

MECHANICAL SPECIFICATION
FOR
COMMUNITY URBAN SPACE PROJECT
PHASE 3 – NEWMARKET COMMUNITY CENTRE
ADDITION AND RENOVATION
NEWMARKET, ONTARIO

MMM GROUP NO.: 1810061-000
OCTOBER 5, 2010



MMM Group Limited
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SECTION 15002 - FORM OF SUPPLEMENTARY MECHANICAL TENDER

NAME OF BIDDING SUBCONTRACTOR: _____

DATE: _____

PROJECT: **Phase 3 – Newmarket Community Centre Addition and Renovation**
MMM No. 1810061-000

To: MMM Group Limited
100 Commerce Valley Drive West
Thornhill, Ontario
L3T 0A1

Attn: Mr. Yang Zhang
Email: zhangy@mmm.ca

Submit document in accordance with the Instructions to Bidders and submit a copy directly to MMM Group Limited, by means of email addressed as above within twenty-four (24) hours after the Mechanical Tender closing.

Note: The Specifications shall govern over this list. Where names are added/deleted by addenda, it shall be understood that this list will reflect the respective changes. Failure to complete and submit this document as directed may result in your Bid being ruled informal.

DIVISION 15 - LIST OF MANUFACTURERS/SUPPLIERS

We submit, herein, typed or neatly printed the names of the manufacturers upon whose products our Bid Price is based and which we will supply. If no name is indicated, or if name identified is not listed in issued documents, or if more than one name is indicated for a particular product, we will if requested, provide the base specified manufacturer's product. Where products are named in the specifications with only one (1) manufacturer/supplier, or are not listed herein, we are also prepared to provide the base specified named product. We will provide Canadian manufactured products if costs and quality are similar.

We understand that the first manufacturer specified for any product is the manufacturer upon whose product the design is based, and that the other manufacturers specified for a particular product are manufacturers acceptable to the Owner and whose product produces equivalent quality, performance and size. We further understand if we indicate a manufacturer other than the manufacturer whose product is the basis of the design, we are responsible for ensuring that the product supplied is equivalent in quality, performance and size to the base design product, and that any additional costs incurred as a result of use of such products will be borne by us. Acceptance of non-base specified manufacturers with respect to their equivalency shall be as sole discretion of Consultant.

SECTION	PRODUCT	MANUFACTURER/SUPPLIER & CATALOGUE NUMBER
15050	Gate, Globe and Swing Type Check Valves	
15050	Ball Valves	
15050	Butterfly Valves	
15050	Motor Control Centres & Starters	
15050	Vibration Isolation	
15250	Fibreglass Insulation	
15400	Water Meter	
15400	Fire Extinguisher	
15450	Vitreous China Fixtures	
15450	Stainless Steel Sinks	
15450	Emergency Eye Washes	

CONTRACTOR'S AUTHORIZED SIGNATURE _____

PROJECT NO. 0910

05/10/2010
MMM GROUP NO.: 1810061-000

15002-1

SECTION 15002 - FORM OF SUPPLEMENTARY MECHANICAL TENDER

SECTION	PRODUCT	MANUFACTURER/SUPPLIER & CATALOGUE NUMBER
15450	Mop Sinks	
15450	Flush Valves	
15450	Fixture Carriers	
15450	Mixing Valves	
15450	Supply Fittings	
15450	Drain Fittings	
15500	Sprinkler Heads	
15500	Excess Pressure Pump and Control Panel	
15500	Fire Extinguisher	
15650	Refrigerant Concentration Monitor	
15650	Self-contained Breathing Apparatus	
15850	Rooftop Air Handling Unit (RTU-1 to 6)	
15850	Rooftop Heating Ventilating Unit (HV-1)	
15850	In-Line Fans	
15850	Roof Mounted Fans	
15850	Gas Fired Unit Heater	
15880	Fusible Link Fire Dampers	
15880	Grilles and Diffusers	
15880	Motorized Dampers	
15880	Silencers	
15880	Terminal Units	

END OF LIST OF MANUFACTURERS

CONTRACTOR'S AUTHORIZED SIGNATURE _____

PROJECT NO. 0910

05/10/2010
MMM GROUP NO.: 1810061-000

15002-2

SECTION 15010 - MECHANICAL WORK GENERAL INSTRUCTIONS

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NIL

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NIL

SECTION 15010 - MECHANICAL WORK GENERAL INSTRUCTIONS

PART 1 - GENERAL

1.1 REFERENCES

- .1 The "General Conditions", the "Supplementary Conditions", and all Sections of Division 1 apply to and are a part of this Section of the Specification.

1.2 APPLICATION

- .1 This Section applies to and is an integral part of all Sections of Division 15 of the Specification.

1.3 DEFINITIONS

- .1 The following are definitions of words found in Sections of Division 15 of the Specification and on associated drawings:
 - .1 "concealed" - means hidden from normal sight in furred spaces, shafts, ceiling spaces, walls and partitions;
 - .2 "exposed" - means work normally visible, including work in equipment rooms, tunnels, and similar spaces;
 - .3 "provide" (and tenses of "provide") - means supply and install complete;
 - .4 "install" (and tenses of "install") - means secure in position and connect complete;
 - .5 "supply" - means supply only;
 - .6 "TON" – Town of Newmarket.

1.4 EXAMINATION OF SITE

- .1 Carefully examine all conditions at the site that will or may affect mechanical work, and become familiar with site conditions, the building construction, finishes, and work associated with mechanical work in order that your Bid Price includes for everything necessary for completion of the mechanical work.

1.5 PLANNING AND LAYOUT OF WORK

- .1 The exact locations and routing of mechanical and electrical services shall be properly planned, coordinated and established with all affected trades prior to installation such that the services will clear each other as well as any obstructions. Generally, give the right of way to piping requiring uniform pitch and locate and arrange other services to suit.
- .2 Prepare working detail drawings, supplementary to the contract drawings, when deemed necessary by the Consultant, for all areas where a multiplicity of services and/or equipment occurs, or where the work due to architectural and structural considerations involves special study and treatment. Submit working detail drawings to the Consultant in shop drawing form for review before the affected work is installed.
- .3 Carry out all alterations in the arrangement of work that has been installed without proper co-ordination, study, and review, even if in accordance with the contract documents, in order to conceal the work behind finishes, or to allow the installation of other work, without additional cost. In addition, make any alterations necessary in other work required by such alterations, without additional cost.

1.6 PHASING

- .1 Phasing and scheduling of the work is required in order to maintain existing building operations. Include in your Bid Price all costs (including costs for "off hours" work) for scheduling, coordination and construction phasing to suit this project as specified in Division 1.

SECTION 15010 - MECHANICAL WORK GENERAL INSTRUCTIONS

1.7 DOCUMENTS

- .1 The drawings and Specification are intended to be co-operative. Perform all work that is shown, specified or reasonably implied on the drawings but not mentioned in the Specification, or vice-versa, as though fully covered by both. When the scale and date of the drawings are the same, or when the discrepancy exists within the Specification, include the most costly arrangement. In the case of discrepancies or conflicts between the drawings and Specification, the documents will govern in the following order:
 - .1 the Specification;
 - .2 drawings of larger scale;
 - .3 drawings of smaller scale;
 - .4 drawings of later date when the scale of the drawings is the same.
- .2 The Specification is arranged in accordance with the CSI/CSC 16 Division Format. Sections of Division 15 are not intended to delegate functions nor to delegate work and supply of materials to any specific trade, but rather to generally designate a basic unit of work, and the Sections shall be read as a whole.
- .3 The mechanical drawings are performance drawings, diagrammatic, and show approximate locations of equipment and materials. The drawings are intended to convey the scope of work and do not show architectural and structural details. The locations of materials and equipment shown may be altered, when reviewed by the Consultant, to meet requirements of the material and/or equipment, other equipment and systems being installed, and of the building. Provide all fittings, offsets, transformations, and similar items required as a result of obstructions and other architectural or structural details but not shown on the mechanical drawings.
- .4 The Specification does not generally indicate the specific number of items or amounts of material required. The Specification is intended to provide product data and installation requirements. It is necessary to refer to schedules, drawings (layouts, riser diagrams, schematics, details) and the Specification to determine correct quantities. In Division 15 of the Specification, singular may be read as plural, and vice-versa.
- .5 The drawings and specifications are prepared solely for use by the party with whom the Consultant has entered into a contract and there are no representations of any kind made by the Consultant to any party with whom the Consultant has not entered into a contract.

1.8 SHOP DRAWINGS

- .1 Submit for review, properly identified and dimensioned shop drawings showing in detail the design, construction and performance of equipment and materials as requested in Sections of Division 15 of the Specification.
- .2 Endorse each shop drawing copy "CERTIFIED TO BE IN ACCORDANCE WITH ALL REQUIREMENTS", include your company name, the submittal date, and sign each copy. Shop drawings that are received and are not endorsed, dated and signed will be returned for resubmittal. The number of copies of shop drawings shall be ten (10).
- .3 The Consultant will review shop drawings and will indicate his review status by stamping shop drawing copies as follows:
 - .1 "REVIEWED" or "REVIEWED AS NOTED" - If the Consultant's review of shop drawing is final, the Consultant will stamp the shop drawing "REVIEWED" or "REVIEWED AS NOTED" (appropriately marked);
 - .2 "RETURNED FOR CORRECTION" - If the Consultant's review of shop drawing is not final, the Consultant will stamp the shop drawing "RETURNED FOR CORRECTION", mark the submission with his comments, and return the submission. Revise the shop drawing in accordance with the Consultant's notations and resubmit.

SECTION 15010 - MECHANICAL WORK GENERAL INSTRUCTIONS

- .4 It is understood that the following shall be read in conjunction with the wording on the Consultant's shop drawing review stamp applied to each and every shop drawing submitted:

"THIS REVIEW BY THE CONSULTANT IS FOR THE SOLE PURPOSE OF ASCERTAINING CONFORMANCE WITH THE GENERAL DESIGN CONCEPT. THIS REVIEW DOES NOT MEAN THAT THE CONSULTANT APPROVES THE DETAIL DESIGN INHERENT IN THE SHOP DRAWINGS, RESPONSIBILITY FOR WHICH REMAINS WITH THE CONTRACTOR, AND SUCH REVIEW DOES NOT RELIEVE THE CONTRACTOR OF THE RESPONSIBILITY FOR ERRORS OR OMISSIONS IN THE SHOP DRAWINGS OR OF HIS RESPONSIBILITY FOR MEETING ALL REQUIREMENTS OF THE CONTRACT DOCUMENTS. BE RESPONSIBLE FOR DIMENSIONS TO BE CONFIRMED AND CORRELATED AT THE JOB SITE, FOR INFORMATION THAT PERTAINS SOLELY TO FABRICATION PROCESSES OR TO TECHNIQUES OF CONSTRUCTION AND INSTALLATION, AND FOR CO-ORDINATION OF THE WORK OF ALL SUBTRADES".

1.9 WORK STANDARDS

- .1 Where regulatory codes, standards and regulations are at variance with the drawings and Specification, the more stringent requirement will apply.
- .2 Where any code, regulation, by-law or standard is quoted it means, unless otherwise specifically noted, the current edition including all revisions or amendments at the time of the contract. Where references are made to printed instructions, it means the current edition of such instructions.

1.10 PERMITS, CERTIFICATES AND FEES

- .1 Obtain and pay for all permits required to complete mechanical work.
- .2 Include in each copy of operating and maintenance instruction manuals, copies of inspection certificates issued by governing authorities to certify that the completed work is in accordance with the regulations of the governing authorities and are acceptable to them.

1.11 CHANGES OR REVISIONS TO THE WORK

- .1 Wherever the Consultant proposes in writing to make a change or revision to the design, arrangement, quantity or type of any work from that called for on or in the contract documents, submit to the Consultant for approval, a detailed, itemized, estimate breakdown of the cost of all equipment, materials and labour entering into each change or revision.
- .2 Do not execute any changes or revisions until written authorization for such changes or revisions has been issued by the Consultant.
- .3 Note: For any revision which includes deleted work as well as additional work, the total cost of the deleted work must be subtracted from the cost of the additional work before adding percentages for overhead and profit.

1.12 CLEANING UP

- .1 During construction, and on a daily basis, keep the site reasonably clear of rubbish and waste material resulting from mechanical work to the satisfaction of the Consultant. Before applying for a Certificate of Substantial Performance of the Work, remove all of your rubbish and debris, and arrange for and pay for the repair of any damage caused as a result of mechanical work.

1.13 PROTECTION OF EQUIPMENT AND MATERIALS

- .1 Properly protect all mechanical equipment and materials on site from damage due to the elements, the mechanical work and the work of other trades, to the satisfaction of the Consultant. All equipment and materials must be in new condition when the work is substantially performed.
- .2 Wherever possible, co-ordinate equipment deliveries with manufacturers and/or suppliers so that equipment is delivered to the site when it is required, or so that it can be stored within the building and protected from the elements.

SECTION 15010 - MECHANICAL WORK GENERAL INSTRUCTIONS

1.14 TRIAL USAGE

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

1.15 RECORD (AS-BUILT) DRAWINGS

- .1 The drawings for this project have been prepared on a CAD system using AutoCAD Release 2004 software. For the purpose of producing record "as-built" drawings, copies of contract drawings may be purchased from the Engineer, at the Contractor's expense of \$25.00 CDN plus GST, per drawing, up to the first ten (10) drawings and \$5.00 CDN plus GST, per drawing for all additional drawings thereafter.
- .2 When work begins at the site, clearly and accurately mark on a bound set of white prints of the contract drawings, on a daily basis, all changes and deviations from the routing of piping and ductwork and locations of equipment shown on the contract drawings. Changes and deviations include those made by addenda, change orders, and site instructions, and changes and deviations indicated on supplemental drawings issued with addenda, change orders, and site instructions. Maintain the "as-built" white prints at the site for periodic inspection by the Consultant throughout the duration of the work.
- .3 Pay particular attention to accurately dimensioning the location of all concealed services terminated for future extension, all buried work and services and work concealed within the building in inaccessible locations.
- .4 Before applying for a Certificate of Substantial Performance of the Work, update a clean copy of the Contract Document drawing set in accordance with the marked-up set of "as-built" white prints including all deviations from original Contract Document drawings, thus forming an "as-built" drawing disk set. Submit the "as-built" site drawing prints, to the Consultant for review. Make necessary revisions to drawings to the satisfaction of the Consultant.
- .5 Use the final reviewed "as-built" drawing set to provide CAD files of the drawings and reproducible Mylar drawing set thus forming true "as-built" set of contract drawings. Load drawing files onto compact discs (CD's). Provide two complete sets of as-built drawings on CD's. Submit the "as-built" sets of white prints, Mylar prints and discs to Consultant.
- .6 All submitted drawings shall be of the same quality as original contract drawings. The CAD drawings shall be of the form compatible to the existing AutoCAD software.

1.16 OPERATING AND MAINTENANCE INSTRUCTION MANUALS

- .1 For each item of equipment for which a shop drawing is required (except for drains, plumbing fixtures and trim, and similar simple equipment), supply three (3), specific, indexed copies of equipment manufacturer's operating and maintenance instruction data manuals. Consolidate each copy of the data in an identified hard cover three-ring binder. Each binder shall include:
 - .1 a copy of each "reviewed" shop drawing;
 - .2 complete explanation of operation principles and sequences;
 - .3 complete part lists with numbers;
 - .4 recommended maintenance practices and precautions;
 - .5 copies of all inspection certificates issued by regulatory authorities, including pressure vessel inspection certificates;
 - .6 complete wiring and connection diagrams;

SECTION 15010 - MECHANICAL WORK GENERAL INSTRUCTIONS

- .7 a copy of each valve tag chart;
- .8 a copy of the mechanical systems testing and balancing reports;
- .9 a copy of start-up reports.
- .2 Submit the operating and maintenance instruction manuals to the Consultant before applying for a Certificate of Substantial Performance of the Work.
- .3 When shop drawings are returned to you marked "REVIEWED AS NOTED" with revisions marked on the shop drawing copies, such shop drawings shall be revised by the equipment supplier to incorporate the comments marked on the "reviewed" shop drawings and a clean updated copy is to be included in the operating and maintenance manual.

1.17 WARRANTY

- .1 Unless otherwise noted, warrant the mechanical work to be in strict accordance with the contract documents and free from defects for a period of one (1) year from the date of issue of a Certificate of Substantial Performance of the Work.
- .2 Repair and/or replace any defects that appear in mechanical work within the warranty period, ordinary wear and tear and wilful damage by or carelessness of the Owner's staff or agents excepted, without additional expense to the Owner. Where such defects occur, be responsible for all costs incurred in making the defective work good, including repair or replacement of building finishes, other materials, or damage to other equipment caused by such defects, or by subsequent replacement and repairs.
- .3 The TON reserves the right to initiate a service contract for all equipment with one of the TON approved certified service companies. This shall not affect any of the above extended warranties provided by the manufactures.
- .4 All warranties shall commence from the time of substantial completion, regardless of what is noted within the following sections of the specification. "Drop Date" type warranties are not acceptable. Warranty work shall be performed by the equipment manufacturer and not by the Contractor. The Contractor shall be responsible for retaining the equipment manufacturer to provide whatever "bridging" or additional extended warranty period is required from the time that the material is purchased until the time of substantial completion.

1.18 EQUIPMENT AND MATERIALS

- .1 Provide Canadian manufactured products wherever possible and where required quality and performance is obtainable. Unless otherwise specified, all materials and apparatus shall be new and shall comply with applicable Canadian Standards Association (CSA) Standards and/or Underwriters Laboratories of Canada (ULC) Standards and the requirements of the authorities having jurisdiction. Unless otherwise specified, similar products i.e.: all valves, all control components, all vibration isolation, etc., shall be the product of one (1) manufacturer.
- .2 Materials and equipment scheduled and/or specified, have been selected to establish a performance and quality standard, and, in some instances, a dimensional standard. In most cases, base specified manufacturers are stated for material and equipment, specified by manufacturer's name and model number. Unless otherwise noted, the Bid Price may be based on materials and equipment supplied by any of the manufacturers named as acceptable for the particular material or equipment. If acceptable manufacturers are not stated for a particular material or piece of equipment, base the Bid Price on material supplied by the base specified manufacturers.
- .3 If materials or equipment supplied by a manufacturer named as acceptable are used in lieu of the manufacturer specified, be responsible for ensuring that the substituted material or equipment is equivalent in quality, performance and operating characteristics (including energy consumption if applicable) to the specified materials or equipment, and, it shall be understood that any additional costs, and changes to associated or adjacent work resulting from provision of materials supplied by a manufacturer other than the specified manufacturer is included in the Bid Price. In addition, in equipment spaces where equipment named as acceptable is used in lieu of specified equipment and the dimensions of such equipment differs from the specified equipment, prepare and submit for review, accurately dimensioned layouts of rooms affected.

SECTION 15010 - MECHANICAL WORK GENERAL INSTRUCTIONS

- .4 In addition to the manufacturers specified or named as acceptable, other manufacturers of materials or equipment may be proposed to the Consultant for acceptance, listing in each case a corresponding credit for each alternative proposed, however, the Bid Price must be based on equipment or materials specified or named as acceptable. Certify in writing to the Consultant that the proposed alternative meets all space, power, design, energy consumption, and all other requirements of the specified or acceptable material or equipment. In addition, it shall be understood that there will be no increase in the contract Price by reason of any changes to associated equipment, mechanical and/or electrical, required by acceptance of proposed alternatives. The Consultant has sole discretion in accepting any such proposed alternative material or equipment.
- .5 Where products you intend to provide are proposed as "an equal" and/or "or approved equal", to specified products, certify in writing that the proposed product to be used in lieu of specified product, at least meets space, power, design, energy consumption, noise criteria and other requirements of the specified product and thus shall be equivalent to or better than the specified product. When requested by the Consultant, provide full design detail drawings and specifications of proposed products. Acceptance of these "or equal" and/or "or approved equal" products shall be at the sole discretion of the Consultant. The Consultant's decision shall be final and shall not require explanation. There shall be no increase in the contract Price due to the Consultant's rejection of a proposed equivalent product.
- .6 Only base specified products; specified acceptable products or equipment listed as alternate will be considered for acceptance by the TON. No proposed substitutions will be accepted.
- .7 Indicate on Document 15002, "Form of Supplementary Mechanical Tender", the names of the manufacturers for materials and equipment that you will supply, and which were specified or scheduled with a manufacturer's name. Note: The names of manufacturers on the list must be one (1) of the names stated as acceptable for the particular products, unless prior written permission has been given for use of products by alternative manufacturers. Submit as directed in Document 15002, and unless otherwise specified, submit a copy of Document 15002 with the Bid.

1.19 IMPERIAL AND METRIC MEASUREMENTS

- .1 Generally, both imperial and metric units of measurement are given in Sections of the Specification governed by this Section. Metric conversions are "Soft" and have been rounded off.

1.20 BREAKDOWN OF MECHANICAL WORK COST

- .1 Submit to the Consultant a typewritten breakdown of the mechanical work cost with a schedule of values of the various parts of the work, aggregating the total cost of the mechanical work.
- .2 The extent of the breakdown shall be as directed by the Consultant. The breakdown must be acceptable to the Consultant and is required to assist in evaluation of monthly progress draws.
- .3 Submit the breakdown within ten (10) days of written notification of acceptance of Bid and award of contract.

1.21 SUB-CONTRACTORS TO THE MECHANICAL CONTRACTOR

- .1 The Mechanical Contractor agrees to employ those sub-contractors proposed in the Mechanical Form(s) of Tender and accepted by the TON at the signing of the Contract with the General Contractor.
 - .1 The TON may, for reasonable cause object to the use of a proposed Sub-Contractor and consequently, may require the Mechanical Contractor to employ one of the other Sub-Contractors or Bidders.
- .2 In the event that the TON requires a change from a proposed Sub-Contractor originally proposed by the Mechanical Contractor, the Contract Price shall be adjusted by the difference in cost.
- .3 The Mechanical Contractor shall not be required to employ as a Sub-Contractor, a firm to whom he may reasonably object.

SECTION 15010 - MECHANICAL WORK GENERAL INSTRUCTIONS

1.22 ENERGY EFFICIENCY OF PRODUCTS

- .1 Unless otherwise specified, material and equipment supplied shall meet or exceed minimum efficiencies and/or minimum performances of ASHRAE Standard ASHRAE/IES 90.1-2004.

PART 2 - PRODUCTS

NIL

PART 3 - EXECUTION

NIL

END OF SECTION

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SECTION 15050 - MECHANICAL BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 REFERENCES

- .1 Section 15010 in this Division of the Specification applies to and is part of this Section of the Specification.

1.2 APPLICATION

- .1 This Section specifies products, common criteria and characteristics, and methods and execution that are common to one (1) or more Sections of Division 15. It is intended as a supplement to succeeding Sections of Division 15 and shall be read accordingly.

1.3 SHOP DRAWINGS

- .1 Submit shop drawings for all products specified in Part 2.

1.4 SUBMITTALS

- .1 Submit the following to the Consultant for review:
 - .1 a sample of each proposed type of access door, as well as a Sepia print of architectural reflected ceiling plan drawings showing proposed ceiling access door locations;
 - .2 location drawings for all required sleeves and formed openings in poured concrete or precast concrete construction;
 - .3 samples of materials and any other items as specified in succeeding Sections of this Division of the Specification.
- .2 Submit an affidavit stating that lead free solder was used for all soldered joints in copper potable water, drainage and vent piping.

1.5 RELATED WORK SPECIFIED IN OTHER SECTIONS

- .1 The following work which is related to the work of Division 15 is specified in other Sections of other Divisions of the Specification:
 - .1 installation of access doors in building finishes;
 - .2 provision of large access doors and panels in building finishes;
 - .3 power wiring connections to motor control centres;
 - .4 provision of 115 volt control and interlock wiring, unless otherwise noted;
 - .5 finish painting of exposed mechanical work;
 - .6 flashing for mechanical work penetrating the roof.

1.6 REFERENCE CODES AND STANDARDS

- .1 Codes and/or Standards published by various Societies and Associations listed below, may be referenced throughout this Section and other Sections of Division 15:
 - .1 Associated Air Balance Council (AABC);
 - .2 Air Movement and Control Association (AMCA);
 - .3 American National Standards Institute (ANSI);
 - .4 Air - Conditioning and Refrigeration Institute (ARI);
 - .5 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE);
 - .6 The American Society of Mechanical Engineers (ASME);

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- .7 American Society of Testing and Materials (ASTM);
- .8 American Water Works Association (AWWA);
- .9 National Standards of Canada (CAN);
- .10 Canadian Gas Association (CGA);
- .11 Canadian General Standards Board (CGSB);
- .12 Canadian Standards Association (CSA);
- .13 Electrical and Electronic Manufacturers Association of Canada (EEMAC);
- .14 Factory Mutual Systems (FM);
- .15 Institute of Electrical and Electronic Engineers (IEEE);
- .16 International Standards Organization (ISO);
- .17 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS);
- .18 National Environmental Balancing Bureau (NEBB);
- .19 National Fire Protection Association (NFPA);
- .20 Occupational Safety & Health Administration (OSHA);
- .21 Ontario Building Code (OBC);
- .22 Thermal Insulation Association of Canada (TIAC);
- .23 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA);
- .24 Underwriters Laboratories of Canada Inc. (ULC).

