure, on a project undertaken by the Contractor that:

.1 The measures and procedures prescribed by this Act and regulations are carried out on the project;
.2 Every employer and every worker performing work on the project complies with this Act and the regulations, and;
.3 The health and safety of workers on the project is protected;

.2 This Contract is deemed to be an individual project for the purposes of the Occupational Health and Safety Act and the regulations made thereunder and the Contractor to whom the Contract is awarded unequivocally acknowledges that he is the Constructor as defined in the said Act on this project and shall carry out all of the obligations and shall bear all of the responsibilities of the Constructor as set out in the said Act and Regulations;

.3 If the Owner is designated as the "Constructor" as a result of the Contractor's actions, all the increases in costs shall be borne by the Contractor;

.4 All Occupational Health and Safety Act Regulations for construction projects are to be strictly adhered to.

END OF SECTION

PART 1 - GENERAL

1.1 Work Included

.1 Provide all labour, materials and equipment for all required cutting and patching at penetration of existing roofing system as required to install new roof penetrations.

.2 This contractor shall coordinate with other trades. They shall obtain positive assurance that all pipes, vents and equipment, which pass through the roof have been completely installed. They shall protect walls, etc. from damage due to their work with particular attention to brickwork.

.3 Flashing around the perimeter of the new roof penetrations.

.4 Tapered insulation to establish positive crickets and crossfalls to suit field conditions.

1.2 Inspection

.1 Inspect all surfaces on which roofing work is to be placed and report to the Contractor immediately any defects which would prevent satisfactory execution or permanency of the work. Do not proceed until all such unsatisfactory work has been corrected.

.2 Failure to examine or report, will be taken as an acceptance that preparatory work is satisfactory.

1.3 Guarantee

.1 Any roofing work shall maintain the existing warranty. The warranty shall be for Labour, Material and Workmanship.

1.4 Qualifications

.1 Roofing shall be done by mechanics skilled in this trade in strict accordance with the manufacturer’s printed instructions with a minimum 5 years documented experience.

.2 All work shall be carried out in complete accordance with acknowledged good roofing practice.

1.5 Delivery, Storage and Handling

.1 Materials shall be delivered to the job site in such a way as to avoid damage. They shall be stored on site in protected locations and isolated from damage or deterioration by impact or weather conditions.

.2 Lap seal and adhesives shall be stored at temperatures between 16 degrees C. (60 degrees F) and 27 degrees C (80 degrees F) to facilitate handling and ensure shelf life. Where material has been exposed to lower temperatures it shall be placed in a warm room and brought up to application temperature.

.3 Insulation shall be delivered in protective packages and stored under dry conditions at all times. If insulation is stored outdoors, it shall be stacked on pallets at least 10 cm above the ground and shall be covered with tarpaulin or similar opaque waterproof covering.

.4 Stir adhesives thoroughly before use and cover the container immediately after use to avoid evaporation of the solvent.

.5 Adhesives and sealants may contain petroleum distillates and may be flammable. Do not inhale fumes or use near open flame.

.6 Do not use sharp or heavy objects to contact with sheet during or after installation other than those required for filling.

1.6 Project Conditions

.1 No installation work shall be performed during rainy inclement weather and on frost or wet covered surfaces.

.2 Cold temperature does no necessarily restrict the application of the roofing although very low temperature and winter conditions may call for special techniques. Consult the manufacturer's representatives for their recommendations.

1.7 Sequencing Scheduling

.1 Work shall be so scheduled as to provide a watertight seal at the end of each working day on the area worked upon during the day.

.2 Apply roofing as soon as possible after completion of the roof deck to minimize exposure to the elements and to meet the construction schedule.

1.8 Acceptable Roofing Contractor

.1 Only qualified roofing contractors shall be used. Refer to acceptable products specified under Part 2.

.2 Acceptable Contractors:

.1 Bothwell Accurate

PART 2 - PRODUCT

2.1 All new roofing materials shall be compatible with and match existing roof.

2.2 Acceptable Roofing Products

.1 BUR Tremco Cold Applied

PART 3 - EXECUTION

3.1 Preparatory Work

.1 The surface to which the roofing system is to be installed must be smooth, clean, dry and free from protrusions and sharp edges. Debris, oil and grease must be removed. The applicator is responsible for ensuring that these conditions are met.

.2 Gypsum board installed over steel deck shall be supported on all flutes at end of board and be free of gaps and voids.

3.2 Vent Stack Flashing

.1 Thaler stack jack flashings complete with T.8 Bitumen Protection Cup 460mm (18”) height.

3.3 Adjustments and Clean-up

.1 Installations of details noted as deficient during Final Inspection shall be repaired and corrected by the applicator at his expense, made ready for re-inspection.

.2 Remove all surplus materials, cuttings, etc. off site and leave all of the work clean and complete in all respects.

3.4 Inspections and Approval

.1 Formal final inspection of the completed work shall be made jointly by the manufacturer’s representative, the Roofing Contractor, the Roofing Inspector selected by the Owner and the Consultant.

.2 Warranties shall take effect upon correction of any deficiencies noted during final inspection.

.3 Arrangements shall be made for the manufacturer’s representative to carry out inspections of the work when in progress. The representative shall report to the Consultant on an appropriate form, his findings related to these inspections.

3.5 Clean Up

.1 Clean to the consultant's approval, soiled surfaces, spatters, and damage caused by work of this section.

.2 Check area drains to ensure cleanliness and proper function, and remove debris, equipment and excess material from the site.

END OF SECTION

PART 1 – GENERAL

1.1 General Requirements

.1 Provide all material, labour, equipment, and services to complete all general trades work as outlined on the drawings and specified herein.

1.2 Shop Drawings

.1 Submit shop drawings for ceilings and floor sealing for review by the Engineer and include in Maintenance Manuals.

1.3 Warranty

.1 Provide a one (1) year full parts and labour warranty for all work from date of substantial completion.

PART 2 - PRODUCTS

2.1 General

.1 Include for all cutting, coring and patching. Use fire rated materials for all fire rated assemblies or requirements.

.2 All new work shall be level, plumb and done in a good workmanlike manner acceptable by the Consultant and Owner.

.3 Provide all materials for new walls, doors, frames, hardware, lintels and other finishes for a complete scope of work as outlined on the drawings.

.4 Provide lintels for all new wall openings as per structural drawings.

.5 Provide new shafts and other enclosures for a complete scope of work to ensure all new and reworked services are concealed unless otherwise noted.

.6 Provide all finishing and painting to match existing surroundings and to the acceptance of the Consultant and Owner.

.7 Coordinate paint colours with Owner.

2.2 Equipment Bases

.1 Reuse existing or provide new 4” (100mm) high concrete housekeeping pads for new floor mounted equipment in mechanical room as noted on drawings. Refer to Section 15090.

.2 Paint all sides and around top edge (minimum 300mm (12”)) of concrete pads with two (2) coats of yellow paint.

2.3 Walls and Floor (Mechanical Rooms)

.1 Walls

.1 Clean walls free of existing peeling paint.
.2 Patch and fire stop all existing and new holes and penetrations. Use fire rated materials at all fire separations.
.3 Prime and paint with two (2) coats. Coordinate colour with Owner.

.2 Floor

.1 Stonproof ME7 waterproof membrane sealed with Stonkote GS4 epoxy coating, colour grey.

2.4 Doors

.1 Provide new doors as scheduled on drawings

2.5 Acoustic Tile Ceilings – Non-Rated

.1 Non-rated ceilings shall conform to CAN/CGSB-92.1 and installation to comply with applicable requirements of ASTM C636.

.2 Acoustical Panels – Non-Fire Rated – Except Washrooms

.1 To CAN/CGSB-92.1.
.2 Type: Mineral composition acoustical units, sag resistant.
.3 Pattern: Non-directional fissured.
.4 Flame spread rating of 25 or less.
.5 Smoke developed class of 50 or less.
.6 Noise reduction coefficient (NRC) designation of 0.55 minimum.
.7 Ceiling attenuation class (CAC) designation of 30 minimum.
.8 Light reflectance range of 0.80 and above.
.9 Edge type: Square.
.10 Colour: White.
.11 Size: 16 mm minimum thickness, 610mm by 1220mm.
.12 Shape: Flat.
.13 Acceptable Products:

.1 Armstrong World Industries Canada Ltd.: Fine Fissured 1729
.2 Certainteed Ceilings: Vantage 10, VAN-197
.3 CGC Interiors: Radar Climaplus 2410

.3 Acoustical Panels – Non-Fire Rated – Washrooms

.1 Type: Gypsum core acoustical units with sealed edges, vinyl face and back.
.2 Pattern: Fine-textured.
.3 Flame spread rating of 25 or less.

.4 Smoke developed class of 50 or less.
.5 Noise reduction coefficient (NRC) designation of 0.10 minimum.
.6 Ceiling attenuation class (CAC) designation of 40 minimum.
.7 Light reflectance range of 0.77 and above.
.8 Edge type: Square.
.9 Colour: White.
.10 Size: 13mm minimum thickness, 610mm by 1220mm.
.11 Shape: Flat.
.12 Minimum weight: 9.77kg/m5.
.13 Acceptable Products:

.1 Certainteed Ceilings: Protectone Vinylrock X, 1140-CRF-1.
.2 CGC Interiors: Sheetrock brand lay-in ceiling tile Climaplus 3270

.4 Suspension System – Non-Fire Rated – Except Washrooms

.1 Intermediate duty system to ASTM-C635.
.2 Basic materials for suspension system: commercial quality cold rolled steel zinc coated.
.3 Exposed tee-bar grid components: white colour. Components die cut. Main tee, 43mm high, with double web, rectangular bulb and 25mm rolled cap on exposed face. Cross tee, 43mm high, with rectangular bulb; web extended to form positive interlock with main tee webs; lower flange extended and offset to provide flush intersection; wall moulding, 22mm wide by 22mm high, finished to match main tees and cross tees.
.4 Two directional exposed tee-bar grid, double web.
.5 Acceptable Products:

.1 Armstrong World Industries Canada Ltd.: Prelude ML exposed tee system.
.2 Bailey Metal Products Limited: Lance-Lock System 900 (BEH).
.3 Certainteed Ceilings: Classic Hook System.
.4 CGC Interiors: Donn DX exposed grid suspension system.
.5 Chicago Metallic Corporation: series 1200 suspension system.

.5 Suspension System – Non-Fire Rated – Washrooms

.1 Intermediate duty system to ASTM-C635.
.2 Basic materials for suspension system: commercial quality cold rolled steel zinc coated.
.3 Exposed tee-bar grid components: white colour. Components die cut. Main tee, 43mm high, with double web, rectangular bulb and 25mm rolled cap on exposed face. Cross tee, 43mm high, with rectangular bulb; web extended to form positive interlock with main tee webs; lower flange extended and offset to provide flush intersection; wall moulding, 22mm wide by 22mm high, finished to match main tees and cross tees.
.4 Two directional exposed tee-bar grid, double web.
.5 Hot dipped galvanized, painted steel tee with painted aluminum cap.
.6 Acceptable Products:

.1 Armstrong World Industries Canada Ltd.: Prelude XL for exterior applications.
.2 Bailey Metal Products Limited: Lance-Lock System 700.
.3 Certainteed Ceilings: Classic Aluminum Cap Hook System.
.4 CGC Interiors: Donn ZXLA Suspension System.
.5 Chicago Metallic Corporation: Series 1830 HDG Suspension System.

.6 Accessories

.1 Hanger Wire: galvanized soft annealed steel wire, 3.6mm minimum diameter.
.2 Hanger inserts: Purpose made.
.3 Carrying Channels: 1.2mm cold rolled galvanized steel channel, 38mm deep with 19mm flanges.
.4 Hanger Anchoring Devices: Philips Red Head by Philips Drill Company of Canada Limited.

.1 T32, self-drilling for use in concrete deck.
.2 WS-3822 wedge anchor with tie wire insert for use in composite concrete and steel deck.

.5 Suspension System Accessories: splices, bull nose corner caps, hold down clips, wire ties, retainers and typical flush wall moulding, to complement suspension system components, as recommended by system manufacturer.

.7 Isolation Hangers (if required):

.1 Welded steel housing with anti-rust paint, and colour-coded stable elastomer springs.
.2 Spring static deflection shall be no less than 6mm and shall provide 50% overload capacity. Brackets shall be designed to carry 500% overload without failure.
.3 Hanger assembly shall be equipped with bottom eye bolt.
.4 Manufacturer/Product: BVA Systems Ltd.: Model HD Hangers.

PART 3 - EXECUTION

3.1 General

.1 Provide all finishing and painting work to match existing.

.2 All general trades work including final finishing and painting as it relates to the contract work is the responsibility of the Contractor in a manner acceptable to the Consultant and Owner.

.3 All new or reworked services shall be concealed unless otherwise noted.

.4 Install lintels at new wall openings as per structural drawings.

.5 Protect and clean all surroundings from sanding residue.

.6 Painting shall include two (2) coats of colour approved by the Consultant or the Owner.

3.2 Equipment Bases

.1 Reuse existing or provide new concrete housekeeping pads for new floor mounted equipment in mechanical room. Refer to Section 15090.

.2 Remove redundant existing concrete pads for existing equipment being removed and as indicated on the drawings. Patch and level floor where pad was removed.

.3 Paint all sides and around top edge (minimum 300mm (12")) of all existing and new housekeeping pads with two (2) coats of yellow.

3.1 Doors

.1 Provide new doors as scheduled on drawings.

3.3 Walls and Floor (Mechanical Rooms)

.1 Walls

.1 Clean walls free of existing peeling paint.
.2 Patch and fire stop all existing and new holes and penetrations. Use fire rated materials at all fire separations.
.3 Prime and paint with two (2) coats. Coordinate colour with Owner.

.2 Floor

.1 Work shall <u>not</u> be done during school hours. Obtain approval from Owner prior to scheduling and application.
.2 Stonproof ME7 waterproof membrane sealed with Stonkote GS4 epoxy coating, colour grey.
.3 The substrate shall be cleaned and prepared by diamond grinding to Stonhard's specifications.
.4 One coat of Standard primer shall be applied to seal the surface.
.5 All cracks, divots, and corners shall be pre-addressed using Stonset PM5 patching compound.
.6 Stonproof ME7 two component urethane waterproof membrane shall be applied to the floor and 4" up the walls and curbs.
.7 One coat of Stonkote GS4 epoxy coating shall be applied to seal the surface. Texture two aggregate shall be incorporated into the coating to provide added slip resistance upon request.
.8 Products shall be supplied and installed by Stonhard, Contact: Chad Nissin, 905-424-3333.

.9 Alternate manufacturers and products shall be pre-approved prior to tender closing. The Contractor or Supplier shall submit detailed information for review a minimum of one (1) week before closing.

.10 The Contractor is responsible for:

.1 Supply of garbage container, finish lighting and floor/space temperature 65-70 degrees or as required for the application of all products.

.2 Coordinate unloading facilities, movement of materials and warm dry storage.

.3 Ensuring area is free of trades or any traffic for a 24 hour period after the installation.

3.4 Acoustic Tile Ceilings

.1 Install new acoustic tile ceilings as indicted on drawings. Ceilings shall be rated or non-rated as noted.

.2 Install in accordance with ASTM-C636. Install rated ceilings in conformance with ULC listings.

.3 Install suspension system to manufacturer's instructions.

.4 Do not erect ceiling suspension system until work above ceiling has been inspected by the consultant.

.5 Do not secure hangers to fluted steel floor. Secure hangers to overhead structure using attachment methods as required for particular structure and acceptable to the consultant. Where structural spacing exceeds ceiling hanger spacing, provide double carrying channels nested and placed perpendicular to and on top of bottom flange of steel beams or on top of the lower chords of the open web steel joists, and secured to each joist with three loops of 1.2mm galvanized soft steel wire.

.6 Where obstructions interfere with the placement of ceiling hangers, provide double carrying channels nested and hung from the structure above on both sides of the obstruction.

.7 Install hangers on main tees spaced at maximum 1200mm centres and within 150mm from ends of main tees and tee splices.

.8 Lay out with border units not less than 50% of standard unit width and according to reflected ceiling plans.

.9 Ensure suspension system is coordinated with location of related components.

.10 Install typical wall moulding to provide correct ceiling height. Existing moulding shall not be reused.

.11 Completed suspension system shall support super-imposed loads, such as lighting fixtures, diffusers, grilles, speakers and other ceiling mounted fixtures.

.12 Support at light fixtures and diffusers with additional ceiling suspension hangers within 150mm of each corner and at maximum 600mm around perimeter of fixture. Install an additional hanger immediately above each fastener for ceiling mounted curtain tracks.

.13 Interlock cross member to main runner to provide rigid assembly. Ensure all main tee splices and cross tee end clips are fully engaged.

.14 Frame at openings for light fixtures, air diffusers, speakers and at changes in ceiling heights.

.15 Finished ceiling system shall be square with adjoining walls and level within 6mm in 3000mm. Install acoustical units parallel to building lines with edge unit not less than 50% of unit width. Refer to reflected ceiling plan.

.16 Scribe acoustic units accurately and neatly to fit adjacent work. Butt joints tight, terminate edges with moulding.

.17 Co-ordinate ceiling work to accommodate components of other sections, to be built into acoustical ceiling components, such as light fixtures, diffusers, speakers and sprinkler heads.

.18 Neatly cut acoustical units to fit tightly around all building elements that penetrate ceiling.

.19 Cleaning

.1 Clean with non-solvent based commercial cleaners.

.2 Touch up minor scratches, abrasions, voids and other defects in painted surfaces as acceptable. Replace damaged sections when touch-up is not acceptable to the consultant.

.3 Replace components which are visibly damaged, marred or not cleanable.

.4 Remove all excess material and debris when work of this section is completed.

END OF SECTION

PART 1 - GENERAL

1.1 Section Includes

.1 Progressive cleaning

.2 Final cleaning

1.2 Project Cleanliness

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

.2 Remove waste materials from site at regularly scheduled times or dispose of as directed by the Consultant or Owner. Do not burn waste materials on site.

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

.4 Provide on-site drum containers for collection of waste materials and debris.

.5 Provide and use clearly marked separate bins for recycling.

.6 Remove waste material and debris from site and deposit in waste container at end of each working day.

.7 Dispose of waste materials and debris off site.

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

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

.10 Provide adequate ventilation while using volatile or noxious substances. The use of building ventilation systems is not permitted for this purpose.

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

.12 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces and will not contaminate building systems or electrical or control panels.

1.3 Final Cleaning

.1 Prior to Substantial Completion, remove surplus products, tools, construction machinery and equipment not required for performance of remaining work.

.2 Remove waste products and debris other than that caused by others, and leave the Works clean and suitable for occupancy.

.3 Remove waste products and debris other than that caused by Owner Staff.

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

.5 Remove stains, spots, marks and dirt from walls, and floors created during construction.

.6 Clean lighting reflectors, lenses, and other lighting surfaces.

.7 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.

.8 Clean equipment and fixtures to a sanitary condition and clean or replace filters of mechanical equipment.

.9 Remove debris and surplus materials from all areas.

END OF SECTION

PART 1 - GENERAL

1.1 General

.1 Provide all warranties outlined in the Contract Documents from the time of Substantial Completion of the Works or components of the works.

.2 Perform warranty work required during progress of the work and during the Warranty Period.

.3 Extend warranties on any component of the work that is required to be placed in operation prior to Substantial Performance for the purpose of complying with the sequence of construction.

1.2 Submittals

.1 Inform the Owner in writing of the arrangements made for carrying out warranty work during the Warranty Period.

.2 Provide a telephone number and address for receipt of notices relating to matters requiring action by the Contractor during the Warranty Period.

1.3 Work During Warranty Period

.1 Perform all warranty work required upon receipt of verbal or written notices from the Owner.

1.4 Repair by Owner

.1 The Owner will, without giving notice to the Contractor, repair shrinkages or defects that are dangerous in nature, that constitute an extreme emergency or that affect the operation of the Works. The Contractor will be notified of less serious conditions prior to work being performed.

.2 The Owner will notify the Contractor of emergency work performed by the Owner.

.3 The cost of labour, equipment and material to perform emergency work will be charged to the Contractor.

END OF SECTION

INDEX TO SPECIFICATIONS

PART 1 – GENERAL

1.1 General Requirements

.1 The requirements of this section shall apply to all sections in Division 15.

.2 Conform to Division 1 General Conditions.

.3 All material, labour, equipment, and services required under this section shall be the full responsibility of the Mechanical Contractor including any material, labour, equipment, and services provided by their subcontractors.

.4 Complete and submit the Mechanical Supplementary Bid Form including list of equipment and materials to be used on this project and forming part of the tender documents.

1.2 Pre-Qualified Mechanical Contractors

.1 Refer to front end documents for pre-qualified mechanical contractor list. Only those pre-qualified contractors shall bid on this project.

1.3 Acceptable Sheet Metal Subcontract Bidders:

.1 Refer to front end documents for acceptable sheet metal contractor list.

1.4 Definitions

.1 “Supply” shall mean supply only.

.2 “Install” shall mean install and connect.

.3 “Provide” shall mean supply, install, and connect.

.4 “Drawings and Specifications” shall mean Contract Documents.

.5 “Authorities” or “Authorities having jurisdiction” shall mean all agencies that enforce the applicable laws, ordinances, rules, regulations, or codes of the Place of Work.

.6 “Work” shall mean all equipment, materials, labour, and permits to provide a complete and operational mechanical system as detailed in the drawings and specifications.

.7 “Owner” or “DDSB” shall mean Durham District School Board.

1.5 Related Work

.1 Division 1 – General

.2 Division 16 – Electrical

.3 Division 15 specifications form a part of the Contract Documents and shall be read, interpreted, and coordinated with all other Divisions.

1.6 Intent

.1 The drawings and specifications are not a detailed set of installation instructions. Drawings and specifications are complementary to one another and that which is shown on one is as binding as that which is shown on both.

.2 The Consultant shall be immediately informed of any discrepancies between drawings and specifications leaving in doubt the true intent of the work.

.3 Supply all labour, equipment, and materials necessary to install a complete and operational mechanical system described herein and shown on the drawings.

.4 It is the intent of these drawings and specifications to provide for a mechanical installation complete and in operating condition. The responsibility for supplying and installing all material necessary to accomplish this, except where specifically noted that such work or materials is not included, shall be part of this section.

.5 Assess and be familiar with existing site conditions prior to pricing and construction and allow for same in tender price.

.6 All work must be done by qualified, certified and experienced persons in such line of work. Trade certificates must be available on demand.

.7 All work shall be in accordance with standard industry practice accepted and recognized by the Consultant and the Trade.

.8 This Contractor shall coordinate with and cooperate with all other trades prior to installation. Where work interferes with other trades due to failure to coordinate or cooperate, the work shall be removed and relocated as approved by the Consultant at no extra cost to the Owner.

.9 The Consultant shall have the right to reject any work that does not conform to the Contract Documents and accepted standards of practice including but not limited to performance, quietness of operation and finish.

1.7 Codes, Bylaws, Standards, and Regulations

.1 The mechanical system shall comply with the latest editions and revisions of applicable codes, bylaws, standards, and regulations including but not limited to:

.1 Ontario Building Code
.2 ASHRAE
.3 SMACNA
.4 NFPA
.5 Canadian Standards Association
.6 Canadian Gas Association
.7 Local Building Bylaws

.8 Ontario Occupational Health and Safety Act

.2 Provide work in accordance with the requirements of all applicable government codes, local by-laws, underwriter's regulations base building standards, contract documents, and all authorities having jurisdiction.

.3 Where discrepancies occur between contract drawings and specifications and above codes and standards referred to herein, the Contractor is to notify the Consultant in writing and obtain clarification prior to proceeding with the work.

.4 Contractors shall not reduce the requirements on the contract drawings and specifications by applying any codes and standards referred to herein.

1.8 Permits and Fees

.1 The Consultant will apply for building permit on the Owner's behalf.

.2 The Contractor shall apply for, obtain, and pay for all other required permits, fees, connections, inspections, licenses, certificates or charges necessary including all taxes.

.2 Coordinate all required inspections and give necessary notice to all authorities.

.3 Upon completion of project, provide inspection certificates confirming acceptance by all authorities having jurisdiction for all applicable disciplines.

1.9 Contract Breakdown

.1 After the tenders close, submit a breakdown of the price into scope and trades to the satisfaction of the Consultant based on the sections of the specifications.

.2 Breakdown shall include but not be limited to:

.1 Mobilization (maximum $3,000)
.2 Shop drawing submission (maximum $3,000)
.3 Demolition
.4 Air Handling Unit and Condensing Unit
.5 Rooftop Unit
.6 Boilers
.7 Pumps
.8 Variable Speed Drives
.9 Hydronic Piping & Specialties
.10 Refrigeration Piping
.11 Boiler Breeching
.12 Ductwork
.13 Insulation
.14 Water Treatment
.15 Testing, Startup & Training
.16 Balancing
.17 Electrical – subtrade shall provide detailed breakdown (Refer to 16010)

.18 General Trades – subtrade shall provide detailed breakdown
.19 Structural Steel
.20 Roofing
.21 Close-out Submittals – Manuals & As-built Drawings (minimum $3,000 mechanical)

.3 Progress claims shall be based on the breakdown. Submit in table format showing contract amount, work complete to date as percentage, previous draw, amount this draw and balance for each line item.

1.10 Shop Drawings

.1 Within two (2) weeks of award, the Contractor shall submit shop drawings of all equipment for the project.

.2 Prior to ordering of products or delivery of any products to job site, submit shop drawings electronically in PDF format to the Consultant for review and comments. Submit sufficiently in advance of construction to allow ample time for review. Size of shop drawings shall be 8.5x11". 11x17" will be acceptable where appropriate for content and scale.

.3 Submittals shall contain but not be limited to:

.1 Construction information
.2 Product data
.3 Performance data including performance curves
.4 Acoustical sound power data
.5 Dimensional layout and clearances
.6 Mounting arrangements
.7 Certification of compliance to applicable codes
.8 Operating and Maintenance information
.9 Wiring, single line and schematic diagrams (where applicable)

.4 Clearly mark each sheet of printed submittal material, using arrow, underlining or circling, to show particular sizes, dimensions, wiring diagrams, operating clearances, control diagrams, project identification, types, model numbers, ratings, capacities and options actually being proposed. Cross out non-applicable material.

.5 **Prior to submission to the Consultant, the Mechanical Contractor shall review all shop drawings. By this review the Mechanical Contractor represents that they have determined and verified all field measurements, field construction criteria, materials, catalogue numbers and similar data or will do so and that they have checked and coordinated each shop drawing with the requirements of the Work and of the Contract Documents.**

.6 **The Mechanical Contractor's review of each shop drawing shall be indicated by his approval stamp, date and signature on the front of each page. Drawings will not be considered if not previously checked by the Mechanical Contractor.**

.7 Review comments from the Consultant. If shop drawings are modified, confirm changes before proceeding. If shop drawings are not approved, revise and resubmit changes for approval within one (1) week.

.8 Review of the shop drawings by the Consultant does not relieve the Contractor or his Supplier of the responsibility to provide the correct and complete equipment, material or installation.

.9 Keep one complete set of shop drawings at the job site during construction.

.10 Include stamped reviewed shop drawings in the Maintenance Manuals.

1.11 Product Delivery Schedule

.1 Within two (2) weeks from shop drawing review, a schedule must be submitted by the Contractor showing projected delivery dates of all products to meet required construction schedule.

1.12 Construction Meetings

.1 The Mechanical Contractor shall attend all site meetings unless otherwise pre-approved.

.2 Sub-trades shall attend site meetings as requested or as required.

1.13 As-built Drawings

.1 Refer to Section 15045.

.2 Maintain accurate, neat, and clean as-built drawings on an **on-going basis** during construction to be reviewed periodically by the Consultant during construction.

.3 As-built drawing mark-ups shall be made available at every site meeting or inspection.

.4 As-built drawings shall include but not be limited to final location of any access doors on same for future service requirements.

.5 Upon completion of the work, submit to the Consultant for review, one (1) complete set of clear, legible, certified as-built drawings.

1.14 Reports

.1 Provide the following reports upon completion of work by certified Contractors for review and approval by the Consultant:

.1 Equipment Start-Up Reports
.2 Piping Pressure Test Reports
.3 TSSA Certification

.4 HVAC Systems Cleaning Report (where applicable)
.5 Balance Report
.6 Water Treatment Test Report
.7 Other equipment startup reports and test sheets certified by the manufacturer or a qualified technician
.8 Demonstration Reports/Logs

.2 All reports shall be dated and signed by the Technician who performed the start-up and/or tests.

1.15 Maintenance Manuals

.1 Refer to Section 15045.

.2 Provide the Owner with two (2) **indexed**, hard cover maintenance manuals to local air balance industry standards plus one (1) electronic copy on labeled USB and electronic file transfer. Manuals shall contain and be tabbed in the following order:

.1 Table of Contents
.2 Contractor's, Manufacturer's and Supplier's Contact Information
.3 Warranty Letter
.4 Valve schedule
.5 Colour coding charts for access areas
.6 Reports as specified herein and as applicable
.7 Shop drawings (stamped reviewed by Consultant)
.8 Equipment maintenance instructions and manuals
.9 Controls as-built drawings
.10 As-built drawings

.3 Submit one (1) complete copy to the Consultant for review and approval. Revise based on any comments and resubmit all copies and electronic copy to Consultant.

1.16 Testing and Startup

.1 Refer to Sections 15042 under this Division.

.2 Test and startup all equipment and work.

.3 Fully coordinate all testing and startups with all trades, the Consultant, and authorities having jurisdiction.

.4 Provide adequate notice to all parties.

1.17 Demonstration

.1 Demonstrate to the Owner on proper operation of the system.

.2 The Contractor shall arrange for all necessary personnel and equipment specialists to be in attendance for purposes of demonstration.

.3 Provide instruction by a manufacturer's representatives as required too fully demonstrate the systems.

.4 Demonstration shall include but not be limited to:

.1 Demonstration in the normal, abnormal and emergency operation of all systems provided under this Division.
.2 Review of all necessary maintenance procedures, including winterization, of all systems provided under this Division.
.3 Provision of a documented maintenance program covering all systems provided or modified under this contract.
.4 Review of all close-out documentation including complete maintenance manuals and as-built drawings.

.5 Prepare a Demonstration Agenda and Log for signature by all Participants. Submit to Consultant and include in Manuals.

1.18 Substantial Completion and Performance

.1 Substantial completion and performance shall be determined and awarded by the Consultant.

.2 Complete the following to the satisfaction of the Consultant prior to request for substantial completion:

.1 Fire Dampers and Fire Stopping
.2 System Testing and Startups including report
.3 Balancing including report
.4 Draft copy of maintenance manual
.5 As-built Drawings

.3 Complete the following to the satisfaction of the Consultant prior to request for substantial performance:

.1 Final Maintenance Manuals
.2 Final Drawings
.3 Demonstration and Training

1.19 Warranty

.1 Provide a one (1) year full parts and labour warranty for the new system from date of substantial completion. A draft copy of the maintenance manual shall be submitted before substantial completion is awarded.

.2 Submit warranty letter on Company letterhead signed by Company representative stating warranty terms including warranty period from date of substantial completion.

PART 2 - PRODUCTS

2.1 Materials

.1 All material used shall be new, free from defects, of quality specified, and installed in accordance with manufacturer's instructions.

.2 Major equipment shall have nameplates on the exterior of the equipment in a visible location containing manufacturer's name, model number, serial number, performance data, and electrical characteristics.

.3 The same manufacturer shall be used for types of equipment used in similar applications.

.4 It is the responsibility of the Contractor to store and protect materials supplied by this scope.

.5 Materials shall be stored in original containers.

.6 Submit to the Consultant and the Owner, current MSDS Sheets for any products being used on the job site where they exist.

.7 Remove and dispose of all redundant materials and garbage from site.

.8 Supply anchor bolts and templates for installation by other Divisions.

2.2 Selected Products and Equivalents

.1 Sections within Division 15 list "Acceptable Manufacturers" which must meet characteristics of the specified equipment and products for each section.

.2 Base specified products are specified and/or shown on the drawings, and identified by manufacturer's name, type and catalogue number.

.3 Any alternate manufacturers from base specified products and equipment must equal or exceed the quality, finish and performance of those base specified and/or shown, and not exceed the space requirements allotted on the drawings. Include costs for any associated work to accommodate such substitutions, including the Consultant's time and revisions to the work of other divisions (i.e. electrical changes).

.4 If item or material specified is unobtainable, state in Tender proposed substitute and amount added or deducted for its use. Extra monies will not be paid for substitutions after the Contract has been awarded.

.5 If item of size indicated is unobtainable, supply next larger size without additional charge.

2.3 Quality of Product

.1 All products provided shall be listed and/or approved by relevant authorities and shall be new.

.2 If products specified are not listed and/or approved, obtain approval of provincial regulatory authority. Pay all applicable charges levied and make all modifications required for approval.

.3 All products provided shall be new including those not specified and shall be of a quality best suited to the purpose required and their use subject to approval by the Consultant.

2.4 Product Finishes

.1 Shop drawings shall indicate finishes. Use standard finish unless otherwise specified.

.2 Repair dents and touch up all damaged finishes with matching finish, or if required by the Consultant or Owner, completely repaint or replace damaged surface at no extra cost to the Contract.

2.5 Access Doors/Panels

.1 Provide access doors/panels as required for access, adjustment, operation, service, and maintenance.

.2 Access doors/panels shall be Acudor, Ecuador or equivalent with concealed hinges and screwdriver locking device.

.3 Acceptable Manufacturers:

.1 Acudor
.2 Zurn
.3 Nailor Industries
.4 Le Hage

2.6 Belt Drives

.1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.

.2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise specified.

.3 For motors under 7.5kW (10hp): standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.

.4 For motors 7.5kW (10hp) and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned.

Provide sheave of correct size to suit balancing.

.5 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.

.6 Motor slide rail adjustment plates to allow for centre line adjustment.

.7 Provide sheave changes as required for final air balancing.

2.7 Drive Guards

.1 Provide guards for unprotected drives.

.2 Guards for belt drives:

.1 Expanded metal screen welded to steel frame.
.2 Minimum 1.2 mm (18 gauge) thick sheet metal tops and bottoms.
.3 40mm (1-1/2") diameter holes on both shaft centres for insertion of tachometer.
.4 Removable for servicing.

.3 Provide means to permit lubrication and use of test instruments with guards in place.

.4 Install belt guards to allow movement of motors for adjusting belt tension.

.5 Guard for flexible coupling:

.1 "U" shaped, minimum 106 mm (16 gauge) thick galvanized mild steel.
.2 Securely fasten in place.
.3 Removable for servicing.

.6 Unprotected fan inlets or outlets:

.1 Wire or expanded metal screen, galvanized, 20 mm (3/4") mesh.
.2 Net free area of guard: not less than 80% of fan openings.
.3 Securely fasten in place.
.4 Removable for servicing.

2.8 Equipment Supports

.1 Equipment supports supplied by equipment manufacturer: specified elsewhere in Division 15.

.2 Equipment supports not supplied by equipment manufacturer: fabricate from structural grade steel. Submit structural calculations with shop drawings.

.3 Install base mounted equipment on chamfered edge housekeeping pads, minimum of 100 mm (4") high and 150 mm (6") larger than equipment dimensions all around. All pads shall be painted yellow on sides and top. Refer

to Section 15090.

2.9 Sleeves

.1 Pipe sleeves: at points where pipes pass through masonry, concrete or fire rated assemblies and as indicated.

.2 Schedule 40 steel pipe.

.3 Sleeves with annular fin continuously welded at midpoint:

.1 Through foundation walls.
.2 Where sleeve extends above finished floor.
.3 Through fire rated walls and floors.

.4 Sizes: minimum 6mm (1/4”) clearance all around, between sleeve and un-insulated pipe or between sleeve and insulation.

.5 Terminate sleeves flush with surface of concrete and masonry walls, concrete floors on grade and 25mm (1”) above other floors.

.6 Fill voids around pipes:

.1 Caulk between sleeve and pipe in foundation walls and below grade floors with water proof fire retardant non-hardening mastic.
.2 Where sleeves pass through walls or floors, provide space for firestopping. Where pipes/ducts pass through fire rated walls, floors and partitions, maintain fire rating integrity.
.3 Ensure no contact between copper tube or pipe and ferrous sleeve.
.4 Fill future-use sleeves with lime plaster or other easily removable filler.
.5 Coat exposed exterior surfaces of ferrous sleeves with heavy application of zinc rich paint to CGSB 1-GP-181M+Amdt-Mar-78.

.7 Provide minimum 20 gauge duct sleeves where ducts pass through masonry concrete or fire rated assemblies. Maintain minimum 25mm (1”) clearance all around or to the requirements of the authority having jurisdiction. Seal at all as indicated.

2.10 Fire Stopping

.1 This Contractor shall work with all other Contractors on the project in providing one common method of fire stopping all penetrations made in the fire rated assemblies.

.2 Approved fire stopping and smoke seal material in all fire separations and fire ratings within annular space between pipes, ducts, insulation and adjacent fire separation and/or fire rating.

.3 Do not use cementious or rigid seals around penetrations for pipe, ductwork, or other mechanical items.

.4 Insulated pipes and ducts; ensure integrity of insulation and vapour barrier at fire separation.

.5 Provide materials and systems capable of maintaining effective barrier against flame, smoke and gases. Ensure continuity and integrity of fire separation.

.6 Comply with the requirements of CAN4-S115-M35, and do not exceed opening sized for which they have been tested.

.7 Systems to have an F or FT rating (as applicable) not less than the fire protection rating required for closures in a fire separation. Provide “fire wrap” blanket around services penetrating fire walls. Extent of blanket must correspond to ULC recommendations.

.8 The fire stopping materials are not to shrink, slump or sag and to be free of asbestos, halogens and volatile solvents.

.9 Firestopping materials are to consist of a component sealant applied with a conventional caulking gun and trowel.

.10 Fire stop materials are to be capable of receiving finish materials in those areas which are exposed and scheduled to receive finishes. Exposed surfaces are to be acceptable to consultant prior to application of finish.

.11 Firestopping shall be inspected and approved by the Consultant and local authority prior to concealment of enclosure.

.12 Install material and components in accordance with ULC certification, manufacturer’s instructions and local authority.

.13 Submit product literature and insulation material on fire stopping in shop drawing and product data manual. Maintain copies of these on site for viewing by installers and Consultant.

.14 Manufacturer of product shall provide certification of installation. Submit letter to the Consultant.

.15 Acceptable Manufacturers:

.1 Fryesleeve Industries Inc.
.2 General Electric Pensiil Firestop Systems
.3 International Protective Coatings Corp.
.4 Rectorseal Corporation (Metacaulk)
.5 Proset Systems
.6 3M
.7 AD Systems
.8 Hilti

.16 Ensure firestop manufacturer representative performs on-site inspections and certifies installation. Submit inspection reports/certification at time of substantial

completion.

2.11 Escutcheons

.1 Provide on pipes and ductwork passing through walls, partitions, floors and ceilings in finished areas.

.2 Chrome or nickel plated brass or Type 302 stainless steel, one piece type with set screws.

.3 Outside diameter to cover opening or sleeve.

.4 Inside diameter to fit around finished pipe.

PART 3 - EXECUTION

3.1 Site Examination

.1 Examine the site of work and become familiar with all features and characteristics affecting this work before submitting tender.

.2 No additional compensation will be given for extra work due to existing conditions which such examination should have disclosed.

.3 Report to the Consultant any unsatisfactory conditions which may adversely affect the proper completion of this work.

3.2 Interference and Coordination Drawings

.1 Examine the drawings and all divisions of the specifications.

.2 Prepare interference and equipment layout drawings to ensure all components will be properly accommodated within the spaces provided.

.3 Lay out the work and equipment with due regard to architectural, structural and electrical features, and service requirements.

.4 Submit interference drawings to the Consultant.

.5 Before commencing any work, obtain a ruling from the Consultant if any conflict exists, otherwise no additional compensation will be made for any necessary adjustments.

3.3 Separation of Services

.1 Contact between dissimilar metals, such as copper and aluminum, in damp or wet locations is not permitted.

.2 All pipes, ductwork and wiring shall be supported from permanent building structure. Use of other services for support is not permitted.

3.4 Workplace Safety

.1 The workplace must be kept safe at all times.

.2 Conform to all ministries of labour, and health and safety regulations at all times.

.3 Use ladders and proper techniques as approved by the ministry of labour to perform all work.

.4 Cover all holes/openings and provide barriers around hazards, etc. to ensure occupants and workers are not at risk.

.5 Where work does not conform to such regulations, stop work immediately and report the situation to the Owner's representative or Consultant or rectify the situation immediately.

.6 Report any hazards or concerns to the Owner's representative immediately.

.7 Conform to Owner's safety requirements and construction regulations.

3.5 Temporary Requirements

.1 All temporary requirements to complete mechanical work during construction shall be the responsibility of the Mechanical Contractor except temporary power or water.

3.6 Location of Equipment

.1 Approximate distances and dimensions may be obtained by scaling off the drawings. Figured dimensions shall govern over scaled dimensions.

.2 Equipment locations shown on the drawings are approximate. Locations may be revised to suit construction and equipment arrangements provided design intent is not jeopardized and there is no additional cost to the Owner.

3.7 Mounting Heights

.1 Mounting height of equipment is from finished floor to equipment unless otherwise specified or indicated. Coordinate with block coursing if applicable.

.2 Where mounting heights are not indicated on the drawings, obtain verification from the Consultant before proceeding.

3.8 Excavating and Backfilling

.1 Provide all saw cutting, excavating and backfilling for new underground services. All backfilling shall be new clean granular 'A' fill brought in specifically for the purpose of backfilling to the underside of floor slab. All backfilling shall be compacted at intervals not more than 150mm (6") layer to the satisfaction of the Consultant.

.2 Provide excavating and backfilling outside the building with granular 'A' brought in specifically for backfilling to a minimum of 450mm (18") over the pipe.

.3 Bottoms of trenches shall be excavated so that the pipe will be supported on a 150mm (6") compacted bed of clean granular 'A' fill. Provide all necessary pumping to maintain excavation free of water.

.4 Should water be encountered during excavation, the Mechanical Contractor shall provide all labour and material, including all equipment required for dewatering the excavation. After the water has been removed, this Contractor shall install a 300mm (12") base of compacted 50mm (2") clear stone covered with filter cloth before installing backfill as detailed and/or as specified.

.5 Be responsible for all weather protection required to install piping and/or equipment to the satisfaction of the Consultant.

.6 Be responsible for providing all clear stone or granular 'A' material suitable for application to replace existing soil not suitable for backfilling above the 450mm (18") bedding material.

.7 It is the responsibility of the Contractor to review the soils report. Additional work requested due to failure of soil conditions due to Contractor not reviewing report will not be entertained.

.8 Allow for restoration of concrete and floor finishes.

3.9 Welding, Grinding, Noisy Work, Odours

.1 No welding, grinding, other noisy work or work generating odours shall be done during regular operating/school hours.

.2 All above work shall be done after hours or on weekends outside of regular hours.

.3 Submit hot work permit prior to any welding.

3.10 Cutting, Coring, Patching and Restoration

.1 Allow for all cutting, coring, patching, restoration and finishing. Surface finishes shall exactly match existing finishes of same materials.

.2 Each Section of this Division shall bear expense of cutting, patching and repairing to install their work and/or replacing of work of other Sections required because of its fault, error, tardiness, or because of damage done by it.

3.11 Painting

.1 Apply at least one (1) coat of corrosion resistant primer paint to ferrous supports and site fabricated work.

.2 Paint all new concrete pads for mechanical equipment with 2 coats of yellow paint on all sides and top 12” (300mm) edge.

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

.4 Restore to new condition, or replace equipment at discretion of Consultant, finishes which have been damaged too extensively to be merely primed, painted and touched up.

3.12 Concealment

.1 All equipment, components, piping, and conduit shall be concealed in ceiling spaces, bulkheads or walls in finished areas.

.2 Exposed equipment, components, piping, and conduit installed in unfinished areas, shall be installed as high as possible. Run piping and conduit parallel to building lines, tight to roof deck, floor above and down columns or corners.

3.13 Clearances and Accessibility

.1 Install all work for easy access for adjustment, operation, service, and maintenance.

.2 Maintain clearances for all equipment as per local codes and manufacturer’s instructions.

.3 Access panels shall be Acudor, Ecuador or equivalent with concealed hinges and screwdriver locking device.

.4 Provide access panels of adequate size as required to access equipment and components in concealed areas. Do not install access doors in specialty walls or ceilings.

.5 Provide fire rated access doors where installed in fire separations to match rating of separation.

.6 Install all services in exposed areas so that a minimum head clearance of 2200mm (88”) is maintained.

3.14 Equipment and System Protection

.1 Protect equipment and materials from damage in storage and on site before, during, and after installation until final acceptance.

.2 Protect equipment and system openings from dust and debris with appropriate covers that will withstand through the construction.

.3 Where equipment and system components become dirty or damaged, clean and repair to new condition to the satisfaction of the Consultant and the Owner at no expense to the Owner.

3.15 Supports

.1 Provide all miscellaneous metals and materials as required for support, hanging, anchoring, and guiding of all equipment, ductwork, piping, and all other work in Division 15.

.2 All supports must be securely mounted to structures.

.3 Refer to Section 15090.

3.16 Fire Stopping

.1 Refer to Part 2 herein.

3.17 Cleaning

.1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units prior to turn over to Owner.

.2 In preparation for final acceptance, clean and refurbish all equipment and leave in operating condition including replacement of all filters in all air and piping systems.

3.18 Owner Supplied Equipment

.1 Arrange for delivery and installation of Owner supplied equipment where specified in this Division.

.2 Connect to equipment supplied by the Owner and make operable.

3.19 Identification and Labeling

.1 All equipment, valves, panels and devices shall be labeled under this Division.

.2 Refer to Section 15020.

3.20 TSSA Inspection

.1 Prior to final completion of the project, this Contractor shall make application, arrange, and pay for a TSSA Inspection of all piping systems and equipment installations, including, but not limited to refrigeration, fuel piping, heating plant, and associated equipment installed under the contract.

.2 Provide a copy of the TSSA Report in the maintenance manuals for each system.

3.21 Field Review and Deficiencies

.1 The Contractor shall notify the Consultant when the job is ready for field review at various stages including rough-in stages.

.2 During the course of construction, the Consultants will monitor construction and provide written reports of work progress, discussions and deficiencies.

.3 The Contractor shall correct all deficiencies within the work period prior to the next review.

.4 The Contractor shall not conceal any work until inspected. Where work was concealed, the Contractor shall remove and replace tiles, coverings or other obstructions to allow proper inspection at the Contractor's expense.