PART 2 - PRODUCTS

2.1 PIPE SLEEVES

- .1 Minimum No. 24 USS gauge (0.635 mm thick) galvanized steel with an integral flange to secure the sleeve to formwork construction.
- .2 Factory fabricated, flanged, high density polyethylene sleeves with reinforced nail bosses.
- .3 Schedule 40 mild galvanized steel pipe.

2.2 FIRESTOPPING AND SMOKE SEAL MATERIALS

- .1 Systems shall consists of asbestos-free, both elastomeric materials and intumescent materials, tested, listed and labelled by ULC in accordance with CAN 4-S115-M85, and CAN/ULC-S101-M for installation in ULC designated firestopping and smoke seal systems to provide a positive fire, water and smoke seal and a fire resistance rating (flame, hose stream and temperature) not less than the fire rating for surrounding construction. The fire stopping and smoke seal material system must be specifically ULC certified with designated reference number for its specific installation. Submit copy of ULC certificate, drawings and number for each installation.
- .2 Materials shall be compatible with abutting dissimilar materials and finishes. Coordinate material requirements with trades supplying abutting areas of materials.
- .3 Acceptable certification shall also include certification by Underwriters Laboratories of Northbrook IL, using test conforming to ULC-S115 and given cUL listing published by UL in their "Products Certified for Canada (cUL) Directory".

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- .4 Include costs for and arrange for manufacturer's authorized representative to inspect and verify each installation and application. Submit test report signed and verified by Contractor and manufacturer's representative.
- .5 Pipe insulation forming part of a ULC fire and smoke seal assembly is specified in Section 15250.
- .6 Acceptable manufacturers are 3M Canada Inc., Tremco, Specified Technologies Inc. and A/D Fire Protection Systems and Hilti Canada.

2.3 PIPE ESCUTCHEON PLATES

- .1 One-piece chrome plated black steel or stainless steel plates, sized to cover pipe sleeves or wall or slab openings and to fit tightly around the pipe or pipe insulation.

2.4 CAST IRON PIPE, FITTINGS AND JOINTS

- .1 Class 4000 cast iron pipe and fittings to CSA B70 and CGSB 77-GP-2a.
- .2 Centrifugally cast ductile iron to ANSI/AWWA C151/A21.51-91 complete with a cement mortar lining to ANSI/AWWA C104/A21.4-90 and a protective coating of bituminous paint, standard cement lined cast iron mechanical joint fittings to ANSI/AWWA C110/A21.10-1987 painted as for pipe, and rubber gasket joints to ANSI/AWWA C111/A21.11-90 with electric conductivity strips to bridge joints.

2.5 COPPER PIPE FITTINGS AND JOINTS

- .1 DWV grade hard temper copper to CSA H7 and ASTM B306-88 "Copper Drainage Water Tube (DWV)", with forged copper solder type drainage fittings and 95% tin/5% Antimony solder joints.
- .2 Type "K", "L" and "M", hard drawn seamless copper to CSA H7.6 and certified to ASTM B88-88 "Specification for Seamless Copper Water Tube", with forged copper solder type fittings to suit the pipe, and soldered joints, Englehard Corp. "SILVABRITE 100" or equal 4% silver/96% tin for cold water pipe, 95% tin/5% Antimony or for other pipe.
- .3 Type "L", seamless soft copper to ASTM B77, in continuous lengths of proper size with no joints wherever possible, but with flared tube fitting type joints where absolutely essential.

2.6 GALVANIZED STEEL PIPE, FITTINGS AND JOINTS

- .1 Schedule 40, mild steel, galvanized, ASTM A120 or A53, screwed, complete with galvanized standard weight cast iron screwed fittings to ANSI/ASME B16.4 and screwed joints. Where specified and/or required, joints and fittings shall be screw-on galvanized cast iron companion flange joints.

2.7 BLACK STEEL PIPE, FITTINGS AND JOINTS

- .1 Mild black carbon steel, Grade A, ASTM A53, continuous weld fabricated for pipe with screwed joints, ASTM A53 electric resistance weld fabricated, mill or site bevelled for pipe with welded joints.
- .2 Pipe for fire protection work shall be mild black carbon steel, Grade A ASTM A-795, continuous weld fabricated for pipe with screwed joints, ASTM A-795 electric resistance weld fabricated, mill or site bevelled for pipe with welded joints.
- .3 Threaded fittings shall be Class 125 (standard) or Class 250 (extra heavy) cast iron threaded fittings to ANSI/ASME B16.4.
- .4 Welding fittings shall be factory made, seamless carbon steel, bevelled, butt welding fittings to ASTM A234, Grade WPB, with a wall thickness to match the pipe wall thickness. All elbows shall be long radius pattern except where space conditions do not permit.

2.8 GROOVED END BLACK STEEL PIPE, FITTINGS AND JOINTS

- .1 Mild black carbon steel, Grade A, ASTM A-53, continuous weld fabricated pipe with factory or site grooved ends square cut/roll accordance with Victaulic Co. of Canada Ltd. Specification TS215/83 and to requirements of CSA B242.

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- .2 Pipe for fire protection work shall be mild black carbon steel, Grade A, ASTM A-53 or Grade A, ASTM A-795, with factory or site grooved ends square cut or rolled in accordance with Victaulic Co. of Canada Ltd., specification TS215/83 and to requirements of CSA B242-M1980.
- .3 Couplings shall be Victaulic Co. of Canada Ltd., ULC and FM approved grooved end pipe couplings to CSA B242-M1980, consisting of housings, gaskets, nuts and bolts. Housings shall be cast malleable (ASTM A-47) or ductile (ASTM A-536) iron cast in two (2) or more parts and secured together by heat treated carbon steel bolts and nuts conforming to ASTM A183. Gaskets shall be "EPDM" mechanical grooved coupling design pressure responsive, elastomer, gaskets, and colour code green, suitable in all respects for the application.
- .4 Couplings for standpipe or sprinkler system with pressure less than 175 psi (1200 kPa) shall be style 005 "FIRELOK", other couplings shall be style 07 "ZERO-FLEX" with EPDM gaskets.
- .5 Couplings for piping risers, mains, and in Equipment Rooms shall be Style 07 "ZERO-FLEX" type with Grade "E" EPDM gaskets for water services suitable for temperatures -30°F (-34°C) to 230°F (110°C).
- .6 Fittings shall be malleable or ductile iron grooved end design fittings to accept grooved mechanical couplings without field preparation. Unless otherwise noted in succeeding Sections of this Division, Victaulic "FIT" tee, elbow, and similar fittings **are not** to be used.
- .7 Acceptable manufacturers are Victaulic Co. of Canada and Gruvlok Corp.

2.9 PLASTIC PIPE, FITTINGS AND JOINTS

- .1 IPEX Inc., "BDS", or equal rigid PVC sewer pipe and fittings with solvent weld joints to CSA B182.1.
- .2 IPEX Inc., "Ultra- Rib", or equal rigid PVC sewer pipe and fittings with gasketed joints, Certified to CAN/CSA-B182.4-92 and to ASTM F794. Joints shall withstand 345 kPa hydrostatic pressures.
- .3 IPEX Inc., "BLUE BRUTE" Class 150 "Ring-Tite" rigid PVC pipe, and fittings certified to CAN/CSA-B137.2-M90 and CAN/CSA-B137.2-M89 respectively and FM approved.

2.10 PIPING UNIONS

- .1 Dart Union Co. of Canada Ltd., or equal malleable iron, ground joint, brass to iron or bronze to bronze seat screwed unions and union elbows with a minimum pressure rating of 250 psi (1725 kPa) steam at 500°F (260°C).
- .2 Malleable iron, ground joint, factory tested "RAILROAD" type screwed unions and union elbows with a brass to iron seat and a minimum pressure rating of 600 psi (4140 kPa) WOG (non-shock).

2.11 DIELECTRIC PIPE FITTINGS

- .1 Victaulic Co. of Canada Ltd., style 47 "Clearflow" dielectric pipe fittings to ASTM F-492-77, suitable for maximum temperatures of 225°F (107°C) and pressures of 300 psi (2070 kPa), and each complete with electro-zinc plated casing, NSF/FDA listed, chemically inert dielectric thermoplastic lining, ends to suit piping and overall fitting length matched to pipe size for maximum galvanic corrosion protection.
 - .1 Acceptable manufacturers are Victaulic Co. of Canada Ltd. and Gruvlok Corporation.
- .2 Watts Regulator of Canada Ltd. Series 3000 dielectric pipe unions suitable for use with steam to 300°F (149°C) at 50 psi (345 kPa), to ANSI B16.39 and threaded to ANSI B2.1.

2.12 PIPING DRAIN VALVES

- .1 Minimum 300 psi (2070 kPa) water rated, 3/4" (19 mm) diameter straight pattern bronze globe valve or a bronze ball valve, each complete with a threaded outlet suitable for coupling connection of 3/4" (19 mm) diameter garden hose, and a cap and chain.
- .2 Acceptable manufacturers are Jenkins Valves, Crane Canada Inc., KITZ, Newman-Hattersley, Apollo, Toyo and Nibco.

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2.13 PIPING AIR VENTS

- .1 Flair Hydraulics (Johnson Paterson), No. 16 or equal, 1/8" (3.2 mm) diameter manual valve with a wooden handle.

2.14 GATE, GLOBE AND SWING TYPE CHECK VALVES

- .1 Valves scheduled hereinafter are Jenkins Valves.
- .2 All valves shall be, to the extent possible, the product of a single manufacturer and shall have the manufacturer's name, pressure rating and size clearly marked on the body.
- .3 Valves 2" (50 mm) and smaller shall be constructed of bronze. Valves 2-1/2" (65 mm) and larger shall have iron bodies and bronze mountings.
- .4 The bronze in bodies and bonnets of all bronze valves shall conform to ASTM B-62 for valves rated up to 150 psi (1035 kPa) steam pressure, and ASTM B61 for valves rated at 200 psi (1380 kPa) and 300 psi (2070 kPa) steam pressure.
- .5 Bodies and bonnets of iron body valves shall conform to ASTM A-126, Class B.
- .6 Generally, valves 3" (75 mm) and smaller shall be complete with screwed ends, except for bronze valves installed in copper piping which shall be complete with soldering ends. Generally, valves larger than 3" (75 mm) shall be complete with flanged ends and proper flanged adapters to copper shall be provided where flanged valves are installed in copper piping.
- .7 Valves for installation in chilled water, condenser water, domestic water, heating system water and glycol solution piping with pressures less than 150 psi (1035 kPa), unless otherwise noted, shall conform to the following schedule:

VALVE TYPE	PRESSURE RATING WOG	ENDS	JENKINS FIG. NO.
BRONZE GATE	300 psi (2070 kPa)	SOLDERING	813
BRONZE GATE	200 psi (1380 kPa)	SCREWED	810
BRONZE GLOBE	300 psi (2070 kPa)	SCREWED	106-B
BRONZE GLOBE	400 psi (2760 kPa)	SCREWED	2050
BRONZE CHECK	250 psi (1725 kPa)	SCREWED	4092
BRONZE CHECK	300 psi (2070 kPa)	SOLDERING	4093
IRON GATE	200 psi (1380 kPa)	FLANGED	454
IRON CHECK	200 psi (1380 kPa)	FLANGED	587

- .8 Wheels on bronze gate and globe valves, unless otherwise noted, shall be non-heating malleable iron finished in baked enamel. Wheels on iron body valves shall be cast iron wheels suitable for easy valve operation.
- .9 Acceptable manufacturers are Jenkins Valves, Crane Canada Inc., KITZ, Milwaukee Valve Company, Newman- Hattersley Ltd., Bonney Forge, Toyo, RP&C (Conbraco Industries) and Nibco.

2.15 BALL VALVES

- .1 Unless otherwise noted, full bore, solid ball, bronze ball valves as follows:
 - .1 for copper water piping, Jenkins Valves Fig. No. 202J 600 psi (4140 kPa) W.O.G. with PTFE seats and soldering ends;

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- .2 for natural gas and LP gas piping, with maximum 1/2 psig (3.45 kPag) pressure Neo Valves No. 460 CGA approved, with PTEF seats and screwed ends.
- .3 for natural gas and LP gas piping, with maximum 125 psig (862 kPag) pressure, Neo Valves No. 525 CGA approved, full bore with chrome plated body, PTFE seats, screwed ends and suitable for -40 to 150°F (-40 to 65°C) Temperature range.
- .2 Ball valves in insulated piping shall be complete with extended handles to clear insulation.
- .3 Acceptable manufacturers for valves used in services other than natural gas are Jenkins Valves, Crane Canada Inc., Nibco Inc., Kitz, Milwaukee Valve Company, Newman-Hattersley, Toyo, Apollo, Victaulic Co. of Canada Ltd. and Watts Regulator of Canada Ltd.
- .4 Acceptable manufacturers of valves used in natural gas service are Neo Metals, KITZ, Toyo and Newman-Hattersley.

2.16 BUTTERFLY VALVES

- .1 DeZurik of Canada Ltd., Fig. No. BGS-L1, lug body type, 175 psi (1200 kPa) rated, resilient seated butterfly valves, each complete with a stainless steel shaft, corrosion resistant disc, a seat suitable in all respects for the application, and a flange arrangement which maintains tight shut-off and the valve in position when one side of the connecting piping is removed.
- .2 Butterfly valves up to and including 6" (150 mm) diameter shall be equipped with "ON/OFF" lever handles. Butterfly valves 8" (200 mm) and larger shall be equipped with wheels and gear operators.
- .3 Acceptable manufacturers are DeZurik of Canada Ltd., Keystone Ltd., Watts Industries, Jenkins Valves, Crane Canada Inc., Newman-Hattersley, Centerline, Apollo, Mueller, KITZ, Toyo, WKM and Demco

2.17 WAFER TYPE CHECK VALVES

- .1 Gulf Valve Co., "WAFER CHECK", threaded lug type, ANSI Series 150, 285 psi (1965 kPa) rated at 100°F (38°C), non-slam wafer check valves, each complete with a carbon steel body, stainless steel discs, a shaft, springs, disc stop and thrust bearings constructed of type 316 stainless steel, and seat materials to suit the application. The inside diameter of the valve must be equal the inside diameter of the connecting pipe.
- .2 Acceptable manufacturers are Gulf Valve Co., Checkrite, Mission (Duo-Chek II), and Victaulic Co. of Canada Ltd. (No. 715 dual disc).

2.18 LUBRICATED PLUG VALVES

- .1 Neo Metals Ltd., No. AR40034 screwed and or No. AR40114 flanged or equal CGA approved, cast iron, 150 psi (1035 kPa) rated lubricated plug valves, each complete with a lubricant screw, a lubricant valve, lubricant receptacle, a loose operator, and a plug with lubricant grooves circling the passage in both the open and closed position to ensure a positive seal.
- .2 Acceptable manufacturers are Neo Metals and Newman Hattersley.

2.19 PIPING STRAINERS

- .1 Spirax Sarco Ltd., cast iron wye shaped strainers, type IF-125 screwed and/or type AF-250 flanged, each suitable for working pressures to 130 psi (890 kPa), and complete with a removable type 304 stainless steel strainer screen with perforations sized to suit the application.
- .2 Spirax Sarco Ltd., Type IT, screwed and/or type AF-250 flanged cast iron strainers, generally as specified above but suitable for working pressures in excess of 130 psi (890 kPa).
- .3 Strainers 2" (50 mm) diameter and larger shall be complete with blowdown pipe connection tapings.
- .4 Acceptable manufacturers are Spirax Sarco Ltd., Jenkins Valves, Crane Canada Inc., Nibco Inc., KITZ, Milwaukee Valve Company, Newman-Hattersley and Watts Industries.

2.20 PIPING HANGERS AND SUPPORTS

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- .1 For horizontal piping above ground - adjustable wrought steel clevis hangers and/or adjustable malleable iron swivel ring hangers and/or steel offset pipe hooks and/or heavy steel pipe clips as required.
- .2 For 2" (50 mm) diameter and larger horizontal piping above ground conveying a medium with an operating temperature 100°F (37.7°C) and greater - adjustable roller hangers.
- .3 For vertical piping - wrought steel riser clamps and/or heavy steel pipe clips and/or 1/2" (12 mm) thick welded black structural steel plate anchor assemblies.
- .4 Spring hangers for portions of piping connected to motorized and/or vibration isolated equipment - spring hangers as specified in this Section in the article entitled "VIBRATION ISOLATION MATERIALS".
- .5 For groups of pipe having the same slope - black structural steel angle wall brackets and/or black steel channels or angles of proper dimension supported by hanger rods, and/or Unistrut Ltd. or equal support assemblies.
- .6 Hanger rods shall be black steel, round, threaded, to ASTM A36, sized to suit the loading but in any case minimum 3/8" (9.5 mm) diameter, complete with captive machine nuts with washers at hangers.
- .7 Acceptable hanger and support manufacturers are Anvil, Myatt, Hunt Manufacturing and Apex.

2.21 ACCESS DOORS

- .1 Acudor Acorn Limited, minimum No. 14 USS gauge (2.0 mm thick) prime coat painted steel flush access doors, each complete with a heavy frame and anchor, heavy-duty rust-resistant concealed hinges, a positive locking screwdriver lock, and mounting and finishing features to suit the particular construction in which it is to be installed.
- .2 Access door sizes shall suit the concealed work for which they are supplied, and wherever possible they shall be of a standard size for all applications.
- .3 Access doors in fire rated construction shall be ULC listed and labelled and of a rating to maintain the fire separation integrity.
- .4 Where access doors are located in surfaces where special finishes are required, they shall be of a recessed door type capable of accepting the finish in which they are to be installed so as to maintain the final building surface appearance throughout.
- .5 Acceptable manufacturers are Acudor Acorn Limited and The Williams Brothers Corporation.

2.22 PRESSURE GAUGES AND THERMOMETERS

- .1 H.O. Trerice Co., pressure gauges, thermometers and accessories as follows:
 - .1 pressure gauges - No. 600 Series to ANSI Standard B40, Grade A, fully adjustable, 4-1/2" (115 mm) diameter, complete with a cast aluminum casing, clear glass window, white dual scale (psi and kPa) dial, red tipped black pointer, bronze bushed movement, pressure snubber, and "T" handle gauge cock;
 - .2 thermometers - No. BX93403-1/2 to CAN/CGSB Standard 14.4-M88 fully adjustable angle, 9" (225 mm) white dual scale (degrees F. and degrees C.), complete with cast aluminum case, clear acrylic window lens, front red reading mercury tubing, separable brass socket, brass piping well, and extension necks where used in insulated pipe or equipment.
- .2 Thermometers in ductwork shall be equipped with Trerice No. 065-0015 or equal mounting flanges.
- .3 Pressure gauge and thermometer scale ranges shall be such that the working temperature or pressure of the system for which the instrument is provided is at approximately the mid-point of the instrument scale.
- .4 Pressure gauges in sprinkler fire protection piping shall be Winters, Model Q1721 or equal ULC listed pressure gauges.

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- .5 Instruments and associated accessories shall be registered with the Technical Standards and Safety Authority (TSSA) and shall be complete with CRN No. where possible the CRN No. shall be permanently fixed to the component.
- .6 Acceptable manufacturers of pressure gauges (other than fire protection) and thermometers and related accessories are H.O. Trerice Co. Ltd., Winters, Ashcroft (Dresser Canada Inc.) and Weksler.

2.23 EQUIPMENT DRIVE GUARDS AND ACCESSORIES

- .1 Guards for V-belt drives shall be removable four (4) sided, fully enclosed galvanized sheet steel guards to OSHA Standards, complete with 4-1/2" (112 mm) diameter tachometer openings covered with removable perforated galvanized plates at each shaft location.
- .2 Guards for flexible couplings shall be removable "U" shaped galvanized steel guards with a 0.0905" (2.3 mm) thick frame and expanded mesh face.
- .3 Guards for exposed fan blades, unless otherwise noted, shall be removable 3/4" (19 mm) galvanized steel wire mesh with galvanized steel frames.

2.24 ELECTRIC MOTORS

- .1 Motors shall conform to EEMAC Standard MG1, applicable IEEE Standards, and applicable CSA Standards unless otherwise noted.
- .2 All motors located outside the building, and inside the building in areas exposed to the weather or in sprinklered areas shall be totally enclosed fan cooled type unless otherwise noted, each with a service factor of 1.15 at 104°F (40°C) ambient temperature for all ratings.
- .3 All other motors shall be open drip-proof type unless otherwise noted.
- .4 Vertically mounted and submersible motors shall be purposely designed for mounting in this attitude.
- .5 Unless otherwise noted, motors less than 1/2 HP (0.4 KW) size shall be single phase, 115 volt, 60 cycle, A.C. condenser type.
- .6 Unless otherwise noted, motors 1/2 HP (0.4 KW) size and larger shall be 3 phase, 60 cycle, 1750 RPM, EEMAC design "A", "B" or "C" for normal or high starting torque as required by the application.
- .7 Motors 1 HP (.746 kW) and larger shall be T-Frame, A.C., 3 phase heavy duty service and equal to or exceeding the Energy Policy Act of 1993 and Table 10.2 of ASHRAE 90.1-1999 as tested to either CSA 390 M 1985, or IEEE 112B, and be approved under the Canadian Electrical Safety Code.
- .8 Each motor shall be suitable for direct coupling or V-belt drive as required.
- .9 The frame of each 3-phase motor shall be constructed of corrosion-resistant cast iron with integrally cast feet except for smaller drip-proof motors which may have a rolled steel frame and welded feet. End brackets shall also be constructed of cast iron with precision machined bearing fits. The stator core assembly of each motor shall consist of stacked laminations of specially selected electrical grade steel. Insulation materials shall be non-hygroscopic and meet or exceed Class "B" definition. Motor temperature ratings shall not exceed Class "B" temperature limits when the motor is operated at full load in a maximum ambient temperature of 104°F (40°C).
- .10 Motors used with pulse width modulating variable speed drives shall be inverter duty motors with Class "H" windings and Class "F" insulation.
- .11 Rotor windings shall be die-cast aluminum, surface treated for minimum rotor losses. Each shaft shall be dynamically balanced.
- .12 Bearings, unless otherwise noted, shall be grease lubricated with readily accessible plugs or fittings to allow "in-service" regreasing. Bearings shall be ball type, double shielded, single row width, made from vacuum degassed steel, except for large belted frames where roller bearings are required.
- .13 Motor(s) for 2-speed cooling towers shall be as above with 2-speed single winding motors.
- .14 The motors for 2-speed fans shall be as above but 2-speed double winding motors.

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- .15 Explosion proof motors shall be flame proof type with an explosion proof box and in accordance with CSA C22.2 No. 145-M1986 and Code requirements.
- .16 Motors 30 HP (22.4 kW) and larger shall be complete with or approved equal manual reset resistor type sensing elements with positive temperature co-efficients and tripping relays to disengage the motor starter when an abnormal temperature is sensed within the motor. Turn over the starter tripping relays to the electrical trade for integration into the respective motor starter.
- .17 Motors 150 HP (112 kW) and larger controlled by reduced voltage, wye-delta" starters shall be complete with six (6) leads for connection to the respective motor starter.
- .18 Refer to starter schedule drawing(s) for motor voltage and phase requirements.
- .19 Acceptable manufacturers for motors 1 Hp. (0.75 kW) and larger are US Motors, TECO (Westinghouse Canada Inc.), WEG (V.J. Pamensky), Lincoln Electric Co. Ltd., and Toshiba International Corp.
- .20 Acceptable manufacturers for motors less than 1 Hp. (0.75 kW) are Canadian General Electric Co. Ltd., Emerson Electric Canada Ltd., Baldor Electric Co. and LEESON Electric (Canada) Ltd.

2.25 MOTOR STARTERS AND ACCESSORIES

- .1 Allen-Bradley Canada Ltd., NEMA type, motor starters in accordance with the following specification and the motor starter schedule(s), unless otherwise noted.
- .2 Unless otherwise noted, starters for single phase motors shall be Bulletin 600, 115 volt, thermal overload protected manual starting switches with a neon pilot light, a surface or flush mounting EEMAC enclosure to suit the application, and, where automatic operation is required, a separate "hand-off-automatic" selector switch in an enclosure to match the starter enclosure.
- .3 Unless otherwise noted, starters for 3 phase motors less than 50 Hp (37.3 kW), shall be combination "quick-make" and "quick-break" fused disconnects and full voltage, non-reversing magnetic starters for across-the-line service. Full protection of each phase shall be included in the starters by means of one (1) overload relay per phase per starter. Starters shall be equipped with "hand-off-automatic" switches, pilot lights, control transformers, auxiliary contacts, and other accessories as per the starter schedule(s).
- .4 Unless otherwise noted, starters for 3 phase motors 50 Hp (37.3 kW) up to 150 Hp (112 kW), shall be reduced voltage, non-reversing, autotransformer type starters. Full protection of each phase shall be included in the starters by means of one (1) overload relay per phase per starter. Starters shall be equipped with "hand-off-automatic" switches, pilot lights, control transformers, auxiliary contacts, and other accessories as per the starter schedule(s).
- .5 Unless otherwise noted, starters for 3-phase motors 150 HP (112 kW) or larger, shall be reduced voltage, non-reversing, closed transition "wye-delta" starters. Full protection of each phase shall be included in the starters by means of one (1) overload relay per phase per starter. Starters shall be equipped with "hand-off-automatic" switches, pilot lights, control transformers, auxiliary contacts and other accessories as per the starter schedule(s).
- .6 Enclosures for starters located in sprinklered areas shall be EEMAC 2. All other loose starter enclosures shall be EEMAC 1 unless otherwise noted.
- .7 Motor control centres shall be Allen-Bradley of Canada Ltd. Bulletin 2100 "CENTRELINE", 7-1/2' (2.28 m) high, multi-unit control centres, arranged as per the starter schedule. Each control centre shall be an EEMAC Class 1, type "B" factory assembled, dead front, floor mounted control centre with tin plated copper bus and an EEMAC type 1 or 2 enclosure as for loose starters specified above. Starters installed in control centres shall be as specified above and complete with load wiring and/or control wiring terminal boards. Motor control centres shall be complete with all required provisions for electric "line" and "load" side power connections.

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- .8 Disconnects for motor control centres shall be heavy-duty, CSA approved, front operated with a handle suitable for padlocking in the "OFF" position and arranged so that the enclosure cover cannot be opened while the handle is in the "ON" position. Fusible units shall be complete with fuse clips for HRC fuses, unless otherwise noted. Enclosures shall be EEMAC type 1 or 2 as specified for loose starters above. The ampere rating, number of poles, and fuse requirements shall be as indicated on the starter schedule(s).
- .9 The motor starter(s) for 2-speed fan(s) shall be 2-speed type suitable for use with a two-speed double winding motor and complete with a forty-five (45) second time delay to allow the fan to coast down to low speed before it is operated at low speed.
- .10 Unless otherwise indicated, fuses shall be Form I, Class "J", HRC fuses for constant running equipment and Form II, Class "C", HRC fuses for motorized equipment that cycle "ON" and "OFF".
- .11 Identification nameplates shall be engraved black-white-black Lamacoid, suitably sized, complete with bevelled edges and stainless steel securing screws. Engraving must be approved by the Consultant.
- .12 Each starter you supply must be capable of starting the particular motor under the imposed load.
- .13 Acceptable motor starter manufacturers are Allen-Bradley Canada Ltd., Furnas Electric, Square D Co. Ltd., Cutler-Hammer Canada Ltd., Klockner-Moeller Ltd., Canadian Controllers Ltd., and Siemens.
- .14 Acceptable fuse manufacturers are Brush, Buss and Gould.

2.26 VIBRATION ISOLATION MATERIALS

- .1 BVA Systems Ltd., vibration isolation materials as per the drawing schedule and as specified below.
- .2 All springs shall be stable, colour coded, selected to operate at no greater than 2/3 solid load, and with spring diameters in accordance with the manufacturer's recommendations to suit the static deflection and maximum equipment load.
- .3 Spring mounts shall be complete with levelling devices, 1/4" (6 mm) thick, ribbed neoprene sound pads and zinc plated hardware.
- .4 Type "SH" spring hangers shall be complete with a painted steel housing, an acoustic washer or elastomeric element, a steel washer, retaining cups and selected springs. All hangers must be capable of tolerating a vertical misalignment of 15° (from hangers axis) without loss of stability.
- .5 Type "NSN" neoprene-steel-neoprene pads shall consist of two (2) layers of 1/2" (12 mm) thick type "N" waffle pads bonded to each side of a 1/16" (1.6 mm) thick steel plate. All holes shall be sleeved and complete with isolation washers.
- .6 Spring mounts for equipment located outside the building shall be factory weather-proofed by means of two (2) coats of rust resisting paint, two (2) coats of neoprene and complete with neoprene pads in lieu of standard rubber pads.
- .7 Acceptable manufacturers are BVA Systems Ltd., Vibron, Masdom Corp. (1979) Ltd. and J.P. Environmental Products Inc.

2.27 VARIABLE FREQUENCY DRIVES

- .1 Danfoss Graham VLT 6000 series, variable frequency drives (VFD's), each CSA approved and suitable for installation on the intended motors.
- .2 The drives shall be tested to FCC Rules and Regulations Part 15 regarding radio frequency interference and carry the FCC label of compliance for class A digital devices. Line noise shall not be greater than 3% harmonic distortion and no more than 16,400 volt-microsecond communication notch area, in accordance with IEEE Standard 519-1981 for special applications.
- .3 VFD shall be housed in a metal NEMA 1 enclosure. The VFD's UL listing shall allow mounting in plenum or other air handling compartments. If a NEMA 12 enclosure is required for the plenum rating, the manufacturer must supply a NEMA 12 rated VFD.

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- .4 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 eliminate the need for motor derating.
- .5 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 draw more than full load current during full load and full speed operation.
- .6 The VFD shall include an input full-wave bridge rectifier and maintain a fundamental power factor near unity regardless of speed or load.
- .7 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. Assembly of the option panels by a third-party panel shop is not acceptable. The appropriate CSA or C-UL stickers shall be applied to both the VFD and option panel, in the case where these are not contained in one panel. Both VFD and option panel shall be manufactured in ISO 9001 certified facilities.
- .8 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 3% impedance line reactor.
- .9 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.
- .10 The VFD shall be able to provide full torque at any selected frequency from 28 Hz to base speed to allow driving direct drive fans without derating.
- .11 An automatic energy optimization selection feature shall be provided standard in the VFD. This feature shall automatically and continually monitor the motor's speed and load and adjust the applied voltage to maximize energy savings and provide up to an additional 3% to 10% energy savings.
- .12 Input and output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD. Switching rate may be up to 1 time per minute on the input and unlimited on the output.
- .13 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 de-couple the motor from the load to run the test.
- .14 Galvanic and/or optical isolation shall be provided between the VFD'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. VFDs not including either galvanic or optical isolation on both analog I/O and discrete I/O shall include additional isolation modules.
- .15 VFD power components to be designed for 575VAC. Components designed for 480VAC not acceptable.
- .16 VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD efficiencies while reducing motor noise.
- .17 Protective Features:
 - .1 A minimum of Class 20 I²t electronic motor overload protection for single motor applications and thermal-mechanical overloads for multiple motor applications shall be provided.

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- .2 Protection against input transients, loss of AC line phase, output short circuit, output ground fault, overvoltage, undervoltage, VFD 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.
 - .4 The VFD shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation build up in the stator.
 - .5 To prevent breakdown of the motor winding insulation, the VFD shall be designed to comply with IEC Part 34-17. Motors shall have inverter rated insulation (1600V).
 - .6 VFD shall include a "signal loss detection" circuit to sense the loss of an analog input signal such as 4 to 20 mA or 2 to 10 V DC, and shall be programmable to react as desired in such an instance.
 - .7 VFD shall function normally when the keypad is removed while the VFD is running and continue to follow remote commands. No warnings or alarms shall be issued as a result of removing the keypad.
 - .8 VFD shall catch a rotating motor operating forward or reverse up to full speed.
 - .9 VFD shall be rated for 100,000 amp interrupting capacity (AIC).
 - .10 VFD 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.
 - .11 VFD shall continue to operate without faulting until input voltage reaches 300 V AC on 208/230 volt VFDs, 539 V AC on 460 volt VFDs, and 701V AC on 575 volt VFDs.
- .18 Interface Features:
- .1 Hand/Start, Off/Stop and Auto/Start selector switches shall be provided to start and stop the VFD and determine the speed reference.
 - .2 The VFD shall be able to be programmed to provide a 24 V DC output signal to indicate that the VFD is in Auto/Remote mode.
 - .3 The VFD shall provide 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 The keypads for all sizes of VFDs shall be identical and interchangeable.
 - .6 To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFD's keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters.
 - .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 VFD when the keypad is removed.
 - .10 A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD eliminating the need for macros.

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- .11 The VFD shall include a standard RS-485 communications port and capabilities to be connected at a future date to a Johnson Controls N2, Siemens FLN, or Lonworks. The connection shall be software selectable by the user.
- .12 As a minimum, the following points shall be controlled and/or accessible: VFD Start/Stop, Speed reference, Fault diagnostics, and Meter points as follows; Motor power in HP, Motor power in kW, Motor kW-hr, Motor current, Motor voltage, Hours run, Feedback signal #1, Feedback signal #2, DC link voltage, heatsink temperature, thermal load on motor, and Thermal load on VFD.
- .13 Four additional Form C 230 volt programmable relays shall be available for factory or field installation within the VFD.
- .14 Two set-point control interfaces (PID control) shall be standard in the unit. VFD shall be able to look at two feedback signals, compare with two set-points and make various process control decisions.
- .15 Floating point control interface shall be provided to increase/decrease speed in response to contact closures.
- .16 Four simultaneous displays shall be available. They shall include frequency or speed, run time, output amps and output power. VFDs unable to show these four displays simultaneously shall provide panel meters.
- .17 Sleep mode shall be provided to automatically stop the VFD when its speed drops below set "sleep" level for a specified time. The VFD shall automatically restart when the speed command exceeds the set "wake" level.
- .18 The sleep mode shall be functional in both follower mode and PID mode.
- .19 Run permissive circuit shall be provided to accept a "system ready" signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD 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 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, DC Bus Voltage, VFD Temperature in degrees, and Motor Speed in engineering units per application (in GPM, CFM, etc.). VFD will read out the selected engineering unit either in a linear, square or cubed relationship to output frequency as appropriate to the unit chosen.
- .21 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.
- .22 VFD shall be able to be programmed to sense the loss of load and signal a no load/broken belt warning or fault.
- .23 If the temperature of the VFD's heat sink rises to 80°C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. If the temperature of the heat sink continues to rise the VFD shall automatically reduce its output frequency to the motor. As the VFD's heat sink temperature returns to normal, the VFD shall automatically increase the output frequency to the motor and return the carrier frequency to its normal switching speed.
- .24 The VFD shall have temperature controlled cooling fans for quiet operation and minimized losses.
- .25 The VFD shall store in memory the last 10 faults and related operational data.
- .26 Eight programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.

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- .27 Two programmable relay outputs, one Form C 240 V AC, one Form A 30 V AC, shall be provided for remote indication of VFD status.
 - .28 Three programmable analog inputs shall be provided and shall accept a direct-or-reverse acting signal. Analog reference inputs accepted shall include two voltages (0 to 10 V DC, 2 to 10 V DC) and one current (0 to 20 mA, 4 to 20 mA) input.
 - .29 Two programmable 0 to 20 mA analog outputs shall be provided for indication of VFD status. These outputs shall be programmable for output speed, frequency, current and power. They shall also be programmable to provide a selected 24 V DC status indication.
 - .30 Under fire mode conditions, the VFD shall be able to be programmed to automatically default to a preset speed.
- .19 Adjustments:
- .1 VFD shall have an adjustable carrier frequency in steps of not less than 0.1 kHz to allow tuning the VFD to the 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 shall be automatically contoured to ensure no-trip acceleration and deceleration.
 - .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: under-voltage, over-voltage, current limit and inverter overload.
 - .6 The number of restart attempts shall be selectable from 0 through 20 or infinitely 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.

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- .20 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.
- .21 Quality Assurance:
 - .1 The complete VFD shall be tested by the manufacturer. The VFD shall operate a dynamometer at full load and speed and shall be cycled during the test.
 - .2 All optional features shall be functionally tested at the factory for proper operation.
- .22 Submittals:
 - .1 Submit manufacturer's performance data including dimensional drawings, power circuit diagrams, installation and maintenance manuals, warranty description, VFD's FLA rating, certification agency file numbers and catalog information.
 - .2 Harmonic filtering. The manufacturer or their representative, shall, with the aid of the manufacturer'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.
- .23 All components including drive input and output power conditioning equipment disconnect switch and fusing shall be mounted in a single enclosure. Separate enclosure was housing power conditioning equipment and disconnect are not acceptable.
- .24 All drives shall be pretested and cycled with a motor load at an elevated ambient temperature.
- .25 All drives shall be warranted by the manufacturer for 36 months from the date of shipment, including any travel costs or living expenses necessary to repair in warranty equipment.
- .26 The manufacturer shall also warranty the driven motor from motor insulation breakdown for 36 months for the same period as the drive warranty.
- .27 The manufacturer shall provide start-up assistance in the form of a factory-trained service technician to adjust and set the drive parameters and check all incoming wiring and control.
- .28 Drives employing pulse width modulating technology shall be supplied with output load reactors and L.C. filters.
- .29 Acceptable manufacturers are Graham-Danfoss, Allen-Bradley, Hitachi, Siemens Electric, Toshiba, AC-Tech, Cutler Hammer and Asea, Brown Boveri.

2.28 IDENTIFICATION NAMEPLATES

- .1 Laminated plastic (lamacoid) black-white-black with bevelled edges, stainless steel screws, and proper identification engraving. Each nameplate shall be sized to suit the equipment for which it is provided, and the required wording.
- .2 Minimum size is 1" high x 2" long.

PART 3 - EXECUTION

3.1 GENERAL PIPING AND DUCTWORK INSTALLATION REQUIREMENTS

- .1 Unless otherwise noted, locate and arrange horizontal pipes and ducts above or at the ceiling on floors on which they are shown, arranged so that under consideration of all other work in the area, the maximum ceiling height and/or usable space is maintained.
- .2 Unless otherwise noted, install all work concealed in finished spaces, and concealed to the degree possible in partially finished and unfinished spaces. Refer to and examine the Architectural drawings and room finish schedules to determine finished, partially finished, and unfinished areas.
- .3 Install all pipes and ducts parallel to building lines.
- .4 Neatly group and arrange all exposed work.
- .5 Do not make pipe joints in wall or slabs.
- .6 Locate all valves, dampers and any other equipment which will or may need maintenance or repairs and which is installed in accessible construction so as to be easily accessible from access doors. Where valves, dampers and similar piping or ductwork accessories occur in vertical piping in shafts, pipe spaces or partitions, locate the accessories at the floor level.
- .7 Make all connections between pipes of different materials using proper approved adapters. Provide cast brass dielectric type adapters at connections between steel and copper pipe. Do not make pipe joints in walls or slabs.
- .8 Piping in bath and shower areas shall be non-ferrous in accordance with the requirements specified in applicable section of the Specification.
- .9 Compensate for pipe expansion by the use of swing joints or expansion loops unless otherwise noted. Generally, expansion facilities are indicated on the drawings but exact expansion compensation facilities shall suit the piping as installed. Submit exact detail drawings of expansion compensation facilities in shop drawing form for review.
- .10 Provide pipe guides for all piping where required to prevent any radial movement, and provide double guides at all type expansion compensators and/or loops.
- .11 Provide anchors to secure pipe work to the structure where shown and/or specified. Anchors shall be of a size and type to securely anchor the pipe at the point shown. Submit details of anchors in shop drawing form for review.
- .12 Provide a drain valve at the base of each piping riser conveying a liquid (except drainage piping), in drain connections to equipment, in low points of horizontal piping conveying a liquid (except drainage piping), and wherever else shown and/or specified.
- .13 Unless otherwise specified, provide a manual air vent at all high points of all water piping systems, at equipment connections, and wherever else shown and/or specified. Equip manual air vents with an air chamber consisting of a minimum 6" (150 mm) long length of the same type pipe as the piping in which the air vent is required, and with a diameter one (1) pipe size smaller.
- .14 Provide unions or flanges in piping at all connections to valves, strainers and similar piping system components which may need maintenance or repair, at all equipment connections, in long runs of piping at suitable regular intervals to permit removal of sections of piping, and wherever else indicated on the drawings.
- .15 Ensure that equipment and material manufacturer's installation recommendations and instructions are followed unless otherwise noted herein or on the drawings, and unless such instructions and recommendations contradict governing codes and regulations.
- .16 Carefully clean all ducts, pipe and fittings prior to installation. Temporarily cap or plug ends of pipe, ducts and equipment which are open and exposed during construction.

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- .17 Install piping and ductwork which shall be insulated such that they have sufficient clearance to permit insulation to be applied continuously and unbroken around the pipe or duct except at fire barriers, in which case the insulation will be terminated at each side of the fire barrier.
- .18 Wherever ductwork and piping cross building expansion joints, provide expansion facilities to permit free movement without imposing additional stress or loading upon the support system, and to prevent excessive movement at joints and connections.
- .19 Inspect surfaces and structure prepared by other trades before performing your work. Verify that surfaces or the structure to receive your work have no defects or discrepancies which could result in poor application or cause latent defects in installation and workmanship. Report defects in writing to the Consultant. Installation of your work will constitute acceptance of such surfaces as being satisfactory.
- .20 Ensure that exposed ferrous metal products, except ductwork and piping, have at least one (1) factory prime coat of alkyd metal primer, or paint such ferrous metal products with one (1) prime coat of alkyd metal primer on the job. Clean and wire brush ferrous metal products prior to application of prime coat.
- .21 For factory applied finishes, repaint or refinish surfaces damaged during shipment, erection or construction work. Quality of repair to finish shall be equal to finish provided by equipment manufacturer.

3.2 PIPE JOINT REQUIREMENTS

- .1 Ream all piping ends prior to making joints.
- .2 Properly cut threads in screwed steel piping and coat male threads, unless otherwise noted, with red lead, Teflon tape or paste, or an equivalent thread lubricant. After the pipe has been screwed into the fitting, valve, union, or piping accessory, not more than two (2) pipe threads shall remain exposed.
- .3 Site bevel steel pipe to be welded or supply mill bevelled pipe. Remove all scale and oxide from the bevels and leave same smooth and clean. Ensure that personnel doing welding work are CWB certified welders and qualified for the particular pressure application worked on, and that all tests required by governing authorities are carried out, including X-ray tests where required for certain applications.
- .4 Use Bonney Forge Ltd. or equal welding tees or welding outlet fittings for piping branches off mains, welded or socket type for pipes with welded fittings and threaded type for pipes with screwed fittings.
- .5 Make all flanged joints with Cranite Ltd. or equivalent gasket materials to suit the application, and suitable bolts and nuts. Bolts shall not be longer than the length necessary to screw the nut up flush to the end of the bolt.
- .6 Bolts used for flanged connections in all piping with a working pressure of 100 psi (690 kPa) and greater shall be ASTM A-193, Grade B-7, with heavy hexagon nuts to ASTM A-194, CL-2H.
- .7 Provide suitable washers between each bolt head and the flange and between each nut and the flange.
- .8 A random check of bolted flanged connections will be made by the Consultant to verify that flanged connections are properly mated with no shear force acting on bolts. Supply all labour to disconnect and reconnect the selected flanged joints as directed by the Consultant. If improperly mated joints are found, remove and reinstall the affected piping at your expense so that the flanges mate properly. If improperly mated joints are found, additional joints will be checked, and you will be responsible for the repair of any other improper joints discovered.
- .9 Unless otherwise specified, make all soldered joints in copper piping using flux suitable for and compatible with the type of solder being used. Clean the outside of the pipe end and the inside of the fitting, valve, or similar accessory prior to soldering.
- .10 Install type "MJ" mechanical joint fittings and couplings in accordance with the manufacturer's recommendations.

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- .11 If grooved end fittings and couplings are used, ensure that the proper gaskets are used and are fully compatible with the fluid conveyed, and that all valves and piping accessories are suitable. Grooves in Schedule 40 steel pipe shall be cut and/or rolled. Grooves in Schedule 30 "Lightwall" steel pipe and in copper pipe shall be rolled. Apply fitting manufacturer supplied lubricant to gaskets prior to slipping on to pipe. Make arrangements with the coupling and fitting manufacturer for shop and/or site instructions and demonstrations as required for pipe preparation and groove cutting and/or rolling machine operation, coupling installation, etc. Comply with manufacturer's latest published specifications, instructions and recommendations with respect to pipe, coupling and fitting preparation and installation, and support, anchoring and guiding of the grooved end piping system. For galvanized piping, touch-up damaged finish and exposed underlying surface (i.e. groove) with zinc rich paint.
- .12 Solvent weld PVC piping in accordance with manufacturer's recommendations and ASTM 2855. Solvent welds must be two (2) parts, consisting of priming and cementing stage. Primer and cement used must be compatible with the pipe material and approved by the pipe manufacturer. Use IPS Weld-on 719 cementing compound for cementing 8" (200 mm) diameter and larger piping. Ensure solvent (or cement) is evenly distributed around the joint and joined pipe and sockets are properly aligned prior to solvent or cement taking set.
- .13 Install PVC piping with gasketed joints in accordance with manufacturer's latest published specifications, instructions and recommendations with respect to pipe, coupling and fittings preparation and installation, and support anchoring and guiding of the piping system. Apply pipe and fitting manufacture supplied lubricant to gasket prior to mating components.

3.3 INSTALLATION OF PIPE SLEEVES

- .1 Where pipes pass through concrete and/or masonry floors, walls, the roof, and any other such construction, provides pipe sleeves.
- .2 Pipe sleeves in poured concrete slabs, unless otherwise noted, shall be minimum No. 24 USS gauge (0.635 mm thick) flanged galvanized steel or, where permitted by governing authorities, factory fabricated plastic sleeves.
- .3 Sleeves in concrete or masonry walls shall be Schedule 40 galvanized steel pipe.
- .4 Sleeves in waterproof slabs shall be lengths of Schedule 40 mild galvanized steel pipe in accordance with the detail. Provide waterproof sleeves in the following locations:
 - .1 In mechanical room floor slabs, except where on grade;
 - .2 In slabs over mechanical, fan, electrical and telephone equipment rooms or closets;
 - .3 In all floors equipped with waterproof membranes;
 - .4 In the roof.
- .5 Size sleeves, unless otherwise noted, to leave 1/2" (12 mm) clearance around the pipes, or where pipe is insulated, a 1/2" (12 mm) clearance around the pipe insulation.
- .6 Pack and seal the void between the pipe sleeves and the pipe or pipe insulation for the length of the sleeves as follows:
 - .1 pack sleeves in fire rated construction as specified hereinafter in the Article entitled "INSTALLATION OF FIRESTOPPING AND SMOKE SEAL MATERIALS";
 - .2 pack sleeves in non-fire rated interior construction with mineral wool and seal both ends of the sleeves with non-hardening silicone base caulking compound;
 - .3 in exterior sleeves with watertight "Link Seal" (Corrosion Service Company Ltd., Telephone No. 416-630-2600) mechanical seal assemblies installed between each sleeve and pipe;
 - .4 pack sleeves in exterior walls with lead wool or oakum and seal both ends of the sleeves water-tight with approved non-hardening silicone base caulking compound.

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- .7 Where sleeves are required in masonry work, accurately locate and mark the sleeve position, and turn the sleeves over to the trade performing the masonry work for installation.
- .8 Terminate sleeves for piping which will be exposed so that the sleeve is flush at both ends with the wall, partition or slab surface so that the sleeve may be completely covered by an escutcheon plate, except for sleeves in waterproof floors which are to extend 4" (100 mm) above the finished surface.
- .9 "Gang" type sleeving will be permitted only with the approval of the Consultant.
- .10 Where sleeves are provided for future piping, or where piping has been removed from existing sleeves, cap and seal both ends of the sleeved opening to the approval of the Consultant.

3.4 DUCT, DAMPER AND SIMILAR MATERIAL OPENINGS

- .1 Duct openings, air inlet and outlet openings, fire damper and similar openings will be provided in poured concrete work, masonry, drywall and other building surfaces by the trade responsible for the particular construction in which the opening is required.
- .2 Ensure that openings for fire dampers to 14" (350 mm) high are sized to suit the damper arrangement with the folding blade out of the air stream.

3.5 SLEEVE AND FORMED OPENING LOCATION DRAWINGS

- .1 Prepare and submit for review and forwarding to the concrete reinforcement detailer, drawings indicating all required sleeves, recesses and formed openings in poured concrete work. Such drawings shall be completely and accurately dimensioned and relate sleeve, recesses, and formed openings to suitable grid lines and elevation datum.
- .2 Begin to prepare such drawings immediately upon notification of acceptance of tender and award of contract.

3.6 INSTALLATION OF FIRESTOPPING AND SMOKE SEAL MATERIALS

- .1 Where mechanical work penetrates fire rated construction, provide ULC listed and labelled firestopping and smoke seal material installed in accordance with ULC certification and manufacturers published instructions to provide a temperature and flame rated seal not less than the fire resistance rating of the surrounding wall or floor assembly.
- .2 Inspect surfaces to be firestopped and sealed prior to installing work. Report unsuitable or unsatisfactory conditions to Consultant in writing. Failure to report same shall be deemed as acceptance of conditions and surfaces.
- .3 Installation of the Work shall be carried out by approved specialist firm, employing skilled tradesmen experienced in application of firestopping and smoke seals.
- .4 Note: that the information for insulated piping penetrating fire rated construction is specified in Section 15250 and is fire rated insulation with a vapour barrier jacket, ULC listed as a firestop component for use with ULC Firestop Systems.
- .5 At all fusible link damper locations in ductwork penetrating fire rated construction, seal the perimeter of the angle iron framing on both sides of the wall or slab with ULC listed and labelled sealant material to provide a positive smoke seal.

3.7 INSTALLATION OF PIPE ESCUTCHEON PLATES

- .1 Provide escutcheon plates suitably secured over all exposed piping passing through walls, floors, ceilings, partitions, furrings, and similar construction in finished areas.
- .2 Install the plates so that they are tight against the building surface concerned, and ensure that the plates completely cover pipe sleeves and/or openings, except where waterproof sleeves extend above floors.