.5 Upon completion of the project the Consultant will do a final review. Upon receiving the final inspection report, the Contractor must correct and sign back the inspection report indicated all deficiencies are completed. A re-inspection will only be done once the Consultant receives this in writing. Where the Consultant performs the re-inspection and the work is not complete, the Contractor is responsible for reimbursing the Consultant for the field review. The fee for additional reviews will be at the Consultant's hourly rates plus mileage and applicable taxes to be paid directly to the Consultant prior to performing the next field review.

END OF SECTION

PART 1 – GENERAL

1.1 References

.1 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.60-M89, Interior Alkyd Gloss Enamel.
.2 CAN/CGSB-24.3-92, Identification of Piping Systems.

.2 Canadian Standards Association (CSA)

.1 Natural Gas Installation Code CSA B149.1-00

.3 National Fire Protection Association

.1 NFPA 13 (current edition), Standard for the Installation of Sprinkler Systems
.2 NPFA 14 (current edition), Standard for the installation of Standpipe and Hose Systems

1.2 Product Data

.1 Submit product data in accordance with Division 1, General Requirements.

.2 Product data to include paint colour chips, all other products specified in this section.

1.3 Product Literature

.1 Submit product literature in accordance with Division 1: General Requirements.

.2 Product literature to include nameplates, labels, tags, lists of proposed legends.

PART 2 - PRODUCTS

2.1 Manufacturer’s Equipment Nameplates

.1 Metal or plastic lamacoid nameplate mechanically fastened to each piece of equipment by manufacturer.

.2 Lettering and numbers to be raised or recessed.

.3 Information to include, as appropriate:

.1 Equipment: Manufacturer’s name, model, size, serial number, capacity.
.2 Motor: voltage, Hz, phase, power factor, duty, frame size.

2.2 System Nameplates

.1 Colours:

.1 Hazardous: red letters, white background
.2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).

.2 Construction:

.1 3mm (1/8”) thick laminated plastic, matte finish, with square corners, letters accurately aligned and machine engraved into core.

.3 Sizes:

.1 Conform to the following table:

Size	Dimensions mm (“)	No. of Lines mm (“)	Height of Letters mm (“)
1	10 x 50 (3/8” x 2”)	1 (3/64”)	3 (1/8”)
2	15 x 75 (1/2” x 3”)	1 (3/64”)	6 (1/4”)
3	15 x 75 (1/2” x 3”)	2 (5/64”)	3 (1/8”)
4	20 x 100 (3/4” x 4”)	1 (3/64”)	10 (3/8”)
5	20 x 100 (3/4” x 4”)	2 (6/64”)	6 (1/4”)
6	20 x 200 (3/4” x 8”)	1 (3/64”)	10 (3/8”)
7	25 x 125 (1” x 5”)	1 (3/64”)	15 (1/2”)
8	25 x 125 (1” x 5”)	2 (5/64”)	10 (3/8”)
9	32 x 200 (1-1/4” x 8”)	1 (3/64”)	20 (3/4”)

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

.4 Locations:

.1 Terminal cabinets, control panels: Use size #5.
.2 Equipment in Mechanical Rooms: Use size #9.
.3 Rooftop equipment: Use size #9.
.4 Equipment above ceiling: use size #1 riveted to ceiling suspension system.

2.3 Piping Systems Governed by Code

.1 Natural Gas:

.1 Natural gas: To CSA B149.1-00 and authority having jurisdiction and as indicated elsewhere.
.2 Paint indoor gas piping with **2 coats** of yellow paint.
.3 Paint outdoor gas piping with **2 coats** of weatherproof paint to match building colour where visible from meter and with yellow where not visible

from meter (i.e. roof).

.4 See colour legend specified herein.

2.4 Identification of Piping Systems

.1 Identify contents by background colour marking, description and direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.

.2 Materials

.1 Label piping with pipe markers equal to SMS (Smillie McAdams Summerlin Ltd.) “Coil-Mark”.

.2 Pipe markers shall be semi-rigid plastic vinyl, with surface printing using premium quality ultraviolet inks.

.3 For outside diameters up to 150mm (6”), markers shall be coiled and wrap completely around the pipe with two rows of wording in alternating directions. For outside diameters larger than 150mm (6”), markers shall be saddle style with four rows of wording and installed using 864mm (34”) long nylon cable ties provided with the marker.

.3 Legend:

.1 Block capitals to sizes and colours listed in CAN/CGSB-24.3.

.4 Arrows showing direction of flow:

.1 Outside diameter of pipe insulation less than 75 mm (3”): 100 mm (4”) long x 50 mm (2”) high.

.2 Outside diameter of pipe or insulation 75 mm (3”) and greater: 150 mm (6”) long x 50 mm (2”) high.

.3 Use double-headed arrows where flow is reversible.

.5 Extent of background colour marking:

.1 To full circumference of pipe or insulation.

.2 Length to accommodate pictogram, full length of legend and arrows.

.6 Colours and Legends:

.1 Where not listed, obtain direction from Consultant.

.2 Colours for legends, arrows:

Background colour	Legend	Arrows
Yellow	White	Black
Green	White	Black
Red	White	Black

2.5 Identification of Duct Systems

.1 Label all duct systems with air type and air flow direction.

.2 Black spray painted stencils are acceptable.

2.6 Concrete Pads for Mechanical Equipment

.1 Paint all sides and top 12” (300mm) edge of all concrete pads for mechanical equipment with two (2) coats of yellow paint. Paint colour to match Benjamin Moore Safety Yellow #343.

2.7 Valves, Controllers

.1 Brass tags with 15mm (1/2”) stamped identification data filled with black paint.

.2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

.3 Provide coloured adhesive label indication on ceiling grid to locate valves/equipment above. Label description to match device. Size, colour and description to be pre-approved by Consultant.

2.8 Controls Components Identification

.1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.

.2 Inscriptions to include function and (where appropriate) fail-safe position.

.3 Provide yellow adhesive label indication on ceiling grid to locate control devices above. Label description to match device. Size and description to be pre-approved by Consultant.

2.9 Mechanical Ceiling Components Identification

.1 Identify all other mechanical components in ceiling space (i.e. TMV) with system nameplates specified in this section.

.2 Inscriptions to include description (i.e. TMV access).

.3 Provide lamacoid nameplate or adhesive label indication on ceiling grid to locate component above. Label description to match device. Size and description to be pre-approved by Consultant.

2.10 Language

.1 Identification to be in English.

PART 3 - EXECUTION

3.1 Timing

.1 Provide all identification in ceilings prior to the installation of ceiling tiles for Consultant review. Where identification in ceilings is not complete prior to ceiling tiles being installed it is the Contractor's responsibility to remove any tiles as directed by the Consultant for their review.

3.2 Installation

.1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.

.2 Provide ULC and/or CSA registration plates as required by respective agency.

3.3 Nameplates

.1 Install on all equipment unless otherwise noted.

.2 Equipment labels not required on:

.1 Force flow heaters, Wallfin or Convectors
.2 Expansion tanks
.3 Air Separators and other system accessories

.3 Locations:

.1 In conspicuous location to facilitate easy reading and identification from operating floor.

.4 Standoffs:

.1 Provide for nameplates on hot and/or insulated surfaces.

.5 Protection:

.1 Do not paint, insulate or cover in any way.

3.4 Location of Identification on Piping and Duct Systems

.1 On long straight runs in ceiling spaces and in open areas in boiler rooms, equipment rooms, galleries, tunnels not more than 3m (10') intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.

.2 Adjacent to each change in direction.

.3 At least once in each small room through which piping or ductwork passes.

.4 On both sides of visual obstruction or where run is difficult to follow.

.5 On both sides of separations such as walls, floors, partitions.

.6 Where system is installed in pipe chases, ceiling spaces, galleries, other confined spaces, at entry and exit points, and at each access opening.

.7 At beginning and end points of each run and at each piece of equipment in run.

.8 At point immediately upstream of major manually operated or automatically controlled valves, dampers, etc. Where this is not possible, place identification as close as possible, preferably on upstream side.

.9 Identification to be easily and accurately readable from usual operating areas and from access points.

.1 Position of identification to be approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.5 Valves, Controllers

.1 Valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or close “S” hooks.

.2 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by Consultant. Provide one copy (reduced in size if required) in each operating and maintenance manual.

.3 Number valves in each system consecutively.

3.6 Mechanical Ceiling Components Identification

.1 Provide lamacoid nameplate or adhesive label indication on ceiling grid to locate component above. Label description to match device.

END OF SECTION

PART 1 - GENERAL

1.1 Quality Assurance

.1 Test equipment and material where specified and as required by authorities having jurisdiction to demonstrate its proper and safe operation.

.2 Test procedures shall be in accordance with applicable portions of:

.1 Canadian Gas Association (CGA)
.2 Ontario Building Code
.3 National Fire Protection Association (NFPA)
.4 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
.5 Sheet Metal and Air Conditioning National Association (SMACNA)
.6 American Society of Mechanical Engineers
.7 Ontario Ministry of Health
.8 Local codes and ordinances
.9 Other recognized test codes

.3 Provide additional tests and re-testing as required and requested by the Consultant or Owner.

1.2 Submittals

.1 Obtain certificates of approval and acceptance from authorities having jurisdiction and include in Operating and Maintenance Manuals.

.2 On completion of mechanical installation, provide certification of tests with detailed data as required. Itemize tests as to time performed and personnel responsible. Include a copy of field data in Operating and Maintenance Manuals.

1.3 Liability

.1 During tests, assume responsibility for damages in the event of injury to personnel, building or equipment and bear costs for liability, repairs and restoration.

PART 2 – PRODUCTS

2.1 All equipment and products necessary to perform tests shall be covered under this Division at no cost to the Owner.

PART 3 - EXECUTION

3.1 Pressure Tests

.1 Piping, fixtures or equipment shall not be concealed or covered until reviewed and accepted by the Consultant.

.2 Provide equipment, materials and labour for tests. Use test instruments from approved laboratory or manufacturer and furnish certificate showing degree of accuracy.

.3 Test equipment and material where specified required by authorities having jurisdiction to demonstrate its proper and safe operation.

.4 Provide four (4) days notice to the Consultant before tests.

.5 Carry out hydraulic tests for eight (8) hours and maintain pressure. Where leakage occurs, repair and retest.

.6 Domestic and Make-Up Water Piping: Test to 1½ times maximum working pressure or 1034 kPa (150 psi) water pressure measured at system low point.

.7 Drainage Systems: Test by filling with water to produce water pressure of 35 kPa (5 psi) minimum and 83 kPa (12 psi) maximum. Check for proper grade and obstruction by ball test, or other approved means.

.8 Natural Gas Piping: Conduct a 1 hour test of all gas piping systems up to 11" pressure and a 24 hour chart test at 50 psi of all gas piping systems over 11" pressure. The Contractor shall perform a soap test and electronic test. Arrange and pay for a gas inspection by the local Gas/TSSA Inspector.

.9 Hydronic Water Piping: Test to 1-1/2 times maximum working pressure or minimum 1034 kPa (150 psi).

.10 Duct Pressure Tests: Refer to Section 15810.

3.2 Equipment Tests

.1 Perform testing of all equipment as per manufacturer's recommendations and requirements under full operational ranges and submit reports.

.2 Use the services of a qualified Technician and submit report.

3.3 Test Reports

.1 Submit all test reports to Consultant as specified herein within one (1) week of each test completion.

.2 Include a copy of all test reports in the manuals.

.3 Refer to Section 15010 and 15045.

END OF SECTION

PART 1 - GENERAL

1.1 Work Included

.1 Review location of all balancing valves on drawings for air and water systems prior to construction and submit recommendations for additional balancing dampers or balancing valves to perform complete system balancing.

.2 Balance and adjust all new and upgraded air and water systems and equipment and submit reports. Provide additional scope associated with existing equipment where indicated on drawings.

.3 Allow for a minimum of one (1) return visit for any adjustments and/or to work with the Contractor to investigate any issues.

1.2 Scope of Work

.1 Review design drawings and general function of each system including associated equipment, control sequences and operation cycles. Confirm listing of flow and terminal measurements to be performed.

.2 Confirm balancing valve and damper locations are adequate for system balancing. Recommend additional locations to Contractor and Consultant if required to complete system balancing.

.3 Outline procedures for taking test measurements to establish compliance with requirements. Specify type of instrument to be used, method of instrument application and correct factors.

.4 Balance and adjust entire air and hydronic water systems upon completion of the work. Use approved report format as approved by the Consultant to record all results. Submit sample to Consultant for approval prior to balancing.

.5 Contact Consultant during or immediately following balancing procedures to discuss any concerns or issues prior to issuing any reports.

.6 Submit one (1) copy of the Balance Report to the Consultant for review.

.7 Make adjustments as directed by the Consultant. Include for a minimum of one (1) return visit for any adjustments and/or to work with the Contractor to investigate any issues.

.8 Revise report and resubmit to the Consultant for review.

.9 Upon acceptance of the report, include one (1) final accepted copy in maintenance manuals.

1.3 Balance Reports

.1 Use a format acceptable to the Consultant for Reports.

.2 Submit one (1) copy of the report to the Consultant for review within one (1) week from balance completion and prior to inclusion into Maintenance Manuals. Include any comments or concerns from system balancing on report.

.3 Reports shall include equipment data, design data and balance results in metric and imperial units.

.4 Report shall include but not be limited to:

.1 Balancing Company
.2 Balancing Agent who performed the work
.3 Date the balancing was performed
.4 Date of report
.5 Tools and apparatus used for testing including calibration information
.6 System description
.7 Equipment manufacturer, model, serial, arrangement, size, performance (flow, pressure drop), fan size (if applicable), motor size, voltage and amperage
.8 Design and actual air flows (supply air, return air, outside air, relief air)
.9 Design and actual water flows
.10 Setting of balancing valves
.11 Design and actual pressure drops (air and water)
.12 Electrical characteristics
.13 Design and actual motor FLA, RPM
.14 Comments or concerns on findings

1.4 Acceptable Balancing Agencies

.1 Quality Air
Contact: Mike Noonan
Phone: 1-289-691-1015
Email: mike@qualityairdistribution.com

.2 Flowset Balancing
Contact: Chris Pither
Phone: (416) 410-9793 or (647) 321-5114
Email: chrisp@flowset.com

.3 Design Test and Balance
Contact: Surrinder Singh
Phone: (905) 886-6513
Email: mail@designtest.ca

.4 Air Plus Testing
Contact: Jerry Krosinski
Phone: 905-507-8078
Email: info@airplustesting.ca

.5 Air Flow Testing and Balancing
Contact: Paul Livie
Phone: 613-372-2244 OR 613-876-9314

Email: airflowtesting@gmail.com

PART 2 - PRODUCTS

2.1 Equipment

.1 All equipment and products necessary to perform tests shall be provided and covered by the Balancing Agent.

PART 3 – EXECUTION

3.1 General

.1 Coordinate with system installers to confirm location of all balancing dampers and balancing valves. Balance dampers and valves required in addition to those shown on the drawing must be coordinated prior to installation.

.2 Balance to maximum measured flow deviation from specified values of 10% at terminal device and 5% at equipment.

.3 Mark settings on valves, splitters, dampers and other adjustment devices.

.4 Include any required site investigation and system balancing based on any system deficiencies as noted herein.

.5 Contact Consultant during or immediately following balancing procedures to discuss any concerns or issues prior to issuing any reports.

.6 At final inspection, recheck and prove random selections of data recorded in report at discretion and direction of the Consultant.

3.2 Air System Procedure

.1 Adjust air handling and distribution systems to provide required or design supply and return air quantities.

.2 Make air quantity measurements in ducts by pitot tube traverse of entire cross-sectional area of duct.

.3 Measure air quantities at air inlet and outlet.

.4 Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Affect volume control by duct internal devices, such as dampers and splitters.

.5 Vary total system air quantities by adjustment of fan speeds. Vary branch air quantities by damper regulation.

.6 Provide system schematic with required and actual air quantities at each outlet or inlet.

.7 Provide plugs in any holes created in ductwork for readings.

3.3 Water System Procedure – Hydronic Systems

.1 Adjust water systems to provide required or design quantities.

.2 Use calibrated venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.

.3 Adjust systems to provide specified pressure drops and flow through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

.4 Effect system balance with automatic control valves fully open to heat transfer elements.

.5 Effect adjustment of water distribution systems by means of balancing cocks, valves and fittings. Do not use service or shutoff valves for balancing unless indexed for balance point.

.6 Where pump capacity available is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.4 Reports

.1 Submit written reports for all balancing in a format pre-approved by the Consultant as per Scope of Work above.

.2 Submit one (1) copy of the Balance Report to the Consultant for review.

.3 Make adjustments as directed by the Consultant. Include for a minimum of one (1) return site visit as noted herein.

.4 Revise report and resubmit to the Consultant for review.

.5 Fan Test Reports

.1 Report air flow; air pressure at inlet and discharge; fan speed; motor current; motor voltage; manufacturer; model; fan wheel size.
.2 For fans with power greater than 250 watts, plot design and actual pressure and flow on manufacturer's or drafted fan performance curve.

.6 Pump Test Reports

.1 Report designed water flow; water pressure at inlet and discharge; pump speed; motor current; motor voltage; manufacturer; model; impeller size.
.2 For pumps with power greater than 250 watts, plot design and actual pressure and flow on manufacturer's or drafted pump performance curve.

.7 Upon acceptance of the report, provide copies of final report for maintenance manuals.

END OF SECTION

PART 1 - GENERAL

1.1 Work Included

.1 Operating and Maintenance Manuals

.2 Assembly of equipment details sheets and shop drawings including Owner supplied equipment

.3 Assembly of equipment and systems operating and maintenance instructions

.4 Assembly of equipment start up and tests reports

.5 Assembly of Balancing Report

.6 Assembly of final inspection certificates

.7 As-built Drawings

1.2 Related Work

.1 Division 1

.2 General Mechanical Requirements – Section 15010

PART 2 - PRODUCTS

2.1 Operation and Maintenance Materials

.1 Provide electronic submission of complete manual in PDF format to Consultant for review. Preliminary manuals will not be accepted. Electronic submission shall include numbered Table of Contents and all required sections. Sections/subfolder and file names shall be numbered in order to match table of contents, and named to match what they represent (i.e. subfolder name “3. Reports”; file name “Balance Report”). Only PDF documents will be accepted.

.2 Resubmit updates to electronic manual based on Consultant’s review comments until fully accepted.

.3 Once the electronic manual has been fully approved, the Contractor shall provide one (1) electronic copy on USB to the Client. The Contractor shall coordinate with Client and arrange for delivery to requested location. The USB shall contain the complete manual in electronic PDF format as approved by Consultant, and be labeled with permanent affixed label.

.2 Manufacturer’s data section is to be indexed and ordered to match the sections of the specifications.

.3 Assemble or develop complete and correct documentation for the operation and maintenance information for equipment and systems provided.

.4 Assemble or develop copies of all Consultant-reviewed shop drawings and certified material required to complete the documentation. This generally includes but is not limited to the following:

.1 Table of Contents
.2 Contractors and Subcontractors Information
.3 Manufacturer's and Supplier's Information
.4 Warranty Letter
.5 Reports:

.1 Equipment Start-Up Reports
.2 Boiler Pressure Test Reports
.3 Piping Pressure Test Reports
.4 TSSA Certification
.5 Balance Report
.6 Water Treatment Test Report
.7 Electrical Reports (ESA, Emergency Lighting, Fire Alarm, etc.)
.8 Other equipment startup reports and test sheets certified by the manufacturer or a qualified technician
.9 Demonstration Reports/Logs

.7 Shop drawings (stamped reviewed by Consultant)
.8 Maintenance instructions, requirements and schedule
.9 Controls as-built drawings
.10 Training Log
.11 Valve schedule (where applicable)
.12 Colour coding charts for access areas (where applicable)
.13 As-built drawings

2.2 As-built Drawings

.1 As-built drawings shall be kept up-to-date on an ongoing basis during construction for periodic review by the Consultant. As-built drawings shall always be kept in the same location on site known to the Consultant.

.2 Contractors shall certify that final As-built drawings to be correct by notation and signature on the drawings.

.3 As-built drawings shall precisely identify the configuration, size and location of all systems and equipment installed under this Division, including but not limited to:

.1 Heating and Cooling: shut off valves, balancing valves, piping, access doors.
.2 Controls: controllers, panels, devices, relay cabinets, sensors, thermostats, valve operators, wiring and conduit runs complete with legend.

.3 Miscellaneous: actual room names and numbers, schematic diagrams, riser diagrams.

.4 As-built drawings shall be submitted to the Consultant.

2.3 Balance Reports

.1 Refer to Section 15043 – Balancing.

.2 Include a copy of Balance Report in Operating and Maintenance Manuals.

2.4 Test and Start-Up Reports

.1 Refer to section 15042 – Testing, and Section 15010 – General Mechanical Requirements.

.2 Include a copy of all test and start-up reports in Operating and Maintenance Manuals.

.3 Obtain final copies of any 3rd Party test reports for inclusion in Operating and Maintenance Manuals.

2.5 Demonstration Reports

.1 Refer to Section 15010 – General Mechanical Requirements

.2 Include a copy of all Training literature in the Operating and Maintenance Manuals.

.3 Include a copy of the signed and dated Demonstration Log.

PART 3 - EXECUTION

3.1 General

.1 Substantial Completion will not be granted until a draft hard copy of the complete manual has been submitted by the Contractor and reviewed and accepted by the Consultant.

.2 Submit a draft copy of the manual to the Consultant for review prior to final submission of all copies.

.3 Provide two (2) final hard copies and one (1) electronic copy in PDF format to the Consultant for final acceptance.

3.2 As-built Drawings

.1 Upon completion of the work, submit to the Consultant for review, one (1) complete set of clear, legible, red-lined certified As-built Drawings. The Contractor shall certify and sign the completed As-built Drawings.

.2 Substantial completion will not be granted until the As-built Drawings have been submitted to the Consultant.

END OF SECTION

PART 1 - GENERAL

1.1 Welding

.1 Welding materials and labour shall conform to ASME Code and the provincial Regulations.

.2 Use welders fully qualified and licensed by Provincial Authorities.

1.2 Quality Assurance

.1 Gas piping shall meet the requirements of the latest CSA Gas Installation Code.

.2 Domestic water piping shall meet the requirements of the Ontario Building Code and Municipal Codes.

.3 Pipe fittings shall conform to the following standards:

.1 ANSI B36.10, ASTM-197-47 (Materials)
.2 ANSI B16.3 (Malleable Iron Fittings, Threaded)
.3 ANSI B16.9 (Wrought Carbon Steel Fittings, Butt Weld)
.4 ANSI B16.5 (Forged Carbon Steel Flanges, Threaded, Weld Neck or Slip-on)
.5 ANSI B18.2.1 (Carbon Steel Bolts, Hex Head, Course Thread)
.6 ANSI B18.2.2 (Carbon Steel Nuts, Heavy Hex, Course Thread)
.7 ANSI B16.20 (Gaskets)
.8 ANSI B16.39 (Unions)
.9 CSA B242 [M1980(R1998)] (Groove and Shoulder Type Mechanical Pipe Couplings)

.4 All grooved components (couplings, fittings, valves, gaskets, bolts, nuts) shall be of one manufacturer. Acceptable manufacturers: Victaulic.

1.3 Reference Standards and Codes

.1 Ontario Building Code

.2 ASTM

.3 CSA

.4 CGA

.5 ANSI

.6 NFPA

.7 ULC

.8 Local Codes and Requirements

PART 2 – PRODUCTS

2.1 Domestic Water

.1 Domestic water pipe shall be Type “L” hard drawn copper tubing, conforming to ASTM B88.

.2 Fittings shall be wrought copper, solder joint, pressure type.

.3 Solder to threaded adapters shall be provided at screwed valves or equipment.

.4 Unions shall be all bronze construction with ground joint and either solder joint or screwed ends as required. Provide dielectric unions or couplings at all connections between copper tubing and ferrous piping.

.5 Solder: Potable water systems shall be lead free.

2.2 Hydronic Piping

.1 Piping up to including 2”: Piping shall be Black Steel Schedule 40 with malleable steel threaded screwed fittings.

.2 Piping 2” and over: Piping shall be Black Steel Schedule 40 with welded fittings.

.3 Brass adapters shall be provided at all connections between copper tubing and ferrous piping.

2.3 Expansion Loops

.1 Provide expansion loops equal to Flex Hose Tri-Flex Loop Model TFL4 (+/-4" axial), which provides a flexible pipe loop that will absorb and compensate multi-plane movements simultaneously as well as reduce piping stress.

.2 Construction to be 3 equal length sections of annular corrugated stainless steel close-pitch hose with stainless steel overbraid that will absorb or compensate for pipe movements in all 6 degrees of freedom (3 coordinate axes, plus rotation about those axes) simultaneously.

.3 The corrugated metal hose, braids, and a stainless steel ring-ferrule/band (material gauge not less than .048") must be integrally seal-welded using a 100% circumferential, full penetration TIG welds. End fittings shall be selected per application. Fittings must be attached using a 100% circumferential TIG weld.

.4 Braided stainless steel Tri-Flex Loops must be suitable for operating temperatures up to 850 degrees F (455 degrees C).

.5 Expansion Loops shall be designed for pressure testing to 1.5 times their maximum rated working pressure and a minimum 4:1 (burst to working) safety factor.

.6 Each braided expansion loop shall be individually leak tested by the manufacturer using air-under-water or hydrostatic pressure.

.7 Expansion Loops shall be prepared for shipment using a cut-to-length metal shipping bar, tacked securely between the elbows of the two parallel legs, to maintain the manufactured length during shipping. Shipping bar must be removed prior to system start-up.

.8 The hanger assembly kit shall be used to support and hang the expansion loop.

.9 The ULC Listed Seismic Wire/Cable assemblies conform to the requirements of the ASCE (American Society of Civil Engineers) guidelines for structural applications of wire rope, in that the cable is pre-stretched and the permanent end fittings maintain the break strength of the cable with a safety factor of two.

.10 The pre-manufactured flexible loop shall be installed as per manufacturer's printed installation instructions. Other manufactured loops that require pipe alignment guides shall use "Spider" type with outer housing ring. Units shall be fabricated from carbon steel. Pipe hangers and/or roller supports shall not be considered acceptable for use as guides.

.11 Expansion loops must have a 5-year full product replacement warranty.

2.4 Condensate Piping

.1 Black Steel Schedule 40 with malleable steel threaded screwed fittings or

.2 Type K or L hard copper complete with cast brass or wrought copper drainage fittings with solder joints or

.3 IPEX XFR.

2.5 Equipment Drains (except boiler breeching drains)

.1 Galvanized steel schedule 40 with galvanized threaded fittings or

.2 Type K or L hard copper complete with cast brass or wrought copper drainage fittings with solder joints or

2.6 Boiler Breeching Drains

.1 CPVC and stainless steel complete with neutralizer. Refer to detail on drawings.

2.7 Aboveground Drainage, Venting and Storm

.1 Pipe up to and including 50mm (2") for services **except urinals** shall be:

.1 Copper DWV pipe complete with cast brass or wrought copper drainage fittings with solder joints, use 50/50 solder and matching flux for copper drain, waste, and vent piping or
.2 Cast iron MJ pipe with MJ fittings and stainless steel clamps. Clamps shall be two-band type.

.2 Pipe 75mm (3") and up shall be:

.1 PVC DWV 40 System 15 complete with PVC drainage fittings with solvent weld joints (in concealed areas only, not acceptable in ceilings spaces) or
.2 Cast iron MJ pipe with MJ fittings and stainless steel clamps. Clamps shall be two-band type.

2.8 Drainage System (Underground)

.1 Pipe up to and including 75mm (3") shall be:

.1 ULC certified PVC 40 DWV pipe to CAN/CSA B181.2 complete with PVC DWV fittings to CAN/CSA B181.2 with solvent weld joint.

.2 Pipe 75mm (3") up to and including 100mm (4") shall be:

.1 ULC certified PVC 40 DWV pipe to CAN/CSA B181.2 complete with PVC DWV fittings to CAN/CSA B181.2 with solvent weld joint, or
.2 ULC certified PVC SDR 28/35 BDS pipe to CAN/CSA B182.1 complete with PVC BDS fittings to CAN/CSA B182.2 with solvent weld joints.

.3 Pipe 125mm (5") and up shall be

.1 ULC certified PVC SDR 28/35 sewer pipe to CAN/CSA B182.2 complete with PVC fittings to CAN/CSA B182.2 with ring gasket joints.

2.9 Plumbing Vent Stacks

.1 Plumbing vent stacks shall be 18" (457 mm) high, vandal proof, 0.064" (1.6 mm) mill finish 1100-0T alloy aluminum, to CSA B272-93, with aluminum hood and perforated collar, thick pre-molded urethane insulation liner and EPDM Base Seal, bituminous painted deck flange or to match type of roofing system. Equal to Thaler SJ-31, STACK JACK Flashing.

2.10 Connections

.1 Unions

.1 Use extra heavy duty pattern unions with ground joints, brass seats and

threads to ANSI B1.20.1 for connections 50mm (2") and under.

.2 Rated for minimum 150 psi.

.2 Flanges

.1 Use standard weight type flanges to ANSI B16.1 with neoprene gaskets for connections 63mm (2½") and over.

.2 Rated for minimum 125 psi.

.3 Adapters

.1 Brass adapters shall be provided at all connections between copper tubing and ferrous piping.

2.11 Strainers

.1 Sizes 50mm (2") and under: Screwed brass or iron body, Y pattern with 0.8mm stainless steel perforated screen.

.2 Sizes 63mm to 100mm (2½" to 4)": Flanged iron body, Y pattern with 1.2mm stainless steel screen.

.3 Screen free area shall be minimum three times area of inlet pipe. Provide valved drain and hose connection off strainer bottom.

.4 Grooved end strainers: where grooved end piping systems are allowed shall be rated for 300 PSI (2065 kPa) Y-Type Strainer shall consist of ductile iron body, Type 304 stainless steel cylindrical removable baskets with 1/16" (1,6mm) diameter perforations and 41% open area 2"-3" strainer sizes or 1/8" (3,2mm) diameter perforations and 40% open area 4"-12" strainer sizes. Acceptable material: Victaulic Style 732.

2.12 Natural Gas Piping

.1 Sizes 50mm (2") and under: ASTM A53 Schedule 40 seamless wrought steel with standard threaded malleable fittings to ANSI B16.3.

.2 Sizes over 50mm (2"): ASTM A53 Schedule 40 seamless wrought steel with wrought steel butt welding fittings to ANSI B16.9.

.3 Welding materials and labour shall conform to ASME codes and authorities having jurisdiction.

.4 Provide regulators as required and vent as per code.

.5 Gas vents shall not be within 3m (10') to any natural or mechanical fresh air intakes.

.6 Gas Regulators

.1 Gas regulators shall be complete with internal relief. Where installed indoors, vent to outdoors.
.2 Size using an inlet pressure of 2lb, an outlet pressure of 7" w.c. and a capacity to suit equipment served.
.3 Acceptable Manufacturers: Sensus as supplied by Ontor, Maxitrol, Fisher.

2.13 Firestop Sealants and Collars

.1 Provide firestop sealants around all pipe penetrations through rated separations.

.2 Provide firestop collars for all combustible pipe penetrations through rated separations (where combustible piping is approved).

.3 Intumescent insert: Flexible, elastomeric strip, two stage expansion, designed to firestop penetrations in fire-rated walls and floors and floor/ceiling assemblies.

.4 Provide a minimum of 15 time free expansion.

.5 Sealants shall not contain water soluble expansion ingredients.

PART 3 - EXECUTION

3.1 General

.1 Apply for permit before beginning any work. Have drawings approved for construction by authorities having jurisdiction or local agencies prior to beginning work.

.2 Review all inverts and elevations before beginning any installation.

.3 Have entire installation inspected, at various stages where required, to ensure approval at completion of project.

.4 Provide clearance for proper installation of insulation and for access to components including but not limited to valves, air vents, drains and unions.

.5 Maintain proper grades on piping for proper drainage and provide valves at all low points.

.6 All sanitary lines shall be sloped 1:50.

.7 All gas piping installations shall comply with CGA code CAN 1-B149, gas safety branch bulletins, local codes and NFPA 96. Provide a CGA approved ball valve where new equipment is to be connected.

.8 Install gas piping in open or ventilated spaces. Pitch lines and provide drip legs

for condensation collection points. Where gas piping is run in a concealed space, provide ventilation grilles as required.

.9 All exposed piping to run parallel to walls and in a neat and orderly fashion to maintain headroom. Group piping where possible.

.10 Do not run combustible or nonapproved pipe through fire separations or return air ceiling plenums. Use approved materials and methods only.

.11 Provide drain valves and air vents at low and high points respectively where required.

.12 Make connections to equipment with unions or flanges. Provide dielectric unions or couplings at all connections between copper tubing and ferrous piping or non-conducting type connections for jointing dissimilar metals.

.13 Install piping to allow for expansion and contraction and to eliminate stress on equipment, piping, or connections.

.14 Provide isolation valves or shutoff valves at all equipment.

.15 Provide cleanouts as indicated on drawings and as required by code. Floor cleanouts are not approved in finished floor areas unless otherwise noted. Ensure adequate clearance to all cleanouts.

.16 Provide sleeves for piping passing through floor slab. Caulk around piping and fill entire space between piping and floor slab with approved fire retardant material to maintain required fire rating where necessary.

.17 Provide fire stop sealant at all pipe penetrations through fire separations.

3.2 Natural Gas Piping

.1 All gas piping installations shall comply with CGA code CAN 1-B149, gas safety branch bulletins, local codes and NFPA 96. Provide a CGA approved ball valve where new equipment is to be connected.

.2 Coordinate replacement of existing gas meter with new gas meter with Enbridge (if required).

.3 Install gas piping in open or ventilated spaces. Pitch lines and provide drip legs for condensation collection points. Where gas piping is run in a concealed space, provide ventilation grilles as required.

.4 Provide dog house for all gas piping through roof. Refer to details on drawing.

.5 Provide union, valve and drip leg at final connection to all equipment. Drip leg shall be minimum 50mm (2”) above any floor or roof level.

.6 Refer to Section 15090 for piping supports and roof block supports.

.7 Gas Regulators

.1 Provide regulators as noted on drawings and as required, sized in accordance with loads and equipment as required. Where installed indoors, vent to the outdoors.

.2 Gas pressure regulating valve relief pipe is to be extended upward and remote from the gas vent and the fresh air intake, in compliance with current codes. Provide support and bracing as required.

.8 Testing and Inspections

.1 The Contractor shall perform a soap test and electronic test.

.2 Arrange and pay for a gas inspection by the local Gas/TSSA Inspector.

3.3 Steel Pipe Connection

.1 Screw joint steel piping up to and including 38mm (1½"). Screw or weld 50 mm (2") piping. Weld piping 63mm (2½") and larger, including branch connections. Pipe less than schedule 40 shall not be screw jointed.

.2 Make screwed joints with standard NPT configuration. Use approved nontoxic joint compound or teflon tape.

.3 Use full sized tees or main sized saddle type branch connections for directly connecting branch lines to mains in steel piping. Do not project branch pipes inside the main pipe.

.4 Make reductions in large water pipes with eccentric reducing fittings installed to provide drainage and venting.

3.4 Grades, Routes and Installations

.1 Route piping in orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space.

.2 Run exposed piping parallel to walls. Group piping wherever practical at common elevations.

.3 Install concealed pipes close to the building structure to keep furrings to a minimum.

.4 On closed systems, equip low points with 19mm (¾") drain valves and hose connection.

.5 At high points, provide collecting chambers and high capacity float operated automatic air vents.

3.5 Expansion Loops

.1 Provide expansion loops in piping systems as indicated on drawings and specified herein.

.2 The hanger assembly kit shall be used to support and hang the expansion loops.

.3 The pre-manufactured flexible loop shall be installed as manufacturer's installation instructions. Other manufactured loops that require pipe alignment guides shall use "Spider" type with outer housing ring. Units shall be fabricated from carbon steel. Pipe hangers and/or roller supports shall not be considered acceptable for use as guides.

3.6 Flashing

.1 Where mechanical equipment passes through weather or waterproofed walls and roofs, all roofing including flashing shall be provided under this Division.

.2 Flash floor drains over finished areas by extending flashing 250mm (10”) clear on sides. Fasten flashing to drain clamp device. Use lead sheet or approved nonmetallic waterproofing membrane.

3.7 Sleeves

.1 Where piping passes through floor, ceiling or wall, close off space between pipe and sleeve with noncombustible insulation or approved non combustible insulation, fire rated as required to match the rating of the penetrated surface. Provide tight fitting metal caps on both sides.

.2 Install chrome plated escutcheons where piping passes through finished surfaces.

.3 Size large enough to allow for movement due to expansion and to provide for continuous insulation.

3.8 Identification

.1 Paint all gas piping with two (2) coats of paint.

.2 Identify all piping with type of service and arrows in direction of flow every 3m (10’) and on either side of walls and floors. Labels shall be permanent and pre-approved by the Consultant. Label on exterior of insulation. Match existing labeling where applicable.

.3 Refer to Section 15010.

3.9 Testing

.1 Test drains for tightness and grade as noted or required by code.

.2 Refer to testing procedures in Section 15042.

3.10 Cleaning and Treatment

.1 Leave temporary pump screens in place during flushing.

.2 Thoroughly flush domestic water systems upon completion of work.

.3 Flush, clean and treat heating piping systems before and after testing.

.4 Remove temporary pump screens after flushing and cleaning and leave on site for witness by Consultant.

.5 Leave all filters used during flushing and cleaning on site for witness by Consultant.

.6 Refer to cleaning and treatment section 15095.

END OF SECTION

PART 1 - GENERAL

1.1 Quality Assurance

.1 Domestic water pipe supports shall meet the requirements of Ontario Building Code.

.2 Natural gas pipe supports shall meet the requirements of CGA B149.1, Gas Installation Code.

.3 Hydronic water pipe supports shall meet the requirements of ANSI B31.

.4 Duct hangers shall follow the recommendations of the SMACNA Duct Manuals.

1.2 General Requirements

.1 Provide hangers and supports to secure equipment in place, prevent vibration, maintain grade and provide for expansion and contraction.

.2 Install supports of strength and rigidity to suit loading without unduly stressing building. Locate adjacent to equipment to prevent undue stresses in piping and equipment.

.3 Select hangers and supports for the service and in accordance with the manufacturer's recommended maximum loading. Hangers shall have a safety factor of 5 to 1.

.4 Obtain approval prior to drilling for inserts and supports for piping systems.

.5 Obtain approval prior to using percussion type fastenings.

.6 Use of other piping or equipment for hanger supports is not permitted.

.7 Use of perforated band iron, wire or chain as hangers is not permitted.

1.3 Firestop Sealants and Collars

.1 Standard method of fire tests of firestop system CAN4-S115-M85.

.2 UL Classified and/or FM Systems Approved and tested to the requirements of ASTM E814 (UL1479).

.3 Seals, assemblies and materials for penetration of fire rated surfaces shall be listed by FM and certified by UL or ULC for the service application.

1.4 Submittals

.1 Firestop materials: Submit service limitations, installation instructions, UL certification and FM listing.

.2 Fire rated penetration seals: Submit dimensional data, service limitations, installation instructions, UL certification and FM listing.

PART 2 - PRODUCTS

2.1 Inserts

.1 Inserts shall be malleable iron case or galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods and lugs for attaching to forms.

.2 Size inserts to suit threaded hanger rods.

2.2 Suspended Mechanical Equipment:

.1 Suspend mechanical equipment from structure with adjustable length steel rods, threaded both ends or continuous threaded, complete with lock nuts on both ends. Provide spreader beams to distribute weight.

.2 Construct supports of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.

.3 Provide anchors, bolts and accessories required for mounting and anchoring equipment.

2.3 Pipe Hangers and Supports

.1 Pipe hangers shall wrap around outside of insulation for all sizes. Exception will apply for hot water piping only in limited ceiling clearance applications. Piping shall be provided with insulation flashing of heavy gauge metal to prevent crushing and hanger sized for exterior of insulation.

.2 Hangers:

.1 Pipe Sizes 13mm (½”) to 38mm (1½”): Adjustable wrought steel ring, or plated strap.
.2 Pipe Sizes 50mm (2”) and over: Adjustable wrought steel clevis.
.3 Hanger Rods: Provide steel hanger rods, threaded both ends or continuous threaded, complete with lock nuts on both ends.
.4 Saddles shall wrap around the outside of the insulation for all piping and be sized accordingly.
.5 In limited ceiling clearance applications for pipe sizes up to and including 38mm (1½”), split ring standoff hangers or adjustable band hangers shall be acceptable. Obtain pre-approval from Consultant prior installation on site.

.3 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods, cast iron roll and stand for hot pipe sizes 150mm (6 “) and over.

.4 Wall Support:

.1 Pipe Sizes to 75mm (3”): Cast iron hook, or fabricated bracket of 1”x1”x¼” angle bar.
.2 Pipe Sizes 100mm (4”) and over: Welded steel bracket and wrought steel clamp.

.5 Vertical Support:

.1 Steel riser clamp.

.6 Floor Support:

.1 Fabricated stand and pipe clamp or saddle.

2.4 Natural Gas Piping Roof Supports

.1 Gas pipe support systems shall be continuous block channel supports equal to “DURA-BLOK” DB-Series or DB6-Series as supplied by Cooper B-Line, Inc.

.2 Alternate products must meet or exceed the same physical and performance characteristics as per the following:

.1 Density: 0.52 oz/cu in ASTM C642
.2 Durometer Hardness: 67.2A ± 1 ASTM D2240
.3 Tensile Strength: 231 psi minimum ASTM D412
.4 Compression Deformation: 5% at 70psi and 72ºF ASTM D395
.5 Brittleness at Low Temp: -50ºF ASTM D746
.6 Freeze and thaw when exposed to deicing chemicals: No loss after 50 cycles ASTM C672
.7 Coefficient of Thermal Expansion: 8 x 10-6 in/in/ºF (min) ASTM C531
.8 Weathering: 70 hours at 120ºF ASTM D573
.9 Hardness retained: 100% (±5%)
.10 Compressive strength: 100% (±5%)
.11 Tensile strength: 100% (±5%)
.12 Elongation retained: 100% (±5%)

.3 Curb base shall be made of 100% recycled rubber and polyurethane prepolymer with a uniform load capacity of 500 pounds per linear foot of support. Each base to have a reflective yellow stripe.

.4 Dimensions: 6-inches wide by 5/6.75 inches tall by 9.6/20.2/30.8/41.4/52.0 inches long to suit pipe size.

.5 Steel frame: Steel, 14ga strut galvanized per ASTMA653 or 12ga strut galvanized per ASTMA653 for bridge series.

.6 Attaching hardware: Zinc-plated threaded rod, nuts and attaching hardware per ASTM B633.

2.5 Duct Hangers and Supports

.1 Hangers:

.1 Concealed - Round Duct: Galvanized steel band iron.
.2 Concealed - Rectangular Duct: Galvanized steel band iron or rolled angle and 9mm rods.
.3 Exposed - Round Duct: continuous galvanized steel band iron secured to single 9mm (1/4”) hanger rod.

.2 Wall Supports: Galvanized steel band iron or fabricated angle brackets.

.3 Vertical Support at Floor: Rolled angle.

.4 Support rectangular ducts 1530mm and less in width or depth with 25mm wide 1.3mm or heavier galvanized bent hangers fastened to the side and bottom of the duct at a spacing of not greater than 2240mm using bolts, rivets, or metal screws.

.5 Support duct over 1530mm in width or depth with 10mm vertical hanger rods, bolted to galvanized steel angles at 610mm intervals.

.6 Support round ducts up to 910mm with 25mm wide, 1.0mm thick single galvanized steel traps and 9mm diameter rods. Support larger ducts with 25mm wide, 1.6mm thick double, horizontally split galvanized steel strap and two (2) 9mm diameter rods. Space support at 3600mm intervals.

.7 Where vertical ducts pass through floors, support with galvanized steel angles riveted and/or bolted to the cut and bearing on the structure.

2.6 Equipment Bases and Curbs

.1 Equipment bases and curbs shall be provided by the Mechanical Contractor under this Division.

.2 Equipment bases shall be formed concrete housekeeping pads minimum 100mm (4“) high, extended 150mm (6“) minimum beyond machinery bedplates.

.3 Provide mounting plates to be formed into pads.

.4 Curbs shall be formed concrete minimum 100mm (4”) high around all ducts and pipes through mechanical room floors.

2.7 Flashing

.1 Steel Flashing: 26 gauge galvanized steel.

.2 Aluminum flashing: 26 gauge sheet aluminum.

2.8 Sleeves

.1 Pipes through beams, wall, fire proofing, footings, floor: form with steel pipe, schedule 20, galvanized.

.2 Round Ducts: form with galvanized steel.

.3 Rectangular Ducts: form with galvanized steel.

2.9 Firestop Sealants and Collars

.1 Firestop Sealants and collars for penetrations utilizing nonmetallic cables or combustible pipe insulations as the penetrant.

.2 Intumescent insert: Flexible, elastomeric strip, two stage expansion, designed to firestop penetrations in fire-rated walls and floors and floor/ceiling assemblies.

.3 Provide a minimum of 15 time free expansion.

.4 Contain no water soluble expansion ingredients.

2.10 Roof Jacks and Vent Caps

.1 Aluminum: Compatible with SBS torch down roofing materials and methods, 12 gauge aluminum, 12mm round flange, oversize tube neck TIG welded to flange, aluminum flashing cap.

.2 Vent Caps: Vandal resistant; heavy gauge aluminum, slotted vents, screw secured.

2.11 Plumbing Vent Stacks

.1 Plumbing vent stacks through roof shall be minimum 450mm high double wall, Thaler or Lexcan Hi Tuff membrane to match type of roofing system used.

PART 3 – EXECUTION

3.1 Inserts

.1 Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.

.2 Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over 100mm (4”) or ducts over 1500mm (60”) wide.

.3 Where concrete slabs form finished ceiling, finish inserts flush with slab surface.

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

.5 Expansion bolt type connections will be approved under certain conditions. Obtain approval from the Consultant. Generally, pipe 50mm (2") or smaller, and ducts less than 600mm x 300mm (24" x 12") will be approved, subject to adequate number of support points.

3.2 Suspended Mechanical Equipment:

.1 Suspend mechanical equipment from structure with adjustable length steel rods. Provide spreader beams to distribute weight.

.2 The threaded rod shall be secured to trusses or to steel angle bars spanning the building trusses. The steel spanning bars are to be provided by this Division.

.3 Construct supports of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.

.4 Provide anchor bolts and accessories required for mounting and anchoring equipment.

.5 Provide rigid anchors for ducts and pipes immediately after vibration connections to equipment.

3.3 Pipe Hangers and Support

.1 Fasten hangers and supports to building structure or inserts in concrete construction.

.2 Support horizontal metallic piping as follows:

Nominal Pipe Size	Distance Between Supports	Hanger Rod Diameter
13mm (½")	1.8m (6')	9.5mm (3/8")
19 to 38mm (¾" to 1½")	2.4m (8')	9.5mm (3/8")
50 to 63mm (2" to 2½")	3.0m (10')	9.5mm (3/8")
63 to 100mm (3" to 4")	3.6m (12')	13mm (½")
150 to 300mm (6" to 12")	4.3m (14')	13mm (½")
350 to 450mm (14" to 18")	5.0m (16')	25mm (1")

.3 Install hangers to provide minimum 32mm (1¼") clear space between finished covering and adjacent work.

.4 Place a hanger within 300mm (12") of each horizontal elbow.

.5 Use hangers which are vertically adjustable 38mm (1½") minimum after piping is erected.

.6 Support vertical piping at every floor.

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

.8 Where practical, support riser piping independently of connected horizontal piping.

.9 Exposed piping, with less than 2.6m (8½ ft) clearance to floors shall be provided with two times the number of hangers normally required. Spacing shall be equal or adjusted for maximum benefit.

.10 Provide copper plated hangers and supports for copper piping or provide nonferrous packing between hanger support and piping.

.11 Large capacity piping with vibration potential shall not be suspended from any building structure that will allow transfer of vibrations to the occupied spaces.

.12 Obtain preapproval from Consultant for the use of split ring standoff hangers or adjustable band hangers for use in limited ceiling clearance applications only. Hanger shall not be required to wrap around outside of insulation in this application only.

3.4 Natural Gas Piping Roof Supports

.1 Install in accordance with manufacturer's instructions and recommendations.

.2 If gravel top roof, gravel must be removed around and under pipe support.

.3 Where possible, consult roofing manufacturer for roof membrane compression capacities. If necessary, a compatible sheet of roofing material (rubber pad) may be installed under rooftop support to disperse concentrated loads and add further membrane protection.

.4 Space in conformance with Gas Code and local authorities.

.5 Use properly sized clamps to suit pipe sizes.

3.5 Duct Hangers and Supports

.1 Hanger minimum sizes:

.1 Up to 750mm (30") wide or 330mm (13") diameter: 1¼" x 16 gauge at 3m (10ft) spacing.
.2 750mm (30") to 1200mm (48") wide or up to 450mm (18") diameter: 1½" x 16 gauge at 3m (10ft) spacing.
.3 Over 1200mm (48") wide: 1½" x 16 gauge at 3m (10ft) spacing.

.2 Horizontal duct on wall supports minimum sizes:

.1 Up to 450mm (18”) wide: 1½” x 16 gauge or 1“ x 1“ x 1/8“ at 3m (10’) spacing.
.2 450mm (18”) to 1000mm (40”) wide: 1½” x 1½” x 2” at 1.8m (6’) spacing.

.3 Vertical duct on wall supports minimum sizes:

.1 Riveted or screwed to duct:

.1 Up to 1500mm (60”) wide: 1½” x 1½” x 3”
.2 Over 1500mm (60”) wide: 2” x 1/8”

.4 Vertical duct floor supports minimum sizes:

.1 Riveted or screwed to duct:

.1 Up to 1500mm (60”) wide: 1½” x 1½” x 1/8”
.2 Over 1500mm (60”) wide: 2” x 2” x 1/8”

3.6 Equipment Bases and Curbs

.1 Coordinate installation of concrete housekeeping pads for all new floor mounted equipment with supplied equipment.

.2 Pads shall be 100mm (4“) high minimum, extended 150mm (6“) minimum beyond machinery bedplates. Obtain templates, anchor bolts and accessories required for mounting and anchoring equipment.

.3 Construct supports of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.

.4 Provide rigid anchors for pipes immediately after vibration connections to equipment.

.5 Provide curbs around all ducts and pipes through mechanical room floors.

.6 Paint all sides and around top 12” (300mm) edge of concrete equipment bases with two (2) coats of yellow paint.

3.7 Flashing

.1 Where mechanical equipment passes through weather or waterproofed walls and roofs, roofing, flashing and counter flashing shall be provided under this Division.

.2 Curbs must be minimum 600mm (24”) higher than the top of the roof, unless noted otherwise. Flash and counterflash with galvanized steel, to make waterproof.

.3 Flash floor drains over finished areas by extending flashing 250mm (10") clear on sides. Fasten flashing to drain clamp device. Use lead sheet or approved nonmetallic waterproofing membrane.

3.8 Sleeves

.1 Provide sleeves required for equipment, including openings required for placing equipment.

.2 Set sleeves in position in advance of other work. Provide suitable reinforcing around sleeves.

.3 Where piping passes through floor, ceiling or wall, close off space between pipe and sleeve with noncombustible insulation and fire rate as required to match the rating of the penetrated surface. Provide tight fitting metal caps on both sides.

.4 Extend sleeves through potentially wet floors 50mm (2") above finished floor level. Caulk sleeves full depth and provide floor plate.

.5 Where ductwork passes through floor, ceiling or wall, close off space between duct and sleeve with noncombustible insulation. Provide tight fitting metal caps on both sides.

.6 Where piping passes through floor, ceiling or wall, close off space between pipe and sleeve with noncombustible insulation or approved non-combustible insulation, fire rated as required to match the rating of the penetrated surface. Provide tight fitting metal caps on both sides.

.7 Install chrome plated escutcheons where piping passes through finished surfaces.

.8 Size large enough to allow for movement due to expansion and to provide for continuous insulation.

3.9 Firestop Sealants and Collars

.1 Clean all concrete, masonry and stone penetrations of all contaminants and impurities, concrete form release agents, water repellents, oils, surface dirt and rust, scale, all old sealants and other surface treatments.

.2 Metal surfaces shall be cleaned by wiping them with an oil- free absorbent cloth saturated with solvent such as xylol or toluol. Do not use alcohols.

.3 Do not apply to polycarbonates or to building materials that bleed oils, plasticizers or solvents, or where sealant is not exposed to atmospheric moisture, or to surfaces which have been or will be painted.

.4 Collars are to be installed with steel fasteners or steel expansion anchors. Low melting temperature anchors of lead, plastic or aluminum are not approved.

.5 Installation only when temperatures are between 4°C (40°F) and 37°C (98°F).

3.10 Roof Jacks

.1 Provide roof jacks as required, and in compliance with the roofing specifications. Generally, SBS torch down roofing requires aluminum roof jacks. Conventional bituminous roofing accepts lead or aluminum roof jacks.

.2 Flash pipes projecting above finished roof surface with approved material.

.3 Gas pipes projecting through the roof shall be provided with approved roof jack and flashing flange.

END OF SECTION

PART 1 - GENERAL

1.1 Quality Assurance

.1 Provide chemical treatment, chemicals and equipment by an agency that specializes in this type of work. Agency shall take full responsibility for providing suitable working systems. All glycol and treatment products shall be supplied by the approved water treatment company.

.2 Notify the Owner and the Consultant prior to commencing treatment, testing or cleaning operations.

.3 Confirm all chemicals used are applied and disposed of in compliance with all guidelines, codes, regulations and requirements of Federal, Provincial, and local governments and local sewage and storm water disposal utilities.

1.2 General

.1 The Mechanical Contractor shall retain the services of the approved water treatment company to supply and install a complete water treatment system which meets the requirements for the control and prevention of fouling and corrosion in all new HVAC water systems.

.2 The following are the minimum requirements of the acceptable Water Treatment Vendor:

.1 Must be in business for a minimum of 10 years in treating industrial water applications.
.2 Must be I.S.O. certified for the manufacture and sales of water treatment chemicals.
.3 Must possess Certificate of Accreditation from Contractor Check.
.4 All biocides must be registered under the Pesticide Control Product ACT.
.5 Must have at least one (1) Professional Engineer on staff.

1.3 Submittals

.1 Submit technical information, including proposed chemicals, quantities, and calculations, procedures and equipment to be supplied. Provide written operating instructions and system schematics.

.2 Provide Material Safety Data Sheets with all chemicals. Provide one complete set posted on site when material is delivered to site. Provide complete sets for the Maintenance Manuals.

.3 Provide written report containing log and procedure of system cleaning giving times, dates, problems encountered and condition of water.

1.4 Warranty

.1 Provide one (1) year warranty for all products.

1.5 Acceptable Manufacturers

.1 MK Services and Consulting Inc.
719 Robinson Drive, Cobourg, ON K9A 0H3
Kristen Riley,1-905-376-5779

PART 2 - PRODUCTS

2.1 Closed System(s) Water Treatment:

.1 Provide complete water treatment equipment and chemicals for corrosion protection and sidestream filtration for each upgraded closed system (hot, chilled, & glycol loops).

.2 Each Closed System to include the following water treatment equipment:

.1 One (1) Bypass Feeder, 2 US Gallon (7.5L), rated for 300 PSI @ 200°F, 4 @ ¾" ports (2 upper, 2 lower), carbon steel construction, blue epoxy finish, cast steel 3½" threaded closure high pressure cap with epoxy coated platen and Buna o-ring. Equal to General Filtration PF2X4HP, 20" (508mm) high x 6.26" (159mm) diameter, 27.5lb.

.2 One (1) Bypass Filter Unit with the capacity to handle 2.5-5% of the recirculating pump flow rate, rated for 175 PSI @ 200 °F, cast iron head, 304 stainless steel body, Buna-N head gasket, carbon steel centre post design, ¾" NPTF inline inlet & outlet connections, ¼" NPTF drain connection, suitable for standard DOE 2½" – 2¾" diameter cartridge. Equal to General Filtration GF010 for 10" cartridges or GF020 for 20" cartridges.

.3 Case of 30 filter cartridges, 20 micron removal rating, polypropylene media for water filtration with 200°F maximum temperature (or alternate to suit system), tin-free steel core with 400°F maximum temperature resistance. Equal to Viper Series Precision Wound Filter Cartridges.

.4 Site Flow Indicator, 304 stainless steel body with stainless and nylon internals, nickel plated steel fused class cap, rated for 150 PSI @ 212°F, ¾" NPT = 4-8gpm, 1" NPT = 7-11gpm, 2" NPT (bronze body) = 25-60gpm. Equal to STS (Specified Technical Sales Ltd.) Filter-Mate.

.3 Provide sufficient new system cleaner equal to MK "NC Clean" to initially clean the closed system(s).

2.2 Provide sufficient MK CL 100 Nitrite/Metaborate based corrosion inhibitor to treat the closed system(s) and to maintain required control levels until substantial completion.

2.3 Provide sufficient glycol to fill the glycol systems.

2.4 Aluminum boiler chemistry. In the event that aluminum boilers are used in hot-water heating applications, chemicals must be compatible to maintain a pH of 6.5 – 8.5, or as per manufacturer's specifications.

PART 3 - EXECUTION

3.1 Closed System(s):

.1 Equipment Installation

.1 Install the feeder, filter, flow indicator and site glass in a bypass arrangement and in parallel across the headers of the primary pump set as per schematic on drawings.
.2 Isolation, venting and drain valves should be installed as per installation drawing and on-site instruction by water treatment representative. Installation connections, as required are the responsibility of the Mechanical Contractor.

.2 System Flushing

.1 Thoroughly flush each closed system(s) with raw water to remove loose mill scale and debris. Remove and clean all strainers and flush low points before chemical cleaner is added to the system.
.2 Add system cleaner at amount per system volume as per manufacturer's requirements for the removal of oil, mill scale and iron oxides. Circulate for a minimum of 24 hours and flush. Repeat fill and flush procedure as often as required as per the instructions of the water treatment representative until water is sufficiently clean and clear.
.3 Acceptability of water condition to be determined through testing and visual examination of representative water samples, by the water treatment supplier. Copies of test reports should be submitted by the water treatment supplier to the Mechanical Contractor for verification to the Consultant.
.4 Add corrosion inhibitor at amount per system volume to the final water fill, as per manufacturer's requirements, to achieve prescribed Nitrite maintenance levels for corrosion protection.
.5 Insert cartridges into filter canister and replace as needed.
.6 Leave all used filters on site for witness by the Consultant.

.3 Temporary Pump Strainers

.1 Temporary pump strainers (as supplied with pumps) shall remain in place during flushing and cleaning.
.2 Remove temporary strainers after flushing and cleaning is complete and leave on site for witness by the Consultant.

3.2 Glycol Systems

.1 Fill system with 40% propylene glycol.

3.3 Maintenance

.1 Maintain inhibitor levels and other water quality control ranges as they apply, from the time the system is brought on-line, after flushing and cleaning, up to

Substantial Performance of contract. The chemical supply allotment provided by the water treatment supplier is effective from the time the system is brought online.

.2 The water treatment supplier shall provide all necessary supervision during installation and shall test the systems over the course of the construction period to ensure that proper treatment is being maintained, up to Substantial Completion. Reports generated by the water treatment supplier and are to be compiled for the Consultant's review.

.3 The water treatment supplier shall provide chemical supply and service until Substantial Completion.

3.4 Test Reports

.1 Supply the Consultant with certified documentation from the water treatment supplier that the systems have been properly equipped, chemically cleaned and that they are maintaining sufficient levels of scale and/or corrosion inhibitor.

.2 Test reports shall be received and accepted by the Consultant prior to substantial completion.

3.5 Storage

.1 All chemicals shall be stored off site. No chemicals are permitted to be left on site at any time.

END OF SECTION

PART 1 - GENERAL

1.1 Manufacturer

.1 Provide valves of same manufacturer throughout where possible.

.2 Provide valves with manufacturer's name and pressure rating clearly marked on outside of body.

1.2 Quality Assurance

.1 Valves for gas service shall be trimmed and approved for specified service.

.2 All valves shall meet all MSS, ANSI and ASME manufacturing standards.

1.3 Submittals

.1 Refer to Section 15010 – Mechanical General Requirements.

.2 Manufacturer’s data and shop drawings for all valves and accessories including dimensions, pressure ratings, materials, service acceptability.

PART 2 - PRODUCTS

2.1 General

.1 All valves must be of threaded or flanged type.

.2 Valves 300mm (12”) and larger located with stem in the horizontal position shall be drilled and taped to accommodate a drain valve and equalizing bypass valve assembly.

.3 No yellow brass valves will be allowed.

.4 Wafer style valves (except check valves) are not allowed.

2.2 Valve Connections

.1 Provide valves suitable to connect to adjoining piping as specified for pipe joints. Use pipe size valves.

.2 Thread pipe sizes 50mm (2“) and smaller.

.3 Flange pipe sizes 63mm (2½”) and larger.

.4 Solder or screw to solder adaptors for copper piping.

.5 Use grooved body valves with mechanical grooved jointed piping where approved only.

.6 Provide butterfly valves with tapped lug body when used for isolating service.

2.3 Check Valves - Hydronic

.1 Bronze, swing disc, solder or screwed ends.

.2 Iron body, bronze trim, swing disc, renewable disc and seat, flanged ends.

.3 Iron body, bronze trim, spring loaded, renewable composition disc, flanged ends.

.4 Acceptable Models:

.1 Jenkins 587J
.2 NH T651
.3 Kitz #78
.4 Red & White (Toyo) #435

.5 Grooved end (where approved), working pressure to 300 psi (2065 kPa).
Sizes 2-4": Ductile iron body and 316 stainless steel clapper. EPDM, Nitrile or optional Viton Bumper & Bonnet seals. Stainless steel wetted parts.
Manufacturer: Victaulic Series 716;
Sizes 4-14": Ductile iron disc, elastomer encapsulated suited for the intended service, stainless steel spring and shaft, welded-in nickel seat. Valve inlet is drilled, with venturi-like taps and plugged for flow kit (included with valve). Twin taps on both sides of valve for meter connections and flow measurement.
Manufacturer: Victaulic Series 779.

2.4 Check Valves - Domestic

.1 2 inches (50mm) and smaller: Class 125/200PSI, lead free bronze body and cap, bronze seat, solder or threaded ends. Equal to Kitz #822 and #823.

.2 2.5 inches (63mm) and larger: To Class 150, stainless steel body, hard face seat, 13% chrome, flanged ends. Equal to Kitz #150UOAM.

2.5 Butterfly Valves

.1 Iron body, lug pattern, bronze or stainless steel disc, resilient replaceable EPDM liner seat, plain flanged or grooved ends.

.2 Acceptable Models:

.1 Jenkins 2232ELJ (Lever) 2232EGJ (Gear)
.2 NH 45-313321 (Lever) 45-313322 (Gear)
.3 Kitz #6122-EL (Lever) #6122-EG (Gear)
.4 Kitz #6141-EL (Lever) #6141-EG (Gear)

.5 Red & White (Toyo) #918BESL (Lever) #918-BESG (Gear)
.6 Crane Model 44

.3 Grooved end (where approved): 2.5” and larger where grooved end piping systems are allowed, shall be rated to 300 psi and be both bi-directional and dead-end service capable to full rated pressure. Body material shall be ductile iron with blow-out proof stainless steel stems and electroless nickel coated ductile iron disc. Seat material shall be EPDM (or lubricated nitrile or fluoroelastomer) and have a full 360° continuous contact with the seating surface. Stem seals shall be of the same material grade as the seats. Disc shall be offset from the centerline of the stems and shall be connected to the stem without the use of fasteners or pins. Acceptable manufacturers: Victaulic Vic-300 MasterSeal, Vic-300 AGS.

2.6 Control Valves

.1 Globe valve. Refer to Section 15900.

.2 Control Valve bodies to be supplied by Controls Contractor and turned over to the Heating Contractor for installation.

2.7 Ball Valves – Hydronic

.1 Up to 38mm (1½”): Forged bronze body, delrin seat and seals, chrome plated ball, forged steel pin, screwed ends, 1206 kPa (175 psi). Acceptable material: Victaulic Series 722.

.2 Tail piece supply isolation valves: ball type valves, angle configuration, screw driver operated, compression fittings or threaded as required, chrome plated if exposed.

.3 Acceptable Models:

.1 Jenkins
.2 NH
.3 Kitz #58 amd #59
.4 Red & White (Toyo) #5044A and #5049A
.5 MAS #B3 and #B4

2.8 Ball Valves – Domestic

.1 600 WOG, lead free brass, two or three piece body, chrome plate ball, full port, teflon seats, blow-out proof stem, threaded or soldered ends, lever handle. Soldered up to 3”, threaded up to 4”.

.2 Acceptable Manufacturers:

.1 Jenkins
.2 NH

.3 Kitz #858 & #859
.4 Red & White (Toyo) 5044A-LF & 5049-LF
.5 MAS #B3-LF and #B4-LF

2.9 Gate Valves

.1 Bronze, inside screw, double wedge or disc, solder or screwed ends.

.2 Over 100mm (4“): Iron body, bronze trim, rising stem, OS&Y solid wedge, flanged ends.

.3 Acceptable Models:

.1 Jenkins 454J
.2 NH T504
.3 Kitz #72
.4 Red & White (Toyo) #421

2.10 Globe or Angle Valves

.1 Bronze, renewable composition disc, solder or screwed ends.

.2 Over 100mm (4”): Iron body, bronze trim, rising stem, OS&Y, renewable composition disc, flanged ends.

.3 Acceptable Models:

.1 Jenkins 2342J
.2 NH T731
.3 Kitz #726
.4 Red & White (Toyo) #400

2.11 Circuit Balancing Valves (CBV) – Hydronic

.1 Valves shall be Y-pattern globe style design with provision for connecting a portable differential (ft. of head) pressure meter.

.2 Valves shall have all metal parts of nonferrous, pressure die cast, nonporous Ametal.

.3 The valves shall be suitable for the following functions:

.1 Precise flow measurement
.2 Precise flow balancing
.3 Positive shut-off with no drip seat eliminating the need of an additional isolation valve.
.4 Drain connection using ¾” NPT hose end thread.

.4 Valves shall have four (4) 360° adjustment turns of the handwheel for precise setting with hidden memory to provide a temper-proof balancing setting. Handwheel shall have digital readout. The handwheel can be installed in any position without affecting performance.

.5 For sizes ½" to 2":

.1 300 PSI, Y-pattern, globe type with soldered or threaded ends, non-ferrous Ametal brass copper alloy body, EPDM o-ring seals.
.2 4-turn digital readout handwheel for balancing, hidden memory feature with locking tamper-proof setting, and connections to portable differential meter.
.3 Acceptable Manufacturer: TA Hydronic Series 786 STAS (solder), 787 STAD (threaded) or 78K (MxF) or Armstrong equal.

.6 For sizes 2½" to 16":

.1 300 PSI, Y-pattern, globe type with flanged or grooved ends, ASTM A536 ductile iron body, all other parts of Ametal brass copper alloy, EPDM o-ring seals.
.2 8, 12, 16, 20 or 22 turn digital readout handwheel for balancing, hidden memory feature with locking tamper-proof setting, and connections to portable differential meter.
.3 Acceptable Manufacturer: TA Hydronic Series 788 STAF (flanged) or 789 STAG (grooved) or Armstrong equal.

.7 Acceptable Manufacturers

.1 Tour & Anderson

.8 Circuit Balancing Valve sizing (schedule based on Tour & Anderson):

	Nominal Flow			
Size	**Min.**	**Max.**	**Min.**	**Max.**
(in)	(gpm)	(gpm)	(l/s)	(l/s)
½	0.6	2.8	0.038	0.177
¾	2.0	6.0	0.126	0.379
1	3.9	10.0	0.246	0.631
1-¼	5.0	15.0	0.316	0.947
1-½	6.6	20.0	0.416	1.262
2	12.6	36.0	0.795	2.272
2-½	38.0	100.0	2.398	6.310
3	31.0	130.0	1.956	8.203
4	68.0	200.0	4.291	12.62
5	90.0	320.0	5.679	20.19
6	182.0	450.0	11.48	28.39
8	367.0	820.0	23.16	51.74

10	540.0	1300.0	34.07	82.03
12	960.0	1500.0	60.58	94.65

2.12 Circuit Balancing Valves (CBV) – Domestic Water

.1 Provide circuit balancing valve on each domestic recirculation loop designed specifically for use in drinking water applications, NSF/ANSI 61-G rated for commercial hot water service (temperature rated to 180F / 82C) and certified by the NSF with all wetted parts stainless steel.

.2 Lead free construction in compliance with ANS/NSF-372.

.3 Series 300 stainless steel body, nickel plated brass union nut, and tamper-resistant 300 series stainless steel flow cartridge.

.4 Valve shall be suitable for minimum flow of 0.3gpm and maximum flow of 12.0 gpm, and flow rate pre-set accuracy variation of +/- 5% over 95% of the control range.

.5 Valves shall have a full body rating of 400 psi, but is suitable for working pressures with differential control ranges of 2 – 32 psi or 5 – 60 psi differential.

.6 All wetted parts shall comply with NSF/ANSI Standard 372 for minimal lead content.

.7 Compact inline design for tight installations.

.8 Acceptable Manufacturer

.1 Tour & Anderson, Victaulic ICSS, TA Series 76X, RWV 9519AB

2.13 Pressure Reducing Valves - Water

.1 Less than 100mm (4”): Bronze body, brass bonnet, composition rubber diaphragm, plated or stainless steel spring, internal strainer.

.2 100mm (4”) and over: High tensile cast iron body and bonnet, seat, composition disc and diaphragm, bronze needle control pilot valve with small pressure regulating valve. Flanged body and bonnet.

2.14 Vacuum Breakers – Water

.1 Bronze body, brass trim, composition silicone float disc, full size orifice.

2.15 Relief Valves

.1 Provide ASME rated direct spring loaded type, lever operated nonadjustable factory set discharge pressure as indicated.

2.16 Drain Valves

.1 Bronze compression stop with ¾" hose threaded.

.2 Brass ball valve with ¾" hose thread.

.3 Provide hose thread connection on valve or piping.

.4 Equal to #868C (Lead Free), KITZ #68AC (Non Lead Free)

2.17 Double Check Valve Assembly - Reduced Pressure Type

.1 Bronze or red brass body, stainless steel springs, composition diaphragm.

.2 Independent acting spring loaded double internal disc valve, three chamber, discharge to atmosphere.

.3 Acceptable Models:

.1 Watts 009 QT
.2 Zurn/Wilkins 975 XL
.3 Febco 825 Y
.4 Conbraco 40-200

.4 Non-electronic testing apparatus including gauge, hoses, fittings, accessories, and case. Maximum temperature 104.4°C (220°F), maximum pressure 1034 kPa (150 psi). Equal to Watts TK-9A.

2.18 Strainers

.1 Strainers 50mm (2") and smaller shall be constructed for 250 psig operating pressure at 406 degrees F and shall have a cast iron threaded body and 20 mesh Type 304 stainless steel screen.

.2 Strainers larger than 50mm (2") shall be constructed for 125 psig @ 150 degrees F and shall have a cast iron flanged body and a 3/64" perforated Type 304 stainless steel screen up to 75mm (3") and a 1/8" perforated Type 304 stainless steel screen on 100mm (4") and larger.

.3 Screen free area shall be minimum three times area of inlet pipe. Provide valved drain and hose connection off strainer bottom.

.4 Strainers 50mm (2") and smaller shall have straight thread and gasketed caps and plugged blow-off connections.

.5 Strainers larger than 50mm (2") shall include drain connections complete with ball valve, cap and chain.

.6 Grooved end (where approved): 50mm (2") and larger, 300 PSI (2065 kPa) Y-Type Strainer shall consist of ductile iron body, ASTM A-536, Grade 65-45-12, Type 304 stainless steel perforated metal removable baskets with 1/16" (1,6mm) diameter perforations 2"-3" (DN50-DN75) strainer sizes, 1/8" (3,2mm) diameter perforations 4"- 12" (DN100-DN300) strainer sizes, and 0.156" (4mm) diameter perforations for larger sizes. Victaulic Style 732 and W732.

2.19 Pressure Ratings

.1 Unless otherwise indicated, use valves suitable for minimum 860 kPa (125 psi) and 232°C (450°F).

.2 Use valves for fire protection suitable for 1206 kPa (175 psi).

2.20 Manual Valve Operators

.1 Provide suitable handwheels for gate, globe or angle, radiation and drain valves.

.2 Provide one plug cock wrench for every plug cock valve.

.3 Butterfly Valves: Provide lever lock handle with toothed plate for shutoff service.

.4 Provide valves sized 4" and larger located more than 8 feet from floor in equipment room areas with chain operated sheaves. Extend chains to approximately 60" above floor and hook to clips arranged to clear walking aisles.

PART 3 - EXECUTION

3.1 General

.1 All valves shall be located such that the removal of their bonnets is possible.

.2 Install valves with stems upright or horizontal, not inverted.

.3 All flanged valves in horizontal lines with the valve stem in the horizontal position shall be positioned so that the valve stem is inclined one bolt hole above the horizontal position.

.4 Screw pattern valves placed in horizontal lines shall be installed with their valve stems inclined at an angle of a minimum of 30 degrees above the horizontal position.

.5 All valves shall be installed to allow for ease of access, service and reading of devices from the floor.

3.2 Application

.1 Use ball valves for gas service. Plug cocks are not to be used for gas isolation service.

.2 Use ball valves on pressure gauges.

.3 Use plug cocks, globe valves, ball valves, butterfly valves, and metering valves in water systems for throttling service.

3.3 Isolation Valves

.1 Isolation valves are to be ball type valves, pipe size as required, but in no case less than 13mm (½") diameter.

.2 For equipment removal purposes, isolation valves are to be installed with companion screwed unions on piping less than 75mm (3") diameter, or flanged connections on piping 75mm (3") and larger. Grooved mechanical couplings may be used for equipment removal, subject to accessibility, suitability and where approved by specification terms for that piping system or equipment.

.3 Install valves as close as possible to isolated equipment in order to minimize the amount of water lost during maintenance, replacement or drain down operations.

.4 Isolation drain valves are to be provided with combination air inlet fitting as required to relieve vacuum during draining operations.

.5 Install gate valves or ball valves where approved for shutoff and isolating service, or to isolate equipment, parts of systems or vertical risers.

.6 Provide drain valves at main shutoff valves, low points of piping and equipment.

3.4 Control Valves

.1 Control Valves bodies to be supplied by Controls Contractor and turned over to the Heating Contractor for installation.

.2 Install valves to allow proper access and clearance and so actuators are in horizontal position visible from the floor.

.3 Provide a union upstream and downstream of each control valve.

3.5 Circuit Balancing Valves (CBV) – Hydronic

.1 The Contractor shall size and install balancing valves according to design flow.

.2 Install CBVs in accordance with manufacturer's instructions.

.3 Use flanged type for 2½" and over in areas where welded pipe is to be used. Grooved type is only acceptable where grooved piping is specified.

.4 Valves shall be installed with flow in the direction of the arrow on the valve body.

.5 Install at least five pipe diameters downstream from any fitting or valve, and at least ten pipe diameters downstream from any pump.

.6 Two pipe diameters downstream of the CBV shall be free from any fittings.

.7 Install such that easy and unobstructed access to the valve handwheel and metering port for adjustment and measurement is provided.

.8 Mounting in valve in piping must prevent sediment build-up in metering ports.

.9 Mark up set of as-built drawings indicating balanced flow value and CBV setting.

3.6 Circuit Balancing Valves (CBV) – Domestic Water

.1 The Contractor shall install a CBV on each recirculating loop.

.2 Install CBVs in accordance with manufacturer's instructions including straight pipe run upstream and downstream of CBV.

.3 Valves shall be installed with flow in the direction of the arrow on the valve body.

.4 Label ceiling tile or gypsum board ceilings where CBV is installed above ceiling. Provide access door for access where required.

3.7 Drain Valves

.1 Provide ball valves for drains on open systems.

.2 Provide unions downstream of the valve to allow breaking the piping system.

.3 Provide hose thread connection on drain valve and piping.

3.8 Specialty Valves

.1 Provide relief valves on hot water tanks and where required and pipe to drain.

.2 Provide pressure reducing valves where shown or where required. Provide adequately rated shutoff gate valves.

3.9 Double Check Valve Assembly

.1 Provide reduced pressure type backflow preventers where shown or where required as follows: Make-Up water supply. Pipe overflow to drain with air gap.

.2 Provide shutoff valves and unions on both sides of backflow preventers for testing purposes.

.3 Double check valve assemblies shall be installed maximum 1.5m above floor and are to be installed in a manner which allows a minimum of 1m (3') clearance above the device for connection and operation of testing equipment.

END OF SECTION

PART 1 - GENERAL

1.1 Work Included

.1 Pressure gauges and pressure gauge taps

.2 Thermometers and thermometer wells

.3 Combination instrumentation taps and gauges

1.2 Submittals

.1 Refer to Section 15010.

.2 Submit shop drawings for gauges and thermometers complete with a list which indicates use, operating range, and suitable range of each.

PART 2 - PRODUCTS

2.1 General

.1 All gauges and thermometers shall be calibrated and shall display in either/both metric and imperial units.

2.2 Acceptable Manufacturers

.1 Weiss

.2 Winters

2.3 Pressure Gauges

.1 Steel case, liquid filled, 100mm (4”) diameter, phosphor bronze bourdon tube brass movement, extruded brass socket, accurate to 1.5%.

2.4 Pressure Gauge Taps

.1 Provide brass needle or gate valve.

2.5 Digital Thermometers

.1 Thermometers shall be equal to Weiss Instruments solar digital vari-angle type, model DVU35 complete with CWE35-75BS well.

.1	Case:	Hi-impact ABS
.2	Range (with F/C switch):	-50/300°F (-40/450°C)
.3	Display:	½” LCD digits, wide ambient formula
.4	Accuracy:	1% of reading or 1° whichever is greater

.5	Resolution:	1/10° between -19.9/199.9°F (-28/93°C)
.6	Recalibration:	Through case potentiometer adjustment
.7	Lux Rating:	10 Lux (one foot-candle)
.8	Update:	10 seconds
.9	Ambient Operating:	-30/140°F (-35/60°C)
.10	Ambient Temp Error:	0
.11	Humidity:	100%
.12	Sensor:	Glass passivated thermistor – NTC
.13	Stem Assemblies:	Industrial glass full conformance with Fed Spec GG-T-321D. Fully interchangeable with Industrial Glass Thermometers.

.2 Thermowells shall be brass separable socket, ¾" NPT, complete with gasket and cap, size as required.

.3 Provide tilt adjustment to view without climbing from floor.

2.6 Stem Type Thermometers

.1 11" long, adjustable scale, red indicator, brass separable socket.

.2 Well: Brass separable socket complete with gasket and cap, size as required.

.3 Provide tilt adjustment on devices if required to view without climbing from floor.

2.7 Stem Type Thermometers for Limited Access Ceiling Spaces:

.1 Resin Angle Form 6" scale with well.

.2 Equal to Weiss Instruments HW5A2 complete with SF12-BS.

2.8 Sensor Wells

.1 Sensor wells shall be supplied by Controls Contractor and turned over to the Heating Contractor under this Section for installation.

PART 3 - EXECUTION

3.1 Pressure Gauges

.1 Install where indicated on drawings complete with ball valve.

.2 Provide only one pressure gauge per pump. Install common header, ½ " diameter pipe, complete with four control ball valves to allow selection of pressure reading from each of the following points. Refer to schematic diagram.

.1 before strainers
.2 on pump suction

.3 on pump discharge
.4 on check valve discharge if so equipped

3.2 Pressure Gauge Taps

.1 Both sides of two-way control valves

.2 All lines to three-way control valves

.3 All lines to control valves 25 mm and larger

.4 As shown on drawings.

3.3 Thermometers

.1 Install digital type in Boiler Room, Mechanical Rooms and other Service Rooms unless otherwise indicated.

.2 Install stem type in ceiling spaces. Use smaller units in limited access ceilings.

.3 Install thermometers so they can be easily read from floor level. If this cannot be accomplished, install remote reading units.

.4 Install in locations allowing ease of accurate observation without obstruction, light glare or danger to the reading technicians.

.5 Provide tilt adjustment on devices to view without climbing from floor.

.6 Thermometers are to be installed in thermowells so that they can be replaced without draining the system.

3.4 Sensor Wells

.1 Sensor wells shall be supplied by Controls Contractor and turned over to the Heating Contractor under this Section for installation.

END OF SECTION

PART 1 - GENERAL

1.1 Submittals

.1 Refer to Section 15010 – General Mechanical Requirements.

.2 Submit with shop drawings certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH when applicable.

.3 Submittals without pump head versus flow curves will be discarded. Tabulated data is not acceptable.

1.2 Quality Assurance

.1 Pumps shall be aligned by qualified millwright and alignment certified.

.2 Ensure pumps operate at specified system fluid temperatures. Operate within 25% of midpoint of published maximum efficiency curve.

.3 Polyphase, squirrel cage, single speed NEMA/EEMAC Design A or B induction motors, between 1 hp and 200 hp, whether in packaged equipment or not, shall comply with the current requirements of the Ontario Energy Efficiency Standards Regulation, and specifically, CSA C390-93 Energy Efficiency Test Methods for Three Phase Induction Motors.

1.3 Acceptable Manufacturers

.1 Manufacturers of pumps whose products are approved in principle, but subject to requirements of drawings and specifications are:

.1 ITT – Bell & Gossett
.2 Armstrong
.3 Patterson Pumps

1.4 Alternatives

.1 Equivalent pump selections shall not change type, configuration or motor power, increase noise level, increase speed by more than 10% or increase inlet velocity.

.2 Alternative pump selections shall include plotted pump head vs. flow curves for both the proposed alternative pump and the specified pump on the same graph. The alternative pump curve shall exceed the specified pump performance, and shall not cross the specified pump curve at any point.

.3 Refer to Section 15010 for acceptable materials and equipment.

PART 2 - PRODUCTS

2.1 General

.1 Statically and dynamically balance rotating parts.

.2 Construction shall permit complete servicing without breaking piping or motor connections.

.3 Pumps shall operate at 1,750 rpm unless specified otherwise.

.4 Pump connections shall be flanged for sizes 63mm (2½") and over. Grooved or union connections are approved for pump connections 50mm (2") and under.

.5 Units shall be completely factory wired, tested and name-plated before shipment. Pump manufacturer shall be ISO-9001 certified.

.6 Pumps shall meet types, sizes, capacities, and characteristics as scheduled on the Equipment Schedule drawings. Refer to schedules for unit performance.

.7 Units shall be specifically designed for chilled water and hot water heating systems as indicated on the drawings. Complete unit shall be ETL- Canada listed.

.8 Pumps shall conform to ANSI/HI 9.6.3.1 standard for Preferred Operating Region (POR) unless otherwise approved by the engineer. The pump NPSH shall conform to the ANSI/HI 9.6.1-1997 standards for *Centrifugal and Vertical Pumps for NPSH Margin*.

.9 Motors shall meet scheduled horsepower, speed, voltage, and enclosure design. Pump and motors shall be factory aligned, and shall be realigned (laser alignment) after installation by the manufacturer's representative. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications and conform to the standards outlined in EISA.

.10 The pump(s) vibration limits shall conform to Hydraulic Institute ANSI/HI 1.1-1.5-1994, section 1.4.6.1.1 for recommended acceptable unfiltered field vibration limits (as measured per H.I. 1.4.6.5.2, Figure 1.108) for pumps with rolling contact bearings.

.11 Pumps shall be designed for operation at 225° F and 175 PSIG working pressure unless scheduled otherwise on the drawings.

.12 Base mounted pumps shall have the seismic capability to withstand a horizontal load of 0.5g, excluding piping and/or fasteners used to anchor the pump to mounting pads or to the floor, without adversely affecting pump operation.

2.2 Vertical In-Line Hydronic Water Circulating Pumps

.1 Type: Centrifugal, single stage, close coupled in-line, pull-out design, suitable for horizontal or vertical operation.

.2 Casing: Cast iron, rated for greater of 860 kPa (125 Psi) or 1.5 times actual discharge working pressure, suction and discharge gauge port, air vent, wear rings, seal flush connection, drain plug, flanged suction and discharge.

.3 Impeller: cast steel, fully enclosed, keyed to shaft and secured with locknut.

.4 Shaft: stainless steel or carbon steel with bronze or stainless steel sleeve through seal chamber.

.5 Seals: Carbon rotating against a stationary ceramic seat.

.6 Suction guide and strainer.

2.3 Base Mounted Hydronic Water Circulating Pumps

.1 The pumps shall be long coupled, base mounted, single stage, end suction or double suction, vertical split case design, in cast iron bronze fitted construction.

.2 Vertical split case pumps shall have a center drop-out type coupling between the pump and the motor. Coupler shall allow for removal of pump's rotating element without disturbing pump volute or movement of the pump's motor.

.3 Pumps shall be capable of being serviced without disturbing piping connections, electrical motor connections or pump to motor alignment.

.4 The bearing housing shall supply support for heavy-duty single row permanently lubricated ball bearings, with provision for purging or flushing if desired. The bearings shall be capable of absorbing both radial and thrust loads while maintaining the rotating element in proper axial alignment.

.5 The impeller shaft shall be of solid 416 stainless steel material.

.6 Pump shall be equipped with an internally flushed mechanical seal assembly installed in an enlarged tapered seal chamber. Seal assembly shall have a brass housing, seat gasket, stainless steel spring, and be of a carbon ceramic design with the carbon face rotating against a stationary ceramic face.

.7 Pump volute shall be of a cast iron design with an integrally cast pump discharge and suction. Flanges shall be extra heavy-duty design and will be of 250# thickness while capable of being drilled for 125# ANSI flat face use. Volute shall have integrally cast support feet, gauge ports at nozzles, and vent and drain ports.

.8 A coupling, capable of absorbing torsional vibration and of operating in variable speed applications, shall be employed between the pump and motor.

.9 An ANSI B15.1 and OSHA 1910.219 compliant coupling guard shall shield the coupler during operation. Coupler guard shall contain viewing windows for inspection.

.10 Motor base plate shall be welded structural steel fully enclosed at sides and ends, with securely welded cross members. The minimum base plate stiffness shall conform to ANSI/HI 1.3-2000, section 1.3.5.3 for *Horizontal Base Plate Design* standards.

.11 Pump rotation shall be right-hand or left-hand as viewed from the pump's motor end and in respect to the discharge flange.

.12 Provide Suction Diffusers as follows:

.1 Single suction diffusers shall consist of an angle type body with internal straightening vanes that run the full length of the diffuser and a combination diffuser/strainer/orifice cylinder with 3/16" diameter openings for pump protection.
.2 Double suction diffusers shall consist of a ductile iron double suction angle type body with internal exiting vanes, integrally cast flanges or grooved pump connections, and a 1-1/2" blowdown connection. Internal design shall equally split half of the system flow to each side of a double suction type pump's impeller.
.3 Diffusers for closed system operation shall be equipped with a readily replaceable start-up strainer.

2.4 Hydronic Circulating Pumps

.1 Type: Centrifugal, close coupled horizontal in-line, lubricated type, pull-out design, quiet operation.

.2 Casing: Cast iron, suction and discharge gauge port, air vent, wear rings, seal flush connection, drain plug, flanged suction and discharge.

.3 Impeller: cast steel, fully enclosed, keyed to shaft and secured with locknut.

.4 Shaft: stainless steel or carbon steel with bronze or stainless steel sleeve through seal chamber. Ceramic for small circulators.

.5 Seals: Carbon rotating against a stationary ceramic seat.

.6 Motor Type: open drip proof.

2.5 Suction Diffuser

.1 Provide suction diffuser for each pump.

.2 Body: cast iron with flanged connections.

.3 Strainer: with built-in disposable 1.19mm (3/64") mesh, low pressure drop screen and NPS 25mm (1") blowdown connection.

.4 Permanent magnet particle trap.

.5 Full length straightening vanes.

.6 Pressure gauge tappings.

.7 Adjustable support leg.

.8 Manufacturer shall match pump manufacturer.

2.6 Triple Duty Valves

.1 Not acceptable.

2.7 Glycol Pump

.1 Pump supplied with Glycol Tank. Refer to Tank specification Section 15175.

PART 3 – EXECUTION

3.1 General

.1 Contractor shall install pumps and suction guides in accordance with manufacturer's guidelines.

.2 Triple duty valves are not acceptable. Install circuit balancing valve and check valve as per detail on drawings.

.3 All electrical wiring and accessories, including power wiring from motor control centers and/or motor starter to driven motor, shall be installed in accordance with the requirements specified by Division 16 and the local electrical authority.

.4 Furnish the services of a factory trained representative to review the installation, and to provide equipment startup. Start-up shall include laser alignment of pump and motor assembly.

.5 Remove temporary strainers after flushing is complete and leave in mechanical room for inspection/confirmation by the Consultant.

.6 Contractor shall supply and install concrete inertia bases where required or as specified, complete with flexible pipe connectors on both the suction and discharge side of the pump. Inertia bases shall be 10" thick complete with 2"

deflection springs. The inertia pad shall have reinforcement bars running in two directions on 9” centers, as well as locating anchors for the pump base. The contractor shall level and grout the base according to manufacturer’s instructions.

.7 For inline circulating pumps, support piping adjacent to pump such that no weight is carried on pump casings. Do not provide supports directly on pump casings. Provide supports under elbows on pump suction and discharge line sizes 75mm (3”) and over.

END OF SECTION

PART 1 - GENERAL

1.1 Scope

.1 Inertia bases.

.2 Vibration isolators.

1.2 Reference Standard

.1 Provide and install mechanical equipment so that Average Noise Criteria curves, as outlined in ASHRAE Guide, are not exceeded.

1.3 Submittals

.1 Provide vibration isolation shop drawings showing isolator locations, load on each isolator, inertia slab dimensions.

1.4 General Requirements

.1 Supply vibration isolation equipment and materials by one supplier. Consider side loading of equipment and inertia bases when calculating maximum loads on isolators.

.2 Ensure equipment is sufficiently rigid for isolator point loading.

.3 All elastomer elements within the restraint shall be bridge bearing neoprene.

1.5 Description

.1 Provide vibration isolation on all motor driven equipment with motors of 0.37 kW and greater power output (as indicated on the motor nameplate) and on piping and ductwork, as specified herein. For equipment less than 0.37 kW, provide neoprene grommets at the support points.

.2 Space isolators under equipment so that the minimum distance between adjacent corner isolators is at least equal to the height of the centre of gravity of the equipment. Include height of centre of gravity on shop drawings. Otherwise, design for increased forces on the supports, and submit design calculations with shop drawings for approval. In particular, chillers shall meet this requirement.

.3 For all electrical connections to isolated equipment, provide a minimum 90 degree bend of flexible conduit.

.4 Ensure isolation systems have a vertical natural frequency no higher than one third of the lowest forcing frequency, unless otherwise specified. Use dynamic stiffness for elastomers and do not exceed 60 durometer.

.5 Provide horizontal limit springs on all fans (except vertical discharge) in excess of 1 kPa static pressure, and on hanger supported, horizontally mounted axial fans with more than 333 N thrust due to static pressure.

.6 Isolators and restraining devices which are factory supplied with equipment shall meet the requirements of this section.

.7 Provide concrete inertia bases where specified or required by equipment manufacturers located between all vibrating equipment and the vibration isolation elements. Provide inertia bases on centrifugal fans with static pressure in excess of 875 Pa and/or motor in excess of 40 HP and on base mounted pumps over 10 HP, except slab on grade installations. Refer to structural specifications for concrete work. Concrete work by General Contractor.

.8 Provide concrete inertia bases or structural steel bases for all other motor driven equipment, unless the equipment manufacturer certified direct attachment capabilities.

.9 Coordinate with Division 3 for the provision of housekeeping pads at least 100 mm high under all isolated equipment. Provide at least 175 mm clearance between drilled inserts and edge of housekeeping pads and follow structural consultant's instructions for drilled inserts.

.10 Bolt all equipment to the structure. Do not bridge isolation elements.

.11 For non-isolated equipment (e.g., floor-mounted tanks, heat exchangers, boilers etc.) design anchors and bolts for 2g applied horizontally through the centre of gravity.

.12 For isolated equipment, design anchors, bolts, isolators and bases to withstand without failure or yielding a static load of 2g, minimum, acting through the centre of gravity. For larger isolators, where the 2g requirement cannot be met, provide additional restraint meeting the NBCC requirements.

.13 Where impact forces may be significant, use ductile materials.

1.6 Qualifications/Submittals

.1 All equipment shall be tested in an independent testing laboratory, or certified by a registered professional engineer, to demonstrate that equipment meets the requirements of this section, e.g. static load capability = 2 g, fail safe design, etc. If particular tests are carried out to represent an isolator type, the tests shall be valid for the full load range of the isolator. Submit such tests or certification on request.

.2 Obtain all relevant equipment information and provide shop and placement drawings for all vibration isolation elements and steel bases for review before materials are ordered. Provide attachment to both the equipment and the structure meeting the specified forces involved. Attachment details to the structure to be approved by a Provincially registered professional engineer.

.3 Submit samples of materials required to complete the work of this section for inspection and review if and when requested.

PART 2 - PRODUCTS

2.1 Isolators

.1 Supply all vibration isolation equipment by one approved supplier with the exception of isolators which are factory installed and are standard equipment with the machinery.