3.8 INSTALLATION OF FASTENING AND SECURING HARDWARE

- .1 Provide fasteners, anchors, braces and supports required to maintain installations attached to the structure or to finished floors, walls and ceilings in a secure and rigid manner, capable of withstanding the dead loads, live loads, superimposed dead loads, and any vibration of the installed products.
- .2 Use fasteners compatible with structural requirements, finishes and types of products to be connected. Do not use materials subject to electrolytic action or corrosion where conditions are liable to cause such action.
- .3 Where hangers are suspended from concrete slabs, install inserts before concrete is placed using inserts designed for the specific purpose.
- .4 Where built-in inserts are inaccessible due to subsequent installation of ducts, pipes or other installations, use anchors appropriate to the load requirements, including safety factor.
- .5 Where fastener installations are suspect, conduct on-site tests of installed fasteners, employing an independent testing laboratory acceptable to the Consultant, using properly engineered and calibrated force measuring meters.
- .6 Where the floor, wall or ceiling construction is not suitable to support the loads, provide additional framing or special fasteners to ensure that the load is properly secured to the structure that is to support the products.
- .7 Provide reinforcing or connecting supports where required to distribute the loading to the structural components.
- .8 Do not use wood plugs and hammer impact fasteners. Anchors in floor topping fills are not acceptable. Secure anchors in floors to the structure.
- .9 Where a performance requirement is specified, submit engineering calculations and written verification signed by a registered professional engineer that the installation has been inspected and is structurally sound and in accordance with design requirements.
- .10 Fastenings which cause spalling or cracking of the structure or products to which anchorage is made are not acceptable.
- .11 Obtain the Consultant's consent before using explosive actuation fastening devices. If consent is obtained, comply with CSA A166-1975.
- .12 Space anchors within limits of load bearing or shears capacity and ensure they provide positive permanent anchorage.

3.9 INSTALLATION OF SHUT-OFF VALVES AND CHECK VALVES

- .1 Provide shut-off valves in piping connections to equipment, to isolate piping risers and other sections of systems as shown, and wherever else indicated on the drawings.
- .2 Provide a check valve in the discharge piping of every pump and in piping wherever else shown.
- .3 Shut-off valves in piping where a balancing or throttling effect is required such as inlet piping to water coils shall be globe type unless otherwise noted. All other shut-off valves shall be ball type to and including 2" (50 mm) diameter, butterfly type 2-1/2" (65 mm) diameter or larger, or, where required, gate type.
- .4 Ball valves shall not be used in piping conveying fluid below 60°F (15°C).
- .5 Shut-off valves in natural gas piping shall be lubricated plug types for piping larger than 2" (50 mm) and for piping 2" (50 mm) and smaller including branch piping connections to equipment, CGA approved ball type valves.
- .6 Do not use ball or butterfly valves to replace globe valves.

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- .7 Check valves shall be swing check type installed in horizontal piping, however, provide lug body type wafer check valves in vertical piping where space conditions do not permit the use of swing type check valves in horizontal piping.
- .8 Note that discharge accessories provided with vertical in-line circulating pumps specified in Section 15700 are complete with integral check valves.
- .9 Valve stems in horizontal piping shall be pitched upward.
- .10 Locate all shut-off valves in piping such that valve handles are positioned for easy operation. Wherever possible, install shut-off valves at uniform height.

3.10 INSTALLATION OF PIPING STRAINERS

- .1 Provide strainers in piping where shown on the drawings and wherever specified herein or on the drawings.
- .2 Equip strainers 2" (50 mm) diameter and larger with valved blowdown piping. Terminate blowdown piping over the nearest funnel and floor drain unless otherwise noted.
- .3 Locate all strainers so they are easily accessible for service.
- .4 Note that strainers are integral with inlet suction piping accessories specified in Section 15700 with vertical in-line pumps.

3.11 INSTALLATION OF PIPE HANGERS AND SUPPORTS

- .1 Provide all required pipe hangers and supports.
- .2 For insulated pipe, size the hanger or support to suit the insulated pipe and install the hanger or support on the outside of the insulation.
- .3 Support underground pipe, unless otherwise noted, on a well tamped bed of dry, natural, undisturbed earth free from rocks or protrusions of any kind.
- .4 Support underground service penetrating building exterior walls or foundations in accordance with the requirements of the detail.
- .5 Ensure that all bedding and supports for underground pipes are flat and true and that allowances are made for pipe hubs, couplings, or other protrusions so that no voids are left between the pipe and the bedding.
- .6 Hang and/or support horizontal pipe above ground by means of hangers and/or supports specified in PART 2 of this Section, spaced in accordance with the following schedule:

PIPE MATERIAL	SIZE	PIPE HANGER OR SUPPORT SPACING
Cast Iron	All	At every joint - Maximum 8'(2.4 m) Intervals
Steel	To 3/4" (19 mm)	6' (1.8 m) Intervals
	1" To 6" (25 mm To 150 mm)	8' (2.4 m) Intervals
	8" (200 mm) & Up	10' (3 m) Intervals
Copper	To 1" (25 mm)	6' (1.8 m) Intervals
	1-1/2" (38 mm) & Up	8' (2.4 m) Intervals
Plastic	All	In accordance with pipe

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PIPE MATERIAL	SIZE	PIPE HANGER OR SUPPORT SPACING
		manufacturer's recommendations

- .7 Unless otherwise specified support vertical pipes by means of supports specified in PART 2 of this Section at maximum 12' (3.6 m) intervals or at every floor, whichever is lesser.
- .8 Support vertical cast iron hub and spigot pattern piping at the hubs by means of a clamp bolted around the pipe and anchored to the floor or wall.
- .9 Support all vertical cast iron plain end pipe (mechanical joint type), as for hub and spigot pipe but secure the clamp around the pipe under a flange integral with the pipe for vertical support purposes, or provide a length of hub and spigot pipe to facilitate proper support.
- .10 Provide roller hangers or supports for all piping 2" (50 mm) diameter and larger and conveying a material 100°F (38°C) or greater where required to facilitate pipe movement due to expansion and contraction, and equip the piping with steel protection saddles at roller locations to protect the piping insulation.
- .11 Provide pipe covering shields, sized to suit insulated pipe, between insulated pipe and the pipe hanger or support for all piping not supported by roller hangers and/or supports.
- .12 Support bare copper tubing using specially made copper or plastic coated copper tubing hangers, or provide proper plastic inserts or tape to isolate ferrous hangers and supports from contact with the bare copper tubing.
- .13 Where pipes having the same slope are grouped and a common hanger or support is used, space the hanger or support to suit the spacing requirement of the smallest pipe in the group.
- .14 Where pipes change direction, either horizontally or vertically, provide a hanger or support on the horizontal pipe not more than 12" (300 mm) from the elbow. Where pipes drop from tee branches, support the tees in both directions not more than 2" (50 mm) on each side of the tee.
- .15 Provide all additional structural steel channels, angles and similar accessories required for support of pipes.
- .16 Do not use perforated band, wire, chain or solid ring hangers.
- .17 Do not pierce ductwork with hanger rods, and do not support piping from ductwork or duct support hardware.
- .18 Provide special padded hangers and/or riser clamps for acid proof glass drainage and vent piping. Support the pipe free of strain in a manner to permit limited movement, all in accordance with the pipe manufacturer's recommendations.

3.12 SUPPLY OF ACCESS DOORS

- .1 Supply access doors to give access to all valves, cleanouts, strainers, duct access doors, and other similar mechanical work which may need maintenance or repair but which is concealed in inaccessible construction, except as otherwise specified herein or on the drawings.
- .2 Locate access doors in walls and partitions to the Consultant's approval, and arrange mechanical work to suit. Arrange mechanical work in ceiling spaces to suit access door locations shown on the reviewed and approved Sepia prints of reflected ceiling plan drawing(s) submitted as per PART 1 of this Section.
- .3 Group piping and ductwork to ensure the minimum number of access doors is required. Access doors will be installed by the trades responsible for the particular type of construction in which the doors are required.

3.13 INSTALLATION OF PRESSURE GAUGES AND THERMOMETERS

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- .1 Provide pressure gauges with cocks in the following locations:
 - .1 in valved tubing across the suction, suction strainer (if applicable), and discharge piping of each circulating pump;
 - .2 in the supply and return piping connections to main coils;
 - .3 in condenser water supply and return piping connections to refrigeration machine(s);
 - .4 in chilled water supply and return piping connections to refrigeration machine(s);
 - .5 in the supply and return piping connections to hot water boilers, or in the supply and return piping headers;
 - .6 in the supply and return piping connections to water or glycol solution heat exchanger(s);
 - .7 in closed expansion tank(s);
 - .8 at the top most outlet in each standpipe fire protection system riser;
 - .9 wherever else shown and/or specified on the Drawings or in the Specification.
- .2 Provide an angle type or straight type (as required) thermometer in the following locations:
 - .1 in the supply and return piping connections to main coil(s);
 - .2 in condenser water supply and return piping connections to refrigeration machine(s);
 - .3 in chilled water supply and return piping connections to refrigeration machine(s);
 - .4 in supply and return piping to hot water boilers or in the supply and return headers;
 - .5 in supply and return piping connections to water or glycol solution heat exchanger(s);
 - .6 in supply and return piping connections to domestic hot water storage tank(s);
 - .7 in supply, return and exhaust ductwork;
 - .8 wherever else shown and/or specified herein or on the Drawings or in the Specification.
- .3 Locate and mount all instruments so they are easily readable.

3.14 INSTALLATION OF EQUIPMENT DRIVE GUARDS AND ACCESSORIES

- .1 Protect all exposed rotating parts such as belts drives, couplings, fly wheels, and fan wheels on all mechanical equipment with a guard. Alternatively, where belt guards cannot be installed, provide lockable doors with metal screens around all exposed rotating parts.
- .2 Secure guards to the equipment or equipment base but do not bridge sound or vibration isolation.
- .3 Where equipment oil level gauges, oil reservoirs, grease cups or grease gun fittings are integral with the equipment but are not easily accessible for service, extend to accessible locations.

3.15 SUPPLY OF MOTOR STARTERS AND ACCESSORIES

- .1 Unless otherwise noted, supply a motor starter for each item of motorized equipment which you provide.
- .2 Where three (3) phase starters are indicated and scheduled in motor control centre enclosures, supply the control centres complete with starters and bolt the assemblies to concrete housekeeping pads where shown.
- .3 Where package type equipment with integral starters, or equipment with starters integral in loose control panels supplied with the equipment (either by Division 15 or as part of the work of other Divisions) is fed from a motor control centre, provide a disconnect switch in the motor control centre in lieu of a starter. Refer to the starter schedule(s) for requirements.

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- .4 "Line" side power wiring to motor control centres and "load" side power wiring from control centres to equipment will be done as part of the electrical work of Division 16.
- .5 Unless otherwise noted or shown on the drawings, single phase starters will be mounted adjacent to the equipment they serve and connected complete as part of the electrical work of Division 16. Hand the starters to the electrical trade at the site at the proper time.
- .6 Motor starter interlocking will be done as part of the electrical work of Division 16 in accordance with requirements specified in this Division (15), and as outlined on the starter schedule(s). Equip each starter to be interlocked with all required contacts and control connection accessories.
- .7 Provide an identification nameplate on each motor starter or disconnect located in a motor control centre or on a motor starter panel, on each individually mounted starter which you supply, and on each disconnect which is provided by Division 16 for motorized equipment which you supply.

3.16 IDENTIFICATION PAINTING

- .1 Provide pipe, duct and equipment identification as specified below:
- .2 Identify exposed piping and ductwork in locations as follows:
 - .1 at every end of every piping or duct run;
 - .2 adjacent to each valve, strainer, damper and similar accessory;
 - .3 at each piece of connecting equipment;
 - .4 on both sides of every pipe and duct passing through a floor, wall or partition, unless otherwise noted;
 - .5 at 20' (6 m) intervals on pipe and duct runs exceeding 20' (6 m) in length;
 - .6 on each side of special valves, special fittings and branch connections;
 - .7 at least once in each room, and at least once on pipe and duct runs less than 20' (6 m) in length.
- .3 Identify concealed piping and ductwork in locations as follows:
 - .1 at points where pipes or ducts enter and leave shafts, pipe chases, furred spaces, and similar areas;
 - .2 at maximum 20' (6 m) intervals on piping and ductwork above suspended accessible ceilings, and at least once in each room;
 - .3 at each access door location.
- .4 Identification for piping shall consist of minimum 8" (200 mm) long painted classification colour bands, painted stencilled identification wording to identify the pipe service, and painted stencilled directional arrows to indicate direction of flow, all in accordance with CGSB Standard 24-GP-3A.
- .5 Painted stencilled letters shall be 1" (25 mm) high on equipment and piping 2" (50 mm) diameter and larger, 1/2" (12 mm) high on piping smaller than 2" (50 mm) in diameter. The colour of paint for stencilled lettering shall be white on dark colour coded bands, and black on light colour coded bands. Submit a typed list of proposed identification wording for review.
- .6 Identification for ductwork shall consist of neatly stencilled, painted 1" (25 mm) high lettering to indicate the system the duct is associated with and the duct service, i.e., "SYSTEM ACS-1-SUPPLY", and stencilled directional arrows to indicate air flow. On insulated ductwork with a paintable finish apply the identification directly to the duct insulation. On uninsulated ducts apply the lettering to a rectangular painted white background. Identification paint colour shall be black.
- .7 Equipment identification wording shall be minimum 1" (25 mm) high stencilled lettering and shall indicate the use of the particular pieces of equipment. Abbreviations will not be permitted.

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- .8 Identify piping which is electrically traced and insulated with "ELECTRICALLY TRACED" stencilled lettering at all standard identification locations.
- .9 Note that use of Brady Ltd. or equal plastic coated cloth material colour coded markers with lettering, arrows, and waterproof adhesive backing will be permitted in lieu of painting and stencilling if the surface the marker is to be applied to is dry and sealed with clear lacquer, and clear lacquer is applied over the marker after installation.
- .10 At your option, identification for piping may be SMS Ltd. "Coil-Mark" subsurface printed plastic pipe markers with flow arrow and alternating wording. Markers shall completely wrap around piping and secure it's self to piping 6" (150 mm), including insulation, and smaller by naturally coiling itself onto the piping. Stainless steel springs shall be used to secure markers to piping of outside diameter (including insulation) 6" (150 mm) and larger. Obtain approval for identification wording prior to ordering.
- .11 Paint all natural gas piping as per Code requirements.

3.17 INSTALLATION OF VIBRATION ISOLATION MATERIALS

- .1 Provide vibration isolation materials for mechanical work in accordance with the schedule, details, and requirements specified herein and/or on the drawings.
- .2 Supply to the vibration isolation material manufacturer or supplier a "reviewed" shop drawing copy for each piece of equipment to be isolated and dimensioned pipe layouts of associated piping to be isolated. Unless otherwise noted, all vibration isolation materials shall be the product of one (1) manufacturer.
- .3 Unless otherwise indicated, install isolation materials for base mounted equipment on concrete housekeeping pad bases which extend at least over the full base and isolator area of the isolated equipment.
- .4 Block and shim all bases level so that all ductwork and piping connections can be made to a rigid system at the proper operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and the building structure.
- .5 Isolate all piping larger than 1" (25 mm) diameter directly connected to motorized and/or isolated equipment with 1" (25 mm) static deflection spring hangers in accordance with the following schedule:

PIPE DIAMETER	SPRING HANGER OR MOUNT SPACING
TO 4" (100 mm)	First 3 Points Of Support
5" (125 mm) TO 8" (200 mm)	First 4 Points Of Support

- .6 The first point of support shall have a static deflection of twice the deflection of the isolated equipment (but maximum 2" [50 mm]).
- .7 Arrange and pay for the vibration isolation equipment manufacturer to visit the site to inspect installation of his equipment. Do any revision work required as a result of improper installation. When the vibration isolation equipment manufacturer is satisfied with the installation, obtain from him a letter stating that he has inspected the installation and that his equipment is properly installed. Forward a copy of the letter to the Consultant.

3.18 PIPE LEAKAGE TESTING

- .1 After new piping has been placed in position and all branch piping installed, but before the piping has been insulated or concealed, and before equipment, fixtures and fittings have been connected, test all piping in the presence of governing authorities, if required, and the Consultant or his authorized representative.
- .2 Drainage & Vent Piping:

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- .1 Securely close all openings and pipe ends and fill piping with water up to the highest level, and ensure that the water stands at the same level for a minimum of two (2) hours. After the fixtures and fittings are set and the pipes connected to the building drain or drains, turn on water into all pipes, fixtures, fittings and traps in order to detect any imperfect material or workmanship. Make a smoke test if required by the Municipality.
- .3 Domestic Water Piping:
 - .1 Test piping with cold water at a pressure of 1-1/2 times normal working pressure and maintain the pressure for a minimum of two (2) hours.
- .4 Sprinkler System Piping:
 - .1 Test all system piping with cold water in accordance with requirements of NFPA No. 13, "Installation of Sprinkler Systems", and in accordance with requirements of governing authorities. Prior to the pressure test, flush the system piping to ensure that it is completely free of foreign matter.
- .5 Natural Gas Piping:
 - .1 Test piping in accordance with the requirements of the latest edition of CAN-1-B149.1 and/or requirements of the Utility or Technical Standards and Safety Authority (TSSA). After completion of the verification test at the point of entry of the gas main into the building, affix Test Certificate to the pipe in a secure manner. Check all piping joints and connections for leaks with a water/soap solution while the piping is under pressure.
- .6 General Regarding All Piping:
 - .1 Temporarily remove all piping system specialties which may be damaged by test pressures, prior to pressure testing the systems.
 - .2 When testing is carried out below the highest level of the particular system, increase the test pressure by the hydrostatic head 1 psi (7 kPa) for every 2' (600 mm) below the high point.
 - .3 Include for temporary piping connections required to properly complete the tests.
 - .4 When pressure testing any system, valve off any equipment which has a working pressure lower than the system test pressure.
 - .5 Make tight all leaks found during tests while the piping is under pressure and if this is impossible, remove and refit the piping and reapply the test until satisfactory results are obtained.
 - .6 Where leaks occur in threaded joints in steel piping, no caulking of these joints will be allowed under any conditions.
 - .7 Tests may be done in sections, as later approved.
 - .8 Maintain written logs of all tests performed and keep the logs available at the site for review upon request.
 - .9 In addition to the leakage tests specified above, demonstrate proper flow throughout the systems including mains, connections and equipment, as well as proper venting and drainage. Include for any necessary system adjustments to achieve the proper conditions.

3.19 MECHANICAL PLANT PERFORMANCE AND ACCEPTANCE TESTS

- .1 After individual pieces of equipment have been tested and accepted, but prior to operating tests specified hereinafter, forward to the Consultant a letter stating that the entire mechanical plant is complete in all respects, has been checked and tested, and is ready for start-up. When the letter has been received, the Consultant will visit the site for purpose of witnessing a performance and acceptance test of the entire plant.

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- .2 Include for all required labour for the performance test and any adjustments required due to the results of the test, and ensure that competent and qualified equipment manufacturer's representatives are present during the test.
- .3 When the entire mechanical plant is ready for acceptance, but before acceptance of same, subject the entire plant to a continuous run for the length of time required for the purpose of demonstrating that all apparatus, materials, and systems are in perfect working order, that all controls and operating services are properly adjusted, that all units are heating and/or cooling properly, and that the systems provide uniform temperatures inside the building regardless of outside temperatures or conditions. Make the tests under the direction of the Consultant, and if the plant is not in proper operating condition, the Owner reserves the right, if all defects are not properly rectified, to employ other parties to make the necessary alterations and put the systems in proper working order, at your expense.
- .4 Note that the testing specified above must be complete prior to issue of a Certificate of Substantial Performance.

3.20 EQUIPMENT BASES AND SUPPORTS

- .1 Unless otherwise noted, set all floor mounted equipment on 4" (100 mm) high concrete housekeeping pads 4" (100 mm) wider and longer than the equipment base dimensions.
- .2 Supply dimensioned drawings, equipment base templates and anchor bolts for proper setting and securing of equipment on pads, and be responsible for all required levelling, alignment, and grouting of the equipment.
- .3 For equipment such as shell and tube heat exchangers provide prime coat painted structural steel stands flange bolted to housekeeping pads.
- .4 Provide prime coat painted structural black steel angle or channel frames and brackets for all surface wall mounted equipment not specifically designed for surface wall mounting, unless otherwise noted.

3.21 CONCRETE WORK FOR MECHANICAL SERVICES

- .1 Provide all concrete work, including reinforcing and formwork, required for mechanical work. All concrete shall be minimum 3,000 psi (20,700 kPa) ready-mix concrete provided in accordance with requirements of Division 3, unless otherwise noted.

3.22 PIPING EMBEDDED IN CONCRETE

- .1 Where piping is to be embedded within structural concrete, install such piping in compliance with the requirements of the latest edition of CSA Standard CAN3-A23.1, "Concrete Materials and Methods of Concrete Construction", with specific reference to Section 13.5. Generally installation practices and methods shall be confirmed with and accepted by the Structural Engineer.
- .2 Where piping is to be embedded within slabs, the following criteria shall also be followed:
 - .1 where piping pass by a column, stay at least two times the thickness of the slab and drop away from the column;
 - .2 where piping terminate adjacent to a column or wall, bring the piping in toward the column/wall as close as to 90° to the face of the column as possible within two times the thickness of the slab and drop away from the column;
 - .3 the maximum diameter of a single piping is not to exceed one-quarter of the slab thickness and the total depth of the conduits crossing over each other is to be less than one-third the thickness of the slab;
 - .4 place piping in the middle third of the thickness of the slab. Do not allow conduit to lay directly on the reinforcing steel;
 - .5 do not allow piping to run immediately adjacent to parallel reinforcing bars;
 - .6 do not run piping longitudinally in a beam without specific approval of the Structural Engineer. Pass through beams at right angles to the span of the beam;

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- .7 where piping pass through beams, stay at lease the depth of the beam away form the supports;
- .8 do not run piping in the slab beside a drop or beam within twice the depth of the slab from the edge of the drop or beam.

3.23 EXCAVATION AND BACKFILL

- .1 Do all excavation, backfill and related work required for your work. Perform such work in accordance with requirements of Division 2, except as modified by this Article. Examine the soil test report during the tender period.
- .2 Grade the bottom of trench excavations as required.
- .3 In firm, undisturbed soil, lay pipes directly on the soil.
- .4 In rock and shale, excavate to 6" (150 mm) below and a minimum of 8" (200 mm) to either side of the pipe, and backfill to the required invert with granular "A" material compacted to minimum 95% Standard Proctor Density.
- .5 Prepare new bedding under pipe in unstable soil, in fill, and in all cases where pipe bedding has been removed in earlier excavation, particularly near perimeter walls and at manholes and catch basins. Compact to maximum possible density and support the pipe by 8" (200 mm) thick reinforced concrete cradles spanning full length between firm supports. Install reinforcing steel in the cradles or construct piers every 7.87' (2.4 m) or closer, down to solid load bearing strata. Provide a minimum of one (1) pier per length of pipe. Use the same method where pipes cross.
- .6 Where excavation is necessary in proximity to and below the level of any footing, backfill with 2,000 psi (13,800 kPa) concrete to the level of the highest adjacent footing. Proximity is determined by the angle of repose as established by the Consultant.
- .7 Provide support over at least the bottom one-third (1/3) segment of the pipe in all bedding methods. Shape the excavation to fit pipe hubs, couplings and similar items and ensure even bearing along the barrels.
- .8 Keep walls of trenches straight to at least 18" (450 mm) within the pipe design limits. Have excavations inspected at least once a week by authorities. Break-up rocks and boulders and remove these by drilling and wedging. Do not use blasting unless specifically approved by the Consultant.
- .9 Before backfilling, test work for leakage and arrange for the work to be inspected by the Consultant. Remove all shoring during backfilling.
- .10 Backfill trenches within the building with clean sharp sand in individual layers of maximum 6" (150 mm) thickness compacted to a density of 100% Standard Proctor. Hand compact the first layers up to a compacted level of minimum 12" (300 mm) above the top of the pipe. Hand or machine compact the balance up to grade.
- .11 Backfill trenches outside the building (not under roads, parking lots or traffic areas), up to a compacted level of 18" (450 mm) thick above the pipe with granular "A" material hand compacted to a density of 95% Standard Proctor. Backfill the balance in 6" (150 mm) layers with approved excavated material compacted to 95% Standard Proctor density.
- .12 Backfill trenches outside the building under roads, parking lots or traffic areas with 1/4" (7 mm) crushed stone or granular "A" gravel in layers not exceeding 6" (150 mm) thickness, compacted to 100% Standard Proctor density up to grade level.
- .13 Do not use water for consolidation or during compaction of backfill.
- .14 Fill all depressions to correct grade level with appropriate material, after an adequate period has passed to reveal any settlement. Use maximum possible compaction. Pay all costs required to make good all damage caused by settlement.
- .15 Dispose of surplus excavated materials as specified in Division 2.

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- .16 Do pumping as required to keep excavations free of water.
- .17 The inverts and locations of existing site services shown on the drawings are approximate and it is your responsibility to confirm and satisfy yourself that the inverts and locations as shown are correct, prior to commencing work. Where discrepancies are found, immediately inform the Consultant and await a direction.
- .18 Note: You will be held responsible for any damage done to existing underground services caused by neglect to determine and mark out the location of such services prior to excavation work commencing.
- .19 Ensure that all underground water and drainage piping outside the building has a minimum of 4'-6" (1.37 m) of cover.
- .20 Ensure that all underground water and drainage piping inside the building in unheated areas has a minimum of 18" (450 mm) of cover.

3.24 FINISH PAINTING OF MECHANICAL WORK

- .1 Unless otherwise noted, finish painting of exposed mechanical work will be done as part of the work of Division 9.
- .2 Touch-up paint pre-finished equipment and provide identification painting of conduit, duct and equipment to the Consultant's approval. Confirm colour requirements prior to ordering.