.2 All isolators shall be of the following types, supplied by the manufacturers named, or other acceptable manufacturers listed, or approved:
Type 1 - Pad Isolator
Neoprene/steel/neoprene pad isolators, manufactured from "Bridge bearing quality neoprene", as defined by CSA Standard CAN3-S6-M78 Section 11.10. Select Type 1 pads for a 2.5 mm (0.1") static deflection or greater. Bolt down equipment mounted on neoprene pad isolators using neoprene grommets. Design is based on Vibron Vibropad VSV or Mason WMW, Super W.
Type 4 - Hangers
Spring hangers, c/w 6 mm (0.25") thick sound pads sized for 0.5 mm (0.02") minimum deflection, or neoprene hangers. Design is based on Vibron Series VH, approved equal - Mason HD, HS. A neoprene element alone, without a hanger box, is acceptable provided no short circuiting occurs. Hangers shall allow for a minimum of 10° misalignment.
Type 5 - Air Isolator
Rolling lobe air springs with air spring levelling valves. Design based on Vibron MAS with levelling valves.

.3 Select isolators at the supplier's optimum recommended loading, and do not load beyond the limit specified in the manufacturer's literature.

.4 Design springs in accordance with the Society of Automotive Engineers' Handbook Supplement 9 entitled "Manual on Design and Application of Helical and Spiral Springs - SAE - 1975".

.5 Design springs "iso-stiff" (kx/ky = 1.0 to 1.5) with a working deflection between 0.3 and 0.6 of solid deflection.

.6 Provide hot dipped galvanized housings and neoprene coated springs, or other acceptable weather protection, for all isolation equipment located out of doors or in areas where moisture may cause corrosion.

.7 For all electrical connections to isolated equipment, provide a 90 degree bend of flexible conduit for 25 mm conduit and smaller or 90 degree Crouse-Hind EC couplings for larger conduit. Use connections long enough that the conduit will remain intact if the equipment moves laterally 300 mm from the installed position, and flexible enough to transmit less vibration to the structure than is transmitted through the springs.

2.2 Bases

.1 Provide concrete inertia bases a minimum of 1.5 times the weight of the isolated equipment. Generally base thickness shall be 1/12 of the longest dimension of the base, but not less than 150 mm (6"). Include with base a steel channel concrete form with required steel reinforcement (as determined necessary by suppliers' registered professional engineer). Provide additional steel as required by sleeves or inserts to receive equipment anchor bolts. Use height saving brackets in all mounting locations to maintain a 50 mm (2") clearance below the base. Bases are Mason type K or approved equal. Bases to be furnished with built-in motor slide rails, Motor location as specified/scheduled.

.2 Construct structural steel bases sufficiently rigid to keep deflection and misalignment within acceptable limits as determined by the equipment manufacturer. Use height saving brackets in all mounting locations to provide a base clearance of 50 mm (2"). Bases are Mason type WF or approved equal. Bases to be furnished with built-in motor slide rails. Motor location as specified/scheduled.

.3 Construct bases strictly in accordance with the isolation suppliers' drawings.

2.3 Flexible Pipe Connectors

.1 At the last elbow before piping leaves the mechanical room, and the first elbow entering, provide a bolted flanged 2000 mm long spool piece to facilitate the future installation of silencing equipment.

PART 3 - PRODUCTS

3.1 Execution

.1 Execute the work in accordance with the specifications and, where applicable, in accordance with the manufacturer's instructions and only by workmen experienced in this type of work.

.2 For all equipment mounted on vibration isolators, provide a minimum clearance of 50 mm to other structures, piping, equipment, etc.

.3 Isolate all floor or pier mounted equipment on Type 2 isolators, unless otherwise specified.

.4 Isolate all floor or pier mounted equipment on Type 3 isolators, unless otherwise specified. Isolate pumps rotating at more than 1170 RPM on Type 2 isolators. Use the lowest RPM scheduled for two speed equipment in determining isolator deflection.

.5 For equipment mounted on a slab on grade, absorption chillers and in-line pumps, mount on Type 2 isolators, unless otherwise specified. Use Type 1 pads only where approved.

.6 Select Type 4 spring hangers for a minimum static deflection of 25 mm for all ceiling hung fans, and air handling units, emergency generator exhaust piping and silencers, steam PRV's and any other vibrating sources.

.7 Provide Type 4 resilient hangers on all piping connected to a vibrating source, if the piping is in excess of 40 mm dia. Provide the hangers for a distance of 6.5 m for a 50 mm pipe and 11.5 m for a 250 mm pipe. Isolate all other pipe for a proportionate distance. Isolate all piping in mechanical rooms. If neoprene hangers are proposed for non-critical spaces, change to spring hangers at no additional cost in the event that the isolation proves inadequate.

.8 Where piping connected to noise generating equipment is routed from the mechanical room through plumbing chases, position piping to avoid contact with the concrete structure, future framing, drywall and other finishes which may radiate noise. Submit proposed details to meet this requirement.

.9 Where the weight of equipment located on type 3 isolators may change significantly due to draining or similar as in cooling towers or chillers, provide limit stops to limit spring extensions.

.10 Provide spring isolators on piping connected to isolated equipment to a minimum as follows: up to 100 mm diameter, first 3 points of support; 125 mm to 200 mm diameter, first 4 points of support; 250 mm diameter and over, first 6 points of support. Static deflection of first point shall be twice deflection of isolated equipment.

.11 Provide spring isolators on all piping in mechanical and boiler rooms.

.12 For in-line pumps 18.6 kW and greater, provide two (2) type 2 isolators under each support foot. Provide Type 6 post-disaster anchors for all base mounted isolated equipment.

.13 Where piping or boiler exhaust stacks, etc., connected to or serving noise generating equipment, is routed from the mechanical room through walls and plumbing chases, position piping, stacks, etc. to avoid contact with the concrete structure, future framing, drywall and other finishes which may radiate noise. Submit proposed details to meet this requirement. <Provide 6.5 bar controls compressed air to Type 5 isolators.

.14 Where a pump intake pipe or similar pipe configuration requires a pedestal support, construct inertia or steel base large enough to accommodate pedestal. Provide flexible pipe connections for all pipe connections to chillers.

.15 Provide resilient elements in pipe anchors, where pipe anchors are specified within 11.5 m of a vibration source. Submit details before installation. Protect neoprene isolator components from overheating. Where piping connects new and existing buildings provide flexibility in piping by elbows, offsets, or 2 flexible pipe connectors 30 pipe dia. apart to isolate one building from another.

3.2 Inspections

.1 The supplier shall provide assistance to the contractor as necessary during the course of installation of isolation equipment. Prior to substantial completion, submit a report listing deficiencies to the specification.

END OF SECTION

PART 1 - GENERAL

1.1 Standards

.1 Construct pressure tanks to ASME Code for Unfired Pressure Vessels.

.2 Comply with Provincial Government Regulations.

1.2 Submittals

.1 Submit with shop drawings for tanks, specifications of tank lining and installation instructions.

1.3 Inspections

.1 Obtain inspection certificates for pressure vessels from Provincial Authorities as required.

1.4 Acceptable Manufacturers:

.1 Amtrol

.2 Expanflex

.3 Watts

.4 ITT

PART 2 - PRODUCTS

2.1 Hydronic Expansion Tank - Bladder Type

.1 Pressurized, closed type, welded steel, rated for working pressures of 100 psi, cleaned, prime coated and supplied with steel support saddles.

.2 Construct tank with necessary tappings for installation of accessories.

.3 Full acceptance bladder size, butyl rubber bladder material.

.4 Tanks shall be factory charged with a .302-32 charging valve connection.

.5 Provide quick connect air inlet of automotive tire valve type and tank drain.

.6 Provide pressure relief valve and automatic cold water fill.

2.2 Glycol Tank

.1 The Contractor shall supply and install, as indicated on the plans and in the specifications, a prefabricated, automatic and autonomous make-up package for the glycol system.

2. The package shall be designed to occupy a minimum amount of floor space to operate on a standard 110V, 60 Hz electrical circuit, and to maintain a fill pressure in the glycol system as per schedule.

3. It shall feature a cut-off and alarm arrangement which will stop the pump in case of excessive pressure, or a low solution level, and activate an audible (which can be silenced) and a visual alarm. A 110V signal shall also be available for a remote alarm.

4. A translucent polyethylene solution container, complete with lid, shall be mounted on the pumping assembly and shall include a strainer and a shut off valve. A glycol solution recovery line shall be piped in from the system relief valve outlet to the solution container, through its lid in such a way that the lid can be removed for filling and mixing.

5. The pumping assembly shall be mounted in a sturdy steel frame with legs to keep it off the floor. It shall include a pump (1/3 hp motor), a magnetic starter, a pressure tank with a pressure control, a priming valve, a pressure reducing valve, a shut-off valve and a pressure gauge. It shall be connected to the system with a 1/2" NPT connection.

6. Provide propylene glycol to provide glycol mix in tank.

PART 3 - EXECUTION

3.1 General

.1 Install tanks on 10mm (4”) thick concrete housekeeping pads as per Section 15090.

3.2 Hydronic Expansion Tank - Bladder Type

.1 Submit calculations on required pressure for bladder type tank and confirm that the air charge is preset and correct prior to requesting approval to open water valves.

.2 Follow manufacturer’s recommendations for tank charging and commissioning. Submit report on final pressure.

.3 Set pressure relief valve below 90 PSI. Pipe to drain.

.4 Set pressure reducing valve on make up water line to 15psi unless otherwise required to suit operation conditions.

3.3 Glycol Tank

.1 Follow manufacturers recommendations for tank fill. Mix water and glycol to provide propylene glycol mix as noted in equipment schedules on the drawings. Submit report on final ratio and pressure.

.2 Set pressure relief valve below 90 psi.

.3 Set pressure reducing valve on make-up water line to suit system operating conditions.

END OF SECTION

PART 1 - GENERAL

1.1 Quality Assurance

.1 Comply with Provincial Regulations and have CSA approval.

1.2 Submittals

.1 Provide shop drawings and schedules of manufactured products for review and inclusion in Operating and Maintenance Manuals as per Section 15010.

PART 2 - PRODUCTS

2.1 Automatic Air Vents

.1 Pipe Mains & Lines, Mechanical Rooms, Equipment, Coils, Ceilings spaces and all other spaces except noted above:

.1 Self-closing, float-operated, vertical mounting, 1/4” I.P. male connection, designed for pressures up to 150psi, 4-3/8” x 2-1/4”, bright brass finish.
.2 Acceptable Manufacturers:

.1 Maid-O-Mist #71
.2 Spirax Sarco 13WS
.3 Armstrong

.2 Wallfin, Convectors, Radiators:

.1 Float-operated, vertical mounting, 1/8” I.P. male connection, designed for pressures up to 50psi, 3-3/4” x 9/16”, bright brass finish.
.2 Acceptable Manufacturers:

.1 Maid-O-Mist #67
.2 Spirax Sarco
.3 Armstrong

2.2 Air Separator

.1 Air separator shall have tangential inlet nozzles.

.2 The air separator shall be designed and constructed in accordance with Section VIII, Div 1 of the ASME Boiler and Pressure Vessel Code.

.3 The unit shall be fitted with an NPT vent connection (for connection to a compression tank or an air vent).

.4 An additional NPT tapping shall be provided on the bottom of the air separator to facilitate blow-down.

.5 2" to 3" models should be supplied with a cast iron body and NPT system connections, while 4" to 6" models should be supplied with a cast iron body and ANSI flanges. 8" to 24" models are to be supplied with a fabricated steel body and carbon steel ANSI flanges.

.6 Acceptable Manufacturers:

.1 Armstrong Vortex Model VA
.2 ITT/Bell & Gossett

2.3 Air Eliminator

.1 Heavy duty, high capacity.

.2 Air eliminators for glycol systems must have outlet to allow it to be piped back to glycol tank.

.3 Acceptable Manufacturers for non-glycol systems

.1 Bell & Gossett Model 98
.2 Spirax Sarco Model 13WS
.3 Armstrong Model 1-AV

.4 Acceptable Manufacturers for glycol systems

.1 Bell & Gossett Model 107A
.2 Spirax Sarco Model AE36

2.4 Relief Valves

.1 Provide ASME rated direct spring loaded type, lever operated nonadjustable factory set discharge pressure as indicated.

2.5 Flow Indicators (Water)

.1 Single Double tempered glass window, bronze body, ABS impeller.

.2 Suitable for pressure twice that of working pressure, minimum 125 psig.

.3 Suitable for temperature 200 deg F.

.4 Equal to Ashland Filter-Mate 304SS.

.5 Supplied under Section 15095.

2.6 Side Stream Filter

.1 Body: Heavy Duty, type 304 stainless steel, cast brass nickel plated head, removable gasketed top, drain valve, ¼" diameter inlet and outlet threaded fittings.

.2 Filter: Multiple paper cartridge, disposable, 5 micron, flow rate 20 usgpm, minimum flow.

.3 Supplied under Section 15095.

2.7 Pressure Reducing Valves

.1 Externally piloted pressure reducing valves. Refer to drawings for size and capacity.

.2 Coordinate with Supplier to make sure selection of flow switches suits pipe diameter.

.3 Pressure Reducing Valves shall be equal to Watts U5B-LP (low pressure).

PART 3 - EXECUTION

3.1 Automatic Air Vents

.1 Install size as specified herein and in locations as per drawings, at all system high points and as required for complete air purging.

.2 Where large air quantities can accumulate, provide enlarged air collection standpipe.

.3 Provide ball valve of size to match air vent I.P connection under each air vent. Shut off valve is to allow isolation, removal and service of fitting.

3.2 Air Separator and Air Eliminator

.1 Provide on suction side of system circulation pump and connect to expansion tank.

.2 Install high and/or away from access routes so as not to interfere with access routes. If they are installed in access routes the bottom of the unit must be minimum 8' above finished floor.

.3 Pipe air eliminators for glycol systems back to glycol tank.

3.3 Relief Valves

.1 Provide relief valves at pressure tanks, low pressure side of reducing valves, heating convertors, expansion tanks and where indicated.

.2 Pipe relief valve to nearest floor drain.

.3 System relief valve capacity shall equal make up pressure reducing valve capacity. Equipment relief valve capacity shall exceed input rating of connected equipment.

.4 Where one line vents several relief valves, cross sectional area shall equal sum of individual vent areas.

3.4 Side Stream Filter

.1 Install new filter across hydronic primary piping. Refer to drawings.

.2 Provide isolation valves on inlet and outlet, and drain valve to allow filter maintenance with system in operation.

.3 Provide sight glass indicator on discharge piping.

.4 Extend piping from connection to a point within 60” from the floor, to allow service from the floor without a ladder.

3.5 Pressure Reducing Valve

.1 Install as per manufacturer’s recommendations.

.2 Install in vertical position only.

END OF SECTION

PART 1 - GENERAL

1.1 Work Included

.1 Piping Insulation

.2 Adhesives, Tie Wires, Tapes

.3 Recovering

1.2 Quality Assurance

.1 All workers engaged in the application of insulation shall be journeymen, or indentured apprentices working under a journeyman who is on the site. Trades Qualification certificates must be submitted prior to commencing work and must be on site for inspection.

1.3 Job Conditions

.1 Deliver material to job site in original non-broken factory packaging, labeled with manufacturer's density and thickness.

.2 Perform work at ambient and equipment temperatures as recommended by the adhesive manufacturer. Make good separation of joints or cracking of insulation due to thermal movement or poor workmanship.

1.4 Acceptable Manufacturers:

.1 Fibreglass Canada

.2 Knauf

.3 Mason

.4 Pittsburg Corning

.5 John Mansville

PART 2 - PRODUCTS

2.1 General

.1 Adhesives, Insulation, Coatings, Sealers and Recovering Jackets shall have composite fire and smoke hazard ratings not exceeding 25 for flame spread and 50 for smoke developed.

.2 Adhesives, coatings and sealers shall be waterproof.

2.2 Materials

.1 Insulation shall be pre-covered, preformed insulation complete with foil or kraft all purpose jacket unless otherwise noted.

.2 Hydronic piping insulation shall be 1.5 inches thick for pipe sizes up to 1.25 inches in diameter and 2 inches thick for pipe sizes 1.5 inches in diameter and larger.

.3 Domestic hot and tempered water piping insulation shall be 1 inch thick for pipe sizes up to 1.25 inches in diameter and 1.5 inches thick for pipe sizes 1.5 inches in diameter and larger.

.4 Domestic cold water piping insulation shall be 1 inch thick unless otherwise noted.

.3 Cold Piping, Exposed Vents: Fine fibrous glass insulation with factory applied vapour barrier jacket, molded to conform to piping, "K" value at 0.24 btu/in/sq ft/deg F/hr.

.4 Hot and Tempered Water Piping: Fine fibrous glass insulation with factory applied general purpose jacket, molded to conform to ping, "K" value at 0.24 btu/in/sq. ft/deg. F/hr.

.5 Concealed Vents: Flexible fibrous glass insulation, "K" value at 0.26 btu/in/sq ft/deg F/hr.

.6 Roof Drainage and Vent Piping: Flexible fibrous glass insulation, "K" value at 0.26 btu/in/sq ft/deg F/hr.

.7 Recovering Jackets (Interior):

.1 All exposed areas: PVC pre-formed.

.8 Recovering Jackets (Exterior):

.1 Aluminum:

.1 To ASTM B209
.2 Thickness: 0.5mm sheet.
.3 Finish: Corrugated.
.4 Joining: Longitudinal and circumferential slip joints with 50mm laps.
.5 Fittings: 0.5mm thick die-shaped fitting covers with factory-attached protective liner.

.2 Metal jacket banding and mechanical seals: Stainless steel, 19mm wide, 0.5mm thick at 300mm spacing.

PART 3 - EXECUTION

3.1 Preparation

.1 Do not install covering before piping and equipment has been tested and approved.

.2 Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions.

3.2 Installation

.1 In non fire rated surfaces, ensure insulation is continuous through inside walls. Pack around pipes with fireproof self-supporting insulation material, properly sealed.

.2 Finish insulation neatly at hangers, supports and other protrusions.

.3 Provide PVC pre-formed jackets on exposed insulation in finished and unfinished areas.

.4 Do not install and seal vapour proof insulation if ambient air has a high humidity.

.5 Pipe hangers shall wrap around outside of insulation for all sizes. Piping shall be provided with insulation flashing of heavy gauge metal to prevent crushing and hanger sized for exterior of insulation.

.6 Install aluminum jacket with mechanical banding over all outside insulation. Provide mitered corners and bands to suit.

3.3 Domestic Water Piping – Hot, Cold and Tempered

.1 Insulate all new domestic hot, cold and tempered water piping.

.2 Insulate valves, unions, flanges, strainers, flexible connections and expansion joints for all cold water systems. Not required for hot or tempered water systems.

.3 Cover elbows, tees and similar fittings with equivalent thickness of insulation material.

3.4 Roof Drainage

.1 Insulate all roof hoppers.

.2 Insulate all roof drainage piping including horizontal *and* vertical piping.

.3 Insulate all drain piping located in un-insulated spaces.

3.5 Plumbing Vents

.1 Insulate plumbing vents within 1.5m (5’) of insulated surface penetration.

3.6 Hydronic Piping

.1 Insulate all new heating and glycol heating *supply and return* piping.

.2 Insulation of valves, unions, flanges, strainers, flexible connections and expansion joints is not required for hot water systems.

.3 Cover elbows, tees and similar fittings with equivalent thickness of insulation material.

.4 Do not insulate within radiation enclosures.

END OF SECTION

PART 1 - GENERAL

1.1 Work Included

.1 Duct thermal insulation

.2 Duct acoustic insulation

.3 Recovering

1.2 Quality Assurance

.1 All workers engaged in the application of insulation shall be journeymen, or indentured apprentices working under a journeyman who is on the site.

1.3 Job Conditions

.1 Deliver material to job site in original nonbroken factory packaging, labeled with manufacturer's density and thickness.

.2 Perform work at ambient and equipment temperatures as recommended by the adhesive manufacturer. Make good separation of joints or cracking of insulation due to thermal movement or poor workmanship.

PART 2 - PRODUCTS

2.1 General

.1 Adhesives, Insulation, Coatings, Sealers and Recovering Jackets shall have composite fire and smoke hazard ratings not exceeding 25 for flame spread and 50 for smoke developed.

.2 Adhesives, coatings and sealers shall be waterproof.

2.2 Thermal Duct Insulation – Interior to Building

.1 Insulation shall be pre-covered, preformed insulation complete with foil or kraft all purpose jacket unless otherwise noted.

.2 Use 25 millimeter (1 inch) thick insulation unless otherwise noted.

.3 Exposed Rectangular Ducts: Rigid fibrous glass insulation, "K" value at 0.24 b.t.u. per inch per square foot per degree Fahrenheit per hour with factory applied reinforced aluminum foil vapour barrier.

.4 Round Ducts and Concealed Rectangular Ducts: Flexible fibrous glass insulation, "K" value at 0.26 b.t.u. per inch per square foot per degree Fahrenheit per hour with factory applied reinforced aluminum foil vapour barrier.

.5 Recovering Jackets (Interior): U.L.C. listed "Thermo Canvas", treated cotton fabric. Alternatively, U.L.C. listed PVC recovering jacket. PVC recovering jacket shall be suitable for use in plenum (flame spread and smoke developed ratings)

.6 Acceptable Manufacturers:

.1 Fibreglass Canada
.2 Knauf
.3 Manson
.4 Owens Corning
.5 Johns Manville

2.3 Thermal Duct Insulation – Exterior to Building

.1 Insulation: 3.0 PCF density, 50mm (2”) thick rigid fiberglass insulation board with factory applied fsk facing. Equal to Knauf insulation board with ecose technology.

.2 Jacket: Weatherproof flexible jacket equal to Alumaguard 60.

2.4 Acoustic Duct Insulation

.1 Fiberglass insulation with "K" value at 0.26 b.t.u. per inch per square foot per degree Fahrenheit per hour absolute roughness of exposed surface not to exceed 0.033 millimeters coated to prevent fibre erosion at air velocities up to 400 f.p.m.

.2 All substrate material to be non-darkened, contrasting colour from liner layer.

.3 Use 25 millimeter (1 inch) thick insulation unless otherwise noted.

PART 3 - EXECUTION

3.1 Preparation

.1 Do not install covering before ductwork and equipment has been tested and approved.

.2 Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions.

3.2 Installation - General

.1 In non fire rated surfaces, ensure insulation is continuous through inside walls. Pack around ducts with fireproof self-supporting insulation material properly sealed.

.2 Finish insulation neatly at hangers, supports and other protrusions.

.3 Locate insulation or cover seams in least visible locations.

3.3 Thermal Duct Insulation

.1 Provide insulation on:

.1 All new supply air ductwork, except where internally insulated.
.2 All new outside air ductwork.
.3 All new exhaust air ductwork within 3 meters (10 feet) of insulated surface penetration.

.2 Exposed Rectangular Ducts: Secure rigid insulation with 50 percent coverage of adhesive and 12 gauge galvanized impale anchor tabs on 400 millimeter (16 inch) centres. Seal joints with 100 millimeter (4 inch) wide foil tape.

.3 Round Ducts and Concealed Rectangular Ducts: Adhere flexible insulation to ductwork with adhesive applied in 150 millimeter (6 inch) wide strips on 400 millimeter (16 inch) centres. Provide 16 gauge annealed tie wire, or polypropylene twine, spiral wound or half hitched at 100 millimeter (4 inch) centres for securing duct insulation until adhesive sets. Butt insulation and seal joints and breaks with 100 millimeter (4 inch) foil tape.

.4 Jacket:

.1 Interior to Building: Provide canvas recovering jackets on exposed insulation throughout including but not limited to Mechanical Rooms. Coat recovering jacket with two coats of waterproof fire retardant coating.

.2 Exterior to Building: Provide weatherproof flexible jacket over all duct insulation exterior to building.

3.5 Acoustic Duct Insulation

.1 Apply to interior of:

.1 First 3 meters (10 feet) of supply and return ducts on inlet and discharge of all air handling units including but not limited to A.H.U. and E.F.
.2 Transfer ducts and elbows.
.3 As indicated on drawings or as otherwise noted.

.2 Secure to ductwork with adhesive using 50 percent coverage and 12 gauge impale anchor tabs on 400 millimeter (16 inch) centres. Cut off excess fastener length and cover with brush coat of sealer.

.3 Shop fabrication cuts shall be coated with J.M.’s SuperSeal Duct Butter and Edge Treatment products.

END OF SECTION

PART 1 - GENERAL

1.1 General Requirements

.1 Provide materials, equipment and labour to install plumbing as required by Provincial and local codes as specified herein.

.2 Provide water and drainage connections to equipment specified in other sections of this specification.

1.2 Quality Assurance

.1 Provide new equipment, CSA approved.

1.3 Submittals

.1 Refer to Section 15010 – General Mechanical Requirements.

.2 Submit shop drawings to the Consultant for review prior to ordering or installation.

.3 Shop drawings shall include manufacturer, model numbers, performance data, and indicate conformance to above reference standards.

.4 Cleanouts: Dimensions and installation details

.5 Floor drains: Accessories, dimensions and installation details

.6 Water Hammer Arrestors: Selection criteria, fixture service, capacities and dimensions.

.7 One copy of all stamped reviewed shop drawings shall be included in maintenance manual.

1.4 Acceptable Manufacturers:

.1 Watts

.2 Zurn

.3 Ancon

.4 Smith

PART 2 – PRODUCTS

2.1 Cleanouts and Cleanout Accessories

.1 Sanitary: Provide caulked or threaded type cleanouts extended to unfinished floor or wall surface.

.2 Storm: Provide bolted coverplate or threaded cleanouts on vertical rainwater leaders.

.3 Floor cleanout access covers in unfinished areas shall be round with nickel bronze scoriated frames and plates. Wall cleanouts shall be located behind approved access panels.

.4 Provide cleanout inside building at building wall where sanitary and storm services leave the building. Space cleanouts along horizontal drainage lines per OBC requirements.

.5 Refer to Drawings for specifications.

2.2 Floor Drains

.1 Floor drains to be round, nickel bronze.

.2 Floor drains to be suitable for application and environment they are installed.

.3 Refer to Drawings for specifications.

2.3 Plumbing Vent Stacks

.1 Plumbing vent stacks through roof shall be minimum 450mm high double wall, Thaler or Lexcan Hi Tuff membrane to match type of roofing system used.

2.4 Other

.1 Refer to Drawings for specifications for all other fixtures and accessories.

PART 3 - EXECUTION

3.1 Installation

.1 Install vacuum breakers on plumbing lines where contamination of domestic water may occur. Generally necessary on flush valves and janitor sink trim and shall be integral to fixtures as per schedule.

.2 Install trap primers for all floor drains and as required by codes. Refer to schedule.

.3 Drainage lines shall grade 1% grade unless otherwise shown on drawings.

.4 Install pressure reducing valves to limit maximum static pressure at plumbing fixtures to 550 kPa (80 psi).

.5 Install reduced pressure double check valve assembly to isolate supply from domestic system where indicated on drawings and as required by code.

3.2 Cleanouts and Access Covers

.1 Unless otherwise noted, floor cleanouts in finished areas are not approved.

.2 Ensure ample clearance at cleanout for rodding of drainage systems.

.3 Provide cleanouts at the base of each stack.

3.3 Floor Drains

.1 Provide trap primer connected to intermittent operating cold water service on suitable fixture. Ganging of trap primer lines to a common location is not acceptable unless approved by the Consultant.

.2 Provide sealed drains where indicated.

.3 Set drain at elevation to allow finished floor to slope to mouth. Coordinate setting elevation with floor finish thickness.

.4 Provide flashing of sheet lead or approved nonmetallic membrane where floor drains are located over occupied spaces.

.5 All floor drains shall be covered, sealed and protected during construction to ensure construction waste or other debris does not fall in. If any drainage problems occur due to floor drains not being covered, the Contractor shall rectify at no cost to the Owner.

3.4 Vents and Pipe Penetrating Roof

.1 Vent pipes shall project through the roof and shall be provided with specified roof jack and flashing flange. Flashing shall be extended 300mm (12”) clear on all sides of projecting pipe.

.2 Provide vandal resistant flashing caps as specified.

.3 Vents specified or provided with vandal resistant, close slotted vent caps shall not be sized less than 50mm (2”).

.4 Refer to Section 15090 – Supports, Anchors and Seals.

END OF SECTION

PART 1 - GENERAL

1.1 Requirements

.1 Conform with all Section of Division 15 and Division 1.

.2 Plumbing fixtures shall meet the following requirements where applicable:

.1 Ontario Building Code
.2 Local Codes and Requirements including barrier free

1.2 Codes and Standards

.1 CAN/CSA B45

.2 CSA B125

1.3 Submittals

.1 Shop Drawings:

.1 Submit shop drawings to the Consultant for review prior to ordering or installation.
.2 Shop drawings shall include manufacturer, model numbers, performance data, and indicate conformance to above reference standards.
.3 One copy of all stamped reviewed shop drawings shall be included in maintenance manual.

.2 Operation and Maintenance Data:

.1 Provide operation and maintenance literature for all equipment indicating manufacturer and model of equipment, instructions for operation and maintenance of same, and parts list.
.2 Operation and maintenance data shall be included in the maintenance manual.

PART 2 - PRODUCTS

2.1 Fixtures

.1 Refer to and provide plumbing fixtures as per schedule.

.2 Refer to Section 15010 for mounting heights.

.3 Plumbing fixtures shall be approved for intended application.

.4 Where particular fixture or piece of trim is identified by a manufacturers' catalogue designation this reference is to establish standard and fixture or trim

from manufacturers listed below is equally acceptable when conforming to the same level of quality.

.5 Finished surfaces to be clear, smooth and bright, and guaranteed not to craze, discolour or scale.

.6 Fixtures to be ordered to suit construction schedule.

.7 Acceptable Manufacturers:

.1 Eyewash Stations: Haws, Speakman, Guardian, Bradley
.2 Thermostatic Mixing Valves: Lawler, Haws, Symmons, Powers

2.2 New Plumbing Fixture Schedule: Refer to Schedule on Drawings.

PART 3 - EXECUTION

3.1 Installation

.1 Support fixtures level and square and connect with supplies, drains, traps and vents. Provide trap easily accessible for service and cleaning.

.2 Accurately lay out roughing-in. Offsets will not be accepted.

.3 Provide fixtures complete with necessary trim, including traps, faucets, supplies, stops, strainers and escutcheons. Any exposed trim shall be chrome.

.4 Provide chrome plated rigid or flexible connections with screwdriver stops, reducers, and escutcheons.

.5 Provide trap easily accessible for service and cleaning.

.6 Provide independent threaded check valves on the hot and cold water supply lines to all thermostatic and pressure balancing faucets prior to mixing valves.

.7 Seal fixtures and trim to counters using continuous strip of “Plumber’s Dope”.

.8 Install vacuum breakers on plumbing lines where contamination of domestic water may occur. Generally necessary on flush valves and janitor sink trim and shall be integral to fixtures as per schedule.

.9 Provide caulking around mounting face to seal with clear or white silicone.

.10 Thoroughly clean all plumbing fixtures and trim at completion of the project.

3.2 Fixture Supports

.1 Provide plates, brackets, wall carriers, cleats, and supports to rigidly secure

fixtures in place.

.2 Fasten wall brackets with bolts attached to double steel supporting plates.

3.3 Mounting Heights

.1 Refer to Section 15010 for mounting heights.

.2 Double check valve assemblies and backflow preventers shall not be installed any higher than 5’ (1.5m) above finished floor.

3.4 Protection

.1 Plumbing fixtures and trim to be covered with plywood, cardboard or heavy paper and kept protected before, during and after installation and until work is completed and accepted.

.2 Clean fixtures and trim immediately prior to building completion.

END OF SECTION

PART 1 - GENERAL

1.1 General

.1 Conform to General Mechanical Requirements Section 15010.

1.2 Submittals

.1 Submit shop drawings and product data under provisions of Section 15010.

.2 Submit, as a minimum, the following details:

.1 Complete specifications
.2 Detailed fabrication drawings

.3 Provide data for inclusion in the Operating and Maintenance manuals in accordance with Section 15010.

1.3 Acceptable Manufacturers

.1 The following manufacturers are approved in principle subject to meeting the specifications. Manufacturers are responsible for all coordination issues arising from dimensional variances between plans and site conditions:

.1 ITT Bell & Gossett
.2 Armstrong
.3 Alpha Laval equal

.2 Alternate manufacturers must be pre-approved by the Consultant.

PART 2 - PRODUCTS

2.1 Design

.1 The unit shall be provided with a stainless steel OSHA splash shield.

.2 The units shall be built in accordance with ASME code and when necessary be ASME Code stamped board registered.

2.2 Frame

.1 The frame plate and pressure plate should be carbon steel SA 516 grade 70.

.2 The frame and pressure plate shall be of sufficient thickness to meet the ASME design pressure. Stiffeners or support brackets are not allowed.

.3 Carbon steel frame components shall be painted with Armstrong “Harvester Red” epoxy paint.

.4 Units with 4" or greater connections shall be unlined or alloy-lined studded ports to mate with raised face or flat faced ANSI flanges. Rubber liners are not allowed.

.5 Units with 2" or smaller connections shall have carbon steel female tapped NPT or male NPT connections if an alloy material is required.

.6 Units with 2-1/2" or 3" connections shall be either studded ports or NPT as describe above.

.7 The frame design shall allow the thermal plates to be supported by the carry bar, top bar. The guide bar, bottom bar, shall only help properly align the plates.

.8 A roller assembly from the carry bar shall support the pressure plate for units taller than 50".

.9 Tightening bolts shall be zinc plated carbon steel SA193 B7.

2.3 Plates

.1 Plates shall be constructed of 316L Stainless Steel.

.2 Plates shall be pressed in a one-step stamping process.

.3 Plates shall use an integral rolled edge hanging system to provide a rigid hanger device between the plate and carry bar and guide bar. Welded on hanging brackets or stiffeners are not acceptable.

.4 Plates shall be permanently marked to indicate plate material and thickness.

2.4 Gaskets

.1 The gaskets shall be a one-piece construction with a double gasket barrier at the port region. The area isolated by the double gasket shall be vented to the atmosphere, so that a gasket failure is detected by leakage to the exterior prior to any possible cross contamination.

.2 Gaskests are to be “mechanically fixed”. Glued gaskets are not acceptable.

.3 The gaskets are to be made of NBR.

2.5 Selection, Certification and Testing

.1 The manufacturer shall hydro-test the unit to 1.3 times the design pressure as directed by ASME Code.

.2 The plate and frame heat exchangers must be selected in accordance with the ARI 400 standard, and the unit must bear the ARI certified sticker.

.3 The plate and frame heat exchanger manufacturer must be a certified member of the ARI 400 standard.

PART 3 - EXECUTION

3.1 Installation

.1 Install unit on 4” high concrete housekeeping pad.

.2 Install in accordance with the manufacturers’ installation instructions.

.3 Provide isolation, balancing and strainers on unit connections as per details on the plans and as per Manufacturers’ recommendations.

END OF SECTION

PART 1 - GENERAL

1.1 References

.1 UL 508

.2 NEC

1.2 Quality Assurance

.1 To ensure quality and minimize infantile failures at the jobsite, the complete VFD shall be tested by the manufacturer. The VFD shall operate a dynamometer at full load and the load and speed shall be cycled during the test.

.2 All optional features shall be functionally tested at the factory for proper operation.

1.3 Submittals

.1 Shop drawings must be submitted and reviewed by the Consultant prior to the contractor ordering or shipping any subject equipment. Payments will not be processed for equipment not properly documented and reviewed under the terms of submittal.

.2 Submit manufacturer's performance data including dimensional drawings, power circuit diagrams, installation and maintenance manuals, warranty description, VFDs FLA rating, certification agency file numbers and catalog information.

.3 The specification lists the minimum VFD performance requirements for this project. Each supplier shall list any exceptions to the specification. If no departures from the specification are identified, the supplier shall be bound by the specification.

.4 Submit a Harmonic Distortion Analysis for the jobsite location.

.5 Harmonic filtering. The seller shall, with the aid of the buyer’s electrical power single line diagram, providing the data required by IEEE-519, perform an analysis to initially demonstrate the supplied equipment will meet the IEEE standards after installation. If, as a result of the analysis, it is determined that additional filter equipment is required to meet the IEEE recommendations, then the cost of such equipment shall be included in the bid. A harmonic analysis shall be submitted with the approval drawings to verify compliance with the latest version of IEEE-519 voltage and current distortion limits as shown in table 10.2 and 10.3 at the point of common coupling (PCC). The PCC shall be defined as the consumer-utility interface or primary side of the main distribution transformer.

1.4 Warranty

.1 The VFD shall be warranted by the manufacturer for a period of 36 months from

date of shipment. The warranty shall include parts, labor, travel costs and living expenses incurred by the manufacturer to provide factory authorized on-site service. The warranty shall be provided by the VFD manufacturer.

1.5 Acceptable Manufacturers:

.1 Danfoss

.2 Allen Bradley

.3 ABB

PART 2 - PRODUCTS

2.1 Furnish complete variable frequency drives as specified herein for the fans and pumps designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD enclosure, unless otherwise specified. VFD shall be housed in a metal NEMA 1 enclosure, or other NEMA type according to the installation and operating conditions at the job site.

2.2 The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan control and to negate the need for motor derating.

2.3 With the motor's rated voltage applied to the VFD input, the VFD shall allow the motor to produce full rated power at rated amps, RMS fundamental volts, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not be overloaded under operating conditions.

2.4 The VFD shall include a disconnect, fused or unfused, as noted in the schedule.

2.5 The VFD shall include a full-wave diode bridge rectifier and maintain a fundamental power factor near unity regardless of speed or load.

2.6 The VFD and options shall be tested to ANSI/UL Standard 508. The complete VFD, including all specified options, shall be assembled by the manufacturer, which shall be UL-508 certified for the building and assembly of option panels. Local representative panel shop assembly for option panels is not acceptable. The appropriate UL stickers shall be applied to both the drive and option panel, in the case where these are not contained in one panel. When these drives are to be located in Canada, the CSA or C-UL certifications shall apply. Both drive and option panel shall be manufactured in ISO 9001 certified facilities.

2.7 The VFD shall have DC link reactors on both the positive and negative rails of the DC bus to minimize power line harmonics. VFDs without DC link reactors shall provide a

minimum 5% impedance line reactor.

2.8 The VFD's full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 160% of rated current for up to 0.5 second while starting.

2.9 The VFD shall be able to provide full torque at any selected speed up to base speed to allow driving direct drive fans without derating.

2.10 An automatic energy optimization selection feature shall be provided standard in the drive. This feature shall automatically and continually monitor the motor's speed and load and adjust the applied voltage to maximize energy savings and provide a 3% to 10% additional energy savings.

2.11 Input and output power circuit switching can be done without interlocks or damage to the VFD.

2.12 An automatic motor adaptation test algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or decouple the motor from the load to run the test.

2.13 Galvanic and/or optical isolation shall be provided between the drive's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. Drives not including isolation on both analog I/O and discrete I/O shall include additional isolation modules.

2.14 VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted optimizing motor and drive efficiencies while reducing motor noise. Drives not incorporating this feature shall have a fixed carrier frequency above 10 kHz without output current derating or reduced motor performance.

2.15 Protective Features

.1 A minimum class 20 I^2t electronic motor overload protection for single motor applications and thermal-mechanical overloads for multiple motor applications shall be provided.

.2 Protection against input transients, loss of AC line phase, short circuit, ground fault, overvoltage, undervoltage, drive overtemperature and motor overtemperature. The VFD shall display all faults in plain English. Codes are not acceptable.

.3 Protect VFD from sustained power or phase loss. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output with an input voltage as low as 164 volts for 208/230 volt units, and 313 volts for 460 volt units.

.4 The VFD shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation build up in the stator.

.5 Drive package shall include semi-conductor rated input fuses to protect power components.

.6 To prevent breakdown of the motor winding insulation, the drive shall be designed to comply with IEC Part 34-17. Otherwise the drive manufacturer must ensure that inverter rated motors are supplied.

.7 Drive shall include a “signal loss detection” circuit to sense the loss of the control signal, and shall be programmable to react as desired in such instance.

.8 Drive shall function normally when the keypad is removed while the drive is running and continue to follow remote commands. No warnings or alarms shall be issued.

.9 Drive shall catch a rotating motor operating forward or reverse up to full speed.

.10 VFD shall be rated for 100,000 amp interrupting capacity (AIC).

.11 Drive shall include current sensors on all three output phases to detect and report phase loss to the motor. The VFD will identify which of the output phases is low or lost.

.12 Drive shall continue to operate without faulting until input voltage exceeds 300 volts on 208/230 volt drives, and 539 volts on 460 volt drives.

2.16 Interface Features

.1 Hand/Start, Off/Stop and Auto/Start selector switches shall be provided to start and stop the drive and determine the speed reference.

.2 Provide a 24 V DC output signal to indicate that the drive is in Auto/Remote mode.

.3 Digital manual speed control. Potentiometers are not acceptable.

.4 Lockable, alphanumeric backlit display keypad can be remotely mounted up to 10 feet away using standard 9-pin cable.

.5 All keypads shall be identical and interchangeable.

.6 To setup multiple drives, it shall be possible to upload all setup parameters to the drive’s keypad, place that keypad on all other drives in turn and download the setup to each drive.

.7 Display shall be programmable to display in 9 languages including English, Spanish and French.

.8 The display shall have four lines, with 20 characters on three lines and eight large characters on one line.

.9 A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the drive when the keypad is removed.

.10 A quick setup menu with factory preset typical HVAC parameters shall be provided on the drive eliminating the need for macros.

.11 The drive shall be fitted with an RS 485 serial communications port and be supplied with Windows® compatible software to display all monitoring, fault, alarm and status signals. The software shall allow parameter changes to be made to the drive settings, as well as storage of each controller's operating and setup parameters, and remote operation of the drive. The same software shall be used throughout the entire product range.

.12 The drive shall include as standard RS-485 communications capabilities to be connected at a future date to Johnson Controls N2 and/or Seimens Landis Division System 600 FLN at no additional cost to the owner. The connection shall be software selectable by the user.

.13 As a minimum, the following points shall be controlled and/or accessible:

.1 Drive start/stop
.2 Speed reference
.3 Fault diagnosis
.4 Meter points

.1 Motor power in kW
.2 Motor power in HP
.3 Motor kW/hr
.4 Motor current
.5 Motor voltage
.6 Hours run
.7 Feedback signal #1
.8 Feedback signal #2
.9 DC link voltage
.10 Thermal load on motor
.11 Thermal load on drive
.12 Heatsink temperature

.14 Two set-point control interface (PID control) shall be standard in the unit. Drive shall be able to look at two feedback signals, compare with two set-points and make various process control decisions.

.15 The sleep mode shall be functional in both follower mode and PID mode.

.16 Floating point control interface shall be provided to increase/decrease speed in

response to switch closures.

.17 Four simultaneous displays shall be available. They shall include frequency or speed, run time, output amps and output power. Drives unable to show these four displays simultaneously shall provide panel meters.

.18 Sleep mode shall be provided to automatically stop the drive when speed drops below set “sleep” level for a specified time. Drive automatically restarts when speed command exceeds set “wake” level.

.19 Run permissive circuit shall be provided to accept a “system ready” signal to assure that the drive does not start until dampers or other auxiliary equipment are in the proper state for drive operation. The run permissive circuit shall also be capable of sending an output signal as a start command to actuate external equipment before allowing the VFD to start.

.20 An elapsed time meter and kWh meter shall be provided.

.21 The following displays shall be accessible from the control panel in actual units: Reference Signal Value in actual units, Output Frequency in Hz or percent, Output Amps, Motor HP, Motor kW, kWhr, Output Voltage, No Load Warning, DC Bus Voltage, Drive Temperature in degrees, and Motor Speed in engineering units per application (in percent speed, GPM, CFM,...). Drive will read out the selected engineering unit either in a linear, square or cubed relationship to output frequency as appropriate to the unit chosen.

.22 The display shall be programmed to read in inches of water column (in-wg) for an air handler application, pressure per square inch (psi) for a pump application and temperature (°F) for a cooling tower application.

.23 Four meter displays can be shown at once on the display. This allows the actual value of the follower signal to be shown simultaneously with the drive’s response to that signal for ease in commissioning.

.24 Drive will sense the loss of load and signal a no load/broken belt warning or fault.

.25 If the temperature of the drive’s heat sink rises to 80°C, the drive shall automatically reduce its carrier frequency to reduce the heat sink temperature. If the temperature of the heat sink continues to rise, the drive shall automatically reduce its output frequency to the motor. As the drive’s heat sink temperature returns to normal, the drive shall automatically increase the output frequency to the motor and return the carrier frequency to it’s normal switching speed.

.26 The VFD shall have temperature controlled cooling fans for quiet operation and minimized losses.

.27 The VFD shall store in memory the last 20 faults and record all operational data.

.28 Eight programmable digital inputs shall be provided for interfacing with the

systems control and safety interlock circuitry.

.29 Two programmable relay outputs, one Form C 240 V AC, one Form A 50 V AC, shall be provided for remote indication of drive status.

.30 Two programmable analog inputs shall be provided and shall accept a direct-or-reverse acting signal. Analog reference inputs accepted shall include 0-10 V dc, 0-20 mA and 4-20 mA.

.31 Two programmable 0 to20 mA analog outputs shall be provided for indication of drive status. These outputs shall be programmable for output speed, voltage, frequency, amps and input kW.

.32 Under fire mode conditions the VFD shall automatically default to a preset speed.

2.17 Adjustments

.1 VFD shall have an adjustable carrier frequency in steps of not less than 0.1 kHz to allow tuning of drive to motor.

.2 Sixteen preset speeds shall be provided.

.3 Four acceleration and four deceleration ramps shall be provided. Accel and decel time shall be adjustable over the range from 0 to 3,600 seconds to base speed. The shape of these curves may be automatically contoured to prevent tripping.

.4 Four current limit settings shall be provided.

.5 If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: undervoltage, overvoltage, current limit, inverter overload and motor overload.

.6 The number of restart attempts shall be selectable from 0 through 20 and the time between attempts shall be adjustable from 0 through 600 seconds.

.7 An automatic “on delay” may be selected from 0 to 120 seconds.

2.18 Service Conditions

.1 Ambient temperature, -10 to 40°C (14 to 104°F).

.2 0 to 95% relative humidity, non-condensing.

.3 Elevation to 3,300 feet without derating.

.4 AC line voltage variation, -10 to +10% of nominal with full output.

.5 No side clearance shall be required for cooling of any units. All power and control wiring shall be done from the bottom.

PART 3 - EXECUTION

3.1 Start-up Service

.1 The manufacturer shall provide start-up and commissioning of the variable frequency drive and its optional circuits by a factory certified service technician who is experienced in start-up and repair services. The commissioning personnel shall be the same personnel that will provide the factory service and warranty repairs at the customer's site. Sales personnel and other agents who are not factory certified technicians for VFD field repair shall not be acceptable as commissioning agents. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system. Start-up shall include customer operator training at the time of the equipment commissioning.

3.2 Examination

.1 Contractor to verify that job site conditions for installation meet factory recommended and code-required conditions for VFD installation prior to start-up, including clearance spacing, temperature, contamination, dust, and moisture of the environment. Separate conduit installation of the motor wiring, power wiring, and control wiring, and installation per the manufacturer's recommendations shall be verified.

.2 The VFD is to be covered and protected from installation dust and contamination until the environment is cleaned and ready for operation. The VFD shall not be operated while the unit is covered.

END OF SECTION

PART 1 - GENERAL

1.1 Scope

.1 Provide design and engineering, labor, material, and equipment for low voltage passive harmonic filters as required for the complete performance of the work, as herein specified.

.2 The work specified in this section includes, the characteristics for a continuous duty passive harmonic filter designed to reduce the total voltage/current harmonic distortions (THDv and THDi) and to improve the system power factor (PF).

1.2 References

.1 General: The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the contract documents, unless otherwise specified.

.2 Institute of Electrical and Electronics Engineers, Inc. (IEEE):

.1 ANSI/IEEE 519-2014, "Guide for Harmonic Control in Electrical Power Systems."
.2 ANSI/IEEE C62.41-1991, “Guide for Surge Voltages in Low AC Power Circuits”
.3 ANSI/IEEE C-84.1-1995 “Electric Power Systems and Equipment – Voltage Ratings”

.3 Canadian Standards Association (CSA):

.1 CSA C.22.2 No. 14, “Industrial Control Equipment.”

.4 Underwriters Laboratories, Inc. (UL):

.1 UL 508, "Standard for Industrial Control Equipment."

1.3 System Description

.1 Performance Requirements:

.1 General: The passive harmonic filter shall incorporate reactors and capacitors and is designed to reduce harmonic voltage and current distortion produced by a single or multiple VFD’s connected to the filter output as follows:

.1 Limit the total voltage distortion (THDV) so as not to exceed the limits defined in Table 10-2 of IEEE-519 (2014) immediately to the line side of the filter installation point with up to 1 percent voltage

unbalance as defined in ANSI C-84.1-1995. The Point of Common Coupling (PCC) shall be the input terminals of the harmonic filter.

.2 Limit the total current harmonic distortion (THDi) to less than 5% at the Point of Common Coupling (PCC) over the range of 55% to 100% load.

.3 If the voltage unbalance is greater than 1 percent but less than 3% then total current harmonic distortion shall not exceed full load THDi by more than 50% (i.e. if the limit is 5% THDi at full load then THDi shall not be more than 7.5% at light load).

.4 The passive filter supplier shall not be responsible for pre-existing voltage distortion caused by other harmonic sources.

.5 The power factor shall be >95%, in the operating range from 40% load to full load.

.6 Voltage Regulation: Voltage regulation of the filter shall not exceed 5%.

.7 The passive filter shall not resonate with the power distribution system nor sink harmonic currents from other sources.

.8 The capacitive kVAr in the passive filter shall not exceed 20% of its kVA rating to assure compatibility on a generator power supply.

.2 Note: The passive filter shall not correct for distortion caused by equipment installed upstream of the system installation point or for incoming utility voltage distortion. The passive filter installation point shall be defined as the installation point for the system input wiring.

.2 Environmental Service Conditions

.1 Ambient Operation Temperature: Up to 50ºC
.2 Humidity: 0 to 95%, non-condensing
.3 Altitude: Operate up to 1000 M (de-rated at higher altitudes)

1.4 Quality Assurance

.1 Third Party Certification: The passive filter shall have the third party certification by Underwriters Laboratories (UL listing).

.2 Manufacturer Qualifications: The manufacturer shall have been engaged in the production of low voltage magnetic components for a minimum of 10 years.

1.5 Submittals

.1 Shop drawings must be submitted and reviewed by the Consultant prior to the contractor ordering or shipping any subject equipment. Payments will not be processed for equipment not properly documented and reviewed under the terms of submittal.

.2 Technical brochure detailing the features of the passive filter.

.3 Dimensional drawings with the size, installed weight, and heat dissipation for

each passive filter size provided.

.4 Installation wiring diagram for each passive filter provided.

1.6 Warranty

.1 Warranty by the manufacturer for a period of 36 months from date of shipment. The warranty shall include parts, labor, travel costs and living expenses incurred by the manufacturer to provide factory authorized on-site service. The warranty shall be provided by the harmonic filter manufacturer.

PART 2 - PRODUCTS

2.1 Manufacturers

.1 Basis of Design: The passive filter specified shall be manufactured by Hammond Power Solutions. This specification is to establish a standard of quality for the design, function, materials and appearance of the systems.

.2 Acceptable Manufacturers:

.1 Hammond Power Solutions
.2 Eaton
.3 Mirus Inter
.4 Siemens

2.2 Equipment Size and Ratings

.1 Passive harmonic filter shall be designed to operate from an input voltage of 600 VAC, +/- 10%, 3-phase, 3 or 4 wire system.

.2 Passive filter shall be designed to operate with a supply frequency of 60 Hz, ±2 Hz.

.3 Passive filter efficiency shall be no less than 98% at full load.

2.3 Passive Harmonic Filter System

.1 Enclosure:

.1 Passive filter shall be provided in a Type 3R enclosure or in open style format.
.2 All units shall be provided with a grounding lug.

.2 Capacitors

.1 Capacitors shall be rated to handle nominal system voltage plus 10% continuously. Capacitors shall be rated to operate at a case temperature of at least 65 degrees C. The tolerance on the capacitance shall not be

more than +/-10%. Capacitors shall be UL recognized.

.2 Capacitors shall discharge to reduce residual voltage to less than 50V within one minute of de-energization (NEC article 460-6).

.3 Inductors

.1 The inductors shall be UL recognized and shall be built to comply with UL 508. The inductors shall have 220 degrees C class insulation with maximum temperature rise of 130 degrees C. Coil conductors shall be copper windings.

.4 Capacitor Contactor

.1 The capacitor contactor shall be UL recognized. The contactor option shall allow the user to open and close a contact that will remove the capacitors from the circuit. Operation shall be controlled by a contact from the customer's equipment.

2.4 Source Quality Control

.1 The manufacturer shall energize the passive filter at full voltage in addition to performing bill of material checks, continuity checks and insulation resistance check with hi-pot.

PART 3 - EXECUTION

3.1 Installation

.1 Preparation and installation of the passive filter shall be in accordance with reviewed product data, final shop drawings, and manufacturer's written recommendations.

.1 Install low voltage passive harmonic filters in accordance with the NEC and applicable local codes.

3.2 Field Quality Control

.1 Field inspection start up and testing shall be performed by a qualified technician from the owner, the contractor or the manufacturer.

.2 Perform equipment start up and testing in accordance with the manufacturer's instruction manual using qualified personnel.

.3 Document equipment nameplate information and startup/testing data on the manufacturer's recommended startup/test report including insulation resistance for future reference.

END OF SECTION

PART 1 - GENERAL

1.1 Quality Assurance

.1 Unit Heaters shall be products of manufacturer regularly engaged in production of such units who issues complete catalogue data on such products.

.2 Fans rated in accordance with AMCA.

.3 One year warranty.

1.2 Submittals

.1 Submit certified performance data, water flow, pressure drop, suspension method, weight, fan power, fan performance, electrical characteristics.

1.3 Acceptable Manufacturers

.1 Sigma

.2 Engineered Air

.3 Trane

PART 2 - PRODUCTS

2.1 Unit Heaters

.1 Casing: High quality, heavy gauge, die formed, cold rolled steel with threaded connections for hanger rods.

.2 Finish: Sheet metal chemically degreased, phosphatized and etched. Semi-gloss “grey” paint finish.

.3 Coils: Steel pipe headers, copper tubes, ribbed aluminum plate fins. All coils tested at 200 psig air pressure under water.

.4 Fans: Aluminum blades. Sturdy, balanced, efficient and quiet.

.5 Motors: Totally enclosed, tested, thermally protected, permanently lubricated for a minimum of 20,000 hours.

.6 Motor Mounts: Rugged, corrosion resistant, resiliently mounted.

.7 Air Outlet: Louver fin diffusers shall have individually adjustable blades for maximum air distribution flexibility.

.8 Controls: Provide required relays for low voltage tie in by BAS.

PART 3 - EXECUTION

3.1 Installation

.1 Install all units as per manufacturers recommendations.

.2 Suspend unit heaters from “speed grip nut” using rod.

.3 Provide each unit with shutoff valve and other accessories as per details on drawings.

.4 Provide each unit with easily accessible automatic air vent at high point. If not easily accessible, extend vent to exterior surface of cabinet for easy servicing.

.5 Confirm mounting type to suit site conditions. Recess wherever possible.

END OF SECTION

PART 1 - GENERAL

1.1 General

.1 Conform to General Provisions under Section 15010.

1.2 Quality Assurance

.1 Meet the requirements of ARI, CSA, CGA Provincial and Municipal Codes and be CSA listed.

.2 Provide units of manufacturer's who provide local service personnel from factory representative, franchised dealer or certified maintenance service shop.

.3 Fans shall confirm to AMCA Bulletins regarding construction and testing.

.4 Filter media shall be UL listed.

1.3 Submittals

.1 Shop drawings must be submitted and reviewed by the Consultant prior to the contractor ordering or shipping any subject equipment.

.2 Submit certified shop drawings for the following:

.1 Fan curves and sound data
.2 Heating and cooling and air delivery performance data.
.3 Energy Recover performance data
.4 Filter frame and media details, dimensions and efficiency.
.5 Coil materials, pressure drop, accessories.
.6 Fan details, isolation and details.
.7 Cabinet construction, gauge, access doors, fasteners.
.8 Dimensions and weights.
.9 Power wiring diagrams and electrical characteristics.
.10 Control wiring diagrams and interfacing details.
.11 Maintenance requirements.
.12 Installation and hoisting instructions.
.13 Anti-vibration pads

1.4 Acceptable Manufacturers

.1 Manufacturers of units whose products are approved in principle, but subject to requirements of drawings and specifications are:

.1 Daikin - McQuay
.2 Engineered Air
.3 Trane

.2 Alternate manufacturers must be pre-approved by the Consultant.

PART 2 - PRODUCTS

2.1 General

.1 The supplier shall provide a indoor air handling units as specified. Air Handling Units shall be built to the level of quality as herein specified and to the description of the Air Handling Unit Schedule.

.2 Contractor shall coordinate with supplier to ensure units are sectioned to allow for installation.

.3 All equipment shall where specified and applicable, be pre-wired, and factory certified by an approved testing agency such as CETL, ETL, UL, CSA prior to shipment.

.4 Energy Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

.5 Prewired air handling units shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the National Electric Code, Part 2 (Canada).

.6 All electrical circuits shall undergo a dielectric strength test, and shall be factory tested and checked as to proper function.

.7 Belt drive fans: Fan motors shall be wired to a junction box on the outside of the unit for connection by others.

.8 ECM fans: Fans shall have remote panels. Contractor to provide all wiring from motor to remote panel (power and control).

.9 Controls by others.

.10 The air handling units and major components shall be products of manufacturers regularly engaged in the production of such equipment and with a minimum of fifteen continuous years of proven production experience.

.11 Manufacturer shall have a fully implemented and auditable quality assurance program, equal to the ISO-9002 Quality Standard.

.12 The unit shall undergo a complete factory run test prior to shipment. The factory test shall include final balancing of the fan assemblies.

.13 The manufacturer shall supply a one (1) year warranty including all parts and labour. The warranty shall commence at the date of final unit start-up or substantial completion whichever is later.

2.2 Casing

.1 Fabricate unit with 16 gauge nominal channel posts and panels secured with mechanical fasteners. All panels and access doors shall be sealed with bulb-type gasket.

.2 Panels and access doors shall be constructed as a 2-inch (50-mm) nominal thick, thermal broke double wall assembly, injected with foam insulation for an R-value of not less than R-13. The outer casing shall be constructed of heavy gauge G60 galvanized steel, phosphatized and painted with baked on enamel.

.3 The inner liner shall be constructed of G90 galvanized steel. Panel deflection shall not exceed L/240 at 125% of design static pressure, minimum +/- 5". Deflection shall be measured at the midpoint of the panel height.

.4 Unit floors shall be aluminum checker plate (painted floors will not be acceptable). Units less than 36" tall shall be galvanized floors.

.5 Access doors shall be flush mounted to the cabinetry and secured with heavy-duty stainless steel hinges. The door latch handle assembly shall be provided with a full-size grip handle and roller ball for smooth operation. The assembly shall be gasketed and sealed to prevent thermal bridging. All access doors shall open against pressure.

.6 Provide inspection window for each fan section access door (size permitting). Provide inspection window either upstream or downstream of each heat wheel at a height easily accessible for viewing. Heat wheel inspection window shall coincide with heat wheel marine light for verifying wheel rotation status.

.7 Provide lights in all fan access sections (size permitting). Where applicable, provide lights in heat wheel section for viewing from heat wheel inspection window.

.8 Construct drain pans from stainless steel with cross break and pitch to drain connection. Provide drain pans under cooling and heating.

.9 Provide unit with factory installed 4 and 6 inch high formed galvanized channel base rail (minimum).

.10 Each compartment of the unit shall have instrument test ports through the casing accessible from the outside. Test ports shall be Durodyne IP-2.

2.3 Fans

.1 Provide forward curved/air foil fans/direct drive fan array as scheduled. Dynamically balance fans before and after installation in fan cabinet section. Ensure maximum fan RPM is below the first critical speed fan.

.2 Locate fan and motor internally on a steel base. Factory mount motor on a slide base that can be slid out of unit. Provide access to motor, drive and bearings

through hinged access door. Provide fan and motor assembly mounted on 2" deflection spring vibration isolators inside cabinet as scheduled.

.3 Provide self-aligning, grease lubricated, ball or roller bearings with extended copper lubrication lines to access side of unit. Provide grease fittings attached to fan base assembly near access door.

.4 Provide OSHA compliant belt and fan guards (applicable to belt driven fans only).

.5 Bearings and Drives

1. Provide bearings with basic load rating computed in accordance with AFBMA - ANSI Standards, L-50 life at 400,000 hours, heavy duty pillow block type, self-aligning, grease-lubricated ball bearings. Provide extended grease lines to all bearings, to the access side. Extended grease lines shall be factory filled with grease.
2. Provide solid, hot rolled steel, ground and polished shaft, protectively coated with lubricating oil.
3. Provide variable pitch sheaves on all motors 7 1/2 HP and lower. Provide constant pitch sheaves on all motors greater than 7 1/2 HP sizes V-belt drive for a service factor of 1.25. On constant pitch units, allow for one sheave change including belts (parts only, labour by balancing contractor).

.6 Provide premium efficiciency open drip proof inverter duty motors.

2.4 Coils

.1 Provide access to coils as shown and indicated in the schedules and drawings for service and cleaning. Enclose coil headers and return bends fully within unit casing. Fabricate coil connections, vents and drains to extend beyond unit casing including gromments for an airtight unit casing. Coils shall be removable through side panels and/or top panels of unit without removal and disassembly of entire section.

.2 Provide stainless steel drain pan located underneath and extending downstream of coil and intermediate drain pans where coils are stacked (cooling only).

.3 Coil performance shall be as per schedule. Coil performance data shall be certified in accordance with ARI Standard 410 where applicable.

.4 Construction:

1. Tubes: Copper.
2. Fins: Aluminum mechanically bonded to tubes.
3. Headers: Seamless copper with vent and drain connections.
4. Casing: 16 gauge, galvanized steel (stainless steel – on cooling) channels with 16 gauge center and end supports.

.5 Water heating and cooling coils shall be circuited drainable with a vent connection at the highest point and a drain connection at the lowest point. Coil headers shall be copper with steel male pipe connections.

.6 Space shall be provided for future refrigerant or chilled water cooling coil in all AHUs without cooling coils.

2.5 Filters

.1 Provide filter box section with filter guides, hinged and latching access doors on access sides, for side loading of filters.

.2 Filter media shall be UL 900 listed, Class I or Class II.

.3 Provide Flat or Angled arrangement galvanized metal frames suitable for 2" pleated MERV 8 prefilters. Filters will be replaced by MERV 13 filters. Allow for additional static pressure drop. Side loading.

.4 Provide a differential pressure gauge for each filter bank. Mount gauge into unit casing and provide factory mounted probes.

2.6 Mixing Section

.1 Provide mixing section with outside, exhaust and return air openings. Dampers to be provided with unit or external by others as noted on schedules and drawings.

.2 All dampers shall be insulated TAMCO 9000 parrallel blade.

.3 Dampers shown internal to the units (outside air and exhaust air) shall be by the air handling unit manufacturer.

.4 Dampers shown external to the air handling units (return air) shall be supplied and installed by mechancial contractor. The Contactor shall confirm size and orientation with the manufacturer prior to installation.

.5 Damper actuators provided and installed by controls contractor.

2.7 Access Sections

.1 Access sections shall be as shown. Provide access doors of galvanized steel flush mounted, with gasket, latch and handle assembly.

2.8 Unit 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 VFD's (excluding heat wheel where applicable) shall be provided by others, see applicable section.

.3 ECM Motors shall be provided with a loose panel for field installation by the installing contractor. Panel shall contain a main disconnect and individual Motor Circuit Protectors (MCP) for each motor along with a BAS Enable/Disable and Speed control terminal block. Contractor to provide all wiring, co-ordinate with manufacturer.

.4 All motors (excluding heat wheel where applicable) shall be factory wired to a junction box on the outside of the unit. Mechanical Contractor to provide VFDs for each fan (supply and return) and Electrical Contractor to provide wiring to respective fan junction boxes.

.5 Marine lights shall be factory wired to junction boxes on the outside of each associated section. Electrical Contractor shall provide interconnect wiring between junction boxes once unit is site assembled.

2.9 Factory Start-Up

.1 For all units shipped in sections and field assembled, the manufacturer's agent shall perform a complete run test identical to factory run tests performed on unit prior to shipment. Submit detailed test reports to Engineer for review

PART 3 - EXECUTION

3.1 Installation

.1 The Contractor shall coordinate with the Supplier, a site inspection with the Supplier and Consultant prior to final preparation of shop drawings, to confirm installation requirements and dimension limitations.

.2 The units shall be shipped in sections to allow installation through building and in space. Re-assembly of sections by contractor as per manufacturer's installation instructions.

.3 Sections that cannot fit through the access route or doors will need to be disassembled by the contractor and re-assembled in the mechanical room by the contractor. Co-ordinate with manufacturer. Manufacturer shall verify all work and maintain intact all manufacturers warranties.

.4 The off-loading, hoisting/transporting, assembly and installation of the air handling units shall be performed by the contractor in accordance with manufacturer's instructions.

.5 Units must be installed in mecahnical room as soon as delivered to site. Storage on site prior to installation shall not be acceptable

.6 The Contractor shall protect the walls and floor while transporting the unit through the school to the Mechanical Room. Any damage shall be fixed by the Contractor at their cost.

.7 Provide rubber/cork anti-vibration pads under each corner of units and at intervals along base to suit load rating. Size of pads to be minimum 4x4x1" but shall be larger to suit load rating. Submit shop drawing for pads.

.8 The Manufacturer shall provide assistance during field assembly of unit sections.

.1 Install as per manufacturer's recommendations and drawings.
.2 Install level and plumb on 100mm (4") high concrete housekeeping pad.
.3 Provide rubber/cork anti-vibration pads under each corner of units and at intervals along base to suit load rating. Size of pads to be minimum 4x4x1" but shall be larger to suit load rating. Submit shop drawing for pads.
.4 Maintain required clearances for service and maintenance and as required by code and manufacturer's requirements.
.5 Arrange piping as to provide adequate clearance for service and operation.
.6 Install thermometers and pressure gauges on supply and return piping no higher than 1.8m (6') above floor.
.7 The Contractor shall clean or replace filters prior to turning the building over to the owner.

.8 The Contractor shall clean or replace filters prior to turning the building over to the owner.

3.2 Dampers

.1 For dampers external to unit, supplied and installed by the Contractor (outside air and exhaust air), the Contactor shall confirm size and orientation with the manufacturer prior to installation.

3.3 Startup

.1 The manufacturer's agent that supplies the equipment will be responsible for overseeing or reviewing the installation at the initial start-up.

.2 The manufacturer shall furnish a factory trained service technician to perform the unit startup and submit reports.

.3 The manufacturer shall provide instruction to the Owner's personnel on the operation and maintenance of the units.

3.4 Demonstration

.1 The manufacturer shall provide a technical representative and participate in the demonstration to the Owner. Participants in the demonstration will also include the contractor and may include the Consultant and a third party commissioning Agent.

END OF SECTION

PART 1 - GENERAL

1.1 Reference Standards

.1 Ontario Building Code

.2 SMACNA

.3 NFPA 90A – Air Conditioning and Ventilation Systems

.4 ASTM A653

.5 ULC

.6 Local Codes and Requirements

1.2 Acceptable Sheet Metal Subcontract Bidders:

.1 Refer to Division 0 for acceptable sheet metal subcontractors.

PART 2 - PRODUCTS

2.1 General

.1 Provide ductwork as recommended and specified in the latest revision of the Sheet Metal and Air Conditioning Contractors National Association incorporated (SMACNA).

2.2 Ductwork

.1 Ductwork shall be galvanized steel with G90 designation zinc coating lock forming quality to ASTM A525M.

.2 Rectangular or Square:

.1 Conform to SMACNA standards.

.3 Round:

.1 Factory fabricated, spiral wound, with matching fittings and specials. Longitudinal seam type is not acceptable.
.2 Transverse joints up to 900mm (36”): slip type with tape and sealants.
.3 Transverse joints over 900mm (36”): Ductmate or Exanno Nexas Duct System.

.4 Exposed Ductwork in Finished Areas (i.e. Gymnasiums):

.1 All exposed ductwork in finished areas shall be satin finish (galvannealed) to allow for painting without peeling.
.2 All exposed ductwork in finished areas shall be spiral unless otherwise indicated.

.3 All exposed ductwork in finished areas shall be painted.

.5 Comply with NFPA standards for exhaust ductwork and hoods which are used in applications resulting in airborne grease entrainment. 18 gauge stainless steel continuous welded. Refer to drawings for details and specifications.

2.3 Duct Construction

.1 All supply air ductwork from air handling unit fan discharge to first VAV component or first reheat coil shall be constructed to SMACNA 750 PA (3" wg) duct construction class. All other supply air ductwork upstream of VAV components or reheat coils shall be constructed to SMACNA 500 Pa (2" wg) duct construction class. For all other constant volume systems, all supply air ductwork installed in mechanical rooms shall be constructed to SMACNA 500 Pa (2" wg) duct construction class.

.2 All supply air ductwork downstream of VAV components or reheat coils shall be constructed to SMACNA 250 Pa (1" wg) duct construction class.

.3 All return air ductwork and all exhaust air ductwork installed in mechanical rooms shall be constructed to SMACNA 500 Pa (2" wg) duct construction class. All other return air ductwork and exhaust air ductwork shall be constructed to 250 Pa (1" wg) duct construction class.

.4 Tie rods shall not be used in lieu of external duct reinforcement except where specifically mandated by SMACNA duct construction standards.

.5 Duct tapers to be at 14 degrees maximum (1:4 ratio) for all systems with air velocities less than 1500fpm and 8 degrees (1:7 ratio) for velocities 1500 fpm and greater.

.6 Provide a schedule of proposed duct construction, meeting SMACNA standards, to be used on the project. Schedule shall include panel width, gauge, transverse connector, reinforcement, longitudinal seam, sealing class and sealing compound. Submit schedule prior to performing any duct fabrication/installation.

2.4 Fittings

.1 Fabrication: to SMACNA.

.2 Radiused elbows:

.1 Rectangular: standard radius and or short radius with double thickness turning vanes Centreline radius: 105 times width of duct.
.2 Round: in exposed areas one-piece smooth radius, 1.5 times diameter.

.3 Mitred elbows, rectangular:

.1 To 400mm (16"): with double thickness turning vanes.
.2 Over 400mm (16"): with double thickness turning vanes.

.4 Branches:

.1 Rectangular main and branch: with 45° entry on branch.
.2 Round main and branch: enter main duct at 45° with conical connection.
.3 Provide volume control damper in branch duct near connection to main duct.
.4 Main duct branches: with splitter damper.

.5 Diffuser connection to main:

.1 High efficiency takeoffs complete with rectangular duct opening and 45° slope body. Takeoffs shall be furnished complete with balancing damper and locking quadrant.
.2 Contractor shall notify Consultant if height of takeoff is required to be reduced to suit ceiling clearances and obtain approval from the same prior to installing or fabricating.
.3 Takeoffs shall be equal to SMC H.E.T.O. or fabricated on site.

.6 Transitions:

.1 Diverging: 20° maximum included angle.
.2 Converging: 30° maximum included angle.

.7 Offsets:

.1 Full short radiused elbows.

.8 Obstruction deflectors: maintain full cross-sectional area.

2.5 Acoustic Insulation

.1 Refer to Section 15258.

2.6 Firestopping

.1 40mm x 40mm x 3mm (1-1/2” x 1-1/2” x 16ga) retaining angles all around duct, on both sides of fire separation.

.2 Firestopping material and installation must not distort duct.

.3 All ductwork passing through partition walls shall be firestopped.

2.7 Fasteners

.1 Fasteners shall be sheet metal screws, rivets, and bolts.

2.8 Flexible Ductwork

.1 Listed in accordance with ULC-S110 and classified Class 1.

.2 Flame spread rating not more than 25. Smoke developed rating not more than 50.

.3 Semi-rigid and lightweight air duct, manufactured using a dead soft aluminum strip which is spirally wound and mechanically joined together to form an air tight and leak-proof three ply mechanical seam. Self-supporting and corrosive resistant that provides excellent strength and rigidity.

.4 Provide insulated or uninsulated as noted.

.5 Performance - Uninsulated:

.1 Material: Aluminum
.2 Maximum rated velocity: 5500 fpm
.3 Maximum positive pressure: 2.5 kPa (10 in.wc.)
.4 Maximum negative pressure: 3.0 kPa (12 in.wc.)
.5 Temperature Range : -51C to 315C (-60F to 600F)
.6 Bend Radius : 1.5 times diameter
.7 Available sizes : 50mm to 610mm (2 inches to 24 inches)

.6 Performance - Insulated:

.1 Core material: Aluminum
.2 Thermal Resistance: Available in R4.2, R6, R8
.3 Maximum rated velocity: 4000 fpm
.4 Maximum positive pressure: 3.0 kPa (12 in.wc.)
.5 Maximum negative pressure: 0.25 kPa (1 in.wc.)
.6 Temperature Range : -40C to 121C (-40F to 250F)
.7 Bend Radius : 1.5 times diameter
.8 Available sizes : 100mm to 500mm (4 inches to 20 inches)

.7 Acceptable Manufacturers:

.1 Uninsulated: Flexmaster Triple Lock T/L Aluminum Flexible Ducting
.2 Insulated: Flexmaster Triple Lock T/L Aluminum Thermal Flexible Ducting

2.9 Hangers and Supports

.1 Refer to Section 15090.

2.10 Duct Sealer

.1 Duct Sealer to be ULC classified for surface burning characteristics and be water based.

.2 Duct Sealer shall be Duro-Dyne DWN, grey, water-based for medium and high pressure duct systems, non-flammable (wet state), fire retardant (dry state).

.3 Duct Sealer shall be clear silicone type on all exposed ductwork or duct sealer shall be applied to inside of fittings to ensure clean look.

2.11 Turning Vanes

.1 Turning vanes shall be of steel construction with prime coat finish and complete with supports and fastenings.

.2 Turning vanes shall be double wall with correct airfoil pattern.

2.12 Instrument Test Ports

.1 Instrument port covers shall be Duro-Dyne IP-1 for bare ducts and IP-2 for insulated ducts.

PART 3 - EXECUTION

3.1 Rigid Ductwork

.1 Coordinate with other trades prior to installing ductwork.

.2 All ductwork and fittings shall be installed in accordance with SMACNA and ASHRAE standards.

.3 All exposed ductwork shall be satin finish (galvannealed) to allow for painting. Paint all exposed ductwork in finished areas.

.4 Duct tapers to be at 14 degrees maximum (1:4 ratio) for all systems with air velocities less than 1500fpm and 8 degrees (1:7 ratio) for velocities 1500 fpm and greater.

.5 Provide acoustic liner as per drawings and Section 15258.

.6 Ductwork shall be properly constructed, braced, connected and jointed. Suspend with hangers to SMACNA Standards. Refer to Section 23 05 29.

.7 Do not suspend hangers including wires and rods from the steel roof deck nor from other mechanical or electrical components. Support hangers from structural bearings such as beam, top chords of steel joists or structural concrete slabs. Where structural bearings do not exist, provide angle or channel iron form nearest structural bearings to support hangers.

.8 Use of “S and drive” or equivalent slip joint method, or Ductmate flange joint method is permissible. Fabricate and install in accordance with SMACNA reinforcement standards. Leave smooth finish on edges and interior of duct runs. Install internal ends of slip joints in direction of flow.

.9 Ducts and joints shall be tight and rigid so as not to leak, rattle, or vibrate.

.10 Install ductwork to allow adequate space for normal operation and maintenance of equipment nearby.

.11 Where possible, radiused duct elbows with radiused splitter vanes are preferable over square elbows with turning vanes. Where square duct elbows are necessary, turning vanes to be double thickness airfoil type installed in every slot on the vane rail.

.12 Direct size duct spin-ons are not acceptable. Conical spin-on or square-to-round fittings shall be provided. Where take-off is same size as main, use a 45 degree lead-in fitting.

.13 Where ducts pass through walls, seal around ducts with noncombustible material.

.14 All openings through wall must be sleeved and lined as specified. Openings shall be 50mm (2") larger all around than duct or piping and filled with fireproof Rockwool type insulation complete with fire retardant sealant both sides.

.15 All open ductwork, not being worked on, must be completely covered during construction phase until all sanding, plastering, painting, and finishing is complete.

.16 Inspect and test ductwork prior to any required painting or insulation for air leakage at joints and connections under normal operating conditions. Air leakage tests shall be performed as specified herein.

.17 Paint all ductwork in exposed areas.

.18 Paint ductwork visible through registers, grilles and diffusers flat black.

.19 Under no conditions are pipes, rods or wires allowed to penetrate ducts.

.20 Kitchen exhaust duct shall be welded, sloped and with access doors in conformance with NFPA 96.

3.2 Flexible Ductwork

.1 Install in accordance with SMACNA.

.2 Maximum length shall be 1.8m (6'). Minimum 12" (300mm) straight vertical duct run to be provided at all diffusers.

.3 Provide support at centre of flexible duct.

3.3 Duct Sealing

.1 Seal all ductwork with duct sealer as specified herein. Ducts constructed to SMACNA 500Pa (2") duct construction class and under shall be sealed to SMACNA Standard Section 1.6 and 1.7, Class C. Ducts constructed to SMACNA 750Pa (3") duct construction class shall be sealed to SMACNA Standard Section 1.6 and 1.7, Class B. Duct sealer shall be applied behind fittings for all exposed ductwork in finished areas.

.2 The sealer shall be stored at room temperature for at least 24 hours prior to use. Surfaces shall be clean, dry and free from oil, grease, and any other foreign material.

.3 Clean fittings to a depth of four inches with a solvent, exercising safe practices as recommended by the manufacturer.

.4 Stir sealer thoroughly before application.

.5 Use a brush, cartridge guns or spatula to apply the sealer to male section of spiral duct or to both fittings of rectangular duct. Join joints while sealer is wet (within approximately 15 minutes) and secure with sheet metal screws applied as close as possible (1/2" or less). Apply sealer to outside of assembly with a 2" wide band of sealer, thoroughly covering joint head and sheet metal screws. Allow sealer to set (approximately 72 hours) before pressure testing. Do not thin.

.6 The Consultant shall inspect the duct sealing prior to any insulation being installed. Provide minimum four (4) working days' notice.

3.4 Instrument Test Ports

.1 Ports shall be supplied and installed by the mechanical contractor prior to installation of external insulation.

.2 With the assistance of the balancing contractor, the contractor will mark the spacing for the instrument ports on the ductwork after installation of the ductwork and notify the commissioning team of the number of ports.

3.5 Duct Leakage Tests

.1 Duct leakage testing not required.

3.6 Painting

.1 All exposed ductwork in finished areas shall be painted. Coordinate colour with Owner.

3.7 Cleaning (prior to start-up)

.1 Keep ductwork and duct liners clear from dust and debris during construction.

.2 Prior to starting HVAC equipment, inspect and clean all equipment, and ductwork on the inside and outside to ensure that they are completely free from dust and debris.

.3 Install clean filters in all units.

END OF SECTION

PART 1 - GENERAL

1.1 Reference Standards

.1 Ontario Building Code

.2 ASHRAE

.3 SMACNA

.4 NFPA 90A – Air Conditioning and Ventilation Systems

.5 ULC

.6 CSA

.7 Local Codes and Requirements

1.2 Submittals

.1 Submit shop drawings showing location, ratings, sizes of all fire dampers.

.2 One copy of all stamped reviewed shop drawings plus operation and maintenance data shall be included in the maintenance manual.

1.3 Delivery, Storage and Handling

.1 Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

.2 Storage: Store materials in a dry area indoor, protected from damage and in accordance with manufacturer's instructions.

.3 Handling: Handle and lift dampers in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.

PART 2 - PRODUCTS

2.1 General

.1 All required accessories shall conform to ASHRAE and SMACNA standards and recommendations.

2.2 Fire Dampers

.1 Provide fire dampers in ducts penetrating fire rated walls, floors, or ceiling as indicated on the drawings.

.2 Fire dampers shall be UL STD 555 to 1-1/2 hour fire ratings.

.3 Fire dampers shall be equipped for vertical or horizontal suitable for application.

.4 Frame: 4-7/8", 20 gauge galvanized steel channel.

.5 Blades: 24 gauge galvanized steel blades, curtain type, recessed out of air stream.

.6 Fusible link: 165°F.

.7 Provide duct access doors of adequate size to service fire dampers. Provide Pull Tab for horizontal dampers where access door is located below the fire damper. Refer to Duct Access Doors within this section.

.8 Acceptable Manufacturers

.1 Ruskin – Series IBD2 Style B
.2 Nailor Industries – 0120 Type B
.3 National Controlled Air (NCA) – FD – 80 Type B
.4 Tamco

2.3 Combination Fire Smoke Dampers

.1 Combination fire/smoke dampers meeting or exceeding the following specifications shall be furnished and installed at locations shown on plans or as described in schedules.

.2 Combination fire smoke dampers shall be triple-V groove blades.

.3 Dampers shall meet the requirements of NFPA90A, 92A and 92B and shall be classified for use for fire resistance ratings of less than 3 hours, in accordance with UL555, and classified as Smoke Dampers in accordance with the latest version of UL555S.

.4 Quality Assurance

.1 Dampers shall be warranted against manufacturing defects for a period of 5 years.
.2 Dampers shall be tested, rated and labeled in accordance with the latest ULC requirements.
.3 Damper pressure drop ratings shall be based on tests and procedures performed in accordance with AMCA 500 and certified by AMCA (if applicable).
.4 Factory Tests: Factory cycle damper and actuator assembly to assure proper operation.

.5 Ratings:

.1 Fire Resistance: 1-1/2 hours in accordance with ULC555.
.2 Smoke Rating: Leakage Class II Smoke Damper in accordance with UL555S. A Class II smoke damper leaks no more than 20 cubic feet per minute (.57 m^3/min) at 4 in. wg. (1 kPa) differential pressure.
.3 Elevated Temperature Rating: 165°F.
.4 Air Flow Rating: 2000 fpm.
.5 Differential Pressure Rating: 4 in. wg.

.6 Construction:

.1 Frame: 5 inches x minimum 16 gage (127 x minimum 1.6 mm) roll formed, galvanized steel hat-shaped channel, reinforced at corners. Structurally equivalent to 13 gage (2.3 mm) U-channel type frame.
.2 Blades:

.1 Style: Single skin with 3 longitudinal grooves (flat blades are not acceptable).
.2 Action: Opposed.
.3 Material: Minimum 16 gage (1.6 mm) galvanized steel.
.4 Width: Maximum 6 inches (152 mm).

.3 Bearings: Self-lubricating stainless steel sleeve type, turning in extruded hole in frame.
.4 Seals:

.1 Blade: Inflatable silicone fiberglass material to maintain smoke leakage rating to a minimum of 450°F (232°C) and galvanized steel for flame seal to 1,900°F (1,038°C). Mechanically attached to blade edge (glue-on or grip type seals are not acceptable).
.2 Jamb: Stainless steel, flexible metal compression type.

.5 Linkage: Concealed in frame.
.6 Axles: Minimum ½ inch (13) diameter plated steel, hex-shaped, mechanically attached to blade.
.7 Mounting: Vertical and/or Horizontal.
.8 Temperature Release Device: Heat-Actuated, Quick Detect.

.1 Close (in a controlled manner) and lock damper during test, smoke detection, power failure, or fire conditions through actuator closure spring. At no time shall actuator disengage from damper blades.
.2 Allow damper to be automatically and remotely reset after test or power failure conditions. After exposure to high temperature or fire, inspect damper before reset to ensure proper operation.
.3 Controlled closing and locking of damper in 7 to 15 seconds to allow duct pressure to equalize. Instantaneous closure is not acceptable.

.9 Release Temperature:
.10 Actuator:

.1 Type: Electric 120V, 60 Hz, two-position, fail close.
.2 Mounting: External

.11 Finish: Mill galvanized.

.7 Accessories

.1 Sleeves, sized to suit wall or floor thickness.

.8 Acceptable Manufacturers:
.1 Ruskin - FSD36 or equal
.2 National Controlled Air (NCA) – FSD-3V
.3 Nailor - 1271
.4 Tamco

2.4 Balancing Dampers

.1 Multi-blade damper: Galvanized steel minimum 16 gauge, provide with quadrants or adjustment rods and lock screw.

.2 Single blade damper: Galvanized steel minimum 18 gauge, provide with quadrants and lock screw.

.3 Fabricate splitter dampers of double thickness sheet metal to streamline shape, properly stiffened to avoid vibration. Size on basis of straight air volume proportioning.

.4 Fabricate single blade dampers for duct sizes to maximum 250mm x 750mm (10” x 30”).

.5 Fabricate multi-blade dampers of opposed blade pattern with maximum blade sizes 300mm (12”) to 1.8m (6’). Assemble centre and edge crimped blades in prime coated or galvanized channel frame with approved type hardware.

.6 Include for the supply and installation of twelve (12) extra balance dampers in installed ductwork pending balance results and comments.

2.4 Turning Vanes

.1 Factory or shop fabricated double thickness to SMACNA standards.

.2 Acceptable Manufacturers:

.1 Duro Dyne
.2 Ductmate

2.5 Automatic Dampers

.1 Damper frames and blades shall not be less than 12 gauge, 0.081” (2.1mm) extruded aluminium. Channel frame to be 4” (101.6mm) deep.

.2 Blades to be single unit, internally reinforced and connected to frame with a 7/16” hexagon rod. Internal hollows to be insulated with 7/8” thick polyurethane foam with T factor of 5.0 per inch. Blades shall be thermally broken. All fresh air intake dampers to be complete with insulated frame and blade.

.3 Blade and frame seals to be extruded synthetic rubber secured in an integral slot within the blade extrusion.

.4 Frame shall be insulated with polystyrene, R factor of 5.0 per inch.

.5 Bearings to be comprised of Celcon inner bearing fixed onto a hexagon rod rotating within a Polycarbonate outer bearing inserted into frame, resulting in no metal to metal contact.

.6 Linkage hardware to be out of air stream and constructed of aluminium and corrosion resistant zinc plated steel, equipped with cup-point trunnion screw for slip-proof grip.

.7 Dampers shall be suitable for operating in temperatures ranging between -40°F (-40°C) and 165°F (731°C).

.8 Leakage shall not exceed 0.6% of the rated air flow at 10” WG differential static pressure across the damper.

.9 This Contractor shall provide all 120-24V transformers as required.

.10 Acceptable Manufacturers:

.1 Tamco 9000
.2 Ruskin
.3 Nailor

2.6 Damper Actuators

.1 Damper actuators shall be supplied with the unit by the unit manufacturer or by Controls Contractor under Section 15900 as indicated in the equipment schedules, equipment specifications and controls details.

2.7 Duct Access Doors

.1 Provide access doors in ductwork of adequate size in the following locations:

.1 at each fire damper

.2 before and after each reheat coil
.3 bottom of all duct risers part of or next to outside air intakes and outlets
.4 in plenum and equipment casings to facilitate maintenance and cleaning of all components.

.2 Construct access doors from double thickness 22 gauge galvanized steel sheets or aluminium in equal strength where required, 25mm apart, with necessary reinforcing inside for rigidity. Fill the 25mm space with glass fibre insulation.

.3 Access doors to be ultra-low leakage with positive seal polyethylene gasket.

.4 Access doors shall be square, rectangular or flat oval. Square and rectangular access doors shall be equal to Nailor 085CL. Flat oval access doors shall be equal to Nailor 0800.

.5 Access Doors shall have minimum two plated steel camlock fasteners for sizes up to 350mm (14”), and four camlock compression latches for sizes over 350mm (14”).

.6 Sizes

.1 Fire dampers and reheat coils

.1 Square/rectangle: minimum 16x16” or 2” less duct size
.2 Flat Oval: minimum 18x10” or 2” less duct size

.2 Duct Risers

.1 Square/rectangle: minimum 24x24” or 2” less duct size

.7 Acceptable Manufacturers

.1 Nailor
.2 Price
.3 Ruskin

2.8 Flexible Connections

.1 Flexible Connections shall be Duro Dyne heavy glass, ULC listed, non-combustible, waterproof fabric, double coated with neoprene and shall be 150 mm minimum width, 0.81mm thick, density of 1.3 kg/m^2. Temperature rating shall be -40C (-40F) to +90C (+194F).

.2 Flexible connectors shall be attached to 24 gauge metal strips minimum 75mm (3”) wide.

.3 Acceptable Manufacturers:

.1 Duro Dyne

.2 Mercer Rubber Co.

2.9 Test Ports

.1 Test ports shall be equal to Duro Dyne TH-1, IP-2, IP-4 to suit application complete with screw in cap, neoprene gasket, insulating plug, and extensions for insulated ductwork.

.2 Acceptable Manufacturers:

.1 Duro Dyne
.2 Ductmate

PART 3 - EXECUTION

3.1 Installation

.1 Provide access doors of adequate size to service, maintain, or inspect within duct stream where required. Locations include but are not limited to automatic dampers, fire dampers, and filters. Coordinate installation with General Contractor.

.2 Install flexible connections where rigid duct connects to equipment that is susceptible to vibration and as indicated on drawings.

.3 Install instrument test ports to allow Pitot tube insertion with cam-action handle.

3.2 Fire Dampers

.1 Confirm rating of devices with ratings of surfaces or separations.

.2 Provide fire dampers at locations shown, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction.

.3 Fire dampers shall be complete with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

.4 Where access door is located below horizontal fire damper, damper shall be equipped with pull tab release.

.5 Provide duct access doors to service fire dampers for those air transfer openings mounted with ducts.

.6 Provide fire stop flaps on air outlets penetrating fire rated membranes or surfaces.

3.3 Combination Fire Smoke Dampers

.1 Inspect areas to receive dampers. Notify the Engineer of conditions that would adversely affect the installation or subsequent utilization of the dampers. Do not proceed with installation until unsatisfactory conditions are corrected.

.2 Install dampers at locations indicated on the drawings and in accordance with manufacturer's ULC approved installation instructions.

.3 Install dampers square and free from racking with blades running horizontally.

.4 Do not compress or stretch damper frame into duct or opening.

.5 Handle damper using sleeve or frame. Do not lift damper using blades, actuator, or jackshaft.

.6 Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

3.4 Balancing Dampers

.1 Provide balancing dampers, whether shown or required, at points on supply, return and exhaust systems, where branches are taken from larger ducts, for proper air balancing.

.2 Review balance damper locations with the Balancing Contractor prior to installation. Additional costs to add balance dampers for proper balancing after installation will not be accepted.

.3 Include for the supply and installation of twelve (12) extra balance dampers in the already installed ductwork pending balance results and comments.

3.4 Turning Vanes

.1 Install in conformance with SMACNA standards.

.2 Install in all square elbows and short radius elbows for supply and return air ductwork.

3.5 Automatic Dampers

.1 Install opposed blade automatic control dampers as indicated on drawings.

.2 Opposed Blade Dampers: Use for shut off service, modulating service without companion dampers, throttling services.

.3 Parallel Blade Dampers: Use for mixing or relief service, variable position service with companion dampers.

.4 Coordinate installation of operator and controls with Controls Contractor where applicable.

.5 Damper actuators shall be supplied by Controls Contractor under Section 15900 as indicated in the equipment schedules, equipment specifications and controls details.

3.6 Access Doors

.1 Provide access doors in ductwork of adequate size in the following locations:

.1 at each fire damper
.2 before and after each reheat coil
.3 bottom of all duct risers – part of, or next to, outside air intakes and outlets
.4 in plenum and equipment casings to facilitate maintenance and cleaning of all components.

.2 Sizes

.1 Fire dampers and reheat coils

.1 Square/rectangle: minimum 16x16” or 2” less duct size
.2 Flat Oval: minimum 18x10” or 2” less duct size

.2 Duct Risers

.1 Square/rectangle: minimum 24x24” or 2” less duct size

3.7 Flexible Connections

.1 Provide flexible connections on inlet and outlet duct connections of air handling units or other equipment likely to be affected by, or to cause vibration or noise to be transmitted through ductwork.

.2 Install in accordance with SMACNA.

END OF SECTION

PART 1 - GENERAL

1.1 Requirements

.1 Air outlets shall meet the following standards and requirements:

.1 ASHRAE
.2 AMCA
.3 Local Codes and Requirements

.2 Air flow tests and sound levels shall be made in accordance with ASHRAE standards.

.3 Manufacturers shall certify performance and application.

1.2 Submittals

.1 Shop Drawings:

.1 Submit shop drawings to the Consultant for review prior to ordering or installation.
.2 Shop drawings shall include manufacturer, model numbers, performance data, and indicate conformance to above reference standards. Louver shop drawings shall include free area, pressure drop and water carry over data.
.3 One copy of all stamped reviewed shop drawings shall be included in maintenance manual.

.2 Operation and Maintenance Data:

.1 Provide operation and maintenance literature for all equipment indicating manufacturer and model of equipment, instructions for operation and maintenance of same, and parts list.
.2 Operation and maintenance data shall be included in the maintenance manual.

PART 2 – PRODUCTS

2.1 General

.1 Air flow tests and sound levels shall be made in accordance with ASHRAE standards.

.2 Manufacturers shall certify performance and application.

.3 All supply grilles shall be adjustable with double deflection.