3.25 PACKING AND SEALING CORE DRILLED PIPE OPENINGS

- .1 Pack and seal the void between the pipe opening and the pipe or pipe insulation for the length of the opening as follows:
 - .1 pack openings in non-fire rated interior construction with mineral wool and seal both ends of the opening with non-hardening silicone base caulking compound to produce a water-tight seal;
 - .2 pack and seal openings in fire rated walls and slabs as specified in this Section in the Article entitled "INSTALLATION OF FIRESTOPPING AND SMOKE SEAL MATERIALS";
 - .3 pack openings in exterior walls with lead wool or oakum and seal both ends of the opening water-tight with approved non-hardening silicone base caulking compound.

3.26 INSTRUCTIONS TO OWNER

- .1 Instruct the Owner's designated representatives in all aspects of the operation and maintenance of systems and equipment specified in succeeding Sections of this Division of the Specification. Obtain in writing from the Consultant a list of the Owner's representatives to receive instructions.
- .2 Arrange and pay for the services at the site of qualified technicians and other manufacturer's representatives to instruct on specialized portions of the installation.
- .3 Submit to the Consultant prior to application for a Certificate of Substantial Performance, a complete list of systems for which instructions were given, stating for each system:
 - .1 date instructions were given to the Owner's staff;
 - .2 duration of instructions;
 - .3 names of persons instructed;
 - .4 other parties present (manufacturer's representatives, etc.).
- .4 Obtain the signatures of the Owner's staff to verify they properly understood the system installation, operation and maintenance requirements and have received operating and maintenance manuals and record drawings.

3.27 INSTALLATION OF VARIABLE SPEED DRIVES

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- .1 Provide variable speed drives for each fan and pump identified on the equipment schedules or identified in the control drawings as "Variable Speed" or "VFD" or "VSD" controlled.
- .2 Install variable speed drives in accordance with the manufacturer's instructions.
- .3 "Load" side power wiring from the electrical source to each variable speed drive and from the variable speed drive to the motor shall be provided as part of Division 16
- .4 Provide all required control wiring in conduit per manufacturer's control diagrams and co-ordinate work with the requirements of Division 15 and Division 16.
- .5 All variable speed drives shall be the product of one manufacturer per Section 15010.
- .6 Under no circumstances shall variable speed drives be installed within equipment.

3.28 INSTALLATION OF IDENTIFICATION NAMEPLATES

- .1 For each piece of mechanical equipment, provide nameplates.
- .2 Where nameplate cannot be satisfactorily attached with adhesive, provide a nylon tie to attach the nameplate.

3.29 MOTOR STARTER SCHEDULES

- .1 Motor Starter Schedules inclusive are included at the end of this Section of the Specification and forms an integral part of this Section.

END OF SECTION

ITEM No.	ITEM	KW	RC AMPS	REQUIRED	FUSE SIZE	COMBINATION STARTER & DISCONNECT		MODIFICATIONS				BRANCH FEEDERS		REMARKS				
						FUSED DISC.	STARTER	AUX. CONT.	CABLE OR BUS	CONDUIT	WP DISCONNECT AT MOTOR	DISCONNECT AT MOTOR	F.A. SHUT DOWN		DISCONNECT ONLY			
1	TE-1	0.19	5.8	-	-	B600	-	-	-	-	-	-	-	-	-	①		
2	ERE-1	0.19	5.8	-	-	B600	-	-	-	-	-	-	-	-	-	-	①	
3	ERE-2	0.19	5.8	-	-	B600	-	-	-	-	-	-	-	-	-	-	①	
4	ERE-3	-	-	-	-	B600	-	-	-	-	-	-	-	-	-	-	①	
5	GE-1	0.13	4.4	-	-	B600	-	-	-	-	-	-	-	-	-	-	①	
6	GE-2	0.13	4.4	-	-	B600	-	-	-	-	-	-	-	-	-	-	①	
7	ZRE-1	0.19	5.8	-	-	B600	-	-	-	-	-	-	-	-	-	-	①	
8	WRE-1	0.19	5.8	-	-	B600	-	-	-	-	-	-	-	-	-	-	①	
9	SUMP PUMP	0.37	9.8	-	-	B600	-	-	-	-	-	-	-	-	-	-	①	
10	SUMP PUMP	0.37	9.8	-	-	B600	-	-	-	-	-	-	-	-	-	-	①	

NOTES:
 ① REFER TO FLOOR PLANS AND PANEL SCHEDULES FOR BRANCH FEEDER.

JOB: NEW MARKET COMMUNITY CENTER	DATE:	JOB NO. 1810061-000	REVISION:	DRAWING NO. SS-01
DRAWING TITLE: MOTOR STARTER SCHEDULE - MECHANICAL & ELECTRICAL	DRAWN BY: T.A.	CHECKED BY: T.A./ Y.Z.		
MMM GROUP LTD.				

LOOSE THREE PHASE STARTERS

MOTOR STARTER SCHEDULE

208, 3Ø, 3W

ITEM No.	ITEM	KW	RC AMPS REQUIRED	FUSE SIZE	TYPE	COMBINATION STARTER & DISCONNECT		MODIFICATIONS				BRANCH FEEDERS		REMARKS		
						FUSED DISC.	STARTER	N.O.	N.C.	CABLE OR BUS	CONDUIT	WP DISCONNECT AT MOTOR	DISCONNECT AT MOTOR		F.A. SHUT DOWN DISCONNECT ONLY	SEE NOTE No.
1	RRE-1 VFD CONTROL	0.37	2.2	✓	-	-	✓	-	-	-	-	✓	-	-	①	CONNECT TO VFD
2	RF-1 (RTU-6 RETURN AIR)	0.56	3.1	✓	-	1	FVNR	✓	-	-	✓	-	-	-	①	

NOTES:
 ① REFER TO FLOOR PLANS AND PANEL SCHEDULES FOR BRANCH FEEDER.

JOB: NEW MARKET COMMUNITY CENTER	DATE:	JOB NO.:	REVISION:	DRAWING NO.:
DRAWING TITLE: MOTOR STARTER SCHEDULE - MECHANICAL & ELECTRICAL	DRAWN BY: T.A.	1810061-000		SS-02
MMM GROUP LTD.	CHECKED BY: T.A./ Y.Z.			

SECTION 15250 - INSULATION

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SECTION 15250 - INSULATION

PART 1 - GENERAL

1.1 REFERENCES

- .1 Section 15010 in this Division of the Specification applies to and is a part of this Section of the Specification.
- .2 Section 15050 in this Division of the Specification applies to and is a part of this Section of the Specification. The Section contains requirements, products, and methods of execution that apply to this Section as well as to other Sections of Division 15.

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

- .1 The following work which is related to the insulation work is specified in other Sections of the Specification:
 - .1 plumbing and drainage piping and equipment;
 - .2 liquid heat transfer system piping and/or equipment;
 - .3 refrigeration system piping and/or equipment;
 - .4 supply of insulation accessories for circuit balancing valves;
 - .5 air handling equipment and accessories;
 - .6 ductwork, casings, plenums and similar sheet metal work.
 - .7 supply of insulation accessories for circuit balancing valves;
 - .8 electric heating cable for pipe and/or equipment piping.

1.3 SAMPLES

- .1 Submit to the Consultant for approval, a sample of each type of insulation, in applied form. Mount the samples on a rigid plywood board. Identify each sample with the manufacturer's name and insulation type, and the proposed use of the insulation. The sample board shall be provided in shop drawing form. Accompanying the sample board shall be complete, up to date literature from the manufacturer for each product. It shall be understood that any and all insulation supplied and/or installed on the project shall be in accordance with the reviewed sample board.

1.4 VAPOUR BARRIER JACKET

- .1 Insulation specified with a vapour jacket, shall be supplied with the vapour barrier jacket factory installed. Installation of a vapour barrier jacket outside of the insulation manufacturer's factory is not acceptable and will be considered deficient work. Contractor and manufacturer shall certify in writing that vapour barrier jacketed insulation supplied and installed on the work is in accordance with this stipulation.

PART 2 - PRODUCTS

2.1 FIRE HAZARD RATINGS

- .1 Unless otherwise noted, all insulation system materials must meet requirements of NFPA 90A, and must have a fire hazard rating of not more than 25 for flame spread and 50 for smoke developed when tested in accordance with CAN/ULC 4-S102-M.

2.2 THERMAL PERFORMANCE

- .1 Unless otherwise noted, thermal performance (i.e. conductivity) of insulation shall meet or exceed the values given in Table 6.8.2.A, 6.8.2.B and 6.8.3 of the ASHRAE/IES Standard 90.1-2004.

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2.3 PIPE INSULATION MATERIALS

- .1 Johns-Manville, "MICRO-LOK" rigid, moulded, sectional glass fibre pipe insulation with a factory applied "AP-T" vapour barrier jacket.
- .2 Johns-Manville, "MICROLITE" flexible blanket type glass fibre insulation.
- .3 Fiberglas Canada Inc., No. MP-105, factory formed glass fibre insulation for pipe fittings, valves, and similar items.
- .4 Pittsburg Corning Corporation "FOAMGLAS", rigid, moulded sectional cellular glass pipe insulation.
- .5 Instant Firestop Inc., "PI" or equal, non-combustible, fire-rated, sectional longitudinally split pipe insulation with a reinforced vapour barrier jacket, ULC listed and labelled as a component in a firestop system assembly.

2.4 EQUIPMENT INSULATION MATERIALS

- .1 Johns-Manville, "Pipe and Tank" flexible, fibreglass blanket, insulation bonded to a non-woven fibreglass mat backing.
- .2 Johns-Manville "Pipe and Tank - AP" flexible, fibreglass blanket type insulation bonded to a type "AP" vapour barrier backing.
- .3 Armstrong World Industries Canada Ltd., "AP ARMAFLEX" flexible, elastomeric, 25/50 rates, closed cell, fire retardant sheet insulation.

2.5 DUCTWORK SYSTEM INSULATION MATERIALS

- .1 Johns-Manville, "800 Series Spin Glass - FSK", rigid fibreglass insulation with a factory applied, glass fibre reinforced, foil and flame retardant kraft paper vapour barrier facing.
- .2 Johns-Manville, "Microlite - FSK" flexible, blanket type fibreglass insulation with a factory applied, glass fibre reinforced, foil and flame retardant kraft paper vapour barrier facing.
- .3 Armstrong World Industries Canada Ltd., "AP ARMAFLEX" flexible, elastomeric, 25/50 rates, closed cell, fire retardant sheet insulation.

2.6 INSULATION FINISH MATERIALS

- .1 S. Fattal Canvas Inc., ULC listed and labelled "Thermocanvas", with an ASTM flame spread rating of less than 25 and a smoke developed rating of less than 50.
- .2 Childers Products Company, "Rolled Jacketing" embossed or smooth, .016" (0.40 mm) thick, aluminum insulation jacket selected internal vapour barrier to suit application and matching prefabricated fitting covers.
- .3 CCX Fabric "Glass-Fab", or equal, 20-10 weave fibreglass mesh.
- .4 Pipe insulation jacket and fitting covers – The Sure-Fit System "SMOKE-LESS 25/50" 15 MIL thick, gloss white PVC pipe insulation jacket and fitting covers with manufacturer supplied adhesive and PVC tape.

2.7 LAGGING ADHESIVE

- .1 BAKOR No. 120-09, or equal, fire resistive resin emulsion, heavy duty lagging coating rated 25/50 per ASTM E84, suitable for indoor and outdoor use.

2.8 INSULATION CEMENTS

- .1 Asbestos free, hydraulic setting insulating and finishing cement.

2.9 INSULATION ADHESIVES

SECTION 15250 - INSULATION

- .1 Fibrous insulation - BAKOR No. 200-37, rubberized emulsion based, waterproof adhesive, fire resistive when dry, non-flammable when wet and 0/0 rated per CAN/ULC4-S102.
- .2 Flexible elastomeric insulation – Armstrong World Industries Canada Ltd., No. 520 synthetic based adhesive, 5/15 rated per ASTM E84.

2.10 INSULATION ACCESSORIES

- .1 Insulation protection shields - Grinnel Corporation Fig. No. 167, or equal, galvanized carbon steel insulation protection shield to MSS SP-69 and designed for a maximum of 4 psi (27.6 kPa) compressive stress based on a 10' (3.0 m) span between supports or hangers.
- .2 Wire - No. 15 gauge (.072" [1.8 mm] diameter) galvanized annealed wire.
- .3 Twine - Jute or fibrous glass twine.
- .4 Mesh - 1" (25 mm) hexagonal mesh constructed of No. 15 gauge (.072" [1.8 mm] diameter) galvanized annealed wire.
- .5 Aluminum strap – 1/2" (12 mm) wide, 0.020" (0.5 mm) thick aluminum strapping.
- .6 Steel strap - 1/2" (12 mm) wide, 0.015" (0.4 mm) thick, galvanized steel strapping.
- .7 Fitting covers – The Sure-Fit System "SMOKE-LESS 25/50" 15 MIL thick, gloss white PVC fitting covers with manufacturer supplied adhesive and PVC tape.
- .8 Pins and clips - No. 14 gauge (.080" [2 mm] diameter) weld-on pins with 1-1/4" (32 mm) square plated metal type or round nylon clips.
- .9 Cloth tape - Fibreglas Canada Inc., fibreglass reinforced cloth.
- .10 Mactac Canada Ltd. – pressure sensitive tape sealant type FSK-1 (foil/scrim/Kraft) or ASJ (All Service Jacket) to suit insulation vapour barrier material type.

2.11 ACCEPTABLE INSULATION MANUFACTURERS

- .1 Acceptable insulation and insulation manufacturers are as follows:
 - .1 fibreglass insulation - Johns-Marville, Manson, Knauf and Owens Corning Canada Inc.;
 - .2 flexible elastomeric insulation – Armstrong World Industries Canada Ltd. and Rubatex;
 - .3 canvas jacketing material - S. Fattal Canvas Inc. and Robson Thermal Mfg. Ltd.;
 - .4 aluminum jacketing material - Childers Product Company and Permaclad Products;
 - .5 PVC fitting covers and jacketing material – The Sure-Fit System.

PART 3 - EXECUTION

3.1 GENERAL INSULATION APPLICATION REQUIREMENTS

- .1 Unless otherwise noted, do not insulate the following:
 - .1 factory insulated equipment and piping;
 - .2 heating piping within radiation unit enclosures, including blank filler sections of enclosures;
 - .3 branch domestic water piping located under counters to serve counter mounted plumbing fixtures and fittings;
 - .4 exposed chrome plated domestic water angle supplies from concealed piping to plumbing fixtures and fittings;
 - .5 heated liquid system pump casings;

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- .6 expansion tanks;
- .7 condenser water supply and return piping inside the building;
- .8 manufactured expansion joints and flexible connections;
- .9 acoustically lined ductwork and/or equipment;
- .10 flexible ductwork.
- .2 Install insulation directly over pipes and not over hangers and supports.
- .3 Do not apply insulation until leakage tests have been satisfactorily completed.
- .4 Ensure that all surfaces to be insulated are clean and dry.
- .5 No material including tapes, adhesives, etc. used as part of an insulation assembly shall be rated greater than 25/50 Article 2.1 entitled "FIRE HAZARD RATING OF INSULATION" shall be used within a "plenum" as defined in OBC.
- .6 Install work generally in accordance with TIAC "NATIONAL INSULATION STANDARDS MANUAL" except conform with manufacturer's published instructions and recommendations and the requirements specified herein this Section of the Specification.
- .7 Ensure that the ambient temperature is minimum 55 degrees F. (13 degrees C.) for at least one (1) day prior to the application of insulation, and for the duration of insulation work.
- .8 Where piping and/or equipment is traced with electric heating cable, ensure that the cable has been tested and approved prior to the application of insulation and ensure that the cable is not damaged or displaced during the application of insulation.
- .9 Install piping insulation continuous through pipe openings and sleeves.
- .10 Install duct insulation continuous through walls, partitions, and similar surfaces except at fire dampers.
- .11 Provide proper covering shields, sized to suit the insulated pipe, between the pipe hanger or support and the insulation for all piping not supported by roller hangers or supports.
- .12 Where roller hangers and supports are used, steel protection saddles will be supplied and installed as part of the piping work. Pack the saddle voids with fibreglass insulation.
- .13 When insulating "cold" piping and equipment, extend insulation up valve bodies and other such projections as far as possible, and protect the insulation jacketing from the action of condensation at its junction with the metal.
- .14 The final appearance and finish of exposed mechanical work depends to a large degree on the quality of the insulation application, therefore, first class workmanship will be insisted upon.
- .15 For all piping system components and for equipment or sections of equipment which require insulation but also access to permit maintenance or adjustment, design and install the insulation to permit easy removal and replacement.
- .16 For items such as "circuit balancing valves" which are supplied with insulating accessories, specified in other Sections of the Specification, incorporate the packing into the pipe insulation, but do not contravene fire hazard ratings of CAN4-S102.

3.2 PIPE INSULATION REQUIREMENTS - FIBREGLASS

- .1 Except where other types of insulation are specified for portions of piping in succeeding articles in this Section, insulate the following pipe with rigid fibreglass pipe insulation of the thickness noted:
 - .1 domestic cold water piping, supply and return - 1" (25 mm) thick;
 - .2 domestic hot water piping, supply and return, to and including 2" (50 mm) diameter - 1" (25 mm) thick;

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- .3 domestic hot water piping, supply and return, larger than 2" (50 mm) diameter - 1-1/2" (38 mm) thick;
 - .4 exposed drainage piping (including trap) from all wheelchair lavatories equipped with offset waste fittings – ½" (12 mm) thick;
 - .5 storm drainage piping from roof drains to the point where main vertical risers extend down, without offsets and connect to horizontal mains – 1" (25 mm) thick;
 - .6 all sanitary and storm drainage piping, domestic water, heating water, chilled water, condenser water, fire protection system piping located in unheated areas and indicated on the drawings to be traced with electric heating cable – 2" (50 mm) thick;
 - .7 condensate drainage piping – ½ "(12mm) thick.
- .2 Provide cellular glass pipe insulation extended a minimum of 2"(50 mm) beyond ends of insulation shield at all hanger and support locations for piping 2"(50 mm) diameter and larger and not equipped with pipe saddles. Where pipe insulation is covered by a vapour barrier jacket, wrap the cellular glass insulation with same vapour barrier jacket material overlapped a minimum of 1" (25 mm) on to the adjacent pipe insulation's jacket.
 - .3 Secure overlap flap of the jacketed insulation in place with a full coverage of adhesive. Firmly butt together sections of the insulation and cover the butt joints with 3" (75 mm) wide factory supplied strips of the vapour barrier jacket material secured in place with adhesive.
 - .4 Wrap elbows, valves, flanges and similar fittings with blanket insulation to a thickness and insulating value equal to that of the sectional insulation. Laminate in place with adhesive and secure with twine. Apply a skim coat of insulating cement, wrap the fitting with cloth tape overlapped 50% and set in adhesive, and apply a coat of finishing cement with a smooth finish, or, alternatively, apply P.V.C. fitting covers installed in accordance with the manufacturer's recommendations and instructions in lieu of insulating cement and cloth tape.
 - .5 In lieu of wrapping elbows, valves, etc., with blanket insulation, pre-formed glass fibre fitting insulation may be used. Cover fitting insulation with the same sectional pipe insulation jacket material laminated in place with adhesive.

3.3 PIPE INSULATION REQUIREMENTS - FIRE RATED INSULATION

- .1 Where pipe which is to be insulated as specified above penetrates fire rated walls and slabs, provide fire rated, ULC listed, non-combustible sectional insulation on the portion of pipe in the fire barrier and for a distance of 2" (50 mm) on either side of the fire barrier. Insulation thickness shall be as specified, but in any case minimum 1" (25 mm).

3.4 PIPE INSULATION REQUIREMENTS – FLEXIBLE ELASTOMERIC

- .1 At your option, and where allowed by OBC and approved by governing authorities, you may use flexible elastomeric pipe insulation in lieu of fibreglass pipe insulation on all piping conveying a liquid with a maximum operating temperature of 200 degrees F. (93 degrees C.). Thickness of flexible elastomeric pipe insulation shall be equal to that specified for fibreglass insulation for each piping type.
- .2 Install flexible elastomeric pipe insulation in strict accordance with the manufacturer's published instructions and recommendations.
- .3 Cover exposed elastomeric pipe insulation with glass mesh fully secured to the insulation with adhesive supplied by the insulation manufacturer.

3.5 EQUIPMENT INSULATION REQUIREMENTS

- .1 Insulate the following equipment with fibreglass blanket type insulation (with or without vapour barrier backing) of the thickness noted:
 - .1 roof drain bodies where inside the building - 1-1/2" (38 mm) thick;

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.2 water meter – 1-1/2" (38 mm) thick.

.2 Install the equipment with insulation to a thickness and insulating value equal to an equivalent thickness of sectional pipe insulation. Laminate the insulation in place with adhesive and secure with wire or twine. Apply a jacket of the insulation vapour barrier material secured in place with adhesive.

.3 Provide removable and replaceable insulated metal covers for all equipment with removable heads.

3.6 DUCTWORK SYSTEM INSULATION REQUIREMENTS - FIBREGLASS

.1 Insulate the exterior of the following ductwork systems with fibreglass insulation of the thickness noted:

.1 all fresh air intake ductwork, casings and plenums from fresh air intakes to and including mixing plenums or sections, or, if mixing plenums or sections are not provided, to and including the first heating coil section, or, if both mixing plenums or sections and heating coil sections are not provided, then the fresh air ductwork system complete - 1-1/2" (38 mm) thick;

.2 mixed supply air or preheated supply air casings, plenums and sections to and including the fan section where not factory insulated - 1" (25 mm) thick;

.3 supply ductwork outward from fans, except for branch supply ductwork exposed in the area it serves - 1" (25 mm) thick;

.4 exhaust discharge ductwork for a distance of 10' (3 m) upstream (back) from exhaust openings to atmosphere, including any exhaust plenums within the 10' (3 m) distance - 1" (25 mm) thick;

.5 any other ductwork, casings, plenums, or sections as specified on the drawings - thickness as specified.

.2 Insulation for casings, plenums and exposed rectangular ductwork shall be rigid board type. Insulation for round ductwork and concealed rectangular ductwork shall be blanket type.

.3 Securely butt together adjoining sections of insulation. Secure the insulation in place with a full coverage of adhesive on all surfaces, and on vertical and suspended surfaces with pins welded to the ductwork on 12" (300 mm) to 18" (450 mm) centres with the insulation applied overtop the pins and secured in place with clips. Ensure that the insulation does not sag or bulge.

.4 Make joints in vapour barrier facings with 3" (75 mm) wide overlap strips of the insulation vapour barrier facing secured in place with a full coverage of adhesive.

.5 Insulate silencers located in ductwork systems to be insulated, to the same insulation standard as the ductwork.

.6 Provide dry wall type metal corner beads on edges of exposed rectangular ductwork, casings and plenums in equipment rooms, service corridors and any other area where the insulation is subject to accidental damage.

3.7 DUCTWORK SYSTEM INSULATION REQUIREMENTS- FLEXIBLE ELASTOMERIC

.1 Insulate all exposed ductwork and associated plenums or casings outside the building with 1" (25 mm) thick closed cell flexible elastomeric sheet insulation applied in two (2) 1/2" (12 mm) thick layers with staggered joints.

.2 Install flexible elastomeric sheet insulation in strict accordance with the manufacturer's published instructions and recommendations to produce a weatherproof installation. Seal sheet metal work joints watertight with duct sealer prior to applying insulation.

3.8 INSULATION FINISH REQUIREMENTS

.1 Except as otherwise specified, jacket all fibreglass insulation work inside the building with canvas secured with a full 100% covering coat of lagging adhesive. Neatly trim all canvas joints and shrink the canvas tight in place.

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- .2 At your option, exposed fibreglass insulation inside the building may be jacketed with PVC fitting and jacketing installed and sealed in accordance with the manufacturer's instructions to produce a watertight finish. Do not mix finishing methods in order to maintain uniformity of finish.
- .3 Cover exposed elastomeric insulation with glass mesh fully, and tightly secured to the insulation with adhesive supplied by the insulation manufacturer. Neatly trim glass mesh.
- .4 Protect insulation on exposed piping and ductwork penetrating mechanical room floors with sheet steel or aluminum jacketing for a distance of 3' (1 m) above the floor level.
- .5 Jacket all insulation outside the building with aluminum jacketing with prefabricated fitting covers. Install in accordance with manufacturer's published instructions. Confirm vapour barrier requirements prior to ordering. Jacket the insulation with an aluminum jacket with internal vapour barrier secured in place with aluminum bands on 18" (450 mm) centres and with 2" (50 mm) overlap (or as otherwise stated in manufacturer's published instructions) at butt joints and longitudinal seams to produce a completely weatherproof and water-tight installation.
- .6 Unless otherwise specified, finish all exposed flexible elastomeric insulation work with two (2) coats of finish supplied by the insulation manufacturer. Apply the finish in accordance with the manufacturer's recommendations and instructions. Confirm finish colour requirement(s) and tint finish in accordance with manufacturer's direction to Consultant's colour scheme.

END OF SECTION

SECTION 15400 - PLUMBING SYSTEMS

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SECTION 15400 - PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 REFERENCES

- .1 Section 15010 in this Division of the Specification applies to and is a part of this Section of the Specification.
- .2 Section 15050 in this Division of the Specification also applies to and is a part of this Section of the Specification. The Section contains requirements, products, and methods of execution that apply to this Section as well as to other Sections of Division 15.