2.2 Grilles and Diffusers

.1 Provide grilles, registers and diffusers of the types as shown on the drawings.

.2 Provide vertical throw type as noted based on ceiling heights.

.3 Construction shall be heavy duty, with 14 gauge steel blades and heavy duty steel support bars and frame unless otherwise noted.

.4 Grilles shall be complete with steel volume damper of the opposed blade type for balancing purposes as noted.

.5 Supply diffusers mounted in t-bar shall not contain integral balance dampers. Balance dampers must be installed in branch duct runs to diffusers.

.6 Acceptable Manufacturers:

.1 Price
.2 Nailor
.3 Titus
.4 Metal Aire
.5 Kreuger

2.3 Louvers

.1 Louvers shall be licensed to bear the AMCA seal and certified by the manufacturer for outdoor use.

.2 Louvers shall be sized as noted on drawings and model selected to prevent moisture carry-over (896 fpm for base specified Ventex 2435 or 638 fpm for base specified Ventex 2425).

.3 Frame shall be 0.081" (2.06 mm) extruded aluminium, alloy 6063-T5.

.4 Blades shall be 0.081" (2.06 mm) extruded aluminium, alloy 6063-T5, at an angle of 35° on 3.5” (89mm) centres. Louver assembly shall have blades contained within a single frame.

.5 Louver components including heads, jambs, sills and mullions shall be factory assembled.

.6 All materials shall be factory finished after assembly with Polyester Powder Coat, standard mill finish unless otherwise indicated.

.7 Louvers shall be complete with 19 gauge galvanized birdscreen with ½” x ½” openings.

.8 Submit all performance data with shop drawings for free area, pressure drop and water carry over.

.9 Acceptable Manufacturers:

.1 Ventex
.2 Tamco
.3 Price
.4 Ruskin

PART 3 - EXECUTION

3.1 Grilles and Diffusers

.1 Confirm location, type of mounting and size of all outlets with site conditions prior to ordering and installing.

.2 Provide flanged connection off ductwork for mounting of grilles.

.3 **Paint inside of ductwork flat black behind supply and return wall grilles.**

.4 Position vertical throw diffusers and deflection of grilles to achieve best air flow in area. Adjust to suit Balancing Contractor and Engineer's requirements.

.5 Provide birdscreen on all open-ended return air ducts unless otherwise noted.

3.2 Louvers

.1 Confirm location and size of all louvers with site conditions prior to ordering and installing.

.2 Provide 16 gauge galvanized sheet metal sleeve through wall opening where required.

.3 All louvers shall be equipped with birdscreen.

.5 Provide caulking at all Louvers using non-shrink clear caulking.

END OF SECTION

PART 1 – GENERAL

1.1 Work Included

.1 Conform to Section 15010 – General Mechanical Requirements.

1.2 Description

.1 Provide microprocessor-based Building Automation System (BAS) with electric actuation as indicated on the drawings and as specified.

.2 The BASE BUILDING BAS provider shall carry in their contract the following project scope which shall include, but not be limited to, the following work:

.1 Installation of an electronic building automation system as outlined in the specifications, and drawings and as required to execute the sequence of operations.
.2 Integration to new and pre-purchased equipment (i.e. AHUs, RTUs, Pumps).

.3 The BASE BUILDING PNEUMATICS provider shall carry in their contract the following project scope which shall include, but not be limited to, the following work:

.1 Decommissioning and removal of all redundant pneumatic controls along with removal of all redundant pneumatic tubing. Pneumatic tubing and devices shall be turned over to the Board as confirmed.

1.3 Approved Suppliers and Manufacturers

.1 Approved Suppliers and Manufacturer Product Lines to Table 1. Manufacturer Product Line applies to Operator Software, Controller Resident Software, Building Controllers, Advanced Application Controllers and Specific Application Controllers.

Supplier	Manufacturer Product Line	Contact
Base Bid:		
Analysts of Pneumatic Systems Ltd. (APS)	Pneumatic Controls Contractor	Dave Strain Office: 1-905-640-2333 analystsofpneumatic@bellnet.ca
Total Control Building Automation Solutions	Johnson Controls	Ken Friderichs, Field Service Supervisor Cell: 1-905-242-7574 ken.friderichs@totalcontrolcanada.com

.2 Prequalified Controls Contractors shall retain the services of one of the following for all installation and wiring. Note this requirement is specific and deviations are not acceptable.

.1 Partec Controls, Oshawa (Andrew Reesor, 1-905-922-9686)
.2 Multiservice Electric, Claremont (Bob Smith, 1-905-649-5157)

.3 GTA Building Systems (Jim Tilley, 1-647-407-6030)

1.4 Codes and Standards

.1 Comply with rules and regulations of codes and ordinances of local, provincial, and federal authorities; such codes and ordinances, when more restrictive, take precedence over the Contract Documents.

.2 Provide products listed and classified by the testing firm acceptable to the authority having jurisdiction as suitable for the purpose indicated and specified.

1.5 BAS Performance

.1 Graphic Display: Display the selected graphic representation at Operator Interfaces with current point object data at a minimum rate of twenty points in ten seconds.

.2 Graphic Refresh: Update the selected graphic representation at Operator Interfaces with current point object data at a minimum rate of twenty points in eight seconds.

.3 Data Scan: Update point object data at controllers and Operator Interfaces with current point object data at a minimum rate of once every six seconds.

.4 Binary Object Command: Controlled device will react within two seconds of an operator initiated command on a binary point object.

.5 Analog Object Command: Controlled device will start to react within two seconds of an operator initiated command on an analog point object.

.6 Alarmed Object Display: Alarm will annunciate visually and audibly at Operator Interfaces within five seconds on local area networks and within forty-five seconds on wide-area networks from the time the object entered the alarmed state.

.7 Program Execution Rate: Provide ability to execute programs at a minimum rate of once every five seconds. Provide execution rates suitable for processes controlled.

.8 PID Execution Rate: Provide adjustable execution rates for proportional-integral-derivative (PID) loops; update the controlled variable and command the controlled device at this same rate. Provide execution rates suitable for processes controlled.

.9 Display and Report Accuracy: Provide minimum accuracy for point object data displayed at Operator Interfaces, reported to printers, reported to data files to Table 2: Display and Report Accuracy.

.10 Control Tolerance: Maintain controlled variable to control tolerance from set point to Table 3: Control Tolerance.

Table 2: Display and Report Accuracy.	
Point Object	Accuracy
Room Air Temperature	+/-0.5 deg. C (+/-0.9 deg. F) from actual
Duct Air Temperature	+/-0.5 deg. C (+/-0.9 deg. F) from actual
Outside Air Temperature	+/-0.5 deg. C (+/-0.9 deg. F) from actual
Dew Point Temperature	+/-1.5 deg. C (+/-2.7 deg. F) from actual
Water Temperature	+/-0.5 deg. C (+/-0.9 deg. F) from actual
Relative Humidity	+/-2.2 % of actual
Water Flow	+/-1.2 % of actual for 3.0 to 30.0 ft/s
Air Flow, Terminal Unit	+/-5.0 % of actual
Air Flow, Fan Bell and Duct	+/-5.0 % of actual
Air Flow, Pressurized Space	+/-3.0 % of actual
Air Pressure, Duct	+/-0.45 % of scale length
Air Pressure, Room	+/-0.45 % of scale length
Fluid Pressure (other than air)	+/-0.45 % of scale length (see Note 1)
Electrical (current, voltage, power)	+/-1.2 % of actual (see Note 2)
Carbon Monoxide	+/-3.2 % of actual
Carbon Dioxide	+/-3.2 % of actual
Note 1: For both absolute and differential pressure.	
Note 2: Does not include utility grade meters.	

Table 3: Control Tolerance.		
Controlled Variable	Range	Control Tolerance from Set Point
Room Temperature		+/-0.6 deg. C (+/-1.1 deg. F)
Duct Temperature		+/-0.6 deg. C (+/-1.1 deg. F)
Humidity		+/-5 % RH
Air Flow		+/-1.0 % of scale length
Air Pressure	0-1500 Pa (0-6 in. w.g.)	+/-1.0 % of scale length
	-25 to 25 Pa (-0.1 to 0.1 in. w.g.)	+/- 10.0 % of scale length
Fluid Pressure (other than air)		+/- 1.0 % of scale length

1.6 Submittals

.1 Product Data and Shop Drawings:

.1 Refer to Division 1 and Section 15010.
.2 Provide shop drawings in electronic format.
.3 Riser Diagrams: Indicate: communication wire paths and connections to network devices; power wire and ground wire connections to Operator Interfaces and network devices; wire types and port types with manufacturer's model numbers; communication protocol and communication speed for network segments; power panel and breaker designations; wire terminal designations; addresses for network devices; room designations.
.4 Specifications and Instructions: Indicate: dimensions, capacities, electrical characteristics, mechanical characteristics, environmental characteristics, performance characteristics, finishes. Circle model number for products provided or furnished. General catalogue sheets are not acceptable. Provide installation instructions.
.5 System Flow Diagrams: Indicate: control devices, control device designation, control device range, control device fail-safe position, point object type, point object name, point object address. Indicate flow directions for gases and liquids relevant to the controlled process. Indicate hardwired interlocks between control devices and equipment. Indicate the location of field control devices.
.6 Products Schedule: Indicate: product designation, product name, product manufacturer, product model number, product data sheet reference number, quantities. Provide quantities required under the Work.
.7 Valve Schedule: Indicate: system designation, control device designation, valve body size, pipe sizes, valve design flow, selected valve Cv, selected valve design flow pressure drop, valve body configuration, valve body model number, actuator fail-safe position, actuator model number, actuator quantity, actuator close-off pressure rating.
.8 Damper Schedule: Indicate: system designation, control device designation, duct dimensions, blade width, blade type, damper model number, actuator model number, actuator quantity, actuator fail-safe position, provisions for edge and blade seals, actuator mounting configuration.
.9 Room Schedule: Indicate: controller object name, controller address, controller model number, application designation, room designation, sensor model numbers.
.10 Cabinet Layouts: Interior: Indicate: orientation of contents including controllers, transformers, cable trays, terminal strips, relays, control devices, labels. Exterior: Indicate: orientation of gauges, displays, switches, labels.
.11 Wire Details: Indicate: connections between control devices, controllers and equipment; connections to sources of power and grounds; control device designations, control device terminal designations, control device location; equipment terminal designations; cabinet terminal strip designations; wire designations. For control devices shown on multiple drawings, indicate the control

device with the same designation on all drawings. Differentiate between manufacturer installed wire and field installed wire.

.12 Sequence of Operation: Provide a complete description of operation to SEQUENCE OF OPERATION. Provide description of operation for interlocks that directly connect to the Work. Indicate references to the system flow diagram by control device designation or point object name.

.13 Custom Application Programs (Algorithms): Provide in printed format to SEQUENCE OF OPERATION. Provide comments that describe the details of program functions.

.14 Flow Diagrams for Custom Application Programs (Algorithms): Provide in printed format SEQUENCE OF OPERATION.

.15 Points Schedule: Indicate: input points, output points and virtual points for each controller. Indicate: point object address, point object name, point object description, point object alarm limits. List points in ascending order based on point object address.

.16 PICS: Provide a BACnet Protocol Implementation Conformance Statement for each model of Operator Interface and controller under the Work.

.2 Samples:

.1 Provide with submittal under Part 1: Product Data and Shop Drawings for approval by the Owner and/or Consultant:

.1 Graphic Representations: Conceptual layouts in printed format of images and point objects for systems under Part 3: Execution, Operator Interface. Indicate or explain which other graphic representations are directly accessed.

.2 Test Forms: In printed format for test forms under Part 3: Execution, Testing and Commissioning.

.3 Products: As specified under Part 3: Execution, Control Devices.

.3 Work Schedule:

.1 Provide a schedule of the Work within two weeks of contract award. Indicate: intended sequence of tasks, start dates, task durations, and delivery dates for material and equipment requiring long lead times, restraints on work by other trades or situations.

.2 Provide monthly updated Work Schedule indicating percentage complete and revisions to expected delivery dates.

.4 Values Schedule:

.1 Provide a schedule of separate system prices that comprises the price of the Work of this Section within four weeks of contract award. In addition to the system price, indicate material and labour prices separately for the system. Indicate each mechanical and electrical system as a separate price. Indicate terminal unit systems of the same type on a floor as a separate system price for the respective floor. Include the price for communication networks and power networks allocated proportionately to the separate system prices. Indicate the Operator Interfaces as a separate system price. Include

all costs associated with the work of the system in the separate system price.

.2 The Values Schedule provides the basis for progress payments.

.5 Project Record Documents:

.1 Operation and Maintenance Manuals:

.1 Provide two copies in printed format for review by the Consultant at least ten weeks before the projected substantial completion date.

.2 Provide three copies of corrected manuals in printed format within three weeks following completion of Acceptance Test under Part 3: Execution. Provide manuals in hard cover three-ring binders with index page and indexing tab per section.

.3 Sections:

.1 Contact Information: Provide names, addresses, 24-hour telephone numbers of service representatives and installing subcontractors.

.2 Operation: Provide owner operating manuals in printed format and electronic format for Operator Interfaces, Controller Resident Software, Building Controllers, Advanced Application Controllers, Specific Application Controllers, control devices, compressed air system. For Custom Application Programs (Algorithms) Editor, provide a reference manual for the language syntax that describes each function.

.3 Engineering, Installation and Maintenance: Provide manuals for design and installation of point objects, controllers, control devices. Provide instructions for calibrating, troubleshooting and replacing controllers and control devices.

.4 Software: Provide complete original issue media and release notes for Operator Interfaces.

.5 Preventive Maintenance Procedures: Provide for Operator Interfaces, controllers, control devices. Provide a schedule of tasks; indicate dates for inspection, maintenance and calibration; indicate the pages in the engineering, installation and maintenance manuals that list the procedures.

.6 Replacement Parts List: Indicate: manufacturer name, manufacturer model number, supplier name, supplier address, supplier telephone number.

.7 Certificates: Provide original issue certificates for installation, maintenance and calibration.

.8 Test Forms: Provide copies of test forms completed under Part 3: Execution, Testing and Commissioning.

.9 Provide certificate of pressure test under Part 3: Execution, Control Air Tubing.

.10 Provide licenses, guarantees and warranty documents for products and systems.

.2 As-built Product Data and Shop Drawings:

.1 Provide electronic format for approval by the Consultant within three weeks following the successful completion of Acceptance Test under Part 3: Execution.
.2 Points Schedule: For points schedule generated under Part 1: Submittals, Product Data and Shop Drawings, indicate operating conditions for point object data; list point objects by system designation and alphabetically by point object name.
.3 Time-of-Day (TOD) Schedules: Indicate: objects assigned to the TOD Schedule, Occupied Mode times.

.3 As-built Floor Plans:

.1 Maintain on the project site as-built conditions on one full-size set of Contract Drawings, referred to as Marked-up Drawings; indicate on these drawings as-built locations for: control devices, cabinets, network devices with network address, communication networks by type and address, connection points to communication networks for Operator Interfaces, power networks, conduit paths, junction boxes, Operator Interfaces.
.2 Submit three copies of Marked-up Drawings to Consultant for review within three weeks following successful completion of Acceptance Test under Part 3: Execution. Revise Contract Drawings to match the approved Marked-up Drawings; submit two copies as full-size in printed format and one electronic format.

.4 Objects Backup:

.1 Provide with As-built Product Data and Shop Drawings.

1.7 Warranty

.1 Warrant the Work in accordance with the General Conditions and as amended below.

.2 Warranty start date will be the date the Work is accepted under Part 3: Execution, Acceptance Test.

.3 Provide a single warranty start date even when the Owner has received beneficial use prior to acceptance of the Work. For Work split into multiple contracts or for a multi-phase contract, provide a separate warranty start date and period for each contract or phase.

.4 Adjust, repair or replace defects and failures in the Work at no additional cost during the warranty period and without reduction in service to the Owner. Provide warranty service during normal business hours and within 24 hours of the Owner’s request for service.

.5 Provide warranty service by factory trained service representatives of the Supplier.

.6 Replace Operator Interface software, Controller Resident Software, controller firmware and database files with revisions that correct deficiencies or defects during the warranty period at no charge to the Owner. Notify the Owner of changes and schedule the installation. Update Operation and Maintenance Manuals with firmware release notes.

.7 Prior to testing date under Part 3: Execution, Acceptance Test, update firmware in controllers to latest revisions at no additional cost to the Owner; update Operation and Maintenance Manuals with firmware release notes.

.8 During the Warranty period check the tuning of each control loop once during heating season and once during cooling season; notify the Owner when this work is to occur. Forward to the Consultant documentation indicating observations and adjustments made.

.9 Warrant products that are reconditioned under the Work to the same requirements as new products.

1.8 Ownership of Proprietary Material

.1 Software and documentation generated under the Work becomes the property of the Owner, including and not limited to graphic files, database files, Custom Application Programs, Project Record Documents, and Training Manuals.

PART 2 – GENERAL

2.1 Materials

.1 New Products: Non-beta versions currently under manufacture and have been applied in similar installations for a minimum period of one year.

.2 Revisions: Latest available revision for Operator Software, Controller Resident Software and controller firmware at start of Warranty.

.3 Replacement Parts: Readily available and not scheduled for discontinuation at time of Total Project Completion.

.4 Expansion: Expandable through additional inputs and outputs and to card access, security, fire alarm and lighting control systems

2.2 Communication

.1 The BAS consists of primary and secondary communication networks.

.2 Primary Communication Network:

.1 Protocol: Bacnet/IP to ANSI/ASHRAE Standard 135-2004 Bacnet - A Data Communication Protocol for Building Automation and Control Networks, and to Annex J of same standard.

.2 Data Link/Physical Layers: ISO 8802-3 ("Ethernet") LAN to

ANSI/ASHRAE Standard 135-2004 Bacnet - A Data Communication Protocol for Building Automation and Control Networks.

.3 Connected to this network shall be Operator Workstations, Building Controllers, and Advanced Application Controllers which are peers on the network.

.4 The primary communication network shall have the following minimum capabilities:

.1 High speed data transfer for alarm reporting; point log reporting and uploading/downloading of programs. Minimum baud rate shall be 1 Mbps.
.2 Single or multiple node failure reporting.
.3 Message and alarm buffering to prevent data loss.
.4 Error detection, correction and re-transmission to ensure data integrity.
.5 Synchronization of the real time clocks in the Building Controllers and Advanced Application Controllers.
.6 Multiple operator access to the primary and secondary communication networks from any node on the primary communication network.

.3 Secondary Communication Network:

.1 Protocol: Bacnet to ANSI/ASHRAE Standard 135-2004 Bacnet - A Data Communication Protocol for Building Automation and Control Networks.

.2 Data Link/Physical Layers: ARCNET LAN or MASTER-SLAVE/TOKEN PASSING (MS/TP) LAN to ANSI/ASHRAE Standard 135-2004 Bacnet - A Data Communication Protocol for Building Automation and Control Networks.

.3 Connected to the secondary communication network shall be Specific Application Controllers which are peers or nodes on the network.

.4 Each Building Controller shall manage their individual secondary communication networks.

.5 The secondary communication network shall have the following minimum capabilities:

.1 The Building Controller shall manage internetwork point object sharing between nodes on the secondary communication network and internetwork.
.2 The minimum communication rate shall be 78.8 kbps.
.3 Provide multiple operator access to nodes on the internetwork from any Advanced Application Controller for peer-to-peer communication protocols. Provide a communication network to achieve operator interface communication to nodes on the internetwork from any Advanced Application Controller location for poll-and-response communication protocols.

.6 A failure of any component or controller on either the primary or secondary communication networks shall not interrupt the execution of communication on these networks.

.7 Provide transient surge protection for all products connected to the

internetwork.

2.3 Operator Interface

.1 Operator Workstation (OWS):

.1 OWS Hardware: One Personal Computer (PC): 6th Generation Intel® Core™ i5 Processor, 8GB Memory, 500GB Hard Drive, RAID 1 hardware implemented disk controllers, DVD-ROM/CD-RW combination drive, two USB 3.0 ports, one serial port, one parallel port, graphics accelerator card with 2 GB memory, 24" LCD monitor displaying 1920x1080 non-interlaced native resolution, chassis with three available PCI expansion slots and 2 available full size drive bays, 10/100/1000 Ethernet network interface card with RJ-45 network connector, full size keyboard, 2-button USB mouse, 220W power supply, all required cables.

.2 OWS Battery Backup: 30 minutes of backup power for OWS. Automatically logoff operator and perform orderly shutdown of OWS at end of backup power period.

.3 OWS Storage Redundancy: refer to RAID requirements for OWS Hardware above.

.4 OWS Software: Windows 7 Professional or later, with latest service pack installed at start of Warranty; with password protected login.

.5 OWS Alarm, Event and Report Printer: 600 dpi laser printer, complete with toner, 500 sheets letter size white 24 lb paper.

.2 Operator Software:

.1 User Interface: Graphical; keyboard and mouse driven; executes multiple applications simultaneously.

.2 Security:

.1 Access Level: Defines operator's ability to view, command and modify objects, and execute applications and system functions.

.2 Definition: Multiple operators are assigned access levels, and independent user login names and passwords are configurable.

.3 Processing: Automatically log off operator after an adjustable period of mouse or keyboard inactivity. Log operator activity.

.4 Storage: Store operator data, login names and passwords in encrypted format.

.3 On-line Help: Context-sensitive for operation and configuration tasks.

.4 Objects and Properties:

.1 Definition: Create and delete objects. View and modify object properties.

.2 Backup and Restore:

.1 Automatically backup objects and operator overrides to local hard drive of the Operator Workstation when a change is made in the controller.

.2 Manually backup objects and operator overrides to local hard drive of the Operator Workstation when initiated by the

operator.

.3 Automatically restore objects to a controller with an empty objects database.

.4 Automatically backup database files from Operator Workstation to OWS Mass Storage device. Instruct operator to exchange tapes or disks weekly.

.5 System Diagnostics: Display diagnostic messages at Operator Workstations. Store diagnostic messages to local hard drive of Operator Workstations.

.6 Alarms and Events:

.1 Definition: Alarm limits, alarm limit differentials, states and reactions are adjustable.

.2 Processing: Alarm and event messages are independently configured to route to network devices and modems. Enable and disable alarms and events manually by the operator and automatically through Custom Application Programs. Message displays at Operator Workstations and indicates source, location and nature without using acronyms.

.3 Storage: Store alarm and event messages to local hard drive of the Operator Workstation.

.7 Trends:

.1 Definition: Create, delete and modify trends. Title blocks and legends are configurable.

.2 Storage: Store trend data to local hard drive of the Operator Workstation. Maintain twelve consecutive months of trend data on the hard drive. Trend data is available for use in spreadsheets and database programs.

.8 Reports:

.1 Definition: Create, delete and modify reports. Report data includes date and time stamps. Title blocks and legends are configurable.

.2 Storage: Reports are printed and stored to local hard drive of the Operator Workstation automatically and by operator command. Report data is available for use in spreadsheets and database programs.

.9 Time-of-Day (TOD) Schedules:

.1 Definition: Create, delete and modify TOD Schedules. Assign objects to TOD Schedules based on function and location.

.10 Custom Application Programs (Algorithms):

.1 Definition: Create, delete and modify programs and program statements.

.2 Debugger: Provide messages for syntax and execution errors.
.3 Syntax: Support the syntax under Part 2: Products, Controller Resident Software, Custom Application Programs.

.11 Graphics:

.1 Definition: Create, delete and modify graphic representations as the Operator Interface is communicating or not communicating with the network. Import and convert images from other programs, including and not limited to: Micrografx Designer, Microsoft Visio, AutoCAD.
.2 Dynamic Values: Add point object data to graphic representations.
.3 Library: Provide library of image files; include standard images for chillers, boilers, air handlers and terminal units and standard symbols for fans, pumps, coils, control devices, pipes, dampers and ducts.

2.4 Controller Resident Software

.1 The software resides in Building Controllers and Advanced Application Controllers and is edited by means of the Operator Interface.

.2 Security:

.1 Definition: Multiple operators are assigned access levels, and independent user login names and passwords are configurable.
.2 Processing: Automatically log off operator after an adjustable period of mouse or keyboard inactivity.

.3 Alarms and Events:

.1 Definition: Alarm limits, alarm limit differentials, states and reactions are adjustable.
.2 Processing: Alarm and event messages are independently configured to route to network devices and modems. Enable and disable alarms and events manually by the operator and automatically through Custom Application Programs.

.4 Trends:

.1 Definition: Create, delete and modify trends. Title blocks and legends are configurable.
.2 Storage: Store 1344 values per point object. Store trend data to controller RAM memory. Trend data is retrieved by the Operator Interface.
.3 Samples:

.1 Analog Point Objects: Store instantaneous point object data at every point object change of value (COV) for the analog type or at time intervals of fifteen minutes.

.1 Temperature COV: 2.0 Deg. C (3.6 Deg. F).
.2 Relative Humidity COV: 5 % RH.
.3 Other Analog COV: 5 % of scale length.

.2 Binary Point Objects: Store instantaneous point object data at every point object change of value.

.5 Time-of-Day (TOD) Schedules:

.1 Definition: Create, delete and modify TOD Schedules. Assign objects to TOD Schedules based on function and location.

.6 Custom Application Programs (Algorithms):

.1 Definition: Create, delete and modify programs and program statements.
.2 Debugger: Provide messages for syntax and execution errors.
.3 Syntax Capabilities:

.1 Analog and binary point objects.
.2 Conditional statements (IF, THEN, ELSE, ELSE IF) using compound Boolean relations (AND, OR and NOT) and comparisons (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL).
.3 Floating-point arithmetic using operators for addition, subtraction, division, multiplication and square root; absolute value and minimum/maximum value arithmetic functions.
.4 Predefined objects representing date, time of day, day of week, month of year and elapsed time.
.5 Create, delete and modify custom function blocks.

.7 Maintenance Messages: Display at Operator Workstations. Indicate equipment name and maintenance required based on equipment run time, starts, and calendar date limits.

.8 PID Control: PID (proportional-integral-derivative), PI and P algorithms for direct acting and reverse acting. Analog output is time-varying. Output control device is adjustable by the operator. Set point and gains are adjustable.

.9 Staged Starts: Time delays between starts for motors.

.10 Anti-Short Cycling: Minimum on and minimum off times for motors.

.11 Dead-band Switch: Cycle a binary point object based on controlled point object and set point for direct acting and reverse acting. Differentials are adjustable.

.12 Equipment Run Time: Accumulated run time expressed in unit hours.

2.5 Controllers

.1 Controllers / supervisory field panels shall be PXC modular series.

.2 Building Controllers (BC):

.1 Independent, networked, microprocessor-based for internetwork control strategies.
.2 Manage connected input and output control devices; transmit real and virtual point object data to distributed controllers and Operator Interfaces.
.3 Real-time clock.
.4 Continuous monitoring of processor, memory and communication circuits; assume a predetermined failure mode for abnormal conditions; assume a failsafe operating mode for failed communication with objects.
.5 Communicates to card access, security, fire alarm, lighting control systems.
.6 Service communication port for communication with Portable Operator Terminals.
.7 Memory: Nonvolatile EEPROM for firmware. Seventy-two hours battery backed memory for object database and custom application programs. Twenty percent spare memory capacity.
.8 Environment: Suitable for anticipated ambient conditions.
.9 Serviceability: LEDs for power, communication and processor status.
.10 Immunity to Power: Rated for 90% to 110% of nominal voltage.

.3 Advanced Application Controllers (AAC):

.1 Independent, networked [standalone], microprocessor-based.
.2 Manage connected input and output control devices; transmit real and virtual point object data to distributed controllers and Operator Interfaces.
.3 Real-time clock.
.4 Continuous monitoring of processor, memory and communication circuits; assume a predetermined failure mode for abnormal conditions; assume a failsafe operating mode for failed communication with objects.
.5 Service communication port for communication with Portable Operator Terminals.
.6 Nonvolatile EEPROM for firmware. Seventy-two hours of battery backed memory for object database and custom application programs. Twenty percent spare memory capacity.
.7 Suitable for anticipated ambient conditions.
.8 Serviceability: LEDs for power, communication and processor status.
.9 Immunity to Power: Rated for 90% to 110% of nominal voltage.

.4 Specific Application Controllers (SAC):

.1 Microprocessor-based networked [standalone]. Non-adjustable programs with operator adjustable settings for customized operation within equipment design limits.

.2 Service communication port for communication with Portable Operator Terminals.
.3 Memory: Nonvolatile EEPROM memory for firmware and program data.
.4 Environment: Suitable for anticipated ambient conditions.
.5 Serviceability: LEDs for power, communication and processor status.
.6 Immunity to Power: Rated for 90% to 110% of nominal voltage.

.5 Input/Output Interface:

.1 Electronic Analog Outputs:

.1 Signal: 4 to 20 mA, 0 to 10 VDC. Provide range and zero adjustment.
.2 Accuracy Rating: +/- 1% of scale length.
.3 Manual Override: Two-position (Manual/Auto) switch with status LED and manually adjustable potentiometer for Building Controllers and Advanced Application Controllers.

.2 Binary Outputs:

.1 Electrical Contacts: Rated for 0.5 A at 24 VAC; provide secondary relay for higher loads.
.2 Manual Override: Three-position (On/Off/Auto) switch with status LED for Building Controllers and Advanced Application Controllers.

.3 Analog Inputs:

.1 Signal: 4 to 20 mA, 0 to 10 VDC, thermistor, RTD.

.4 Binary Inputs:

.1 Detect dry contact closure.
.2 Wetting Current: Supplied by the controller.

.5 Pulsed Inputs:

.1 Detect pulse of dry contact closure.
.2 Pulse Frequency: Compatible with input device.
.3 Wetting Current: Supplied by the controller.

2.6 Power Supplies and Line Filtering

.1 Voltage Transformers:

.1 Type: Enclosed; Class 2 current-limiting or provide over-current protection in primary and secondary circuits for Class 2 service to the Canadian Electrical Code.
.2 Applied Loads: To 80% of rated capacity.
.3 DC Power Supply: Regulated output.
.4 Regulatory: CSA approved.

2.7 Cabinets

.1 Type: NEMA rated and suitable for installed environment.

.2 Door: Hinged with key-lock latch with common key for all cabinets; provide duplicate keys; for Specific Application Controllers provide screwed tight slide-off cover.

2.8 Control Devices

.1 Motor Operated Dampers:

.1 Dampers to be supplied under Section 15820 or supplied with mechanical equipment.

.2 Actuators for Dampers, Electronic:

.1 Control Signal: Compatible with BC, AAC and ASC.
.2 Operating Time: Maximum 120 seconds throughout the full rotation.
.3 Mounting: Direct coupled to drive shaft or jackshaft using a V bolt design.
Stall protection: Mechanical or electronic.
.4 Failsafe: Spring returns to normal position within 15 seconds.
.5 Manual Override: Crank type. External gear release for non-spring return actuators.
.6 Position Indicator: Reversible for clockwise or counter-clockwise rotation; set the 0 degrees mark to the failsafe position.
.7 Torque: To damper manufacturer's requirements to provide complete compression of seals between frame and blades and for smooth control.

.3 Control Valves:

.1 Characteristics, materials and pressure ratings suitable for the application; refer to schedules.

.2 Flow Characteristic:

.1 Water:

.1 Two-way: Equal percentage.
.2 Three-way: A Port: Equal percentage. B Port: Linear or modified linear.

.3 Sizing Water Valves:

.1 Two-position: Line size with full ports.
.2 Two-way Modulating:

.1 Air Handling Units: Pressure drop equal to the pressure drop through the coil or 27 kPa (4 psi), whichever is greater.
.2 Non-Radiation: Pressure drop equal to the pressure drop

through the coil or 14 kPa (2 psi), whichever is greater.
.3 Radiation: Pressure drop equal to 7 kPa (1 psi).

.3 Three-way Modulating:

.1 Air Handling Units: Pressure drop equal to the pressure drop through the coil or 27 kPa (4 psi), whichever is greater.
.2 Non-Radiation: Pressure drop equal to the pressure drop through the coil or 14 kPa (2 psi), whichever is greater.
.3 Radiation: Pressure drop equal to 7 kPa (1 psi).

.4 Butterfly Valves:

.1 Type: High-performance (HPBV).
.2 Make and Model: Dezurik BHP or equivalent.
.3 Tee-fitting: Provide for three-way application; with motor mounting bracket and linkage hardware.

.5 Valves 12 mm (1/2 in.) through 50 mm (2 in.):

.1 Screwed ANSI Class 250 bronze body.
.2 Body Style: Globe.

.6 Valves 62 mm (2-1/2 in.) and Larger:

.1 Water temperature less than 121 deg. C (250 deg. F) at 1035 kPa (150 psi) or less than 93.2 deg. C (200 deg. F) at 1139 kPa (165 psi): Flanged ANSI Class 125 cast iron body.
.2 Water temperature greater than 121 deg. C (250 deg. F) at 1035 kPa (150 psi) or greater than 93.9 deg. C (200 deg. F) at 1138 kPa (165 psi): Flanged ANSI Class 250 cast iron body or ANSI Class 300 cast steel body.
.3 Body Style: Globe or butterfly.

.7 Leakage: ANSI Class IV.
.8 Materials:

.1 Stems: Stainless steel.
.2 Plugs and Seats: Brass or steel.
.3 Packing: PTFE for steam.

.9 Rangeability: 40:1 minimum.

.4 Actuators for Control Valves, Electronic:

.1 Control Signal: Compatible with BC, AAC and ASC.
.2 Operating Time: Maximum 150 seconds throughout the full rotation.
.3 Mounting: Corrosion resistant hardware.
.4 Stall Protection: Electronic overload or digital rotation sensing.
.5 Failsafe: Spring return for all. Spring returns to normal position within 15 seconds.
.6 Manual Override: Manual Override: Crank type. External gear

release for non-spring return actuators.

.7 Position Indicator: Provide. Indicate valve open and closed positions.

.8 Close-off Pressure:

.1 Water:

.1 Two-way: 150% of total system head.

.2 Three-way: 300% of the pressure differential between ports A and B at design flow, or 100% of total system head.

.5 Electric Relays:

.1 Type: General purpose; enclosed coil; diodes provided for inductive switched loads; override button; LED “energized” indicator; plug-in type base.

.2 Electrical Contacts: Rated for 5 A resistive, 4 FLA at 120 VAC; normally open unless otherwise specified.

.3 Regulatory: UL listed.

.6 Level Switches:

.1 Type: Float.

.2 Electrical Contacts: Rated for 10 A resistive, 6 FLA at 120 VAC.

.3 Mounting: Outside of fluid of measured fluid.

.4 Enclosure: NEMA rated for the application.

.7 Low Limit Electromechanical Thermostat:

.1 Type: Vapour Pressure; minimum 6000 mm (20 ft.) of capillary; actuated by any 300 mm (12 in.) of capillary element; manual reset upon activation.

.2 Electrical Contacts: Double-pole double-throw (DPDT), snap-acting; rated for 10 A resistive, 6 FLA at 120 VAC.

.3 Adjustable Set Point: Range: -1 deg. C to 13 deg. C (30 deg. F to 55 deg. F).

.4 Regulatory: UL listed.

.8 High Limit Electromechanical Thermostat:

.1 Type: Bimetallic sensing; manual reset upon activation.

.2 Mounting: Air stream.

.3 Electrical Contacts: Single-pole single-throw (SPST), normally closed, snap-acting; rated for 10 A resistive, 6 FLA at 120 VAC.

.4 Adjustable Set Point: Range: 38 deg. C to 66 deg. C (100 deg. F to 150 deg. F) and set to 57 deg. C (135 deg. F).

.9 Electromechanical Thermostat:

.1 Wall Mount:

.1 Provide samples of covers to Part 1: Submittals, Samples.

.2 Low Voltage:

.1 Type: 24 VAC, bimetal-operated, mercury-switch; adjustable or fixed anticipation heater; vented ABS plastic concealed cover.
.2 Set Point: Range: 13 deg. C to 30 deg. C (55 deg. F to 85 deg. F); 1 deg. C (2 deg. F) maximum differential.

.3 Line Voltage:

.1 Type: Bimetal-actuated open contact, or bellow-actuated enclosed snap-switch type, or equivalent solid state type; anticipation heater; vented metal concealed cover.
.2 Electrical Contacts: Rated for 10 A resistive, 6 A FLA at 120 VAC.
.3 Set Point: Range: 13 deg. C to 30 deg. C (55 deg. F to 85 deg. F); 1 deg. C (2 deg. F) maximum differential.
.4 Regulatory: UL listed.

.10 Temperature Sensors:

.1 Sensing Element:

.1 Averaging Applications: Platinum RTD; minimum 1.5 m (5 ft) of capillary per 1 sq m (10 sq ft) of duct cross-section.
.2 Single-Point Applications: Thermistor.
.3 Hermetically sealed.

.2 Materials:

.1 Stem: Stainless steel for single-point applications.
.2 Assembly: Corrosion resistant, vibration-proof.
.3 Thermowells:

.1 Brass or Type 316 stainless steel suitable for the application.
.2 Heat transfer compound compatible with sensing element.

.4 Outside Air Sensor: Type 304 stainless steel solar shield.

.3 Response Time: Maximum three seconds.
.4 Accuracy Rating: +/- 0.1 deg. C throughout the scale length.
.5 Covers for Wall Mount Sensors:

.1 Overrides: Exposed set point adjustment and override button.
.2 Communication Port: For communication between Portable Operator Terminals and ASC controllers.

.11 Guards for Sensors and Thermostats:

.1 Provide a flush-mounted (flat plate) stainless steel sensor for all sensors or thermostats mounted in corridors, stairways, vestibules, lobbies, gymnasiums, and storage rooms.

.12 Air Static Pressure Sensors:

.1 Sensing Element:

.1 Type: Capacitance sensing with pitot tube sensing tips screwed securely to duct.
.2 Materials: Suitable for continuous contact with measured medium.

.2 Transmitter:

.1 Range: Not to exceed two times the operating pressure.
.2 Signal: 4 to 20 mA; internal zero and span adjustment.

.3 Accuracy Rating: +/- 0.25% of scale length.

.4 Response Time: Maximum 0.5 seconds.

.13 Gauge Pressure Sensors:

.1 Sensing Element:

.1 Type: Capacitance sensing.
.2 Materials: Suitable for continuous contact with measured medium.

.2 Transmitter:

.1 Range: Not to exceed two times the operating pressure.
.2 Signal: 4 to 20 mA; internal zero and span adjustment.

.3 Accuracy Rating: +/- 0.25 % of scale length.
.4 Response Time: Maximum 0.5 seconds.
.5 Isolation Valve: Between process connection and gauge.

.14 Wet/Wet Differential Pressure Sensors:

.1 Sensing Element:

.1 Type: Capacitance sensing.
.2 Materials: Suitable for continuous contact with measured medium.

.2 Transmitter:

.1 Range: Not to exceed two times the operating pressure.
.2 Signal: 4 to 20 mA; internal zero and span adjustment.

.3 Accuracy Rating: +/- 0.25 % of scale length.
.4 Response Time: Maximum 0.5 seconds.
.5 3-Way Valve Manifold: For sensor isolation and zeroing.

.15 Relative Humidity Sensors:

.1 Sensing Element:

.1 Type: Thin film capacitance.

.2 Transmitter:

.1 Range: 0 to 100% RH.
.2 Signal: 4 to 20 mA.

.3 Accuracy Rating: +/- 2 % of output reading.

.16 AC Current Sensors:

.1 Type: Self-powered solid-state.
.2 Electrical Contacts: Rated for 1 A resistive at 30 VAC/DC.
.3 Insulation Rating: 600 VAC.
.4 Latch Level: Variable Speed Motors: 1.5 A Fixed; Constant Speed Motors: Adjustable.

.17 AC Current Transducers:

.1 Type: Self-powered or loop-powered solid-state.
.2 Amperage Range: Motors: Factory calibrated to LRA; Switchgears: Factory calibrated to design load.
.3 Insulation Rating: 600 VAC.
.4 Signal: 4 to 20 mA; internal zero and span adjustment.
.5 Accuracy Rating: +/- 2 % of output reading.
.6 Regulatory: UL listed or CSA approved.

.18 Water Flow Meters:

.1 Type: Turbine electronic impedance sensing.
.2 Scale length not to exceed twice process design flow.
.3 Wetted Materials: Water and 50% Glycol: Nickel plated brass; Steam: 316 stainless steel.
.4 Pressure Drop: Less than 1 PSI at 20 ft/s in 1-1/2 in. pipe.
.5 Power Supply: 24 VAC/VDC.
.6 Signal: 4 to 20 mA, 0 to 10 VDC.
.7 Accuracy Rating: +/- 2 % of reading.

2.9 Wire and Conduit

.1 Conduit: Electrical metallic tubing EMT with compression type fittings in dry locations; cold rolled steel zinc coated or zinc coated rigid steel with threaded fittings in wet locations or where exposed to weather.

.2 Outlet boxes: Dry locations: sheradized or galvanized drawn steel 100 mm (4 in.) square or octagon with suitable raised cover; Exposed to Weather: threaded hub cast aluminum boxes with gasket plate.

.3 Junction boxes: Sized according to number, size and position of entering raceway; type: suitable for the environment.

.4 Wire:

.1 Network: Stranded 18 gauge copper twisted shielded pair, coax.
.2 Analog Input, Output: Stranded 18 gauge copper twisted shielded pair; lengths less than or equal to 50 m (160 ft.) 22 gauge wire is acceptable.
.3 Binary Input, Output: 18 gauge, minimum insulation rating of 600 volts.
.4 Class 2: FT-6 without conduit in ceiling plenums; FT-4 in conduit for all other cases.

PART 3 – EXECUTION

3.1 General Workmanship

.1 Install in readily accessible locations to the Canadian Electrical Code.
.2 Install products to manufacturer's installation instructions.

.3 Install parallel to building walls and floors unless indicated or specified or required by manufacturer's installation instructions.

.4 BAS Performance: To Part 1: General, BAS Performance.

3.2 Coordination

.1 Submittals: To Part 1: General, Submittals.
.2 Variable Speed Drives:

.1 Provide remote interface using one of the specified communication protocols to drives under Section 15723 Variable Speed Drives to the requirements of this Section.
.2 Coordinate with manufacturer's representative under 15723 Variable Speed Drives for testing and commissioning of remote functions to drives.

.3 Testing and Balancing Piping Systems:

.1 Command control valves as instructed under 15043 Balancing.

.4 Testing and Balancing Air Systems:

.1 Furnish one set of tools for testing and balancing air systems and for use under Section 15043 Balancing. Provide three hours of training in use of tools furnished. At the end of testing and balancing receive the tools furnished.
.2 Assist with the Work of Section 15043 Balancing for: two controllers for each type of variable air volume application; and for one primary air system.

.3 Set up an operator with view access to all objects and command access to testing and balancing objects for use under Section 15043 Balancing.

3.3 Communication

.1 Provide wire and active components for networks.

3.4 Operator Interface

.1 Provide the Operator Interface under Part 2: Products.

.2 Operator Software:

.1 Provide for each Operator Workstation.
.2 Security: Set up operators with independent user login name and password and assign access levels to Owner's requirements.
.3 Reports: Configure the following reports:

.1 List of objects and point object data sorted by point object name in ascending order.
.2 List of objects and point object data that are in alarm state sorted by priority in descending order then by point object name in ascending order.
.3 List of disabled point objects sorted by point object name in ascending order.
.4 List of TOD Schedules: Indicate: objects assigned to the TOD Schedule, Occupied Mode times.

.4 Graphics: Generate graphic representations for systems under Sequence of Operation as follows:

.1 Building elevation in three dimensions; indicate: floors and mechanical rooms.
.2 Floor plans: Indicate: Equipment rooms; point object data for temperature, humidity and pressure. Directly access graphic representation for terminal systems.
.3 Equipment Rooms: Indicate locations for systems.
.4 Systems: Indicate: Equipment, service connections, point object data, set points, reset schedules. Highlight point objects under operator command.
.5 Graphic representations link to and display graphic representations for associated systems.

3.5 Controller Resident Software

.1 Provide the Controller Resident Software under Part 2: Products.

.2 Security: Set up operators with independent user login name and password and assign access levels to Owner's requirements.

.3 Alarms and Events:

.1 Set alarm limits for point objects, not to include terminal unit point objects, to generate alarm when point object data is outside of Control Tolerance from Set Point under Part 1: General, Bas Performance, Control Tolerance.
.2 Set alarm limits for point objects to generate alarm, with sixty seconds time delay, when analog input point object data is outside the normal operating range for the control device.
.3 Set alarm limits for point objects to generate alarm, with sixty seconds time delay, when binary input point object data deviates from associated binary output point object data.
.4 Hardwired safeties, including and not limited to high temperature detection thermostats and low temperature detection thermostats generate alarm once triggered.

.4 Trends: Configure the following trends for systems, not to include terminal systems:

.1 Analog point object data representing control devices as inputs to loops and switching statements.
.2 Analog point object data representing control devices as outputs from loops.
.3 Binary point object data representing control devices as inputs.

.5 TOD Schedules: Configure TOD Schedules and Occupied Mode times to Part 4 - SEQUENCE OF OPERATION and to Owner's requirements.

.6 Custom Application Programs: Generate to Part 4 – Sequence of Operation.

.7 PID Control: Provide closed-loop control for P, PI, PID loops.

.8 Staged Starts: Provide for motors.

.9 Anti-Short Cycling: Provide for motors.

.10 Equipment Run Time: Provide for motors.

3.6 Controllers

.1 Provide controllers as indicated on the drawings and to the requirements of this Section and to execute sequence of operation under Part 4 – Sequence of Operation.

.2 Install controllers in cabinets.

.3 Under power failure, control device fails to normal position. Under return from power failure, programs start after time delay. Provide time delays to stage equipment starts and to minimize electrical demand.

3.7 Power Supplies and Line Filtering

.1 Provide 120V wiring to control panels from the nearest electrical panel with

designated or spare breakers. Contractor to provide both normal and essential power circuits to each controller.

.2 Provide a CSA approved static transfer switch to automatically switch between the normal and essential power supplies with the essential power supply being the preferred source.

.3 Provide an uninterruptible power supply (UPS) unit, sized according to the controller loads with a minimum of 10 minutes of battery power.

.4 Contractor to combine the transfer switch and UPS into one enclosure with it all being pre-wired prior to arriving on site. Contractor to provide all on-site connections to connect the main 120V supply feeders and the feeder to the controller panel.

.5 Provide voltage transformers.

3.8 Cabinets

.1 Install rigidly to wall or to an independent frame installed to the floor slab. Installation to duct, equipment and locations subject to vibration is not accepted.

.2 Cabinets for ASC controllers: Install to terminal equipment. Installation to duct, equipment and locations subject to vibration that could affect controller operation or calibration of control device is not accepted.

3.9 Control Devices

.1 Provide or furnish control devices as indicated on the drawings and to the requirements of this Section and to execute sequence of operation.

.2 Motor Operated Dampers:

.1 Motor operated dampers shall be supplied and installed under Section 15-820 Duct Accessories or be supplied with equipment.

.3 Actuators for Dampers, Electronic:

.1 Provide field installed actuator to damper. BAS contractor is responsible for all required linkages and hardware to mount and actuator dampers.

.4 Control Valves:

.1 Furnish control valves for installation under Section 15100 Valves.
.2 Provide supervision on site during installation.

.5 Actuators for Control Valves, Electronic:

.1 Factory install or field install actuator to valve body.

.6 Low Limit Electromechanical Thermostat:

.1 Install hardwire interlocked to supply fan starter for respective system.
.2 Provide to Part 4 – Sequence of Operation.
.3 Shut down the fan when duct temperature is equal to or less than 1.67 deg. C (35 deg. F).
.4 Provide to adequately cover potential areas of low level stratification. Provide one low-limit thermostat for each 1.86 sq M (20 sq ft) of duct cross section. Mount sensing element on plastic clips.

.7 High Limit Electromechanical Thermostat:

.1 Install hardwire interlocked to fan starters for respective system.
.2 Provide at the following locations:

.1 Discharge of return air fans.
.2 Discharge of exhaust air fans.

.3 Shut down the fans when duct temperature is equal to or greater than 51.7 deg. C (125 deg. F).
.4 Provide one high-limit thermostat for each 3.7 sq M (40 sq ft) of duct cross section.

.8 Electromechanical Thermostats and Temperature Sensors:

.1 Furnish sensing wells for installation under Section 23 21 16 Hydronic Specialties. Provide supervision on site during installation.
.2 Samples: Provide for wall mount type to Part 1: Submittals, Samples.
.3 Wall Mount Type:

.1 Cover Colour: White.
.2 Install to furred-in columns and permanent walls. Installation to mobile and temporary partitions is not accepted.
.3 Installation to exposed architectural concrete columns and walls is not accepted, unless otherwise indicated or specified. For installation to concrete, set conduit in place before pouring of concrete.

.4 Single Point Type, Duct:

.1 Provide sufficient contact with process fluid to measure average conditions.
.2 Install Duro Dyne Instrument Test Port Model IP-4, or equivalent, to duct adjacent to control device; apply pipe sealing compound to plug thread.

.5 Single Point Type, Pipe: Provide sufficient contact with process fluid to measure average conditions.

.6 Outdoor Type:

.1 Install to north side of building away from sources of heat such as lamps and exhaust vents; to greater than 1500 mm (5 ft) above horizontal surfaces.

.2 Where indicated or specified for installation in outside air intake, locate so as not to be affected by exhaust air flow or reverse flow.
.3 Provide solar shield. Install shield to open downward.
.4 Seal interior of conduit at penetration through exterior wall.

.9 Guards for Thermostats and Temperature Sensors:

.1 Provide for wall mount sensors and thermostats where indicated on the drawings.
.2 Samples: Provide to Part 1: Submittals, Samples.

.10 Air Static Pressure Sensors:

.1 Provide where indicated on the drawings and as specified under Part 4 – Sequence of Operation.

.11 Relative Humidity Sensors:

.1 Install to requirements for Electric Thermostats and Temperature Sensors.

.12 AC Current Sensors and Transducers:

.1 Install in motor starter cabinet.

.13 Air Flow Sensors, Duct Mount:

.1 Furnish duct mount air flow sensors for installation under Section 23 33 00 Duct Accessories. Provide supervision on site during installation.

3.10 Wire and Conduit

.1 Controls shall be fed through base of roof mounted equipment wherever possible. Where not possible supply 90 degree pitch pocket and coordinate roofing with General Contractor. Seal end of pitch pocket after feeder is installed.

.2 Wire shall be neatly tie wrapped to conduit mounted to the building structure but must be installed at right angles or parallel to the building. Loose wiring shall only be allowed over a distance of 1500 mm (5 ft.) but must not pass over lighting fixtures.

.3 Wiring in Equipment Room, between floors, or between concrete walls shall be installed in conduit. Exposed wiring will not be accepted. Conduit shall be installed at right angles or parallel to the building walls.

.4 Where the wire terminates at a screw connection, provide a crimp spade connector.

.5 Should it become necessary to splice field wiring it shall be soldered. If

soldering is not possible, approved B type crimp connectors are an acceptable alternative. Wire nuts and Marr connections are not acceptable. Provide a 500 mm (20 in.) loop length at all splices.

.6 Conceal conduit within finished shafts, ceilings, and walls as required. Install exposed conduit parallel with or at right angles to the building walls.

.7 Plug or cap unused conduit openings and stubs with compatible fittings.

.8 Route all conduit to clear beams, plates, footings and structural members except through column footings and grade beams.

.9 Provide watertight seals at penetrations through outside foundation walls.

.10 Support conduit 25 mm (1 in.) and smaller to the building with one-hole non-perforated malleable iron or steel pipe straps. Suspend conduits larger than 1 in. on pipe racks with split-ring hangers and rods.

.11 Maintain caps on conduit openings throughout construction.

.12 Where conduit is attached to vibrating or rotating equipment, install and anchor flexible metal conduit with a minimum length of 450 mm (18 in.) and a maximum length of 900 mm (36 in.) in such a manner that vibration and equipment noise will not be transmitted to the rigid conduit.

.13 Where exposed to weather or in damp or wet locations, provide waterproof flexible conduit.

.14 Fill conduit to maximum of 40% of its capacity. Provide a pull rope within the conduit when the installation is complete. Bend conduit to a radius of greater than 3 times the conduit diameter to a maximum of three 1/4 bends permitted between pull boxes.

.15 Wire within cabinets shall be installed in a plastic tray with a cover. Terminate wires to field-removable, modular terminal strips.

.16 All field sensors shall be provided with a flexible conduit connection minimum length of 450mm (18 in.) and an enclosure for the electrical connections.

3.11 Identification

.1 All wires shall be tagged at both ends. The tagging shall identify the device it is connected to. Use of the point object name is acceptable.

.2 All wires passing through a junction box shall be tagged with the device identity or its termination point.

.3 The junction boxes shall be tagged “BAS” with a sequential number suffix.

.4 Label wires, control devices, controllers.

3.12 Testing and Commissioning

.1 Test and commission the BAS prior to the Demonstration and Acceptance Test.

.2 Prepare test forms which shall identify each test. The forms shall be sub-divided into points, controllers, programs, loops, networks and graphics.

.3 Device tests shall identify and confirm successful completion of the following:

.1 Device installation.
.2 Device identification.
.3 Device calibration.
.4 Device operation.
.5 Wiring to device, connection details and wire type.
.6 Validation of the device signal at the controller.

.4 Controller tests shall identify and confirm successful completion of the following:

.1 Controller installation.
.2 Power source and grounding.
.3 Make, model and serial number, software revisions.

.5 Software tests shall identify and confirm successful completion of the following:

.1 Custom application programs.
.2 Alarm reporting.
.3 Trending and reports.
.4 Energy management programs.

.6 Loop tuning tests shall identify and confirm successful completion of the following:

.1 Loop input signal.
.2 Loop output signal.
.3 Set point adjustment.
.4 Device response.
.5 Control response.

.7 Network communication tests shall identify and confirm successful completion of the following:

.1 Primary network communication function.
.2 Secondary network communication function.
.3 Alarm reporting function.
.4 Operator communication.

.8 Dynamic graphics tests shall identify and confirm successful completion of the following:

.1 All graphics.
.2 All point objects per graphic.
.3 All set-points per graphic.

3.13 Demonstration

.1 When all tests have been completed and the documentation completed, request a meeting with the Consultant and Owner. Provide at this meeting a demonstration that all systems on the BAS are operating. At the successful conclusion of this demonstration the Consultant will allow the Acceptance Test to begin.

.2 At the discretion of the Consultant and Owner, demonstrate up to 10% of the tests described in Part 3: Execution, Testing and Commissioning and witnessed by the Consultant and Owner. Should any test fail then the BAS Contractor shall retest the failed components or functionality.

3.14 Acceptance Test

.1 When Testing and Commissioning and the Demonstration have been completed satisfactorily the Consultant will give approval for commencement of the Acceptance Test.

.2 Notify the Owner and Consultant in writing 2 weeks prior to the testing date.

.3 Furnish a new operator's log book to building operators.

.4 The Acceptance Test period shall be 21 days. Visit the site each morning, Monday to Friday, to review the BAS operation and the building operators log book which contains records of all problems experienced by the building operators, the point object name and value and time and date of failure, and time of return to service. During the first 14 days of the acceptance test, any operational failures due to malfunction of wiring, controllers or Operator Interfaces, shall designate a restart to testing for 21 days. Any failure of control devices shall be corrected and the acceptance test shall continue from the date the failure has been corrected. During the last 7 days of testing, no failures of any kind will be accepted, or the last 7 days shall be repeated.

.5 The BAS shall not be accepted or considered substantially complete until the Acceptance Test is successfully completed.

.6 At the successful completion of the Acceptance Test, provide a certificate of completion.

3.15 Instruction and Training

.1 Provide instruction that shall cover the operation and maintenance of the BAS systems. The instruction shall be conducted on the Owner's premises. Instruction shall include:

.1 Operation and maintenance of Operator Interfaces.

.2 Operation and maintenance of controllers.
.3 Custom Application Programming software.
.4 Point objects addressing and commanding.
.5 Custom reporting.
.6 Creating and modifying graphics.
.7 Data base modification, deletion and back-up and restore operations.
.8 System malfunction diagnostics and maintenance.
.9 Control devices, operation and maintenance.

PART 4 – SEQUENCE OF OPERATION

4.1 General

.1 Refer to this Section and to the Drawings for control points included in the Work.

.2 Confirm setpoints with Owner's representative.

.3 Coordinate alarm requirements with Owner's representative.

4.2 Air-Handling Unit:

.1 The air-handling unit consists of variable-frequency supply & return fans, EA, RA and OA dampers and glycol heating coils

.2 Scheduling:

.1 The occupied period shall be initially set to 7:00am to 4:30pm, Monday to Friday. The occupancy schedule shall be adjustable by the owner.

.3 Fan Control:

.1 The supply fan and return fan shall be enabled and run continuously during the occupied period unless shutdown on safeties.
.2 The fans shall be disabled during the unoccupied period unless required for heating or night purge. If there is a call for heating or night purge, the fan shall be enabled for the duration of the call. Mechanical cooling shall be disabled during the unoccupied period.

.4 Temperature Control:

.1 The heating water valve and mixing dampers modulate in sequence without overlap to maintain AHU supply air temperature to set point.
.2 The heating water coil valves shall be cycled a minimum of once per day if not required for heating. When the AHU is OFF, the heating valve modulates to maintain a mixing plenum temperature of 13°C.
.3 Occupied period:

.1 The supply air temperature setpoint shall be initially set to 21°C (adj.). The setpoint shall be reset as required to maintain

occupied space temperature setpoint. When the AHU starts in Occupied Mode, the outdoor air/return air/exhaust air dampers open to minimum outside air position.

.2 On a call for heating, the supply fan speed shall be ramped to full speed. The heating coil valve shall be modulated to maintain space temperature setpoint. Refer to Heating Control section.

.3 The economizer shall be enabled for cooling when the outside air temperature is less than 21°C (adj.), the RA temperature is greater than the OA temperature, and the supply fan is on.

.4 Economizer low limit shall limit the outdoor air/return air/exhaust air dampers position to a mixed air temperature low limit of 10°C.

.5 On a call for cooling when the economizer is enabled, the outside air, mixed air, return air dampers shall be modulated for free cooling.

.4 Unoccupied period:

.1 On a call for heating, the AHU supply and return fans will start with all dampers closed to the outside and the heating coil valve open. The heating valve modulates to maintain AHU supply air temperature of 35°C once the supply fan has started. The AHU resumes operation in Unoccupied Mode when requests for heating from the space are satisfied.

.2 On a call for cooling, if the outside air temperature is at least 3°C (adj.) less than the space temperature, the unit will be enabled for night purge. The dampers shall be configured for 100% outside air (adj.) and the unit shall provide free cooling to the space.

.5 Morning Warm-up:

.1 If the time is prior to the start of the occupied period and the representative zone temperature is less than setpoint and heating water is available; then, the AHU supply and return fans will start with all dampers closed to the outside air, the heating coil valve opens fully to raise the representative zone temperature to the warm up set point. The AHU resumes operation in Occupied Mode when the representative zone temperature reaches warm up set point, or at the start time of Occupied Mode, whichever occurs first. Morning warm-up routine is a learning routine set to start automatically for a given day and conditions at a calculated time, starting no sooner than two hours (adjustable) prior to occupancy start, sufficient to bring the zone temperature to set point by the scheduled start time of the Occupied Mode.

.6 Morning Cool-down/Purge:

.1 If the time is prior to the start of the occupied period and the representative zone temperature is greater than set point and

outside free cooling is available; then, the AHU supply and return fans will start with all dampers open to the outside air, the heating coil and cooling coil valves closed to lower the representative zone temperature to the occupied period set point. The AHU resumes operation in Occupied Mode when the representative zone temperature reaches Occupied Mode set point, or at the start time of Occupied Mode, whichever occurs first. Morning cool-down/purge routine is a learning routine set to start automatically for a given day and conditions at a calculated time, starting no sooner than two hours (adjustable) prior to occupancy start, sufficient to bring the zone temperature to set point by the scheduled start time of the Occupied Mode.

.5 Heating Control

.1 The heating coil valve shall be enabled for control when the supply fan status is on and the hot water boiler system is enabled.
.2 The heating coil valve shall be modulated to maintain the supply air temperature setpoint.
.3 The heating coil valve shall fail open to the coil.
.4 The heating coil valve shall be commanded closed when not enabled for control.
.5 Space heating is performed by wallfin or reheat coils in the individual spaces.

.6 Filter Pressure Monitoring

.1 The BAS shall monitor filter differential pressure across the filters.
.2 Coordinate filter differential pressure alarm setpoints with balancer.
.3 Create a trend report and archive measured value.

.9 Monitoring

.1 The following data points shall be monitored:

.1 Supply air temperature
.2 Mixed air temperature
.3 Return air temperature

.10 Alarms

.1 Alarms shall be provided as follows:

.1 Fan Alarm – Typical

.1 If the fan has Failed-to-Command after 5 minutes (adj.) or the VFD indicates a fault (no delay)

.2 Low Temperature Alarm

.1 If the low temperature alarm contact indicates an alarm (no time delay)

.2 Coordinate additional alarm requirements with Owner.

4.4 Rooftop Unit

.1 System Description

.1 System consists of a variable volume rooftop unit with gas fired heating, energy recovery wheel and powered exhaust providing conditioned air to the zones.

.2 Scheduling

.1 The occupied period shall be initially set to 8:00am to 6:00pm, Monday to Friday. The occupancy schedule shall be adjustable by the owner at the front end.

.3 Fan Control

.1 The fan shall be enabled and run continuously during the occupied period unless shutdown on safeties.
.2 The fan shall be disabled during the unoccupied period unless required for heating or cooling and perimeter heat in the space is not able to satisfy the call. If there is a call for heating or cooling, the fan shall be enabled for the duration of the call.
.3 The unit shall be configured as a constant volume unit.
.4 The supply fan speeds shall be determined during balancing so that unit provides the scheduled airflow capacity. Coordinate work with balancing contractor. Fan speed shall be adjustable through the BAS.
.5 The exhaust fan speed shall be determined during balancing. Coordinate work with balancing contractor. The following conditions shall be tested, and corresponding speed values programmed into the BAS for operation points:

.1 Condition 1 (minimum position):

.1 Exhaust Air Flow at MIN. O/A CFM
.2 Economizer Dampers set for MIN. O/A CFM

.2 Condition 2 (full economizer):

.1 Exhaust Air Flow at TOTAL S/A CFM
.2 Economizer Dampers set for TOTAL S/A CFM (full economizer)

.3 Exhaust fan speed shall be set by the BAS based on the operation conditions.
.4 Standard occupied mode shall use the speed determined at Condition 1.
.5 In Economizer mode, the BAS shall ramp the exhaust fan speed to Condition 2 based on cooling demand. The Economizer damper shall be ramped in unison with the fan.

.4 Temperature Setpoints

.1 The occupied heating and cooling setpoints shall initially be set to 22°C (adj.) and 24°C (adj.), respectively.
.2 The unoccupied heating and cooling setpoints shall initially be set to 16°C (adj.) and 29°C (adj.), respectively.

.5 Temperature Control – Occupied Period

.1 On a call for heating, and the fan is ON, the gas heating shall be enabled. Refer to Heating Control section.
.2 The economizer shall be enabled for cooling when the outside air temperature is less than 22°C (adj.).
.3 On a call for cooling when the economizer is enabled, the economizer damper signal shall be modulated for free cooling. Mechanical cooling shall be available to supplement economizer cooling if enabled based on outside air temperature.

.6 Temperature Control – Unoccupied Period

.1 On a call for heating, the unit shall be enabled with the dampers closed to the outdoor air. The supply fan speed shall be set to maximum. The gas heating shall be enabled and reset, if required, for a discharge temperature of 32°C (adj.) for the duration of the call.
.2 On a call for cooling, if the outside air temperature is at least 5°C (adj.) less than the space temperature, the unit will be enabled for night purge. The dampers shall be configured for 100% outside air (adj.) and the unit shall provide free cooling to the space.

.7 Heating Control

.1 The gas heating shall be enabled for control when the supply fan status is on and the Outside Air temperature is lower than 12 deg. C (adjustable).
.2 Following an initial heat exchanger warmup cycle, the gas heating shall fire at low fire.
.3 The unit's integral discharge air temperature controller shall increase the firing rate of the gas heating based on the reset signal from the BAS. The BAS shall provide a reset signal that shall maintain the discharge air temperature at 23°C using a 0-10VDC signal. The BAS shall not directly control the gas valve.
.4 The unit's integral discharge air temperature controller is not capable of reducing the firing rate below low fire. The unit's integral controller shall increase the firing rate of the gas heating to reach the requested discharge air temperature setpoint. At moderate ambient conditions, the discharge air temperature at low fire may exceed the requested discharge air temperature setpoint via the reset signal.
.5 The BAS shall reset the requested discharge air temperature reset signal and/or cycle the gas heating enable contact as required to maintain space temperature setpoint.

.8 Integral Energy Recovery Wheel (ERW):

.1 When the rooftop unit fans are operating in Occupied mode, integral ERW operates.
.2 Economizer dampers open to minimum position, heat wheel bypass dampers are closed.
.3 Energy recovery wheel speed shall be modulated to maintain the supply air temperature set point in the winter and at 100% speed in the summer.
.4 Energy recovery wheel speed shall be slowed down to prevent frost on the discharge side of the exhaust air of the ERW as measured by the exhaust air temperature sensor.
.5 Economizer mode. When the unit is in economizer mode, the energy recovery wheel shall be turned off, the energy recovery wheel bypass dampers shall open. Economizer dampers shall modulate as required to maintain the desired supply air temperature set point.
Economizer low limit shall limit damper position to maintain a mixed air temperature of 50F.

.9 Ventilation Control

.1 Ventilation shall be enabled when the system is running during the occupied period or for night purge mode.
.2 When the ventilation is enabled, the economizer dampers shall be modulated as required for economizer, or night purge mode.
.3 Ventilation shall be disabled at all times during the scheduled unoccupied period unless required for night purge mode and during morning start-up mode.

.10 Economizer / Mixed Air Damper Control

.1 The mixed air dampers shall be set to minimum position during the occupied period when the economizer is not enabled. The minimum position shall be initially set to 20% (adj.). Coordinate minimum position with balancing contractor to ensure fresh air requirements are met.
.2 The economizer shall be enabled when cooling is required, the outside air temperature is less than 22°C (adj.), the return air temperature is greater than the outside air temperature, and the supply fan is on. The mixed air dampers shall be modulated to maintain the mixed air temperature 2°C (adj.) less than the supply air temperature setpoint. Mixed air damper position shall be reset towards closed if the mixed air temperature drops below 7°C (adj.). Power exhaust shall be internally controlled by the unit (where option is specified).
.3 When the economizer mode is enabled, the Exhaust Fan speed and economizer dampers shall be modulated for economizer temperature control.
.4 The mixed air dampers shall be set to full recirculation during the unoccupied period unless required for cooling demands and economizer is available.

.11 Morning Start-up Mode

.1 The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up and cool-down period while still achieving comfort conditions by the start of scheduled occupied period.
.2 The unit shall be set to full recirculation during morning start-up.

.12 Monitoring

.1 The following data points shall be monitored:

.1 Supply air temperature
.2 Mixed air temperature
.3 Return air temperature

.13 Alarms

.1 Alarms shall be provided as follows:

.1 Fan Alarm
.1 If the fan has Failed-to-Command after 5 minutes (adj.)

.2 Low Space Temperature Alarm
.1 If the space temperature is more than 5°C (adj.) below setpoint for 15 minutes (adj.)

.3 High Space Temperature Alarm
.1 If the space temperature is more than 5°C (adj.) above setpoint for 15 minutes (adj.)

.4 High Supply Air Temperature Alarm
.1 If the supply air temperature is more than 5°C (adj.) above setpoint for 15 minutes (adj.)

.5 Filter Alarm
.1 If the filter alarm contact is closed indicating filters are loaded and require replacing. Coordinate device trip setting with balancer.
.2 Coordinate additional alarm requirements with Owner.

4.3 Heat Exchanger and Glycol Pumps

.1 The lead pump shall be enabled to run continuously when the system is enabled.

.2 Pump status shall be monitored.

.3 On failure of the lead pump, the lead pump shall be locked out. The standby pump shall be enabled and take over operation. On alarm reset, the failed pump shall return to service.

.4 Lead pump assignment shall be rotated weekly, and initially scheduled to occur 10:00am every Wednesday. Contractor shall coordinate scheduling requirements with building owner. Schedule shall be adjustable.

.5 Heat exchanger cold side entering and leaving water temperatures, and hot side leaving water temperatures shall be monitored.

.6 The three-way control valve located on the hot side entering water piping shall modulate to maintain a constant cold side leaving water temperature (heat exchanger to constantly supply 66°C glycol to the RTUs or AHUs).

4.4 Hot Water Reheat Coils

.1 Reheat coil controls shall only be active during the heating season. Reheat coil control valve shall remain closed during cooling season (heating system disabled).

.2 Reheat coil control valve modulates to maintain heating space air temperature to set point, initially set to 22 deg. C (adjustable) during occupied period, and 18 deg. C (adjustable) during unoccupied period.

.3 Heating Morning Warmup: When triggered by the AHU, the zone controller operates under morning warm-up mode to heat the zone to the occupied mode set point.

4.3 Hot Water Wallfin Radiation

.1 Wallfin radiation control valve shall modulate to maintain space temperature setpoint when enabled. Utilize 2 floating points.

.2 The occupied and unoccupied heating setpoints shall initially be set to 22 deg. C (adjustable) and 18 deg. C (adjustable), respectively. Confirm setpoints with DDSB representative.

4.4 Hot Water Convector

.1 Hot water convector control valve shall modulate to maintain space air temperature set point when enabled. Utilize 2 floating points.

.2 The occupied and unoccupied heating setpoints shall initially be set to 22 deg. C (adjustable) and 18 deg. C (adjustable), respectively. Confirm setpoints with DDSB representative.

.3 All convectors in washrooms and corridors will be controlled by a Danfoss rad valve in lieu of control valve with sensor.

4.5 Hot Water Force Flow Heater or Unit Heater

.1 Unit is enabled and disabled to maintain space air temperature to set point, initially set to 22 deg. C (adjustable) during occupied period and 18 deg. C (adjustable) during unoccupied period.

4.6 Exhaust Fans

.1 Start and stop the fan to a Time-of-Day schedule, initially set to 7:00am to 4:30pm, Monday to Friday. The occupancy schedule shall be adjustable by the owner.

4.7 Existing Points List:

.1 For existing equipment being demolished, Controls Contractor shall decommission respective control points.

.2 For existing equipment to remain, Controls Contractor shall integrate existing and remaining control points onto new BAS controllers and integrate the Work onto existing BAS network.

.3 For new equipment, Controls Contractor shall provide new control points, components and new BAS controllers, and integrate the Work onto existing BAS network.

END OF SECTION

INDEX TO SPECIFICATIONS

PART 1 - GENERAL

1.1 General Requirements

.1 The requirements of this section shall apply to all sections in Division 16 – Electrical.

.2 All material, labour, equipment, and services required under this section shall be the full responsibility of the Contractor including any material, labour, equipment, and services provided by their sub-contractors.

1.2 Pre-Qualified Electrical Contractors

.1 Refer to front end documents for pre-qualified electrical contractor list. Only those pre-qualified contractors shall bid on this project.

1.3 Definitions

.1 “Supply” shall mean supply only.

.2 “Install” shall mean install and connect.

.3 “Provide” shall mean supply, install, connect and test.

.4 “Drawings and Specifications” shall mean Contract Documents.

.5 “Authorities” or Authorities having jurisdiction” shall mean all agencies that enforce the applicable laws, ordinances, rules, regulations, or codes of the Place of Work.

.6 “Work” shall mean all equipment, materials, labour, and permits to provide a complete and operational electrical system as detailed in the drawings and specifications.

.7 “Owner” or “DDSB” shall mean Durham District School Board.

1.4 Related Work

.1 Division 1 – General

.2 Division 15 – Mechanical

.3 Division 16 specifications form a part of the Contract Documents and shall be read, interpreted, and coordinated with all other Divisions. The Instructions to Bidders, General Conditions, General Requirements, Supplementary General Conditions and Amendments and Supplements thereto form a part of this Division and contain items related to the electrical work.

1.5 Intent

.1 The drawings and specifications are not a detailed set of installation instructions. Drawings and specifications are complementary to one another and that which is shown on one is as binding as that which is shown on both.

.2 The Consultant shall be immediately informed of any discrepancies between drawings and specifications leaving in doubt the true intent of the work.

.3 Supply all labour, equipment, and materials necessary to install a complete and operational electrical system described herein and shown on the drawings.

.4 It is the intent of these drawings and specifications to provide for an electrical installation complete and in operating condition. The responsibility for supplying and installing all material necessary to accomplish this, except where specifically noted that such work or materials is not included, shall be part of this section.

.5 Assess and be familiar with existing site conditions prior to pricing and construction and allow for same in tender price.

.6 All work must be done by qualified and certified persons in such line of work. Trade certificates must be available on demand.

.7 All work shall be in accordance with standard industry practice accepted and recognized by the Consultant and the Trade.

.8 The Contractor shall coordinate with and cooperate with all other trades prior to installation. Where work interferes with other trades due to failure to coordinate or cooperate, the work shall be removed and relocated as approved by the Consultant at no extra cost to the Owner.

.9 The Consultant shall have the right to reject any work that does not conform to the Contract Documents and accepted standards of practice including but not limited to performance, quietness of operation, and finish.

.10 Responsibility to determine which Division provides various products and work rests with the Contractor. Additional compensation will not be considered because of differences in interpretation of specifications.

1.6 Codes, Bylaws, Standards, and Regulations

.1 The electrical system shall comply with the latest editions and revisions of applicable codes, bylaws, bulletins, standards, and regulations including but not limited to:

.1 Ontario Building Code
.2 Ontario Electrical Safety Code
.3 Canadian Standards Association
.4 Local Municipal Codes

.5 Local Building Bylaws
.6 Ontario Occupational Health and Safety Act
.7 IEEE

.2 Provide work in accordance with the requirements of all applicable government codes, local by-laws, underwriter's regulations base building standards, contract documents, and all authorities having jurisdiction.

.3 Where discrepancies occur between contract drawings and specifications and above codes and standards referred to herein, the Contractor is to notify the Consultant in writing and obtain clarification prior to proceeding with the work.

.4 Contractors shall not reduce the requirements on the contract drawings and specifications by applying any codes and standards referred to herein.

1.7 Permits and Fees

.1 Apply for, obtain, and pay for all permits, fees, connections, inspections, licenses, certificates or charges necessary including all taxes.

.2 Coordinate all required inspections and give necessary notice to all authorities.

.3 Upon completion of project, provide inspection certificates confirming acceptance by all authorities having jurisdiction.

1.8 Contract Breakdown

.1 After the tenders close, submit a breakdown of the price into scope and trades to the satisfaction of the Consultant based on the sections of the specifications.

.2 Breakdown shall include but not be limited to:

.1 Mobilization and shop drawing submission
.2 Permits and Fees
.3 Panelboards and other miscellaneous distribution equipment
.4 Starters, contactors and control devices
.5 Conduits, cable and wiring
.6 Luminaires
.7 Close-out Submittals – Manual information & Record Drawings

.3 Progress claims shall be based on the breakdown. Submit in table format showing contract amount, work complete to date as percentage, previous draw, amount this draw and balance for each line item.

1.9 Shop Drawings

.1 Within two (2) weeks of award, the Contractor shall submit shop drawings of all equipment for the project.

.2 Prior to ordering of products or delivery of any products to job site, submit shop drawings electronically in PDF format to the Consultant for review and comments. Submit sufficiently in advance of construction to allow ample time for review. Size of shop drawings shall be 8.5x11. 11x17 will be acceptable where appropriate for content and scale.

.3 Submittals shall contain but not be limited to details, dimensions, construction, size, arrangement, operating clearances, performance characteristics and capacities of products and parts of the work. Include wiring drawings and schematics showing interconnection with work of other Divisions.

.4 Clearly mark each sheet of printed submittal material, using arrow, underlining or circling, to show particular sizes, dimensions, wiring diagrams, operating clearances, control diagrams, project identification, types, model numbers, ratings, capacities and options actually being proposed. Cross out non applicable material. Note on the submittal specified features such as special tank linings, pump seals, materials or painting.

.5 Prior to submission to the Consultant, the Electrical Contractor shall review all shop drawings. By this review the Electrical Contractor represents that he has determined and verified all field measurements, field construction criteria, materials, catalogue numbers and similar data or will do so and that he has checked and coordinated each shop drawing with the requirements of the Work and of the Contract Documents.

.6 The Electrical Contractor's review of each shop drawing shall be indicated by his approval stamp, date and signature on the front of each page. Drawings will not be considered if not previously checked by the Electrical Contractor.

.7 Review comments from Consultant. If shop drawings are modified, confirm changes before proceeding. If shop drawings are not approved, revise and resubmit changes for approval.

.8 Review of the shop drawings by the Consultant does not relieve the contractor or his supplier of the responsibility to provide the correct and complete equipment, material or installation.

.9 Keep one complete set of shop drawings at job site during construction.

.10 Include stamped reviewed shop drawings in the Maintenance Manuals.

1.10 Product Delivery Schedule

.1 Within two (2) weeks from shop drawing review, a schedule must be submitted by the Contractor showing projected delivery dates of all products to meet required construction schedule.

1.11 Construction Meetings

.1 The Electrical Contractor shall attend all site meetings unless otherwise pre-approved.

.2 Sub-trades shall attend site meetings as requested or as required.

1.12 As-Built Drawings

.1 Refer to Section 16045.

.2 Maintain accurate, neat, and clean As-Built Drawings on an **on-going basis** during construction to be reviewed periodically by the Consultant during construction.

.3 As-Built drawing mark-ups shall be made available at every site meeting or inspection.

.4 As-Built drawings shall include but not be limited to final location of all **component locations and conduit runs.**

.5 Upon completion of the work, submit to the Consultant for review, one (1) complete set of clear, legible, certified as-built drawings.

1.13 ESA Certificates

.1 Furnish an unconditional Certificate of Acceptance from Electrical Safety Authority on completion of work. Arrange for interim and rough-in inspections. Arrange and pay for Occupancy Inspections if required for partial occupancies.

.2 Incorporate a copy of the final ESA Certificate in the operating and maintenance manual.

1.14 Maintenance Manuals

.1 Refer to Section 16045.

.2 Provide information to Prime Contractor for inclusion into combined Maintenance Manual in both hard copy and electronic format.

.3 Information shall include:

.1 Warranty Letter
.2 Final ESA Certificate
.3 Fire Alarm Verification Report, Fire Alarm Certificate and Audibility Results (if applicable)
.4 Emergency Lighting Test Report (if applicable)
.5 Shop drawings (as reviewed by Consultant)
.6 Maintenance instructions, requirements, and schedule

.7 As-Built drawings

1.15 Testing

.1 The installation shall be free of open circuits and grounds.

.2 On completion, measure insulation resistances and comply with Table 24 of Ontario Electrical Safety Code.

.3 Test all wiring and connections for continuity and grounds before equipment is energized.

.4 Before energizing system, check all connections and set and calibrate all relays and instruments for proper operation, obtain necessary clearances, approval and instructions from utility company.

.5 Carry out all tests and furnish all equipment required to demonstrate safe and proper completion of the work, without cost to the Owner.

.6 Check load balance on all feeders and make necessary adjustments to provide a "balanced" load.

.7 Fully coordinate all testing and commissioning with all trades, the Consultant, and authorities having jurisdiction.

.8 Test and verify all existing systems being modified due to construction including but not limited to fire alarm, security, P.A., data and voice.

.9 Provide a minimum of forty-eight (48) hours written notice to all parties.

1.16 Demonstration

.1 Demonstrate to the Owner on proper operation of the Electrical and Auxiliary systems.

.2 Work with and assist Division 15 during Division 15 training as required.

.3 The Contractor shall arrange for all necessary personnel and equipment specialists to be in attendance for purposes of demonstration and training.

.4 Provide instruction by a manufacturer’s representatives as required too fully demonstrate the systems.

1.17 Substantial Completion and Performance

.1 Substantial completion and performance shall be determined and awarded by the Consultant.

.2 Complete the following to the satisfaction of the Consultant prior to request for substantial completion:

.1 Submit Electrical Safety Authority Certificate
.2 Submit reports as specified herein
.3 Fire stopping
.4 Inclusion of material for draft copy of maintenance manual
.5 As-Built Drawings

1.18 Warranty

.1 Provide a one (1) year full parts and labour warranty for the new system from date of substantial completion.

.2 Submit warranty letter on Company letterhead signed by Company representative stating warranty terms including warranty period from date of substantial completion.

PART 2 - PRODUCTS

2.1 General

.1 All material used shall be new, free from defects, of quality specified, and installed in accordance with manufacturer’s instructions.

.2 Major components shall have nameplates on the exterior of the equipment in a visible location containing manufacturer’s name, model number, serial number, performance data, and electrical characteristics.

.3 The same manufacturer shall be used for types of components used in similar applications.

.4 It is the responsibility of the Contractor to store and protect materials supplied by this scope.

.5 Materials must be stored in original containers.

.6 Remove and dispose of all redundant materials and garbage from site.

2.2 Selected Products and Equivalents

.1 Sections within Division 16 list “Acceptable Manufacturers” which must meet characteristics of the specified equipment and products for each section.

.2 Base specified products are specified and/or shown on the drawings, and identified by manufacturer's name, type and catalogue number.

.3 Any alternate manufacturers from base specified products and equipment must equal or exceed the quality, finish and performance of those base specified and/or shown, and not exceed the space requirements allotted on the drawings. Include costs for any associated work to accommodate such substitutions, including the Consultant's time and revisions to the work of other divisions.

.4 If item or material specified is unobtainable, state in Tender proposed substitute and amount added or deducted for its use. Extra monies will not be paid for substitutions after the Contract has been awarded.

.5 If item of size indicated is unobtainable, supply next larger size without additional charge.

2.3 Quality of Product

.1 All products provided shall be CSA approved, approved by other relevant authorities.

.2 If supplied products are not CSA approved, obtain approval of provincial regulatory authority. Pay all applicable charges levied and make all modifications required for approval.

.3 All products provided shall be new including those not specified and shall be of a quality best suited to the purpose required and their use subject to approval by the Consultant.

2.4 Voltage Ratings

.1 Operating Voltages: to CAN3-C235.

.2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60Hz within normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

2.5 Electric Motors, Equipment and Controls

.1 Refer to Drawings for Contractor's equipment wiring responsibility.

.2 Control wiring and conduit shall be covered under this Division except connections below 50V which are related to control systems specified under Division 15.

2.6 Product Finishes

.1 Shop drawings shall include finishes.

.2 All cabinets, panelboards, switchboards, cable trays, etc. shall be finished in ANSI 61 grey enamel unless otherwise specified.

.3 Apply primer on all items which are to be finished on the job.

.4 Repair dents and touch up all damaged finishes with matching finish, or if required by the Consultant or Owner, completely repaint or replace damaged surface at no extra cost to the Contract.

2.7 Access Doors

.1 Provide access doors/panels as required for access, adjustment, operation, service, and maintenance.

.2 Access doors shall be flush mounted 600mmx600mm (24”x24”) for body entry and 300mmx300mm (12”x12”) for hand entry. Doors to open 180 degrees, have rounded safety corners, concealed hinges, screwdriver latches and anchor straps.

.3 Acceptable Manufacturers:

.1 Acudor
.2 Zurn
.3 Nailor Industries
.4 Le Hage

2.8 Floor Mounted Equipment

.1 Mount Switchboards, Motor Control Centres and all other floor mounted electrical equipment on chamfered edge housekeeping pads, minimum of 100 mm (4”) high and 150 mm (6”) larger than equipment dimensions all around.

2.9 Sleeves

.1 Provide sleeves for all cables passing through masonry, concrete or fire rated assemblies unless run in conduit.

.2 Sleeves shall be EMT conduit.

.3 Coordinate exact location of sleeves prior to construction of walls, floors, etc.

2.10 Fire Stopping

.1 This Contractor shall work with all other Contractors on the project in providing one common method of fire stopping all penetrations made in the fire rated assemblies.

.2 Approved fire stopping and smoke seal material in all fire separations and fire ratings within annular space between pipes, ducts, insulation and adjacent fire separation and/or fire rating.

.3 Do not use cementitious or rigid seals around penetrations for pipe, ductwork, or

other mechanical items.

.4 Provide materials and systems capable of maintaining effective barrier against flame, smoke and gases. Ensure continuity and integrity of fire separation.

.5 Comply with the requirements of CAN4-S115-M35, and do not exceed opening sized for which they have been tested.

.6 Systems to have an F or FT rating (as applicable) not less than the fire protection rating required for closures in a fire separation. Provide “fire wrap” blanket around services penetrating fire walls. Extent of blanket must correspond to ULC recommendations.

.7 The fire stopping materials are not to shrink, slump or sag and to be free of asbestos, halogens and volatile solvents.

.8 Firestopping materials are to consist of a component sealant applied with a conventional caulking gun and trowel.

.9 Fire stop materials are to be capable of receiving finish materials in those areas which are exposed and scheduled to receive finishes. Exposed surfaces are to be acceptable to consultant prior to application of finish.

.10 Firestopping shall be inspected and approved by local authority prior to concealment of enclosure.

.11 Install material and components in accordance with ULC certification, manufacturer’s instructions and local authority.

.12 Submit product literature and insulation material on fire stopping in shop drawing and product data manual. Maintain copies of these on site for viewing by installers and Consultant.

.13 Manufacturer of product shall provide certification of installation. Submit letter to the consultant.

.14 Acceptable Manufacturers:

.1 Fryesleeve Industries Inc.
.2 General Electric Pensiil Firestop Systems
.3 International Protective Coatings Corp.
.4 Rectorseal Corporation (Metacaulk)
.5 Proset Systems
.6 3M
.7 AD Systems
.8 Hilti

.15 Ensure firestop manufacturer representative performs on-site inspections and certifies installation. Submit inspection reports/certification at time of substantial

completion.

PART 3 - EXECUTION

3.1 Site Examination

.1 Examine the site of work and become familiar with all features and characteristics affecting this work before submitting tender.

.2 No additional compensation will be given for extra work due to existing conditions which such examination should have disclosed.

.3 Report to the Consultant any unsatisfactory conditions which may adversely affect the proper completion of this work.

3.2 Interference and Coordination Drawings

.1 Examine the drawings and all divisions of the specifications.

.2 Prepare interference and equipment layout drawings to ensure all components will be properly accommodated within the spaces provided.

.3 Lay out the work and equipment with due regard to architectural, structural and mechanical features, and service requirements.

.4 Submit interference drawings to the Consultant.

.5 Before commencing any work, obtain a ruling from the Consultant if any conflict exists, otherwise no additional compensation will be made for any necessary adjustments.

3.3 Separation of Services

.1 Maintain separation between electrical wiring system and building piping, ductwork, etc. so that wiring system is isolated (except at approved connections to such systems) to prevent galvanic corrosion.

.2 In particular, contact between dissimilar metals, such as copper and aluminum, in damp or wet locations is not permitted.

.3 Do not support wiring from pipes, ductwork, etc. Hangers for suspended ceilings may be used for the support of wiring only when approval is obtained from ceiling installer, and approved clips or hangers are used.

3.4 Workplace Safety

.1 The workplace must be kept safe at all times.
.2 Conform to all ministries of labour, and health and safety regulations at all times.

.3 Use ladders and proper techniques as approved by the ministry of labour to perform all work.

.4 Cover all holes/openings and provide barriers around hazards, etc. to ensure occupants and workers are not at risk.

.5 Where work does not conform to such regulations, stop work immediately and report the situation to the Owner's representative or Consultant or rectify the situation immediately.

.6 Report any hazards or concerns to the Owner's representative immediately.

.7 Conform to the Owner's safety requirements and construction regulations.

3.5 Temporary Requirements

.1 Provide grounded extension cords and temporary lights required for work.

.2 Any specific task lighting required on site is the responsibility of this Division.

3.6 Location of Luminaires

.1 Locations may have to be revised to suit construction and equipment arrangements and it is expected that such changes will not result in additional cost to the Owner, provided that no additional labour or material is required and installation has not been completed.

3.7 Mounting Heights

.1 Mounting height of equipment is from finished floor to centerline of equipment unless specified or indicated otherwise. Coordinate with block coursing (if applicable).

.2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.

.3 Install electrical equipment at following heights unless indicated otherwise.

.1 Local switches: 1150mm (46")
.2 Wall receptacles:

.1 General: 400mm (16")
.2 In mechanical rooms: 1200mm (48")

.3 Panelboards: as required by Code or 1400mm (56")
.4 Thermostat: 1150mm (46")

3.8 Welding, Grinding, Noisy Work, Odours

.1 No welding, grinding, other noisy work or work generating odours shall be done during regular operating/school hours.

.2 All above work shall be done after hours or on weekends outside of regular hours.

.3 Submit hot work permit prior to any welding.

3.9 Cutting, Coring, Repairs and Restoration

.1 Patch and repair walls, floors, ceilings, and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.

.2 Each Section of this Division shall bear expense of cutting, patching, and repairing to install their work and/or replacing of work of other Sections required because of its fault, error, tardiness, or because of damage done by it.

.3 Cutting, patching, repairing, and replacing pavements, sidewalks, roads, and curbs to permit installation of work of this Division is responsibility of Section installing work.

.4 All patching, painting and making good of the existing walls, floors, ceilings, partitions and roof will be at the expense of this Contractor, but performed by the Contractor specializing in the type of work involved unless otherwise noted.

3.10 Painting

.1 Refer to other Divisions for Painting unless otherwise specified herein.

.2 Apply at least one (1) coat of corrosion resistant primer paint to ferrous supports and site fabricated work.

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

.4 Restore to new condition, or replace equipment at discretion of Consultant, finishes which have been damaged too extensively to be merely primed, painted and touched up.

3.11 Concealment

.1 All equipment, components, piping, and conduit shall be concealed in ceiling spaces, bulkheads or walls where possible unless otherwise noted on the drawings or approved by the Owner or Consultant.

.2 Exposed equipment, components, piping, and conduit installed in unfinished areas, shall be installed as high as possible. Run piping and conduit tight to roof deck and down columns.

.3 Any surface mounted conduit requirements must be pre-approved by consultant and/or owner prior to installation.

3.12 Clearances and Accessibility

.1 Install all work for easy access for adjustment, operation, and maintenance.

.2 Maintain clearances for all components as per code and manufacturer's instructions.

.3 Provide access panels of adequate size as required to access components in concealed areas. Do not install access doors in specialty walls or ceilings.

.4 Provide fire rated access doors shall be installed in fire separations and match rating of separation.

3.13 Equipment and System Protection

.1 Protect components and materials from damage in storage and on site before, during, and after installation until final acceptance.

.2 Protect inside and outside of components from dust and debris with appropriate covers that will withstand through the construction.

.3 Where equipment and system components become dirty or damaged, clean and repair to new condition to the satisfaction of the Consultant at the expense of this Contractor.

3.14 Supports

.1 Provide all miscellaneous metals and materials as required for support, hanging, anchoring, and guiding of all components.

.2 All supports must be securely mounted to structures.

3.15 Location of Outlets

.1 Do not install outlets back-to-back in wall. Allow minimum 150mm (6") horizontal clearance between boxes.

.2 Change location of outlets at no extra cost or credit, providing distance does not exceed 3m (10') and information is given before installation.

.3 Locate light switches on latch side of doors. Locate disconnect devices in mechanical and elevator machine rooms on latch side of door.

3.16 Fire Stopping

.1 Refer to Part 2 herein.

3.17 Cleaning

.1 In preparation for final acceptance, clean and refurbish all equipment and leave in operating condition.

3.18 Owner Supplied Equipment

.1 Connect to equipment supplied by the Owner and make operable.

3.19 Equipment Identification

.1 Identify electrical equipment with nameplates as follows:

.2 Nameplates:

.1 Lamacoid 3mm (1/8”) thick plastic engraving sheet, black face, white core, mechanically attached with self-tapping screws.

Nameplate Sizes

Size 1	9mm x 50mm (3/8” xx 2”)	1 line	3mm (1/8”) high letters
Size 2	12mm x 70mm (1/2” x 2-1/2”)	1 line	5mm (3/16”) high letters
Size 3	12mm x 70mm (1/2” x 2-1/2”)	2 lines	3mm (1/8”) high letters
Size 4	20mm x 90mm (3/4” x 3-1/2”)	1 line	9mm (3/8”) high letters
Size 5	20mm x 90mm (3/4” x 3-1/2”)	2 lines	5mm (3/16”) high letters
Size 6	25mm x 100mm (1” x 4”)	1 line	12mm (1/2”) high letters
Size 7	25mm x 100mm (1” x 4”)	2 lines	6mm (1/4”) high letters

.3 Wording on nameplates labels to be approved by Consultant prior to manufacture.

.4 Allow for average of twenty-five (25) letters per nameplate.

.5 Identification to be English.

.6 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.

.7 Nameplates for disconnects, starters and contactors must indicate equipment being controlled, voltage and amperage (if not visible on equipment).

.8 The nameplates for switchboards, distribution panels, power panels, etc. shall be Lamacoid with typical identification such as “PP-A, 208V 3PH 4W, fed from switchboard ‘A’”.

.9 The nameplates for lighting panels shall be Lamacoid with typical identification such as LP-'A', 208V 3PH 4W, fed from PP 'A'.