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

- .1 The following work which is related to the plumbing work is specified in other Sections of the Specification:
 - .1 provision of underground drainage and water service piping outside the building and to a point 5' (1.5 m) outside building lines;
 - .2 mounting and flashing only (in roof areas) of roof drain bodies;
 - .3 provision of site applied thermal insulation for plumbing work;
 - .4 plumbing fixtures and fittings;
 - .5 installation of vent stack roof flashing accessories;
 - .6 provision of washroom accessories including grab bars and soap dispenser;
 - .7 installation of vent stack roof flashing accessories.

1.3 SHOP DRAWINGS

- .1 Submit shop drawings for all plumbing materials and equipment specified PART 2 of this Section except drainage piping cleanouts, vacuum breakers, chlorine, and standard shut-off and check valves.
- .2 Submit certified performance curves with all pump shop drawings.

PART 2 - PRODUCTS

2.1 VENT PIPING ROOF FLASHING ACCESSORY

- .1 Lexsuco Canada Ltd., spun aluminum, vandal-proof, vent stack covers each complete with a hooded sleeve and an insulation sleeve all sized to suit the vent stack.
- .2 Acceptable manufacturers are Lexsuco Canada Ltd. and Thaler Metal Industries Ltd.

2.2 DRAINAGE PIPING CLEANOUTS

- .1 TY fittings, with extra heavy brass plugs screwed into the fittings.
- .2 Smith No. 4500 or equal, enamelled cast iron cleanout tees, each complete with a large access opening and gasketed removable cover with stainless steel hardware.
- .3 Bronze or copper cleanout tees each complete with a bronze ferrule.
- .4 Acceptable manufacturers are J.R. Smith, Mifab, Watts industries and Zurn Industries Canada Ltd.

SECTION 15400 - PLUMBING SYSTEMS

2.3 CLEANOUT TERMINATIONS

- .1 Unless otherwise specified, J.R. Smith, oven cured epoxy enamel coated cast iron, adjustable, gasketed cleanout terminations each complete with captive stainless steel screws and a cover to suit the floor finish.
- .2 Acceptable manufacturers are J.R. Smith, Mifab, Watts industries and Zurn Industries Canada Ltd.

2.4 DRAINS

- .1 Unless otherwise specified, J.R. Smith, oven cured, epoxy coated cast iron body drains as specified on the drawing symbol list, each meeting requirements of CAN3-B79-M79 and complete with all required accessories.
- .2 Acceptable manufacturers are J.R. Smith, Mifab, Watts industries and Zurn Industries Canada Ltd.
- .3 All drains connected with sanitary drainage piping and equipped with traps shall be complete with a 1/2" (12 mm) diameter trap primer tapping.

2.5 FLOOR DRAIN TRAP SEAL PRIMERS

- .1 Single drain primers - J.R. Smith No. 2699, bronze trap seal primers, each complete with an integral vacuum breaker and a gasketed bronze cap.
- .2 Multiple drain primers - P.P.P. Inc. Model PT, Electronic Trap Priming Manifold, where four or more traps requiring priming within 30.8m proximity to each other, the unit shall supply a minimum of 0.3L of water per opening, in each 24 hour period or as selected with adjustable recycle timer on a 24 hour period based on a system pressure of 421kpa. Factory assembled with a bronze body ball valve, water hammer arrestor, solenoid valve, atmospheric vacuum breaker and a type L copper manifold c/w compression fitting. Electric single power point connection 120v. 1 amp. manual override switch, all encased within a 16 gauge steel cabinet with removable door.
- .3 Acceptable manufacturers are J.R. Smith, Mifab, Watts industries and Zurn Industries Canada Ltd.

2.6 WATER HAMMER ARRESTORS

- .1 J.R. Smith 5000 Series, all stainless steel construction shock absorbers, each with a pre-charged air chamber of nesting steel bellows, and each sized to suit the connecting pipe size and the equipment it is provided for.

2.7 HOSE BIBBS

- .1 Hose bibbs shall be:
 - .1 on exterior walls and unheated areas such as garbage rooms - J.R. Smith bronze flush mounted non-freeze type with box complete with vacuum breaker and identified key as specified on the drawing;
 - .2 in interior spaces - Chicago Faucets No. 5T-E27 with male inlet, hose thread outlet, removable handle, and spout outlet in-line vacuum breaker with threaded inlet and outlet.
- .2 Acceptable manufacturers are J.R. Smith, Watts industries and Zurn Industries Ltd.

2.8 WATER PRESSURE REDUCING VALVES

- .1 Watts Industries (Canada) Inc., Series U5B, adjustable, bronze body pressure reducing valve with a high temperature resisting diaphragm, removable stainless steel seat and built-in thermal expansion by-pass check valve.
- .2 Singer Valve Co. Ltd., series 106-PR, pilot operated, adjustable, pressure reducing valve as specified on the drawing(s), complete with a bronze globe valve modulated by a diaphragm which in turn is operated by the pilot.
- .3 Acceptable manufacturers are Singer Valve Co. Ltd., Braukman Controls Co. Ltd., Watts Industries (Canada) Inc. and Spirax Sarco Canada Ltd.

SECTION 15400 - PLUMBING SYSTEMS

2.9 WATER PIPING VACUUM BREAKER

- .1 Watts Industries (Canada) Inc., No. NF8 vacuum breaker to CAN/CSA-B64.2-94.
- .2 Acceptable manufacturers are Watts Industries (Canada) Inc., Hersey Products Inc. and Wilkins Regulator Co..

2.10 WATER PIPING BACKFLOW PREVENTER

- .1 Watts Regulator of Canada Ltd., No. 9D, CSA certified, continuous pressure type backflow preventer with a brass body, stainless steel working parts, an integral strainer, and an intermediate atmospheric vent.
- .2 Watts Regulator of Canada Ltd., No. 909 Series, reduced pressure principle, CSA certified, all bronze backflow assembly complete with two (2) independent check valves, intermediate relief valve, inlet strainer and inlet and outlet shut-off valves.
- .3 Acceptable manufacturers are Watts Regulator of Canada Ltd., Apollo Conbraco Industries, and Wilkins Regulator Co.
- .4 Water piping backflow preventer shall comply with the Halton Region Cross – Connection control by law.

2.11 CHLORINE

- .1 Sodium hypochlorite to AWWA B300-75.

2.12 RECIRCULATING CIRCUIT BALANCING VALVES

- .1 S.A. Armstrong Ltd., Series "CBV-S" soldered end, or "CBV-T", threaded end, globe style, bronze bodied, circuit balancing valves, suitable in all respects for potable water service, designed to facilitate precise flow measurement, precision flow balancing, and positive shut-off, complete with capped and valved drain connection, valved ports for connection to a S.A. Armstrong Ltd. Model CBVM 135/60 or equal, differential pressure meter and an insulation accessory meeting the requirements of article entitled "Fire Hazard Ratings", of Section 15250.
- .2 Acceptable manufacturers are S.A. Armstrong Ltd., Tour & Andersson, Danfoss and Newman-Hattersley.

2.13 DOMESTIC HOT WATER CIRCULATING PUMPS

- .1 S.A. Armstrong Ltd., in-line type, centrifugal, horizontal bronze pump non-overloading under all operating conditions as per the drawing schedule, complete with:
 - .2 a bronze casing with in-line pipe connections;
 - .3 a dynamically balanced closed type bronze impeller fitted to a stainless steel shaft and complete with oil submerged double bronze bearings and thrust collar;
 - .4 a water-tight mechanical seal suitable for the temperature and pressure of the water being pumped;
 - .5 a 1750 R.P.M. resiliently mounted motor connected to the pump shaft by means of a single spring flexible coupling.
- .6 Acceptable manufacturers are S.A. Armstrong Ltd., ITT Bell & Gossett, TACO and Grundfoss.

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2.14 SUBMERSIBLE DRAINAGE PUMP SET

- .1 Hydr-O-Matic Pump Co., submersible sump pump set, as per the drawing schedule, each pump complete with:
 - .2 a cast iron pump casing and motor cover;
 - .3 an oil filled, overload protected, submersible ball bearing type 3 phase motor with a minimum of 50' (15 m) of PVC jacketed power cord pre-wired to the motor;
 - .4 an open, two (2) vane type, non-clog impeller secured to a stainless steel pump and motor shaft.
- .5 Pump set control components supplied by the pump manufacturer shall consist of:
 - .6 four (4) No. ME10 mercury tube switches, each sealed in a polyurethane float and complete with a minimum of 10' (3 m) of control cord: three (3) for pump set control, one (1) for sump pit high water level alarm;
 - .7 a bracket to support float switch cables;
 - .8 a wall mounting power and control panel with an EEMAC 3R dead front enclosure containing a circuit breaker, magnetic starter, run lights, and H.O.A. switch for each pump, and a relay alternating circuit to alternate the lead pump after each successive pumping cycle;
 - .9 a separate, wall mounting, automatic reset, 115 volt alarm panel with EEMAC 3R enclosure, alarm bell, warning light, and silencing switch.
- .10 The pump power cord and the float switch control cords must be of sufficient length to extend unbroken from the sump pit through conduit to 3' (1 m) up the wall on which the starter and control panel are to be located.
- .11 Acceptable manufacturers are Hydr-O-Matic Pump Co. (Scarboro Pump Manufacturing), F.E. Myers (Canada) Ltd., and Barnes Pumps (GSW Pump Company).

PART 3 - EXECUTION

3.1 SUPPLY OF FLASHING ACCESSORIES FOR ROOF VENT STACKS

- .1 Supply a vent stack cover accessory for each vent stack penetrating the roof.
- .2 Hand the vent stack cover to the roofing trade at the site for installation and flashing into roof construction as part of the roofing work.
- .3 Install vent stack piping up through and to a height as per vent stack cover manufacturer's instructions.

3.2 DRAINAGE AND VENT PIPING INSTALLATION REQUIREMENTS

- .1 Provide all required drainage and vent piping. Pipe, unless otherwise specified, shall be as follows:
 - .1 for underground pipe inside the building and to points 5' (1.5 m) outside building lines - Class 4000 cast iron, or rigid PVC sewer pipe, minimum 3" (75 mm) diameter; If PVC piping is used, provide type "BDS" or equal, piping for drainage piping up to 6" (150 mm) in diameter and type "Ultra-Rib" or equal, where drainage piping exceeds 6" (150 mm) diameter. PVC piping is specified in Section 15050;
 - .2 for pipe inside the building and above ground in sizes larger than 3" (75 mm) diameter - Class 4000 cast iron;
 - .3 for pipe inside the building and above ground in sizes to and including 3" (75 mm) diameter - type DWV copper.
- .2 Unless otherwise noted, slope horizontal drainage piping above ground in sizes to and including 3" (75 mm) diameter with a 2% slope, and pipe 4" (100 mm) diameter and larger with a 1% slope.

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- .3 Install and slope underground drainage piping to inverts or slopes indicated on the drawings to facilitate straight and true gradients between the points shown. Verify available slopes before installing the pipes.
- .4 Slope horizontal branches of vent piping down towards the fixture or pipe to which they connect with a minimum pitch of 2%.
- .5 Provide cleanouts in drainage piping in locations as follows:
 - .1 in the building drain or drains as close as possible to the inner face of the outside wall, and, if and where a building trap is installed, locate the cleanout on the downstream side of the building trap;
 - .2 at or as close as practicable to the foot of each drainage stack;
 - .3 at maximum 50' (15 m) intervals in horizontal pipe 4" (100 mm) diameter and smaller;
 - .4 at maximum 100' (30 m) intervals in horizontal pipe larger than 4" (100 mm) diameter;
 - .5 wherever else shown on the drawings.
- .6 Cleanouts shall be the same diameter as the pipe in piping to and including 4" (100 mm) diameter, and not less than 4" (100 mm) in piping larger than 4" (100 mm) diameter.
- .7 Cleanouts in vertical piping shall be cleanout tees, cast iron in piping 3" (75 mm) diameter and larger, copper or bronze in piping smaller than 3" (75 mm).
- .8 Cleanouts in horizontal piping shall consist of TY fittings.
- .9 Cleanouts in horizontal inaccessible piping such as underground piping shall consist of TY fittings extended up to cleanout terminations set flush with the finished floor.
- .10 In waterproof areas, equip each termination with a flashing clamp device.
- .11 Where cleanout terminations occur in finished areas, locate the terminations to the Consultant's direction and arrange piping to suit.
- .12 Where cleanouts are concealed behind walls or partitions, install the cleanouts such that the cover is within 1" (25 mm) of the finished face of the wall or partition.

3.3 INSTALLATION OF DRAINS

- .1 Provide drains where shown on the drawings.
- .2 In Equipment Rooms and similar areas, exactly locate floor drains to suit the layout of mechanical equipment and location of equipment indirect drainage piping.
- .3 In finished areas, confirm the exact location and finish of drains with the Consultant prior to roughing-in.
- .4 Equip each drain connected to sanitary drainage piping with a trap.
- .5 Provide vent piping and cold water supply piping to drains wherever required by Part 7 (Plumbing) of the Ontario Building Code and/or shown on the drawings. Water supply piping from trap seal primers to drains shall consist of Type "M" hard copper tubing above ground and Type "L" soft copper underground, extended from trap seal primers to the floor drain. Provide trap seal primers in domestic cold water piping to the nearest available plumbing fixture.
- .6 Place roof drains in position for flashing into roof construction as part of the roofing work. When mounting is complete, connect with piping and provide drain accessories.

3.4 DOMESTIC WATER PIPING INSTALLATION REQUIREMENTS

- .1 Provide all required domestic water piping in accordance with the requirements of Part 7 (Plumbing) of the OBC. Pipe, unless otherwise noted shall be as follows:

SECTION 15400 - PLUMBING SYSTEMS

- .1 for underground service piping to inside building - cement lined centrifugal ductile iron or where approved by governing authorities, Canron "Blue Brute" rigid PVC;
 - .2 for service pipe inside the building and above ground from termination of underground main to and including meter connection and bypass and similar service entrance connections - type "K" hard drawn copper.
 - .3 for all domestic hot water, cold water and tempered water distribution piping inside the building and above ground except as noted above - type "L" hard copper.
- .2 Brace and secure underground water service pipe at bends and tees with concrete thrust blocks in accordance with Municipal Standards.
 - .3 Slope all piping so that it can be completely drained.
 - .4 Provide an accessible manually operated air vent above the high point of each water piping system unless the systems are suitably vented through frequently used plumbing fixtures or outlets.
 - .5 Provide a vacuum breaker in piping connecting a hose bib or any other fitting to which a hose can be attached, unless a vacuum breaker is provided integral with the hose bib or similar fitting. Install in accordance with CAN/CSA-B64.10-94.
 - .6 Provide water hammer arrestors in piping in accordance with P.D.I. Standard P.D.I.- WH201, and where shown on the drawings and in accordance with drawing equipment connection schedules.
 - .7 Provide recirculating balancing valves in piping generally where shown on the drawings but with exact locations in accordance with instructions of personnel doing system flow balancing work. Confirm locations prior to installation. Ensure that balancing valves are a minimum of ten (10) pipe diameters downstream of any pump or fitting and a minimum of five (5) pipe diameters upstream of any fitting. Hand over insulation accessories to insulation trade, on site, for installation into pipe insulation.
 - .8 Provide a backflow preventer assembly in make-up water piping to mechanical plant circulating systems and equipment. Provide an air gap secured to backflow preventer, and connect with drain piping terminated over nearest funnelled floor drain. Install complete assembly in accordance with manufacturer's instructions and the requirements of CSA Standard CAN/CSA-B64.10-94. Test each back flow assembly in accordance with the requirements of CSA Standard CAN/CSA-B64.10-94.
 - .9 Provide shut-off valves to isolate all equipment and wherever else shown.

3.5 INSTALLATION OF HOSE BIBS

- .1 Provide hose bibs where shown on the drawings.
- .2 Provide a shut-off valve inside the building in piping to each exterior wall mounted hose bib.
- .3 Confirm the exact location of hose bibs in finished areas and all exterior wall mounted hose bibs with the Consultant prior to roughing-in.
- .4 Supply two (2) identified loose key operators for exterior hose bibs and hand the operators over to the Consultant at the site prior to application for a Certificate of Substantial Performance of the Work.

3.6 INSTALLATION OF DOMESTIC WATER PRESSURE REDUCING VALVES

- .1 Provide domestic water pressure reducing valves as follows:
 - .1 in domestic cold water make-up piping to the boiler water circulating system expansion tank;
 - .2 in domestic cold water make-up piping to the glycol heating circulating system expansion tank;
 - .3 Wherever else shown or specified.
- .2 Install each valve in accordance with the manufacturer's recommendations, check and test operation, and adjust as required.

SECTION 15400 - PLUMBING SYSTEMS

3.7 INSTALLATION OF SUBMERSIBLE DRAINAGE PUMP(S)

- .1 Provide submersible drainage pump(s) in the drainage trench as indicated on the drawings.
- .2 Provide all required piping, including a shut-off valve and a check valve for each pump.
- .3 Hand the pump starter and control panel(s) to the electrical trade at the site for installation.

3.8 FLUSHING AND DISINFECTION OF DOMESTIC WATER PIPING

- .1 Flush domestic water piping with a sufficient flow to produce a velocity of 5' (1.5 m) per second for ten (10) minutes, or until all foreign materials have been removed and the flushed water is clear. Provide connections and pumps as required. Open and close valves, faucets, hose bibs and service connections to ensure thorough flushing.
- .2 When flushing is complete, disinfect the piping with a solution of chlorine in accordance with AWWA C601-68. The rate of chlorine application shall be proportional to the rate of water entering the pipe. The point of chlorine application shall be close to the point of filling the piping and shall occur at the same time. Operate valves, faucets and similar appurtenances while the piping contains chlorine solution.
- .3 Flush piping of chlorine solution after twenty-four (24) hours.
- .4 Measure chlorine residuals at the extreme end of each piping system being disinfected. After a chlorine residual of not less than 50 ppm has been obtained, leave the system for twenty-four (24) hours. Take further samples to ensure that there is still not less than 10 ppm of chlorine residual throughout the system.
- .5 When disinfecting is complete, fill the systems.
- .6 Ensure that the new piping being chlorinated is completely isolated from the existing system.

3.9 PLUMBING PIPING CONNECTIONS FOR EQUIPMENT AND SYSTEMS

- .1 Rough-in all required plumbing piping connections to equipment and systems. Confirm exact locations of equipment prior to roughing-in. When equipment or systems are installed, connect from the roughed-in work unless otherwise specified.
- .2 Mechanical equipment connections requirements include the following (where RP and DCAP respectively denote reduced pressure principle type and dual check valve with atmospheric port type backflow preventers):
 - .1 drainage piping connections with deep seal traps to fan system equipment drain pans;
 - .2 valved domestic cold water piping connection with RP Type backflow preventer and pressure reducing valve to heating water circulating system expansion tank make-up piping;
 - .3 valved domestic cold water piping connection with vacuum breaker and hose connection for glycol solution make-up.

END OF SECTION

SECTION 15450 - PLUMBING FIXTURES AND FITTINGS

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SECTION 15450 - PLUMING FIXTURES AND FITTINGS

PART 1 - GENERAL

1.1 REFERENCES

- .1 Section 15010 applies to and is an integral part of this Section of the Specification.
- .2 Section 15050 in this Division of the Specification also applies to and is a part of this Specification. The Section contains requirements, products and methods of execution that apply to this Section as well as to other Sections of Division 15.

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

- .1 The following work which is related to the plumbing fixture and fitting work is specified in other Sections of the Specification:
 - .1 provision of counters and cutting or drilling counters to accept plumbing fixtures and trim;
 - .2 provision of washroom accessories including soap dispensers and grab bars;
 - .3 provision of sealant for fixtures;
 - .4 provision of power wiring, back boxes for "No-Touch" fixture trim.

1.3 SHOP DRAWINGS

- .1 Submit shop drawings (fixture cuts) for all plumbing fixtures and fittings.

PART 2 - PRODUCTS

2.1 WATER CLOSETS – WALL HUNG “W-1”

- .1 American Standard #3353.001 "AFWALL Flowise ELONGATED", 1.3 GAL (6 L) flush, wall hung, vitreous china, EverClean antimicrobial surface, elongated syphon jet flush action bowl, 2 1/8" (54mm) fully glazed internal trapway 1 1/2" (38 mm) diameter back spud and the following:
 - .1 Flush valve – Sloan # -152-1.6-16-WB-ES-S, "REGAL OPTIMA" "Electronic No Touch" flush valve unit, low consumption 6 LPF (1.6 GPF) factory set flow, concealed quiet action, diaphragm type with filtered by-pass, extended flush tube, infrared proximity sensor, courtesy flush over-ride button, solenoid flush controller, circuitry, 16" (406mm) extended tube and rough-in, vacuum breaker, back check angle stop, housed in 13" x 17" (333mm x 435mm) recessed box with 14 1/2" x 18 1/2" (368mm x 470mm) S.S. face, located above toilet, Sloan #EL-154 transformer, 120/24 VAC, 50 VA.
 - .2 Seat – Centoco #AM500STSCC, elongated heavy duty solid plastic with anti-microbial compound, open front less cover, reinforced stainless steel check hinge, posts, washers and nuts.
 - .3 Carrier – J. R. Smith #0210Y single horizontal carrier with block base feet, bolts, cap nuts adjustable nipple, gasket, test plug and protective cap.

2.2 WATER CLOSETS – FLOOR MOUNTED “W-2”

- .1 American Standard #3451.160 "MADERA ELONGATED", 1.3 GAL (6 L) flush, vitreous china, floor mounted, elongated, syphon jet flush action bowl with 1 1/2" (38 mm) diameter top spud, floor flange and gasket, bolt caps, and the following:
 - .1 Flush valve – Sloan # -152-1.6-16-WB-ES-S, "REGAL OPTIMA" "Electronic No Touch" flush valve unit, low consumption 6 LPF (1.6 GPF) factory set flow, concealed quiet action, diaphragm type with filtered by-pass, extended flush tube, infrared proximity sensor, courtesy flush over-ride button, solenoid flush controller, circuitry, 16" (406mm) extended tube and rough-in, vacuum breaker, back check angle stop, housed in 13" x 17" (333mm x 435mm) recessed box with 14 1/2" x 18 1/2" (368mm x 470mm) S.S. face, located above toilet, Sloan #EL-154 transformer, 120/24 VAC, 50 VA.

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- .2 Seat – Centoco #AM500STSCC, elongated heavy duty solid plastic with anti-microbial compound, open front less cover, reinforced stainless steel check hinge, posts, washers and nuts.

2.3 WATER CLOSETS – WALL HUNG (BARRIER FREE) “WH-1”

- .1 American Standard #3353.001 "AFWALL Flowise ELONGATED", 1.3 GAL (6 L) flush, wall hung, vitreous china, Everclean antimicrobial surface, elongated syphon jet flush action bowl, 2 1/8" (54mm) fully glazed internal trapway 1 1/2" (38 mm) diameter back spud and the following:
 - .1 Flush valve – Sloan # -152-1.6-16-WB-ES-S, “REGAL OPTIMA” “Electronic No Touch” flush valve unit, low consumption 6 LPF (1.6 GPF) factory set flow, concealed quiet action, diaphragm type with filtered by-pass, extended flush tube, infrared proximity sensor, courtesy flush over-ride button, solenoid flush controller, circuitry, 16” (406mm) extended tube and rough-in, vacuum breaker, back check angle stop, housed in 13” x 17” (333mm x 435mm) recessed box with 14 ½” x 18 ½” (368mm x 470mm) S.S. face, located above toilet, Sloan #EL-154 transformer, 120/24 VAC, 50 VA.;
 - .2 Seat – Centoco #AM820STS elongated heavy duty solid plastic with anti-microbial compound, open front with cover, reinforced stainless steel check hinge, posts, washers and nuts.
 - .3 Carrier – J. R. Smith #0210Y single horizontal carrier with block base feet, bolts, cap nuts adjustable nipple, gasket, test plug and protective cap

2.4 WATER CLOSETS – FLOOR MOUNTED (BARRIER FREE) “WH-2”

- .1 American Standard #3461.160 'MADERA ELONGATED – 16-1/2" (419mm) HIGH' 'Low Consumption' Toilet, floor mounted for flush valve, vitreous china, elongated syphon jet flush action bowl, 6L (1.6 gal.) per flush, 1-1/2" (38mm) top spud, floor flange and gasket, bolt caps, and the following:
 - .1 Flush valve – Sloan # -152-1.6-16-WB-ES-S, “REGAL OPTIMA” “Electronic No Touch” flush valve unit, low consumption 6 LPF (1.6 GPF) factory set flow, concealed quiet action, diaphragm type with filtered by-pass, extended flush tube, infrared proximity sensor, courtesy flush over-ride button, solenoid flush controller, circuitry, 16” (406mm) extended tube and rough-in, vacuum breaker, back check angle stop, housed in 13” x 17” (333mm x 435mm) recessed box with 14 ½” x 18 ½” (368mm x 470mm) S.S. face, located above toilet, Sloan #EL-154 transformer, 120/24 VAC, 50 VA.;
 - .2 Seat – Centoco #AM820STS elongated heavy duty solid plastic with anti-microbial compound, open front with cover, reinforced stainless steel check hinge, posts, washers and nuts.