.10 Provide neatly typed circuit directories on panel boards to indicate the area or equipment controlled by each branch circuit.

.11 Clearly mark all receptacles with circuit number.

3.20 Wiring Identification

.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.

.2 Maintain phase sequence and colour coding throughout.

.3 Colour code: to CSA C22.1.

.4 Use colour coded wires in communication cables, matched throughout system.

3.21 Conduit and Cable Identification

.1 Colour code conduits, boxes and metallic sheathed cables.

.2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15m (45') intervals.

.3 Colour bands must be 25mm (1") wide.

	Prime
Up to 208V	black
Voice system	Brown
Data system	Blue
Security	Green
Public address	Yellow
Fire alarm	Red

.4 This Contractor must paint all system junction boxes and covers in conformance with the above schedule.

3.22 Wiring Terminations

.1 Lugs, terminals, screws used for termination of wiring to be suitable for either copper or aluminum conductors.

3.23 Warning Signs

.1 Meet requirements of Electrical Safety Authority and Consultant.

.2 Provide porcelain enamel signs, with a minimum size of 175mm x 250mm (7" x 10").

3.24 Load Balance

.1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance. Adjust branch circuit connections as required to obtain best balance of current between phases and record changes.

.2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage equipment.

.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.

3.25 Field Quality Control

.1 Conduct and pay for following tests:

.1 Power distribution system including phasing, voltage, grounding, and load balancing.
.2 Circuits originating from branch distribution panels.
.3 Lighting and its control.
.4 Motors, heaters and associated control equipment including sequenced operating systems where applicable.
.5 Systems: fire alarm system, communications, security.

.2 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.

.3 Insulation resistance testing.

.1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
.2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
.3 Check resistance to ground before energizing.

.4 Carry out tests in presence of Consultant.

.5 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

.6 Submit test results for Consultant's review.

3.26 Coordination of Protective Devices

.1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings as indicated on drawings or as determined from coordination study.

3.27 Testing and Verification

.1 Provide all material and labour required for all testing and verification.

.2 Submit reports of all testing and verification results for review to Consultant.

3.28 Field Review and Deficiencies

.1 The Contractor shall notify the Consultant when the job is ready for field review at various stages including rough-in stages.

.2 During the course of construction, the Consultants will monitor construction and provide written reports of work progress, discussions and deficiencies.

.3 The Contractor shall correct all deficiencies within the work period prior to the next review.

.4 The Contractor shall not conceal any work until inspected. Where work was concealed, the Contractor shall remove and replace tiles, coverings or other obstructions to allow proper inspection at the Contractor's expense.

.5 Upon completion of the project the Consultant will do a final review. Upon receiving the final inspection report, the Contractor must correct and sign back the inspection report indicated all deficiencies are completed. A re-inspection will only be done once the Consultant receives this in writing. Where the Consultant performs the re-inspection and the work is not complete, the Contractor is responsible for reimbursing the Consultant for the field review. The fee for additional reviews will be at the Consultant's hourly rates plus mileage and applicable taxes to be paid directly to the Consultant prior to performing the next field review.

END OF SECTION

PART 1 - GENERAL

1.1 Work Included

.1 Operating and Maintenance Manuals

.2 Assembly of tests reports for new systems

.3 Assembly of shop drawings for new systems

.4 Assembly of equipment and systems operating and maintenance instructions for new systems

.5 Assembly of identification schedule

.6 As-Built Drawings

1.2 Related Work

.1 Division 1

.2 General Electrical Requirements – Section 16010

PART 2 - PRODUCTS

2.1 Operation and Maintenance Materials

.1 Provide information to Prime Contractor for inclusion into combined Maintenance Manual.

.2 Assemble or develop complete and correct documentation for the operation and preventative maintenance of equipment and systems provided.

.3 Assemble or develop copies of all certified shop drawings and material required to complete the documentation. This generally includes but is not limited to the following:

.1 Contractor Information and Contact Information
.2 Contractor's Warranty Letter and Equipment Warranties
.3 Equipment shop drawings (must be those that were reviewed and stamped by the Consultant)
.4 Manufacturer's operating and maintenance instructions.
.5 Test Reports
.6 Emergency Lighting Test Report
.7 Electrical Safety Authority (ESA) Certificate
.8 Fire Alarm Verification Report
.9 As-built Drawings

2.2 As-built Drawings

.1 As-built drawings shall be kept up-to-date on an ongoing basis during construction for periodic review by the Consultant. As-built drawings shall always be kept in the same location on site known to the Consultant.

.2 Upon completion of the work, submit to the Consultant for review, one (1) complete set of clear, legible, red-lined certified as-built drawings.

.3 Provide a set of clear, legible, red-lined certified as-built drawings with the maintenance manuals.

.4 Contractors shall certify that final reproducible as-built drawings to be correct by notation and signature on the drawings.

.5 As-built drawings shall precisely identify the configuration, size and location of all systems and equipment installed under this Division.

.6 As-built drawings shall be submitted to the Consultant.

PART 3 - EXECUTION

3.1 General

.1 Provide information to Prime Contractor for inclusion into combined Maintenance Manual.

.2 Substantial Completion will not be granted until a draft copy of the complete manual has been submitted by the Contractor and reviewed and accepted by the Consultant.

3.2 As-built Drawings

.1 Upon completion of the work, submit to the Consultant for review, one (1) complete set of clear, legible, red-lined certified As-built Drawings. The Contractor shall certify and sign the completed As-built Drawings.

.2 Substantial completion will not be granted until the As-built Drawings have been submitted to the Consultant.

END OF SECTION

PART 1 - GENERAL

1.1 General

.1 The following specification represents the minimum standard required for installation of basic electrical components.

1.2 Work Included

.1 Refer to Section 16010.

.2 Work to be done under this Section includes labour, materials, and equipment required to install, test and operate Electrical and Communication Systems.

.3 Removal of all redundant wiring and conduit including where specifically requested by the Owner.

1.3 Codes and Standards

.1 Ontario Electrical Safety Code – Current Edition.

.2 CSA

.3 ULC

.4 American Electronic/Telecommunication Industry Association

.5 Commercial Building for Telecommunications Pathways and Spaces

.6 Local Telephone Company requirements

.7 Local Codes and Requirements

1.4 Submittals

.1 Shop Drawings:

.1 Submit shop drawings to the Consultant for review prior to ordering or installation.
.2 Shop drawings shall include manufacturer, model numbers, electrical data, wiring diagrams, and indicate conformance to above reference standards.
.3 One copy of all stamped reviewed shop drawings shall be included in maintenance manual.

.2 Operation and Maintenance Data:

.1 Provide operation and maintenance literature for all equipment indicating manufacturer and model of equipment, instructions for operation and

maintenance of same, and parts list.

.2 Operation and maintenance data shall be included in the maintenance manual.

1.5 Standard of Materials

.1 Materials and equipment are specifically described and named in this Specification in order to establish a standard of material and workmanship.

.2 Materials required for performance of work shall be new and the best of their respective kinds and of uniform pattern throughout work.

.3 Equipment items shall be standard products of approved manufacture. Identical units of equipment shall be of same manufacture.

.4 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.

.5 Materials shall bear approval labels as required by Code and/or Inspection Authorities.

.6 Install materials in strict accordance with manufacturer's recommendations.

.7 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.

.8 Remove materials, condemned as not approved for use, from job site and deliver and install suitable approved materials in their place.

.9 Where a specific manufacturer is noted herein, other manufacturers may be considered where approved by the owner.

PART 2 - PRODUCTS

2.1 General

.1 Provide all equipment as per the following description to complete the entire works as shown on drawings and as indicated in the specifications to provide a complete and operational system.

.2 Coordinate with other trades to provide the components required to make all systems operational – see mechanical schedules for details of equipment provided to make sure the works are complete.

2.2 Outlet Boxes

.1 Outlet boxes shall conform to C.S.A. Standard C22.2 No. 18-1972.

.2 Ceiling boxes shall be 103 mm octagon or square, complete with fittings, where required to support fixtures.

.3 Switch and receptacle boxes shall be:

.1 103 mm square with plaster ring, where flush mounted in plaster walls.
.2 No. 1104, 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 shall be 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 Boxes shall be of a size suitable for the number and size of conductors and the space requirements for the wiring device.

2.3 Conduit Accessories, Condulets and Fittings

.1 Conduit accessories, condulets and fittings shall conform to C.S.A. Standard C22.2 No. 18-1972.

.2 Rigid conduit bushings shall be as manufactured by:

.1 Thomas & Betts Ltd. – Series 5031
.2 Efcor of Canada Ltd. – Series 720B
.3 Commander / Iberville

.3 EMT Connectors shall be steel set screw type as manufactured by:

.1 Thomas & Betts Ltd. – Steel City TC 121E Series
.2 Efcor of Canada Ltd. – Series 720B
.3 Commander / Iberville

.4 Ground Bushing shall be as manufactured by:

.1 Thomas & Betts – Blackjack or 1220 Series
.2 Efcor of Canada Ltd.
.3 Commander / Iberville

.5 Flexible conduit connectors shall be as manufactured by:

.1 Thomas & Betts Ltd. – Series 3110
.2 Efcor of Canada Ltd. – Series 1001B
.3 Commander / Iberville

.6 Conduit fittings shall be as manufactured by:

.1 Crouse-Hinds of Canada Ltd.
.2 Kondu Mfg. Co. Limited
.3 Thomas & Betts Ltd.
.4 Killark of Canada
.5 Efcor of Canada Ltd.
.6 Commander / Iberville

.7 Steel conduit shall be as manufactured by:

.1 Conduits National Co. Ltd.
.2 MBF Industries

.8 Aluminum conduits shall be as manufactured by:

.1 Alcan Canada Products Ltd.

.9 Terminate rigid conduit entering boxes or enclosures with nylon insulated steel threaded bushings.

.1 Thomas & Betts – 8125 Series

.10 Terminate EMT entering boxes or enclosures with nylon insulated steel threaded bushings.

.11 Terminate flexible conduit entering boxes or enclosures with nylon insulated steel connectors.

.1 Thomas & Betts – 5332 Series

.12 Install wall entrance seals where conduits pass through exterior walls below grade.

.13 Provide expansion coupling in conduit runs at building expansion joints and in long runs subject to thermal expansion, all in accordance with manufacturer recommendations.

.14 All cabling shall be run in EMT conduit unless otherwise approved.

.15 BX cable may also be used for short drops to light fixtures to a maximum length of 1500mm. Any installations exceeding 1500mm shall be removed and replaced at the Contractor's expense. All installations of BX cable shall be complete with

anti-short bushings at all stripped ends as per OEC #12-608(1)(a). Connectors for BX cable shall be Crouse Hinds #L16ST.

.16 Rigid PVC (unplasticized) conduit shall be CSA approved according to CSA Standard C22.2 No. 136.

.17 Pull Cords/Strings

.1 Nylon twine

2.4 Conductors, Wires and Cables

.1 Wiring installed in conduit, unless otherwise noted, shall be copper 600 volt RW75XLPE, RWU75XLPE or TWH (75 degrees C) nylon jacket as per the requirements on the plans. Lighting and power wiring shall be copper, minimum No. 12 gauge. Size wires for 2% maximum voltage drop to farthest outlet on a maximum 80% loaded circuit.

.2 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.

.3 Colour Coding shall be as follows:

.1 Phase “A” – Red
.2 Phase “B” – Black
.3 Phase “C” – Blue
.4 Control – Orange
.5 Ground – Green
.6 Neutral – White

.4 Wire shall be as manufactured by:

.1 Canada Wire and Cable Co. Ltd.
.2 Industrial Wire and Cable (1970) Ltd.
.3 Phillips Cables Ltd.
.4 Pirelli Cables Ltd.

.5 Neatly train circuit wiring in cabinets, panels, pull boxes and junction boxes and hold with nylon cable ties.

.6 Splice wire, up to and including No. 6 gauge, with nylon insulated expandable spring type connectors.

.1 Thomas & Betts – Marr Max Series

.7 Splice large conductors using compression type connections insulated with heat

shrink sleeves.

.1 Thomas & Betts – 5400 Series lugs and heat shrink type #s series

.8 Where colour coding tape is utilized, it shall be applied for a minimum of 2" at terminations, junction and pull boxes and condulet fittings. Do not paint conductors under any condition. Colour coding shall also apply to bussing in panels and, switchgear, disconnects, and metering cabinets.

2.5 Junction Boxes and Pull Boxes

.1 Junction and pull boxes must conform to CSA C22.2 No. 40 (latest edition).

.2 Welded steel construction with screw-on flat covers for surface mounting.

.3 Covers with 25 mm (1") minimum extension all around, for flush-mounted pull and junction boxes.

2.6 Receptacles

.1 Receptacles shall conform to CSA 22.2 No. 42 (latest edition).

.2 Receptacles shall be specification grade of amperage and voltage indicated on the drawings.

.3 Manually operated general purpose with the following features:

.1 Terminal holes approved for No. 10 AWG wire.
.2 Break-off links for use as split receptacles
.3 Urea or melamine molding for parts subject to carbon tracking
.4 Suitable for back and side wiring (eight back wired entrances, four side wiring screws)
.5 Triple wipe contacts and riveted grounding contacts
.6 Tamper resistant where noted.

.4 Switches and receptacles shall be of the same manufacturer throughout except where a specified item is not made by that manufacturer.

.5 Provide white colour (to be confirmed at shop drawing review).

.6 Receptacles shall be as listed below:

.1 15 ampere, 120V, single phase grounded duplex receptacle shall be NEMA-U-ground type CSA Configuration 5-15R.
.2 20 ampere, 120V, single phase grounded duplex receptacle shall be NEMA-U-ground type CSA Configuration 5-20RA.

.7 Other types of receptacles shall be provided as shown on Drawings.

.8 Catalogue numbers listed below have been used to indicate quality standards.

.1	Standard Duplex	Hubbell BR15WHI
.2	GFI T-Slot	Hubbell GF20WLA
.3	GFI	Hubbell GF15WLA
.4	T-Slot	Hubbell BR20WHI

.9 Weatherproof receptacles shall be equal to 20A GFI and mounted in weatherproof enclosure complete with locking key. Enclosure shall be equivalent to Hubbell WPFS26 with locking device HBLWLC.

.10 Acceptable Manufacturers:

.1 Hubbell of Canada
.2 Pass & Seymour
.3 Leviton

2.7 Cover Plates

.1 Switch, receptacle, telephone and other plates shall be stainless steel 18-8 chrome metal alloy, Type 302, non-metallic in finished areas and pressed steel in unfinished areas. Finish brush marks shall be run in a vertical direction.

.2 Cover plates shall be of the same manufacturer throughout.

.3 Cover plates shall be as manufactured by:

.1 Leviton
.2 Harvey Hubbell of Canada Ltd.
.3 Pass & Seymour Inc.

2.8 Emergency Shut-Off Switches

.1 Emergency shut-off switches shall be red illuminated mushroom type, Siemens Model 3SB1801.

2.9 Disconnect Switches

.1 Fused or Un-fused disconnect or safety switches shall be Type “A”, quick-make, quick-break construction with provision for padlocking switches in either “ON” or “OFF” position.

.2 Switches throughout job shall be of same manufacture.

.3 Fused switches shall have fuse clips designed for Class “J” fuses and designed to reject standard N.E.C. fuses.

.4 Switches shall be as manufactured by:

.1 Cutler Hammer
.2 Siemens
.3 Schneider Electric

.5 Provide fused or un-fused safety or disconnect switches as shown and as required by Code.

.6 Weatherproof disconnects shall be NEMA 3X rated.

2.10 Motor Starters

.1 Starts shall conform to CSA C22.2 No. 14 (latest edition) and EEMAC E14-1.

.2 Single Phase motor starters shall be/have:

.1 Used for single phase motors up to 1HP
.2 Franklin Control System BAS-1P Building Automation Starter
.3 On/Off Disconnect switch with recessed Hand/Auto Modes
.4 Single phase; 110V, 1/10HP – 1HP; 240V, 1/10HP – 1HP
.5 120~240VAC, 1-Phase, 60Hz, across the line, full-voltage non-reversing (1HP)
.6 Adjustable 1-16A Class 10 electronic overload
.7 NEMA Type 1 General Purpose Enclosure, surface mounting
.8 On/Off Switch, concealed Hand/Off/Auto switch
.9 Run Status Verification
.10 Voltage & Dry inputs for Auto Run Command
.11 System override mode
.12 Manual Overload Trip Reset

.3 Single Phase motor starters for above 1HP shall be/have:

.1 Equal to Allen Bradley IEC type
.2 Contactor solenoid operated, rapid action type
.3 Motor overload protective device in each phase, manually reset from outside enclosure
.4 Hand/off/auto push button selector switches
.5 Indicating lights: standard duty, 1 red pilot light for “stop” or “off” and 1 green light for “start” or “on”.
.6 1-N/O and 1-N/C spare auxiliary contacts
.7 24V auxiliary contacts
.8 Wiring and schematic diagram inside starter enclosure in visible location

.4 Combination starters shall be/have:

.1 Used where fused switch and magnetic starter are in same location
.2 Equal to Allen Bradley IEC
.3 Include fused disconnect switch with operating lever on outside of

enclosure to control disconnect
.4 Locking in “OFF” position
.5 Independent locking of enclosure door
.6 Provision for preventing switching to “ON” position while enclosure door is opened.
.7 Magnetic starter features as above.

.5 Provide control transformers and auxiliary contacts as required for control connections.

.6 Provide push to test lights throughout.

.7 Half size and IEC starters will not be accepted.

.8 Acceptable Manufacturers:

.1 Allen Bradley
.2 Siemens
.3 Cutler Hammer
.4 Schneider Electric

2.11 Control Transformers

.1 Control transformers shall conform to CSA C22.2 No. 66 (latest edition).

.2 Auto-transformers shall conform to CSA C22.2 No. 47 (latest edition).

.3 Single phase, dry type, control transformer with primary voltage as indicated and secondary voltage to suit remote control device, complete with secondary fuse, installed in with starter as indicated.

.4 Size control transformer for control circuit load plus 20% spare capacity.

2.12 Contactors

.1 Contactors shall conform to CSA C22.2 No. 14 (latest edition).

.2 Electrically held and controlled by pilot devices as indicated and rated for type of load controlled. (Mechanically held style for exterior lighting control).

.3 Complete with 2 normally open and 2 normally closed auxiliary contacts unless indicated otherwise.

.4 Mount in CSA Enclosure 1 unless otherwise indicated.

.5 Include following options in cover:

.1 Red indicating lamp.
.2 Hand – Off – Auto selector switch.

.6 24V Control transformer: mounted in contactor enclosure.

.7 Acceptable Manufacturers:

.1 Allen-Bradley
.2 Cutler Hammer
.3 Siemens
.4 Schneider Electric

2.13 Control Relays

.1 Control relays shall be equal to Allen Bradley type P, electrically held. Confirm coil voltages for relays controlling mechanical equipment with controls contractor.

2.14 Hangers and Supports

.1 Provide and correctly locate all hangers and inserts required for the installation of all work under this Contract.

.2 Hangers for electrical conduit shall be galvanized after fabrication.

.3 Conduit hangers shall be as manufactured by:

.1 Burndy Canada Ltd.
.2 Canadian Strut Products Ltd.
.3 E. Myatt & Co. Ltd.
.4 Steel City Electric Co.
.5 Pilgrim
.6 Thomas & Betts
.7 B-line

.4 Do not use perforated strapping (grappler bars).

2.15 Finishes and Painting

.1 All factory supplied equipment shall have finish coating factory applied whether finish be painted, galvanized or other, as required and as specified.

.2 Repair dents and touch up all damaged finishes with matching finish, or if required by the Consultant or Owner, completely repaint or replace damaged surface at no extra cost to the Contract.

PART 3 - EXECUTION

3.1 General

.1 All wiring to meet Ontario Electrical Safety Code and local authorities.

.2 All power, interlock and control wiring over 50V, and disconnects shall be supplied and installed by the Electrical Contractor. Coordinate with Division 15.

.3 Division 15 shall install all control and low voltage interlock wiring less 50V or less.

.4 All outdoor wiring to be run in liquidtight. All indoor wiring to be run in conduit. Last 1.5m (5') at final connection to equipment shall be run in flexible conduit only.

.5 Where wire size is not indicated, ampacity must match or exceed rating of protective device.

.6 Panels are specified as sequence bussed and all branch circuit wiring from these panels shall be such that where a common neutral is used for two or three circuits, these circuits shall be fed from adjacent breakers, so that single-pole breakers may be replaced with 2 or 3 pole breakers should this be required in the future. All circuits shall be balanced. All neutrals shall be sized to meet the requirements of Section 4-022 of the Ontario Electrical Safety code and in no case smaller than 12 awg.

.7 Feeders, sub-feeders, circuit wiring and ancillary items shall be colour coded for phase identification. Neutral conductors shall be full capacity with white covering and be continuous throughout the system without fuses, switches or breakers of any kind. All neutrals shall be sized to meet the requirements of Section 4-022 of the Ontario Electrical Safety code.

.8 Install wiring continuously within raceways, splices will be permitted only at outlets and junction boxes. Sufficient slack wire shall be left at these points to permit proper connection of fixtures, devices, equipment, etc.

.9 Any exposed conduits or cables shall be run parallel to or at right angles to building lines and in a neat manner. Conduits shall be thoroughly reamed and each threaded termination shall be provided with two lock nuts. Running threads for rigid conduit will not be accepted.

.10 Internal raceways in the building

.1 Securely cap or plug all openings in conduit and ducts during the execution of the Work to prevent dust and debris from entering the openings.

.2 At completion of the installation, the service entry ducts and the conduit system in the building shall be fished to clear all blocks.

.11 Outlet and pull boxes shall be cleaned out and the system left free from water and moisture.

.12 Provide all conduit, wire, fittings, disconnect switches, line voltage, starters, disconnects, controls and auxiliary materials as previously defined to wire into

service all 3 phase motors, single phase motors and equipment included in other Sections unless specified otherwise.

.13 Install pull boxes through conduit run where required to facilitate the pulling in of cable, and locate in inconspicuous accessible spaces.

.14 Provide flexible connections to mechanical equipment for vibration isolation. Connections to equipment roof mounted or in other damp or wet locations shall be liquid tight.

.15 Conduits and cables shall not be attached to mechanical units for support.

.16 All devices in Mechanical and/or Electrical rooms and all exterior mounted devices shall have wire guards for protection from mechanical damage. Provide wire guards elsewhere as noted on drawings.

3.2 Wiring Methods

.1 Install wiring in conduit unless otherwise specified. Final connections (1500mm maximum) to equipment shall be liquidtight.

.2 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 Use thin wall conduit (EMT), up to and including 53 mm conduit size, for branch circuit and feeder wiring in ceilings, furred spaces, and in hollow walls and partitions. Use rigid galvanized steel conduit for wiring in poured concrete, where exposed, and for conduit 65 mm or larger. Use rigid PVC conduit for wiring in slabs on grade and wiring below grade.

.4 Aluminum conduit may be used, in lieu of rigid steel conduit, in clean and dry locations, but shall not be used in poured concrete, or for signal and intercommunication systems wiring.

.5 Conduit manufacturer’s touch-up enamel shall be used to repair all scratches and gouges on epoxy-coated conduit.

3.3 Outlet Boxes

.1 Where 103 mm square outlet boxes are installed in exposed concrete or cinder block finished areas, blocks will be cut under Masonry Division as instructed under this Section. Opening shall be cut to provide a close fit to boxes and covers so that edges of openings are not visible after installation of plates. Mortar shall not be used to patch up openings that are cut too large or to patch ragged edges.

.2 Ceiling boxes shall be 103 mm octagon or square, complete with fittings, where required to support fixtures.

.3 Provide a suitable outlet box for each light, switch, receptacle or other outlet, approved for the particular area it is to be installed.

.4 Support outlet boxes independently of conduit and cable.

.5 Locate outlet boxes, mounted in hung ceiling space, so they do not obstruct or interfere with the removal of lay-in ceiling tiles.

.6 Offset outlet boxes, shown back to back in partitions, horizontally a min. 150mm to minimize noise transmission between adjacent rooms.

.7 Use gang boxes at locations where more than one device, of the same system only, is to be mounted. Each system shall utilize separate boxes.

.8 Use tile wall covers where 103 mm square outlet boxes are installed in exposed concrete or cinder block in finished areas.

.9 Flush mount boxes, panels, cabinets and electrical devices, which are installed in finished areas, shall be provided with suitable flush trims and doors or covers, unless specifically noted otherwise.

.10 Provide pre-formed polyethylene vapour barriers for all boxes located in walls with internal vapour barriers.

3.5 Conduit Accessories, Condulets and Fittings

.1 Terminate rigid conduit entering boxes or enclosures with nylon insulated steel threaded bushings.

.1 Thomas & Betts – 8125 Series

.2 Terminate EMT entering boxes or enclosures with nylon insulated steel threaded bushings.

.3 Terminate flexible conduit entering boxes or enclosures with nylon insulated steel connectors.

.1 Thomas & Betts – 5332 Series

.4 Install wall entrance seals where conduits pass through exterior walls below grade.

.5 Provide expansion coupling in conduit runs at building expansion joints and in long runs subject to thermal expansion, all in accordance with manufacturer recommendations.

.6 BX cable is acceptable in walls and drywall ceilings. BX cable may also be used for short drops to light fixtures to a maximum length of 1500mm. Any installations exceeding 1500mm shall be removed and replaced at the Contractor’s expense.

All installations of BX cable shall be complete with anti-short bushings at all stripped ends as per OEC #12-608(1)(a). Connectors for BX cable shall be Crouse Hinds #L16ST.

3.6 Conductors, Wires and Cables

.1 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.

.2 Colour Coding shall be as follows:

.1 Phase “A” – Red
.2 Phase “B” – Black
.3 Phase “C” – Blue
.4 Control – Orange
.5 Ground – Green
.6 Neutral – White

.3 Neatly train circuit wiring in cabinets, panels, pull boxes and junction boxes and hold with nylon cable ties.

.4 Splice wire, up to and including No. 6 gauge, with nylon insulated expandable spring type connectors.

.1 Thomas & Betts – Marr Max Series

.5 Splice large conductors using compression type connections insulated with heat shrink sleeves.

.1 Thomas & Betts – 5400 Series lugs and heat shrink type #s series

.6 Where colour coding tape is utilized, it shall be applied for a minimum of 2” at terminations, junction and pull boxes and condulet fittings. Do not paint conductors under any condition. Colour coding shall also apply to bussing in panels and, switchgear, disconnects, and metering cabinets.

3.7 Junction Boxes and Pull Boxes

.1 Install pull boxes in inconspicuous but accessible locations. Provide access doors in all drywall areas.

.2 Install junction boxes and pull boxes so as not to exceed 30m (100’) of conduit run between pull boxes and in conformance with the Electrical Safety Authority.

.3 Provide equipment identification in conformance with Section 16010.

.4 Label all junction boxes with panel and circuit number.

3.8 Receptacles

.1 Mount receptacles so long dimension is in the vertical.

.2 Exact locations shall be verified to suit furniture layout.

.3 Connect receptacle grounding terminal to the outlet box with an insulated green ground strap.

.4 Install receptacles in gang type outlet box when more than one switch is required in one location.

.5 Where split receptacle has one portion switched mount vertically and switch upper portion.

.6 Confirm colour prior to ordering.

.7 Refer to Section 16010 for mounting heights.

3.9 Cover Plates

.1 Do not install plates until final painting of room or area is completed. Remove protective covering.

2.2 Emergency Shut-Off Switches

.1 Emergency shut-off switches shall be connected to all gas fired appliance within the room they serve (boilers, hot water tank, etc).

.2 Label switches with lamacoid nameplate or adhesive label with the equipment it serves (i.e. “Boilers & HWT”).

3.10 Hangers and Supports

.1 Provide and correctly locate all hangers and inserts required for the installation of all work under this Contract.

.2 Support outlet boxes, junction boxes, conduit and all electrical equipment independently with hangers and fastenings to building structural members.

.3 Hangers in general shall be supported from inserts in concrete construction or from building structure using beam clamps for steel structures. Provide all additional angle or channel steel members required between beams for support of conduits, cables, luminaires, etc.

.4 Use coach screws, lag screws or wood screws as appropriate in any wood construction.

.5 Feeders, conduits and power ducts running vertically in a building shall be supported at each floor and between each floor if necessary.

3.11 Mounting Heights

.1 Refer to Section 16010.

3.12 Conduit Sleeves and Curbs

.1 Provide conduit sleeves of galvanized steel for conduit and cable runs passing through concrete walls, beams, slabs and floor. Include for all power, communications and control wiring.

.2 Extend galvanized conduit sleeves for conduit rising through slabs 4” minimum above finished floors. Provide sleeves, passing through floors having a waterproof membrane, with an integral flashing clamp.

3.13 Supports and Bases

.1 Supply and erect special structural work required for 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 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.

3.14 Finishes and Painting

.1 Primary and final painting for work, other than items specified as factory primed

or finished, shall be performed by trades specializing in this type of work.

.2 Repair and finish factory finished equipment, damaged or scratched during installation, in an approved manner.

.3 Leave bare metal surfaces ready for painting by removing dirt, rust, grease or mill scale to Consultant's approval.

.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.

3.15 Electrical Connections for Mechanical Equipment

.1 Provide all required electrical connections to apparatus provided and/or supplied by Division 15, the Owner and as part of the work of other Divisions of the Specifications.

.2 All power and control wiring over 50V and disconnects shall be installed by the Electrical Contractor.

.3 All control and low voltage wiring 50V and under shall be installed by the Mechanical Contractor. Coordinate all low voltage wiring with the Mechanical Contractor.

3.16 Motors and Starters

.1 Division 16 shall supply and install all starters unless otherwise indicated.

.2 Coordinate with Division 15 as required.

.3 Install line voltage disconnect switches at each motor not within the required distance from its starter to meet code requirements.

.4 All motors shall be wired and connected under this Division. The drawings do not necessarily show the exact location of wiring to motors and it shall be the responsibility of this Division to fully coordinate this work with Division 15.

.5 Temperature Controls: Be responsible for the “line" side power connections to all control apparatus where detailed or required to make the system operational.

3.17 Equipment Identification

.1 Refer to Section 16010.

3.18 Testing

.1 Make tests of equipment and wiring at times requested.

.2 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.

.3 Supply meters, materials and personnel as required to carry out these tests.

.4 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.

.5 Before energizing system, check all connections and set and calibrate all relays and instruments for proper operation, obtain necessary clearances, approval and instructions from utility company.

.6 Connect single phase loads so that there is the least possible unbalance of the supply phases.

.7 Submit all test results in report format.

END OF SECTION

PART 1 - GENERAL

1.1 Codes and Standards

.1 Ontario Electrical Safety Code – Current Edition

.2 CSA

.3 ULC

.4 Local Codes and Requirements

1.2 Submittals

.1 Submit shop drawings to the Consultant for review prior to ordering or installation.

.2 Shop drawings shall include manufacturer, model numbers, electrical data, wiring diagrams, and indicate conformance to above reference standards.

PART 2 - PRODUCTS

2.1 Fixtures

.1 Luminaires including fixtures and lamps shall conform to the luminaire schedule.

.2 Manufacturer:

.1 Acceptable Manufacturers: Refer to luminaire legend in drawings set for approved manufacturers.
.2 Alternate manufacturers must provide equal fixtures to the satisfaction of the Engineer. Any alternates that do not satisfy the specifications or the Engineer will be rejected.
.3 Alternate fixtures must be on approved DLC list if base specified fixtures are on approved list for applicable energy benefits.
.4 Where alternates alter functional or visual design, or change the space requirements or mounting details, all such information shall be clearly presented to the Consultant for consideration and any costs associated with same shall be the responsibility of the Contractor.
.5 Once shop drawings are approved, no substitutions will be considered except for special circumstances such as delivery. Delivery reasons shall only be considered if at no fault to the Contractor. Contractor's failure to order fixtures within the schedule will not be acceptable.

.3 Similar luminaires shall be products of same manufacturer.

.4 Luminaires shall be completely factory assembled and delivered in cartons or in palletized form.

.5 All fixtures shall be recessed type in acoustic tile or drywall ceilings unless otherwise indicated. Provide drywall trim frame for recessed drywall applications.

.6 Troffers in ceiling shall be equipped with adjustable mounting brackets.

.7 All fixtures shall be provided with ballasts suitable for the fixture type and application. All ballasts shall be CSA approved and ULC listed and comply with CSA standard C22.2 No. 74. Ballasts shall be suitable for 120 volt application as noted.

.8 Protective wire guards shall be provided for all fixtures where indicated on the drawings and where subject to damage.

2.2 Lenses

.1 In general, lenses shall be K12 distribution acrylic 0.125" (32mm) thick, shall have a recessed prismatic pattern of 3/16" (5mm) square based female cones running 45 degrees to the parallel and perpendicular axis to the panel. Provide vandal lenses where specified.

.2 Panel shall be made of ultraviolet inhibited injection moulded clear virgin acrylic.

.3 Panels shall be strain free and uniform in production. There shall be no fade-outs or streaks to detract from job performance.

.4 Lenses shall be low brightness, sparkling crystal panel that provides maximum efficiency and good brightness control in the direct glare zone.

2.3 Ballast

.1 LED lamp ballasts shall be instant start or program start electronic types, designed to provide full light output of all 4' LED dimmable lamps, and as per the following specifications:

.1 Ballast must be on the LED manufacturer's approved ballast compatibility list. No additional cost will be incurred for using non-approved ballast/lamp configurations.
.2 CSA approved and ULC listed and labeled;
.3 Comply with FCC Rules and Regulations, and ANSI Spec C62.41-1980/C62.45-1987;
.4 In accordance with ANSI Spec C82.11;
.5 Class A sound rating;
.6 Capable of starting lamps down to 0 degrees C;
.7 Total harmonic distortion less than 20%;
.8 Minimum power factor of 0.90 and ballast factor of at least 0.88;
.9 Lamp current crest factor not greater than 1.7;
.10 Frequency of operation between 20kHz minimum to 60kHz, but not between 30kHz and 42kHz; lamps shall operate without visible flicker;
.11 FI/EMI filtering;
.12 Five (5) years full replacement parts and labour included warranty.

.2 Acceptable manufacturers are Philips Advance, Universal Technologies, and Osram Sylvania.

2.4 Lamps

.1 LED lamps shall be energy saving, instant start, T-8 diameter bulb meeting the following specification:

.1 All lamps must be of glass construction;
.2 Lamps must have minimum 220 degree beam angle;
.3 Lumen output must be a minimum 2000 lumens;
.4 Lamps must be able to be installed in luminaire housing without any modifications required to be made to the housing;
.5 Maximum lamp wattage to be 16 watts;
.6 Colour temperature to be 4100°K;
.7 Medium bi-pin base;
.8 Lamps must be rated for 50,000 hour life space based on L70;
.9 Lamps must be DLC listed for applicable energy grants;
.10 Warranty must be a minimum of 5 years;
.11 Only 4'-0" long lamps shall be used. No other lamp lengths will be accepted;
.12 Acceptable manufacturers are Osram Sylvania, LED13T8/L48/DIM/841/SUB/G6

PART 3 – EXECUTION

3.1 General

.1 Luminaires shall be stored in a dry and protected area. Confirm acceptable storage area prior to luminaire being delivered to site.

.2 Lenses for fixtures shall be stored on site and installed separately from the fixtures at a time to be directed by the Consultant.

3.2 Installation of Lighting Fixtures

.1 Provide all lighting fixtures and lamps as shown on the drawings and schedules.

.2 Include for assembly, and mounting of all fixtures, complete with all wiring, connections, fittings, hangers, aligners, box covers and accessories which may be required for any fixture to provide a complete, safe, fully operational assembly.

.3 Install fixtures in accordance with applicable reflected ceiling plans and/or as directed by the Consultant.

.4 In Equipment Rooms, shafts and similar secondary areas, install fixtures after the mechanical and other major work is roughed-in and adjust fixture locations as required at no cost to the Owner. Fixtures in these areas shall be installed at the same height unless otherwise directed.

.5 At the discretion of the Consultant, site test and demonstrate the operation of special application fixtures and adjust their locations within a reasonable distance to obtain the effects desired. Assist in the aligning and positioning of all adjustable fixtures and ensure that fixtures with adjustable lamp holders are properly positioned to correspond with the lamps specified.

.6 Thoroughly review all ceiling types, construction details and mounting arrangements before placing fixture orders and ensure that all mounting assemblies, frames, rings and similar features are included for and match the required installation.

.7 Mount luminaires perfectly level and plumb. Luminaires shall fit tightly to ceiling without showing a space or light leak between frame and ceiling. Re-install improperly installed fixtures at no expense to the Owner.

.8 All fixtures and fixture assemblies shall be properly secured and supported. Support fixtures independent of the ceiling construction complete with all fasteners, framing and hangers as required. Do not secure fixtures to mechanical ductwork or other vibration producing apparatus.

.9 Where fixtures are suspended from the structure they shall utilize self-aligning box covers with an additional ground wire from the outlet through the hanger for continuity of ground.

.10 Carefully coordinate the fixture installation with the work of other trades ensuring that the necessary depths and mounting spaces are provided. Do not alter fixture locations unless approved by the Consultant.

.11 All lamps shall be new and intact when the project is complete, and ready for acceptance. Replace lamps used for testing fixture assemblies at the discretion of the Consultant. Include a full lamp listing in the Operating and Maintenance Instructions.

.12 Provide safety chains on all surface mounted, T-bar mounted or suspended light fixtures. Light fixtures shall have two chains, each supporting two corners of the luminaire (all four corners supported). Chain shall be #10 tensile jack chain, bright inc coated, with a strength of 400 lbs (180 kg). Attachments shall be made using a No. 10 “S” hook. Caddy fasteners may be used where applicable. “S” hooks must be closed after installation.

.13 Industrial luminaires, where suspended, shall have ½” (12mm) conduit hangers and ARB cylinder ball aligners. Length and location shall clear equipment, ducts and pipes. Metal strut (Flexibar or equal) may be used for mounting of luminaires in mechanical areas or electrical rooms.

END OF SECTION

PART 1 - GENERAL

1.1 References

.1 CAN/ULC-S524 (latest edition), Installation of Fire Alarm Systems.

.2 ULC-S525 (latest edition), Audible Signal Appliances for Fire Alarm Systems.

.3 CAN/ULC-S526 (latest edition), Visual Signal Appliances, Fire Alarm.

.4 CAN/ULC-S527 (latest edition), Control Units, Fire Alarm.

.5 CAN/ULC-S528 (latest edition), Manual Pull Stations.

.6 CAN/ULC-S529 (latest edition), Smoke Detectors.

.7 CAN/ULC-S530 (latest edition), Heated Actuated Fire Detectors, Fire Alarm.

.8 CAN/ULC-S531 (latest edition), Smoke Alarms.

.9 CAN/ULC-S536 (latest edition), Inspection and Testing of Fire Alarm Systems.

.10 CAN/ULC-S537 (latest edition), Verification of Fire Alarm Systems.

.11 OBC (latest edition), Ontario Building Code.

1.2 Description of System

.1 Existing system includes:

.1 Control panel to carry out fire alarm and protection functions including receiving alarm signals, initiating general alarm, supervising system continuously, actuating zone annunciators, and initiating trouble signals.
.2 Trouble signal devices.
.3 Power supply facilities.
.4 Addressable manual alarm stations.
.5 Addressable automatic alarm initiating devices.
.6 Audible and visual signal devices.
.7 End-of-line devices.
.8 Annunciators.
.9 Ancillary devices.
.10 Interface and zone modules.

1.3 Requirements of Regulatory Agencies

.1 This system is subject to review by local building department officials, local fire department officials. **Therefore, submission of verification certificate and field technical device verification sheets is required prior to inspection by these officials. Schedule accordingly.**

1.4 Shop Drawings

.1 Submit shop drawings in accordance with Section 16010.

1.5 Operation and Maintenance Data

.1 Provide operation and maintenance data for Fire Alarm System for incorporation into manual specified in Section 16010.

.2 Include:

.1 Technical data – illustrated parts list with parts catalogue numbers.
.2 Copy of approved shop drawings.

1.6 Demonstration

.1 Arrange for on-site demonstrations by fire alarm equipment manufacturer to operational personnel.

1.7 System Operation

.1 Operation of any alarm initiating device to:

.1 Cause audible and visual signal devices to sound throughout building.
.2 Transmit signal to fire department via monitoring station.
.3 Cause zone of alarm device to be indicated on control panel and remote annunciator(s).
.4 Cause air conditioning and ventilating fans to shut down and to function so as to provide required control of smoke movement.
.5 Cause fire doors and smoke control doors of normally held open, to close automatically.
.6 Log the alarm in the historical alarm log file.

.2 System Trouble Operation

.1 Any system trouble shall cause the following to occur:

.1 An audible and visual trouble signal shall sound at the main control panel LCD Display Only until acknowledged by an operator.
.2 Log the trouble condition in the separate Historical Trouble Log File.

1.8 Performance Criteria

.1 These specifications describe the minimum functional requirements for an electronically supervised, microprocessor based, fully integrated system. The initial installation shall include all the necessary electronic hardware, software and memory for a completely operable system in accordance with these

specifications.

1.9 Quality Assurance

.1 Each and all items of the fire alarm system shall be listed as the products of a single manufacturer under the appropriate category by the Underwriter's Laboratories of Canada and shall bear the "ULC" label.

.2 Each and all items of the fire alarm system shall be covered by a one-year parts and labour warranty covering defects resulting from faulty workmanship and materials. The warranty shall be deemed to begin on the date the system is accepted by the Project Manager on issuance of the substantial performance certificate for the project.

.3 All control equipment must have Transient Protection Devices to comply with ULC requirements.

PART 2 – PRODUCTS

2.1 Existing Fire Alarm System

.1 Existing fire alarm system is Simplex 4100ES.

2.2 Devices

.1 Provide all new materials, devices and wiring required for contract work in conformance with all codes.

.2 All new devices shall be compatible with existing system.

.3 Each and all items of the Fire Alarm System shall be compatible with the existing system and listed as a product of a SINGLE fire alarm system manufacturer under the appropriate category by the Underwriters' Laboratories of Canada Inc. (ULC) and listed as Underwriters' Laboratories of Canada Inc. (ULC), and shall bear the "ULC" label.

2.3 Conduit and Wire

.1 Wiring shall be in accordance with local, provincial and national codes, and as recommended by the manufacturer of the fire alarm system.

.2 Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for initiating device circuits and signaling line circuits, and 14 AWG (1.63 mm) for notification appliance circuits.

.3 All wire and cable shall be listed and/or approved by recognized testing agency for use with protective signaling system.

.4 All field wiring shall be electrically supervised for open circuit and ground fault.

.5 All wire shall be installed in conduit. Provide wiremold for all wiring in exposed areas. All surface mounted conduit must be approved by Owner or Consultant prior to installation.

.6 Wire and cable not installed in conduit shall have a fire resistance rating suitable for the installation as indicated in MFPA 70 (e.g. RPLF) and as per OBC.

.7 All junction boxes shall be painted ‘red’ and identified as signal or initiating.

2.4 End-of-Line Devices:

.1 Reuse existing or provide new end-of-line devices mounted within outlet boxes.

.2 Provide on the cover plate for each such device on approved nameplate, engraved "END-OF-LINE RESISTOR" or with an approved symbol. Provide red lamacoid plate with white 6mm letters identifying zone.

2.5 Fan Shut Down

.1 All new air handling equipment shall be tied into fire alarm system for fan shut down (including indoor air handling units, supply fans and return fans).

2.6 Fire Alarm Graphic

.1 Update existing passive graphic to suit renovation.

PART 3 - EXECUTION

3.1 Installation

.1 The entire system shall be installed in accordance with CAN/ULC-S524 (latest edition) and approved manufacturers manuals and wiring diagrams. The contractor shall furnish all conduit, wiring, outlet boxes, junction boxes, cabinets and similar devices necessary for the complete installation. All wiring shall be of the type recommended by the Electrical Safety Code, approved by local authorities having jurisdiction for the purpose, and shall be installed in dedicated conduit throughout.

.2 Locate and install detectors and connect to alarm circuit wiring.

.3 Fire detectors shall not be located closer than 1000mm horizontally from tip of a ceiling suspended (paddle) fan or ceiling mounted unit heater measured to the edge of the detector.

.4 Fire detectors shall not be located closer than 450mm from any supply or exhaust air outlet as measured to the edge of the detector.

.5 Locate duct type detectors in straight portions of ducts.

.6 Locate and install remote relay units to control fan shut down.

.7 All junction boxes shall be painted ‘red’ and identified as signal or initiating.

3.2 Mounting Heights

.1 Wall mounted audible signals: minimum 150mm (6”) below ceiling and no less than 2300mm (90”) A.F.F. to top of device.

.2 Visual signals (strobes): entire lens 2000-2400mm (78”-94”) A.F.F.

.3 Combination horn/strobes: conform to .1 and .2 above.

3.3 Field Quality Control

.1 The system shall be installed and fully tested under the supervision of trained manufacturer’s representative. The system shall be demonstrated to perform all the functions as specified.

3.4 Acceptable Installer

.1 The fire alarm/life safety system specified herein shall be installed by an Authorized Electrical Contractor who is CFAA Certified.

3.5 Examination

.1 Prior to the commencement of any of the work detailed herein, an examination and analysis of the area(s) where the Fire Alarm/Life Safety System and all associated components are to be installed shall be made.

.2 Any of these area(s) which are found to be outside the manufacturer’s recommended environments for the particular specified products shall be noted on a Site Examination Report which shall be given to the Building Owner’s Representative, and the Consultant.

.3 Any shorts, opens, or grounds found on existing wiring shall be corrected prior to the connection of these wires to any panel component or field device.

3.6 Demonstration

.1 Arrange for on-site demonstrations by fire alarm equipment manufacturer to operational personnel, owner, consultant and building official as requested.

3.7 System Test and Verification

.1 Perform tests in accordance with Section 16010 and CAN/ULC-S537 (latest edition) Standard for the Verification of Fire Alarm Systems.

.2 Submit complete report and test letter to the Consultant.

.3 Fire Alarm System:

.1 Test each device and alarm circuit to ensure noted devices transmit alarm to control panel and actuate general alarm ancillary devices.
.2 Check annunciator panels to ensure zones are show correctly.
.3 Simulate grounds and breaks on alarm circuits to ensure proper operation of system.

.4 Class A Circuits:

.1 Test each conductor on all circuits for capability of providing alarm signal on each side of single open-circuit fault condition imposed near middlemost point of circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.
.2 Test each conductor on all circuits for capability of proving alarm signals during ground-fault condition imposed near middlemost point of circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.

.5 Class B Circuits:

.1 Test each conductor on all circuits for capability of providing alarm signal on line side of single open-circuit fault condition imposed at electrically most remote device on circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.

.4 Verify fan shut down for all air handling equipment and include in verification report.

END OF SECTION