2.5 URINALS “UR”

- .1 American Standard #6506.011 “WASHBROOK” low consumption urinal, wall hung, vitreous china, wash out flush action, 3.8 LPF (1.0 GPF), extended sides, integral flush spreader, open trap:
 - .1 Flush Valve – Sloan # -195-1-WB-ES-S, “REGAL OPTIMA” “Electronic No Touch” flush valve unit, low consumption 3.8 LPF (1.0 GPF) factory set flow, concealed quiet action, diaphragm type with filtered by-pass, extended flush tube, infrared proximity sensor, courtesy flush over-ride button, solenoid flush controller, circuitry, 16” (406mm) extended tube and rough-in, vacuum breaker, back check angle stop, housed in 13” x 17” (333mm x 435mm) recessed box with 14 ½” x 18 ½” (368mm x 470mm) S.S. face, located above toilet, Sloan #EL-154 transformer, 120/24 VAC, 50 VA.
 - .2 Urinal wall access cleanout - Smith series #SQ4-1819 with round stainless steel face and vandal-proof screw.
 - .3 Carrier - Smith series #0637, with steel pipe legs, block feet supports and bearing plates;

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2.6 LAVATORIES COUNTER MOUNTED "L-1"

- .1 American Standard No. 0476.028 "AQUALYN", vitreous china, splash back design counter mounted lavatory with 4" (100 mm) centre supply openings, anti-splash rim, front overflow:
 - .1 Supply fitting - SLOAN OPTIMA #ETF-600-LT-VPB, electronic no touch faucet, C.P., solid cast brass with integral proximity sensor, 4" (100 mm) centre, V.P. aerator, 1.84 GPM (8L/min) flow pressure compensating spray outlet, control module, solenoid, strainer, tempered water supplied from thermostatic mixing valve with back checks and stops housed in a 12" (300mm) square recessed metal box with 13" (330mm) square V.P. S.S. face;
 - .2 Drain fitting - McGuire No. 155A, 1-1/4" (32 mm) diameter, with open grid strainer;
 - .3 Basin supply - McGuire No. H165LKN5, 3/8" (9.5 mm) diameter, chrome plated brass, with lockshield stop, chromed stainless steel wall flange, and flexible riser;
 - .4 Trap - McGuire No. 8872C, chrome-plated cast brass, 1-1/4" (32 mm) diameter, adjustable "P" type with wall flange;

2.7 LAVATORIES COUNTER MOUNTED (BARRIER FREE) "LH-1"

- .1 American Standard #09494.001 'CADET UNIVERSAL ACCESS', 102mm centres, with 533mm x 445mm x 175mm deep, counter mounted, vitreous china, integral back splash, rear overflows, self rimming:
 - .1 Supply fitting - SLOAN OPTIMA #ETF-600-LT-VPB, electronic no touch faucet, C.P., solid cast brass with integral proximity sensor, 4" (100 mm) centre, V.P. aerator, 1.84 GPM (8L/min) flow pressure compensating spray outlet, control module, solenoid, strainer, tempered water supplied from thermostatic mixing valve with back checks and stops housed in a 12" (300mm) square recessed metal box with 13" (330mm) square V.P. S.S. face;
 - .2 Drain fitting - McGuire #155WC Basin Drain, C.P., cast brass 1 pc. top, open grid with 17ga. (1.5mm), 1-1/4" (32mm) tailpiece;
 - .3 Basin supply - McGuire #H165LKN3, C.P., polished brass, rigid horizontal nipple 3/8" (9.5mm) x 3" (75mm) long I.P.S., heavy all brass angle stops, with V.P. loose key, escutcheons and S.S. braided flexible risers;
 - .4 Trap - McGuire #8872 'p' Trap, C.P., polished, cast brass adjustable body, 1-1/4" (32mm) with cleanout plug, seamless brass wall bend and escutcheon;

2.8 LAVATORIES WALL HUNG (BARRIER FREE) "LH-2"

- .1 American Standard #0954.000 'MURRO' Basin, 4" (102mm) centres, 21-1/4" x 22" x 5 - 7-1/2" (540mm x 559mm x 127-191mm) deep, wall hung, vitreous china, rear overflow, for concealed arm support, semi-pedestal #0059.020 and the following:
 - .1 Supply fitting - SLOAN OPTIMA #ETF-600-LT-VPB, electronic no touch faucet, C.P., solid cast brass with integral proximity sensor, 4" (100 mm) centre, V.P. aerator, 1.84 GPM (8L/min) flow pressure compensating spray outlet, control module, solenoid, strainer, tempered water supplied from thermostatic mixing valve with back checks and stops housed in a 12" (300mm) square recessed metal box with 13" (330mm) square V.P. S.S. face;
 - .2 Drain fitting - McGuire #155A Basin Drain, C.P., cast brass 1 pc. top, open grid with 17ga. (1.5mm), 1-1/4" (32mm) tailpiece;
 - .3 Basin supply - McGuire #H165LKN3, C.P., polished brass, rigid horizontal nipple 3/8" (9.5mm) x 3" (75mm) long I.P.S., heavy all brass angle stops, with V.P. loose key, escutcheons and S.S. braided flexible risers;
 - .4 Trap - McGuire #8872C 'p' Trap, C.P., polished, cast brass adjustable body, 1-1/4" (32mm) with cleanout plug, seamless brass wall bend and escutcheon;

SECTION 15450 - PLUMING FIXTURES AND FITTINGS

2.9 BAR SINKS – SINGLE COMPARTMENT “BS”

- .1 Kindred Commercial #QSL1515/6/2, single compartment, self-rimming, 15-7/16" x 15-1/8" x 6" (392 mm x 384 mm x 152 mm) deep, Grade 18-8, Type 302 stainless steel counter sink with back ledge, satin finished bowls, mirror polished rim, punched on 4" (102 mm) centres, sound deadening, rim gasket, 3-1/2" (90 mm) diameter crumb cup strainer, installation hardware, and the following:
 - .1 Supply fitting - Chicago Faucets #895-V-XK/E35VP Faucet, C.P. 4" (102mm) C.C., deck mounted, solid cast brass lead-free body, 1/4 turn ceramic disc valve cartridges, 9" (229mm) swing spout, vandal-resistant 5.7 LPM (1.5 GPM) flow aerator outlet and cast brass lever handles.
 - .2 Supplies McGuire #H165LKN5, Polished Brass, rigid horizontal nipples 3/8" (10mm) x 5" (127mm) long, I.P.S. heavy all brass angle stops with V.P. loose key, escutcheons and with flexible copper risers.
 - .3 Trap – McGuire #8912CB, polished cast brass adjustable body, 1-1/2" (38mm) with cleanout plug, seamless brass wall bend and escutcheon.

2.10 COUNTER SINKS – THREE COMPARTMENT “CS-1”

- .1 Kindred Commercial #LBD6410P-1/3, triple compartment, self-rimming, 46-3/8" x 20-9/16" x 10" (1178 mm x 522 mm x 254 mm) deep, Grade 18-8, Type 302 stainless steel counter sink with back ledge, satin finished bowls, mirror polished rim, punched on 8" (200 mm) centres, sound deadening, rim gasket, 3-1/2" (90 mm) diameter crumb cup strainer, installation hardware, and the following:
 - .1 Supply fitting - Chicago Faucets #1100-V-L12-XK-E35VP Faucet, C.P. 8" (203mm) C.C., deck mounted, solid cast brass lead-free body, 1/4 turn ceramic disc valve cartridges, 12" (305mm) swing spout, vandal-resistant 5.7 LPM (1.5 GPM) flow aerator outlet and cast brass hooded lever handles.
 - .2 Supplies McGuire #H165LKN5, Polished Brass, rigid horizontal nipples 3/8" (10mm) x 5" (127mm) long, I.P.S. heavy all brass angle stops with V.P. loose key, escutcheons and with flexible copper risers.
 - .3 Trap – McGuire #8904C, polished cast brass adjustable body, 2" (50mm) with cleanout plug, seamless brass wall bend and escutcheon.

2.11 MOP SINK “MS”

- .1 Stern Williams MTB-2424 'SERVICEPTOR' Mop Sink, 24" x 24" x 10" (610mm x 610mm x 254mm) deep, floor mounted, precast terrazzo, with one piece stainless steel cast integral cap on all four sides and integral drain with strainer, and the following:
 - .1 Supply fitting - Chicago Faucets #305VB-R-XK-hose faucet, C.P. 8" (203mm) centre., wall mounted, solid cast brass lead-free body with 1/4 turn ceramic disc valve cartridges, cast brass lever handles;
 - .2 Stern Williams #BP S.S. Back Splash Panel on back side.
 - .3 Trap - 3" (75 mm) diameter cast iron or rough copper "P" trap.

2.12 EMERGENCY EYE WASH “EW”

- .1 Haws Model #. 7360B wall hung emergency eyewash with factory assembled stainless steel receptor, twin aeration spray heads volume regulator and push handle and complete with:
 - .1 Trap - McGuire No. 8872C, chrome-plated, cast brass, 32mm diameter adjustable “P” type with wall flange
 - .2 Mixing valve as specified in Article 2.11 “Mixing Valve (Eye Washes)
 - .3 Wall bracket and universal sign.

SECTION 15450 - PLUMBING FIXTURES AND FITTINGS

2.13 MIXING VALVE (EYE WASHES)

- .1 Haws 9201EW self-contained thermostatic mixing valve assembly consisting of a thermostatic mixing valve, dial thermometer on the outlet, angle check-stops on the inlets, wall mounting bracket, piping and fittings factory assembled and tested for a maximum water temperature of 90°F (32°C). Unit must be able to maintain a constant temperature within ±3°F (1.6°C) up to a minimum flow of 0.5 GPM (1.9 L/min).
- .2 Unit shall close down on failure of cold water supply, and shall come complete with cold water bypass capable of 1.25 GPM (4.73 L/min) at 30 PSI (63 kPa) pressure drop.
- .3 Temperature regulator shall be locking type set for 85°F (29°C).

2.14 ACCEPTABLE PLUMBING FIXTURE AND FITTING MANUFACTURERS

- .1 Acceptable manufacturers of plumbing fixtures and fittings are as follows:
 - .1 vitreous china, enamelled steel and enamelled cast iron fixtures, unless otherwise noted American Standard, Kohler, and Crane;
 - .2 stainless steel sinks – Kindred Commercial Ltd., and Architectural Metal Products
 - .3 water closet seats - Centoco, Moldex, Olsonite, and Beneke;
 - .4 flush valves – Sloan, Delta Commercial, Zurn;
 - .5 fixture carriers - J. R. Smith, Watts Industries and Zurn Industries;
 - .6 supply fittings, unless otherwise noted - Chicago Faucets, Delta Commercial, Zurn Industries, Sloan, Speakman and American Standard;
 - .7 drain fittings, angle supplies and traps unless otherwise noted McGuire, Zurn Industries, Delta Commercial, Chicago Faucets and American Standard;
 - .8 prefabricated mop sinks - Stern Williams and Fiat;
 - .9 emergency eye washes - Haws, Guardian and Speakman;
 - .10 mechanical and thermostatic mixing valves – Haws, Symmons, Powers, Leonard and RADA.

PART 3 - EXECUTION

3.1 INSTALLATION OF PLUMBING FIXTURES AND FITTINGS

- .1 Provide plumbing fixtures and fittings where shown on the drawings.
- .2 Connect plumbing fixtures and fittings with piping of minimum size in accordance with the following schedule. Refer to manufacturer’s published connection (rough in) requirements. Where manufacturer requires piping connection larger than shown below, provide piping accordingly:

FIXTURE AND/OR FITTING	DRAIN SIZE IN. (mm)	VENT SIZE IN. (mm)	DHW SIZE IN. (mm)	DCW SIZE IN.(mm)	TEMP WATER SIZE IN. (mm)
Water Closets Flush Valve Type	4 (100)	1 1/2 (38)		1 (25)	
Urinals	2 (50)	1 1/2 (38)		3/4 (20)	
Lavatories	1 1/4 (32)	1 1/4 (32)	1/2 (12)	1/2 (12)	
Counter Sinks	1 1/2 (38)	1 1/4 (32)	1/2 (12)	1/2 (12)	
Prefab. Mop Sinks With Drain	3 (75)	1 1/2 (38)	3/4 (20)	3/4 (20)	

SECTION 15450 - PLUMING FIXTURES AND FITTINGS

Emergency Eye Wash					1/2 (12)
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- .3 Confirm the exact location of all plumbing fixtures and trim prior to roughing in. Refer to architectural drawing part plans and elevations as applicable.
- .4 Unless otherwise noted, all vitreous china and enamelled fixtures shall be white.
- .5 Unless otherwise noted, all exposed piping associated with fixtures shall be polished and chrome plated.
- .6 Provide properly sized water hammer arrestors in hot and cold rough in piping at individual or groups of plumbing fixtures. Water hammer arrestors are specified in Section 15400. Install water hammer arrestors in strict accordance with the manufacturer's instructions, and ensure that water hammer arrestors are accessible.
- .7 When installation is complete, check and tests the operation of each fixture and fitting. Adjust or repair as required.
- .8 Supply templates for all counters mounted plumbing fixtures and fittings and turn the templates over to the trade(s) cutting the counter openings.
- .9 Prior to ordering or installation, confirm that carriers specified for wall hung fixtures are suitable in all respects for the fixtures and the wall construction and finish.
- .10 Adjust the fixture carrier for wall hung wheelchair lavatories so that the top of the bowl is 33" (838 mm) above the finished floor.
- .11 Where a mixing valve is specified (i.e., lavatory or sink), pipe outlet of valve to supply fitting hot water inlet, unless shown or specified otherwise.

END OF SECTION

SECTION 15500 - FIRE PROTECTION

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- 2.3 PIPING SHUT-OFF VALVE SUPERVISORY SWITCHES
- 2.4 WATER FLOW ALARM SWITCHES
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- 3.2 INSTALLATION OF FLOW ALARM SWITCH(ES)
- 3.3 INSTALLATION OF SPRINKLER HEADS
- 3.4 INSTALLATION OF FIRE EXTINGUISHERS

SECTION 15500 - FIRE PROTECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 Section 15010 in this Division of the Specification applies to and is a part of this Section.
- .2 Section 15050 in this Division of the Specification also applies to and is a part of this Section of the Specification. The Section contains requirements, products and methods of execution that apply to this Section as well as to other Sections of Division 15.

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

- .1 The following work which is related to the sprinkler work is specified in other Sections of the Specification:
 - .1 fire alarm system wiring connections to sprinkler equipment;
 - .2 provision of electric power wiring connections to equipment and controls.

1.3 SHOP DRAWINGS

- .1 Submit shop drawings for the following:
 - .1 all sprinkler system components except piping, fittings, hangers supports, and standard valves;
 - .2 complete and dimensioned system layout drawings indicating all heads and equipment, pipe sizing, and all calculations and design data used in preparing the layouts and sizing the piping.
- .2 Note that the layout drawings must first be submitted to and approved by the local governing authorities and Owners insurer prior to being submitted to the Consultant for review.

1.4 CONTRACTOR'S REQUIREMENTS

- .1 Contractor providing work of this Section shall be a Member in Good Standing of the Canadian Automatic Sprinkler Association.
- .2 Contractor's personnel installing sprinkler work shall possess a valid Certificate of Qualification issued by the Ontario Department of Labour.
- .3 The above requirements shall supplement other requirements stipulated or implied elsewhere in the Specification.

PART 2 - PRODUCTS

2.1 SPRINKLER PIPING HANGERS AND SUPPORTS

- .1 Generally, as specified in PART 2 of Section 15050, but ULC listed.

2.2 SHUT-OFF AND CHECK VALVES

- .1 Gate type OS&Y shut-off valves or lug body butterfly type shut-off valves, and horizontal swing check valves or lug body wafer type check valves, generally as specified in Section 15050, but minimum 175 psi (1207 kPa) rated and ULC listed and F.M. approved.
- .2 Check valves associated with siamese connection(s) shall be tapped for site installation of a 3/4" (19 mm) diameter automatic ball drip.

SECTION 15500 - FIRE PROTECTION

2.3 PIPING SHUT-OFF VALVE SUPERVISORY SWITCHES

- .1 Conswiss Industries Ltd., "VALVE GUARD", or Potter Electric Signal & Mfg. Ltd., ULC listed and F.M. approved, tamper-proof, 115 volt supervisory switches, each arranged to activate an alarm condition if a shut-off valve is closed or tampered with, and each complete with all mounting and connection hardware. Where Victaulic shut-off valves are used, Victaulic Style 737 ULC listed supervisory switches are acceptable.

2.4 WATER FLOW ALARM SWITCHES

- .1 Potter Inc., Model VSR-SF, ULC listed and F.M. approved, pipe mounting water flow switches, each complete with a vane type sensor operating two (2) single pole double throw snap-action switches when sustained water flow exceeds 10 GPM (0.75 l/s), integral field adjustable pneumatic retard device with automatic reset to delay switch operation to reduce the possibility of false alarms caused by a single or series of transient water flow surges, tamper proof cover, U-bolt, and piping saddle.

2.5 SPRINKLER HEADS

- .1 ULC listed sprinkler heads as follows:
 - .1 equal to Tyco Fire and Building Products Model "TY-FRB", upright, pendant or sidewall type;
 - .2 equal to Tyco Fire and Building Products Model "DS-1", dry sidewall or pendant type sidewall.
 - .3 equal to Tyco Fire and Building Products Model "EC-11", semi recessed pendant with chrome cup & escutcheon;
- .2 Sprinkler heads in finished areas without suspended ceilings, shall be chrome plated unless otherwise noted.
- .3 Sprinkler heads which are in exposed areas where they may be subject to damage shall be complete with wire guards, chrome-plated where in finished areas.
- .4 Sprinkler heads located in areas or over equipment where high ambient temperature is present shall be proper high temperature heads. All other heads shall be 74 degrees C. unless otherwise noted.

2.6 SPRINKLER DROPS

- .1 EasyFlex, or approved equal, corrugated flexible fire sprinkler drops complete with T-bar brackets, snap clamps, stock bars, etc. to NFPA standards, ULC listed and FM approved.

2.7 FIRE EXTINGUISHERS

- .1 National Fire Equipment Ltd., Model ABC-5, 5 lb. (2.3 Kg.), ULC listed and 3A:10BC rated pressurized dry chemical extinguishers, each complete with a wall mounting bracket and securing hardware.
- .2 Acceptable manufacturers are National Fire Equipment Ltd., C.F.H. Industries Ltd., Pyrene and Wilson & Cousins.

2.8 ACCEPTABLE SPRINKLER COMPONENT MANUFACTURERS

- .1 Except where acceptable manufacturers are named for products, equipment, etc., products may be supplied by one (1) of the following manufacturers: The Viking Corporation, Victaulic and Tyco Fire & Building Products.
- .2 Products, equipment, etc., supplied must, as a minimum, have approvals specified plus any other approvals required by the Authority.

PART 3 - EXECUTION

3.1 SPRINKLER SYSTEM PIPING INSTALLATION REQUIREMENTS

- .1 Provide all required sprinkler system piping.

SECTION 15500 - FIRE PROTECTION

- .2 Underground service pipe to inside the building shall be centrifugally cast ductile iron or where approved by the Authority, rigid FM approved PVC pressure pipe braced and secured at bends and tees with concrete thrust blocks in accordance with Municipal standards and details.
- .3 Unless otherwise noted, pipe inside the building and above ground shall be Schedule 40 mild black steel, screwed for pipe to 2-1/2" (65 mm) diameter, screwed or welded for pipe 2-1/2" (65 mm) diameter and larger. Where permitted by NFPA No. 13, pipe may be Schedule 30 and "Thinwall" mild black steel with welding fittings and joints, all in accordance with NFPA No. 13 requirements.
- .4 At your option, pipe inside the building and above ground may be factory or site grooved end black steel pipe with Victaulic fittings and couplings in accordance with the requirements of Section 15050. Where working pressure will not exceed 175 psi (1200 kPa.), couplings and fittings may be Victaulic "FIRELOCK". Victaulic "FIT" fast installation tees will be acceptable for sprinkler head tees only.
- .5 Sprinkler piping in shower areas shall be type "M" hand copper with 95% tin – 5% antimony solder joints.
- .6 Sprinkler work shall be hydraulically sized by a Professional Engineer, based on the procedures of NFPA No. 13. Contractor is responsible for obtaining all required water flow test and pressure data. Submit flow test data and calculations used, with the shop drawings. Calculations used for hydraulically sized systems shall bear the Professional Engineer's signed stamp.
- .7 Provide shut-off valves and check valves in sprinkler piping where shown.
- .8 Where shown, equip shut-off valves with supervisory switches.
- .9 Slope all horizontal piping so that it may be drained completely through risers, equipment or through valved drainage branches.
- .10 Provide sprinkler piping flushing connections consisting of threaded and capped 4" (100 mm) long nipples on the ends of mains where required and/or shown.
- .11 Provide inspector's test connections where required by Code and as shown. Provide all required test connection drainage piping.
- .12 Generally, arrange and install sprinkler work as shown on the drawings, however, exact arrangement and installation must comply with all requirements of the latest edition of "STANDARD FOR THE INSTALLATION OF SPRINKLER SYSTEMS", NFPA No. 13, the Standard of the National Fire Protection Association and as adopted by the Building Code and Fire Department.
- .13 Municipal Water Supply Testing:
 - .1 Arrange for any testing necessary to confirm adequacy of municipal water supplies.
 - .2 Contractor shall be responsible for all work, permits and fees associated with the testing.

3.2 INSTALLATION OF FLOW ALARM SWITCH(ES)

- .1 Provide water flow alarm switch(es) in wet sprinkler zone piping where shown. Install in accordance with the manufacturer's recommendations and instructions and connect with piping as indicated.
- .2 Adjust to suit site water pressure conditions. Check and test operation.
- .3 Where shown on the drawings, install flow alarm switches and inspector's test connection assemblies in flush wall mounted identified boxes. Confirm box locations prior to roughing-in.

3.3 INSTALLATION OF SPRINKLER HEADS

- .1 Provide all required sprinkler heads.
- .2 Unless otherwise noted, sprinkler heads shall be as follows:
 - .1 in areas with finished ceilings – semi-recessed type with chrome cups;
 - .2 in areas without ceilings – pendant upright heads;

SECTION 15500 - FIRE PROTECTION

- .3 in storage and service spaces – upright with wire guards;
- .4 in garbage room – dry type sidewall heads.
- .3 Ensure that the maximum protrusion of semi-recessed sprinkler heads from the underside of the finished ceiling shall be 1" (25 mm). Failure to comply with this requirement shall result in reinstallation of sprinkler heads.
- .4 Maintain maximum headroom in areas with no ceilings.
- .5 Provide guards for heads in storage rooms, and wherever else indicated on drawings where they are subject to damage.
- .6 Provide high temperature heads where required.
- .7 Co-ordinate sprinkler head locations in areas with suspended ceilings with the location of lighting, grilles, diffusers, and similar items recessed in or surface mounted on the ceiling as per the reflected ceiling plans. In areas with lay-in tile, centre the sprinkler head both ways in the lay-in tile.

3.4 INSTALLATION OF FIRE EXTINGUISHERS

- .1 Provide fire extinguishers where shown. Unless otherwise noted, wall mount each extinguisher with a mounting bracket.

END OF SECTION

SECTION 15600 - POWER AND HEAT GENERATION

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- 3.1 GAS PRESSURE
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- 3.3 NATURAL GAS SYSTEM PIPING INSTALLATION REQUIREMENTS

SECTION 15600 - POWER AND HEAT GENERATION

PART 1 - GENERAL

1.1 REFERENCES

- .1 Section 15010 in this Division of the Specification applies to and is a part of this Section.
- .2 Section 15050 in this Division of the Specification also applies to and is a part of this Section of the Specification. The Section contains requirements, products and methods of execution that apply to this Section as well as other Sections of Division 15.

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS OR PROVIDED BY OWNER

- .1 The following work which is related to the power and heat generation work is specified in other Sections of the Specification (or provided by Owner as noted):
 - .1 Provision of domestic water and drainage piping connections to gas fired domestic hot water storage heaters;
 - .2 Provision of power wiring connections to boilers and boiler plant control panel, and all required 115 volt control wiring;
 - .3 Provision of flues and stacks for natural gas fired equipment;

1.3 SHOP DRAWINGS

- .1 Submit shop drawings for all equipment and accessories specified in PART 2 of this Section.

PART 2 - PRODUCTS

2.1 TANKLESS GAS WATER HEATER

- .1 Bradford White., CGA approved, natural gas fired, factory tested gas fired tankless water heaters as per the drawing schedule, each complete with:
 - .1 Lime Accumulation Sensor;
 - .2 Direct Electronic Ignition;
 - .3 Digital main controller integrated into the front panel of the water heater with a default temperature range of 96 F – 120 F.
 - .4 Fully Automatic Controls – outgoing water temperature is to be monitored by built in sensor. Burner and combustion blower to modulate between minimum and maximum input to maintain set point temperature;
 - .5 Heat exchanger – nine pass
 - .6 A temperature and pressure relief valve, to ANSI 21.22 and/or CGA CAN-4.4;
 - .7 A drain valve;
 - .8 Roof vent kit and co-axial venting;
- .2 Acceptable manufacturers are Bradford White, Takagi, Rheem and A.O. Smith Enterprises Ltd.

PART 3 - EXECUTION

3.1 GAS PRESSURE

- .1 Establish the pressure of the gas at all gas fired appliances prior to ordering the equipment.

3.2 INSTALLATION OF TANKLESS GAS FIRED WATER HEATERS

- .1 Provide tankless gas water heaters where shown.
- .2 Secure each heater in place, level and plumb and connect with gas piping.

SECTION 15600 - POWER AND HEAT GENERATION

- .3 Provide vent and intake on each heater and extend and connect vent terminal to vent terminals.
- .4 When installation is complete, check and test heater operation and all safeties and control. Adjust as required and, unless otherwise specified, set the thermostats so the heaters produce 120 degrees F. (49 degree C.) hot water.

3.3 NATURAL GAS SYSTEM PIPING INSTALLATION REQUIREMENTS

- .1 Make all required arrangements with the natural gas supply Utility on behalf of the Owner for installation gas service piping with gas pressure regulator and meter assembly where shown.
- .2 Provide all required natural gas distribution piping to connect gas fired or operated equipment, and provide all required vent piping to atmosphere. Do all piping work in accordance with requirements of CAN1-B149.1-05 as amended by the Ontario Gas Utilization Code and requirements of any other Governing Authority.
- .3 Pipe shall be Schedule 40 mild black steel.
- .4 Provide CGA approved ball type or lubricated plug type shut-off valves to isolate equipment, and wherever else shown.
- .5 Slope gas piping in the direction of flow to low points.
- .6 Provide full pipe diameter, 6" (150 mm) long drip pockets at the bottom of all vertical risers, at all piping low points, and wherever else shown and/or required.
- .7 Identify all natural gas piping in accordance with requirements of Governing Authorities.
- .8 Ensure that Gas Utility and the TSSA has inspected each piece of gas fired equipment and that it has been approved for operation (i.e.: Gas Utility has affixed a tag to each piece of gas fired equipment).

END OF SECTION

SECTION 15650 - REFRIGERATION

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- 2.2 SELF-CONTAINED BREATHING APPARATUS

PART 3 - EXECUTION

- 3.1 INSTALLATION OF REFRIGERANT CONCENTRATION MONITOR
- 3.2 INSTALLATION OF SELF-CONTAINED BREATHING APPARATUS

SECTION 15650 - REFRIGERATION

PART 1 - GENERAL

1.1 REFERENCES

- .1 Section 15010 in this Division of the Specification apply to and are a part of this Section of the Specification.
- .2 Section 15050 in this Division of the Specification also applies to and is a part of this Section of the Specification. The Section contains requirements, products, and methods of execution that apply to this Section as well as to other Sections of Division 15.

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

- .1 The following work which is related to the refrigeration work is specified in other Sections and Issues of the Specification:
 - .1 electric power wiring to equipment;

1.3 SHOP DRAWINGS

- .1 Submit shop drawings for all refrigeration equipment specified in this Section.

PART 2 - PRODUCTS

2.1 REFRIGERANT CONCENTRATION MONITOR

- .1 Vulcain refrigerant leak detection system, as shown on the drawings and specified herein, providing continuous gas concentration display, UL and CSA Certified, with the following:
- .2 VA301EM-RFSA-EMBG Expansion Module for inside the Mechanical Equipment Room
 - .1 The expansion module must be installed inside the mechanical room and be capable of communicating digitally with the networked sensors through RS-485 Modbus communication. Up to 20 sensors can be connected at a maximum distance of 200 feet. One power supply (bringing either 17-27 Vac or 24-38 Vdc) will be sufficient to power the entire gas detection network (expansion module and sensors).
 - .2 The expansion module will manage four internal DPDT relays at fully programmable alarm levels. The relay rating will be no lower than 5 A, 30 Vdc or 250 Vac (resistive load).
 - .3 The expansion module must provide all the functionalities necessary to comply with ASHRAE / B-52 Mechanical Codes. This includes a key for manual fan start/ stop operation, a silence key to acknowledge RFSA 105db horn (audible alarm operation), a RED strobe on top of the unit as a visual alarm and (2) inputs for the "EMBG" breakglass switch for EMERGENCY shutdown .
 - .4 The expansion module will indicate the exact concentration of gas and the gas detected. The LCDscreen display will indicate multiple alarm levels for each sensing point. The LED indicators will also provide visual feedback in the following manner:
 - .1 Normal Operation: Green LED
 - .2 Alarm Level A: Red LED
 - .3 Alarm Level B: Red LED
 - .4 Alarm Level C: Red LED
 - .5 Failure: Yellow LED
 - .6 TX: Yellow LED
 - .5 The standard three high/low alarm levels will be complemented with a fault relay.
 - .6 The expansion module must provide an individual 4-20mA output per sensor for BAS compatibility.

SECTION 15650 - REFRIGERATION

- .7 The unit will be certified to UL and CSA standards. The controller must be manufactured within an ISO 9001 production environment.
- .3 VA301EMRP-RFSA-EMBG Remote Panel for outside the Mechanical Equipment Room
 - .1 The expansion module must be installed outside the mechanical room at each door and be capable of communicating digitally with the Expansion Module. Up to (10) VA-301EMRP-RFSA-EMBG Remote Panels can be connected at a maximum distance 1000ft.
 - .2 The Remote Panel will manage four internal DPDT relays at fully programmable alarm levels. The relay rating will be no lower than 5 A, 30 Vdc or 250 Vac (resistive load).
 - .3 The remote panel must provide all the functionalities necessary to comply with most current ASHRAE or B-52 Mechanical Codes. This includes a key for manual "fan start" only operation, a silence key to acknowledge the internal 65 db audible alarm and a RED strobe on top of the unit as a visual alarm..
 - .4 The Remote panel will indicate the exact concentration of gas and the gas detected. The LCD screen display will indicate multiple alarm levels for each sensing point. The LED indicators will also provide visual feedback in the following manner:
 - .1 Normal Operation: Green LED
 - .2 Alarm Level A: Red LED
 - .3 Alarm Level B: Red LED
 - .4 Alarm Level C: Red LED
 - .5 Failure: Yellow LED
 - .6 TX: Yellow LED
 - .5 The standard three high/low alarm levels will be complemented with a fault relay.
 - .6 The expansion module must provide an individual 4-20mA output per sensor for BAS compatibility.
 - .7 The unit will be certified to UL and CSA standards. The controller must be manufactured within an ISO 9001 production environment.
- .4 EC F9 NH3 EM Ammonia Gas Sensor
 - .1 The power requirement of the EC F9 NH3 will be 24Vdc @ 0.5 A
 - .2 The sensor will be powered by the VA-301EM-RFSA-EMBG expansion module. The transmitter will be capable of transmitting gas concentrations through the control panel for activation of fans or louvers (or other equipment) through the control panel as necessary. The gas transmitter shall be a diffusion type sensor and will incorporate an ammonia selective electrochemical cell. The sensor shall have accuracy of +/- 5% and repeatability of +/- 2% full scale. Response time T90 =1 minute.
 - .3 The transmitter will be capable of operating within relative humidity ranges of 5-90% and temperature ranges of -18oC to 60oC; (0oF to 125oF). The transmitter must also have an optional capability of operating at lower temperature ranges (when equipped with ATMOS option; - 50Deg C to + 60Deg C; 5%-100% RH - Condensing.
 - .4 The sensor housing shall be NEMA 1 gasketed # 16 gauge painted steel with hinged lockable cover.
 - .5 The unit will be manufactured to UL 1244 label and CSA 22.2. The transmitter must be manufactured within an ISO 9001-2000 production environment.
 - .6 The sensor alarm levels and unit are to be installed in accordance with the following parameters:

SECTION 15650 - REFRIGERATION

TOXIC GASES	FIRST ALARM RECOMMENDED SET POINT	SECOND ALARM RECOMMENDED SET POINT	TRANSMITTER LOCATION	RADIUS OF COVERAGE
Ammonia (NH3)	25ppm	35 ppm	300mm (1ft) Below the ceiling	6 Meters (20 Ft)

- .5 Site Services:
 - .1 Conduct site review of installed refrigeration plant and determine (finalize) most suitable location(s) for refrigerant sampling point locations.
 - .2 Manufacturer shall calibrate monitor and certify satisfactory system installation and operation in writing to Consultant.
- .6 Operating And Maintenance Manual:
 - .1 Supply three (3) bound operating and maintenance manuals each complete with:
 - .1 a complete explanation of operation principles and sequences;
 - .2 complete parts list with numbers;
 - .3 recommended maintenance practices and precautions.
- .7 Acceptable manufacturers are Vulcain, MSA Canada Inc. or other manufacturers recommended by refrigerant manufacturer.

2.2 SELF-CONTAINED BREATHING APPARATUS

- .1 Vulcain Model NIOSH self contained breathing apparatus complete with one positive pressure second stage regulator, one first stage pressure reducing valve, one cylinder connector assembly, one shoulder mounted combined pressure indicator, one warning whistle, one positive pressure facemask fitted with optically clear polycarbonate visors, one back plate and harness assembly and one 30 minute aluminum cylinder.
- .2 Wall mount case must have an external latch and lightweight design to allow fast and easy installation. Durable ABS construction resists corrosion for long service life. Window provides view of the cases contents for faster inspections and better emergency location.
- .3 Site Services:
 - .1 Manufacturer shall include for a minimum of 6 hours of instruction to Owner's staff by qualified personnel to demonstrate all facets of equipment fitting, operation, maintenance, etc.

SECTION 15650 - REFRIGERATION

- .4 Operating And Maintenance Manual:
 - .1 Supply three (3) bound, operating and maintenance manuals each complete with:
 - .1 a complete explanation of operation principles and sequences;
 - .2 complete parts list with numbers;
 - .3 recommended maintenance practices and precautions.
 - .5 Acceptable manufacturers are Vulcian, Survivair, MSA Canada Inc. and Scott (Safety Supply Canada).

PART 3 - EXECUTION

3.1 INSTALLATION OF REFRIGERANT CONCENTRATION MONITOR

- .1 Provide a complete refrigerant concentration monitor system where shown.
- .2 Exact location of sampling points and other components shall be determined on site by the manufacturer upon review of completed refrigeration systems. Calibration of system shall be on site by manufacturer.
- .3 Confirm location of monitor panels with Consultant prior to roughing in.
- .4 Install components in strict accordance with manufacturer's instructions and wiring diagrams. Provide low voltage wiring in conduit per the requirements of Division 16.
- .5 Forward four (4) copies of letter from manufacturer certifying satisfactory installation and operation of system.

3.2 INSTALLATION OF SELF-CONTAINED BREATHING APPARATUS

- .1 Provide two (2) self-contained breathing apparatuses and install as indicated by the Consultant on site.
- .2 Arrange and coordinate instructions to Owner's staff by manufacturer, at the convenience of the Owner.
- .3 Provide two (2) spare tanks. Leave all tanks full.

END OF SECTION

SECTION 15850 - AIR HANDLING

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- 2.2 ROOFTOP HEATING VENTILATING UNITS (HV-1)
- 2.3 IN-LINE FANS
- 2.4 ROOF MOUNTED EXHAUST FANS
- 2.5 RANGE HOODS
- 2.6 AIR FILTER GAUGES
- 2.7 GAS FIRED UNIT HEATERS

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- 3.1 INSTALLATION OF ROOFTOP AIR HANDLING UNITS
- 3.2 INSTALLATION OF ROOFTOP HEATING VENTILATING UNITS
- 3.3 INSTALLATION OF IN-LINE FAN
- 3.4 INSTALLATION OF ROOF MOUNTED EXHAUST FANS
- 3.5 INSTALLATION OF RANGE HOODS
- 3.6 INSTALLATION OF AIR FILTER GAUGES
- 3.7 INSTALLATION OF GAS FIRED UNIT HEATERS

SECTION 15850 - AIR HANDLING

PART 1 - GENERAL

1.1 REFERENCES

- .1 Section 15010 in Division 15 applies to and is a part of this Section of the Specification.
- .2 Section 15050 in this Division of the Specification also applies to and is a part of this Section of the Specification. The Section contains requirements, products, and methods of execution that apply to this Section as well as to other Sections of Division 15.

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

- .1 The following work which is related to the air handling work is specified in other Sections of the Specification:
 - .1 all required starter interlock wiring and 115 volt control wiring;
 - .2 supply of control components and control connections to all components such as motorized dampers associated with automatic control systems;
 - .3 installation of curbs for roof mounted air handling units and fans;
 - .4 provision of exterior wall louvres and birdscreen;
 - .5 provision of domestic water and drain piping connections to equipment;
 - .6 provision of casings, plenums, ductwork, dampers, grilles, diffusers, and similar system components;
 - .7 provision of heat transfer piping connections to coils;
 - .8 provision of site applied thermal insulation;
 - .9 provision of products-of-combustion detectors in fan equipment for fire alarm system fan shut-down;
 - .10 provision of controls for heat pipes and heat wheels excluding heat pipe actuator which shall be provided by unit manufacturer;
 - .11 provision of variable frequency drives;
 - .12 provision of outdoor air and exhaust air dampers and actuators.

1.3 SHOP DRAWINGS

- .1 Submit shop drawings for all equipment specified in this Section.
- .2 Shop drawings shall be complete with outline drawings, AMCA certified pressure volume performance curves, showing point of operation and AMCA Certified sound power data shall be submitted.
- .3 Include the name of the fan manufacturer in the submission for cabinet fan assemblies.

PART 2 - PRODUCTS

2.1 ROOFTOP AIR HANDLING UNITS (RTU-1 TO 6)

- .1 General
 - .1 McQuay packaged single zone rooftop air handling units as per schedule. Unit shall include supply fan section, return plenum / economizer section, filter section, cooling coil section, gas heating section, condensing unit section, power exhaust etc. Units shall be completely factory assembled, piped, wired, tested and shipped in one piece to the job site.

SECTION 15850 - AIR HANDLING

- .2 Units shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. The complete unit shall be cULus listed. Gas furnace units shall be UL listed and classified in accordance with ANSI- Z 21.47. Unit shall comply with ASHRAE 90.1-2004 standards for efficiency and EER.
 - .3 MPS packaged units shall be shipped fully charged with Refrigerant 410A and POE oil.
 - .4 The unit shall undergo a complete factory run test prior to shipment. The factory test shall include final balancing of the supply fan assemblies, a refrigeration circuit run test, a unit control system operations checkout, a unit refrigerant leak test and a final unit inspection.
 - .5 All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door. Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit.
 - .6 Warranty: The manufacturer shall provide 12-month warranty on the unit and 48-month warranty on the compressor. The warranty period shall commence at startup or six months after shipment, whichever occurs first.
- .2 Casing
- .1 Panel construction shall be 18 GA single wall construction with a baked powder coat finish. Insulation shall be a minimum of 3/4" thick fiberglass with a foil face surface. Insulation shall be glued to the panel as well as mechanically fastened. In lieu of foil face insulation with mechanical fasteners, double wall construction may be substituted. Panel design shall not have any exposed insulation edges.
 - .2 Exterior surfaces shall be constructed of 18 GA, G90 galvanized, with a baked powder coat finish of a neutral beige color. Finished panel surfaces to withstand a minimum 1000-hour salt spray test in accordance with ASTM B 117 standard for salt spray resistance
 - .3 Base frame shall be 14 GA galvanized steel and be a full perimeter design. The base frame shall have integral forklift slots and rigging holes. The unit base shall overhang the roof curb for positive water runoff and shall seat on the roof curb gasket to provide a positive, weather tight seal.
 - .4 The full unit base pan shall be a one-piece stamped design. The base pan shall have a stamped 1 1/8" flange around the supply and return air openings to prevent any water to penetrate into the building. The base pan shall be insulated with foil face insulation with mechanical fasteners on the underside of the pan. The rooftop base pan shall not have insulation on the air stream side of the equipment
 - .5 Service doors shall be provided on the filter section, supply fan, and the electrical control panel section. All service access doors shall be mounted on multiple hinges and shall be secured by a 1/4 turn latch system. Removable panels secured by multiple mechanical fasteners are not acceptable.
- .3 Supply Fans
- .1 Supply fan shall be a double width double inlet (DWDI) forward curved centrifugal fan. The supply fan shall be mounted using solid-steel shafts and wheel hubs with mating keyways.
 - .2 The fan assembly shall have adjustable pitched sheaves on the motor. Bushings shall be used on all sheaves to allow for easy removal of the pulleys from the fan and motor shaft. Fixed bore pulleys fastened to the shaft by setscrews will not be allowed. The drives shall be selected with a 1.2 service factor.
 - .3 All fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance, prior to shipment. All fan assemblies shall employ solid steel fan shafts. Bearings shall be sized to provide a L-50 life of 250,000 hours.

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- .4 Fan motors shall be heavy-duty, 1800 rpm, open drip-proof (ODP). Motors efficiencies shall meet EPA efficiencies. Motors shall be mounted on an adjustable base that provides for proper alignment and belt tension adjustment.
 - .5 The fan design shall allow for the fan and motor assembly to slide out of the rooftop unit for ease of servicing the equipment.
- .4 Exhaust Fans
- .1 Where indicated on the schedules, provide belt driven or direct drive power exhaust fans. Propellers shall be constructed with fabricated steel blades and hubs. Propellers shall be securely attached to the fan shaft and be statically and dynamically balanced. Exhaust fans shall control building static pressure in economizer mode only.
- .5 Electrical
- .1 A Unit wiring shall comply with NEC requirements and with all applicable UL standards. All electrical components shall be UL recognized where applicable. All wiring and electrical components provided with the unit shall be number and color-coded and labeled according to the electrical diagram provided for easy identification. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a single point power connection for main power connection. A terminal board shall be provided for low voltage control wiring. Each compressor and condenser fan motor shall be furnished with contactors and thermal overload protection. Supply fan motors shall have a factory installed and wired control contactor. Knockouts shall be provided in the bottom of the main control panels for field wiring entrance.
 - .2 A single non-fused disconnect switch shall be provided for disconnecting electrical power at the unit. Disconnect switches shall be mounted internally to the control panel and operated by an externally mounted handle
- .6 Heating and Cooling Sections
- .1 MPS010B - MPS025B ton units: Direct expansion (DX) cooling coils shall be fabricated of seamless high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row design. Units shall have two independent refrigerant circuits and shall use an interlaced coil circuiting that keeps the full coil face active at all load conditions. All coils shall be factory leak tested with high pressure air under water.
 - .2 MPS003B - MPS007B units: Direct expansion (DX) cooling coils shall be fabricated of seamless high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row design. All coils shall be factory leak tested with high pressure air under water.
 - .3 A stainless steel or non-corrosive polymer positively sloped drain pan shall be provided with the cooling coil. The drain pan shall extend beyond the leaving side of the coil and underneath the cooling coil connections. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The slope of the drain pan shall be in two directions and comply with ASHRAE Standard 62.1 The drain pan shall be connected to a threaded drain connection extending through the unit base.
 - .4 The rooftop unit shall include a natural gas heating section. The heating module shall be a tubular design with in-shot gas burners. The heat exchanger tubes shall be constructed of stainless steel. The module shall have an induced draft fan that will maintain a negative pressure in the heat exchanger tubes for the removal of the flue gases.
 - .5 The heater shall have an electronic direct spark ignition system with a remote flame sensor. The gas furnace shall have a flame rollout safety protection switches and a high temperature limit switch that will shut the gas valve off upon detection of improper burner manifold operation. The induced draft fan shall have an airflow safety switch that will prevent the gas valve from turning on in the event of no airflow in the flue chamber.

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- .6 A factory-installed DDC control system shall control the gas heat furnace. The control system shall shut down the entire heating system after two unsuccessful attempts at start-up and require a manual reset. Field installed heating systems shall require a field UL/ETL certification. The manufacturer's rooftop unit UL/ETL certification shall cover the complete unit including the gas heating modules.
- .7 The heating modules shall have a field installed kit for conversion of the unit to LP gas.
- .7 Filters
 - .1 Unit shall be provided with a draw-through filter section. The filter rack shall be designed to accept a 2" filter. The unit design shall have a hinged access door for the filter section.
- .8 Outside / Return Air Section
 - .1 Unit shall be provided with an outdoor air economizer section. The 0 to 100% outside air economizer section shall include outdoor, return, and exhaust air dampers. The outside and return air dampers shall be sized to handle 100% of the supply air volume. Damper blades shall be gasketed with side seals and jamb seals to provide an air leakage rate of 4 cfm / square foot of damper area at 1" differential pressure per ASHRAE 90.1 Energy Standard. Leakage rate to be tested in accordance with AMCA Standard 500. A barometric exhaust damper shall be provided to exhaust air out of the back of the unit. A bird screen shall be provided to prevent infiltration of rain and foreign materials. Exhaust damper blades shall be lined with vinyl gasketing on contact edges. Control of the dampers shall be by a factory installed direct coupled actuator. Damper actuator shall be of the modulating, spring return type. An adjustable enthalpy control shall be provided to sense the dry-bulb temperature and relative humidity of the outdoor air stream to determine if outdoor air is suitable for "free" cooling. If outdoor air is suitable for "free" cooling, the outdoor air dampers shall modulate in response to the unit's temperature control system.
 - .2 Fresh air dampers shall be controlled via a carbon dioxide sensor mounted in the return air duct. Dampers shall modulate open, beyond the minimum setting, in order to satisfy the sensor setting.
- .9 Condensing Section
 - .1 Condenser coils shall be multi-row and fabricated from high efficiency rifled copper tubing mechanically bonded to high efficiency aluminum fins. Each condenser coil shall be factory leak tested with high-pressure air under water. Condenser coils shall be protected from incidental contact to coil fins by a coil guard.
 - .2 For MPS012B only, Condenser coils shall be an all aluminum design. The aluminum tube shall be a micro channel design with high efficiency aluminum fins. Fins shall be brazed to the tubing for a direct bond. Each condenser coil shall be factory leak tested with high-pressure air under water.
 - .3 Condenser fans shall be direct drive, axial type designed for low tip speed and vertical air discharge. Condenser fan rpm shall be 1140 rpm maximum. Fan blades shall be constructed of steel and riveted to a steel center hub. Condenser fan motors shall be heavy-duty, non-reversing type with permanently lubricated ball bearing and thermal protection. Motor design shall be totally enclosed air over (TEAO) to protect the motors from rain and damage by water.
 - .4 Refrigeration circuit shall be complete with a thermal expansion valve and liquid line filter drier.
 - .5 Refrigerant gauge ports shall be external to the cabinet for both low and high pressure for ease of service.
 - .6 Each unit shall have multiple, heavy-duty scroll compressors. Each compressor shall be complete with gauge ports, anti-slug protection, motor overload protection and a time delay to prevent short cycling and simultaneous starting of compressors following a power failure. Compressors shall be isolated with resilient rubber isolators to decrease noise transmission.

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- .7 All units 8 through 12 tons shall have two independent refrigeration circuits. Each circuit shall be dehydrated and factory charged with Refrigerant 410A and oil.
- .8 Provide hot gas bypass on the lead circuit of all units handling more than 35% fresh air.
- .10 Roof Curb
 - .1 The Units will sit on the existing roof curbs with roof curb / roof curb adaptors.
 - .2 The roof curb / roof curb adaptor shall be prefabricated 14-gauge galvanized steel and provided for field assembly on the roof decking prior to unit shipment. The roof curb / roof curb adaptor shall be a full perimeter type with complete perimeter support of the air handling section and condensing section. The curb / adaptor shall be a minimum of 450mm (16") high and include a nominal 2" x 4" wood nailing strip. Gasket shall be provided for field mounting between the unit base and roof curb.
- .11 Acceptable manufacturers are McQuay, Aeon, Johnson Controls, Carrier, and Lennox.

2.2 ROOFTOP HEATING VENTILATING UNITS (HV-1)

- .1 Reznor RPB series packaged rooftop heating ventilating units as per schedule. Units shall be completely factory assembled, piped, wired, tested and shipped in one piece to the job site.
- .2 The complete unit shall be cULus listed, comply with ASHRAE 90.1-2004 standards for efficiency and complete with:
 - .1 insulated double wall weatherized steel cabinet with interlocking joint construction;
 - .2 bottom discharge and return openings;
 - .3 a spark-ignited intermittent pilot and a single-stage, 24-volt gas valve;
 - .4 stainless steel heat exchange;
 - .5 fan and limit safety controls;
 - .6 power venter;
 - .7 reverse air flow limit control;
 - .8 adjustable belt drive;
 - .9 left side access to burner and controls (facing airstream);
 - .10 totally enclosed fan motor;
 - .11 two stage gas control;
 - .12 2" pleated filters with connections for filter gauges;
 - .13 airflow proving switch;
 - .14 DDC control package
 - .15 450mm high roof curb;
- .3 Acceptable manufacturers are Reznor, McQuay, Johnson Controls, Carrier, and Lennox.

2.3 IN-LINE FANS

- .1 Greenheck Fan Corp. in-line fans each as per the drawing schedule, AMCA Air and Sound performance certified and bearing the seal and as specified below.
- .2 Model "BSQ" and "SQ" fans shall be AMCA sound and air performance certified and bear the seal, and shall be complete with:

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- .1 a heavy-gauge, reinforced galvanized steel fan housing lined with 1/2" (12 mm) thick fibreglass acoustic insulation and complete with hanging brackets for spring isolators at each corner, two (2) removable access panels sized to permit easy access to all internal components;
 - .2 a removable, non-overloading, statically and dynamically balanced, backwardly inclined fan wheel keyed to a ground and polished steel shaft;
 - .3 permanently sealed and lubricated pillow block ball bearings selected for a minimum (L50) life of 200,000 hours at maximum catalogue conditions;
 - .4 Model "BSQ" fans shall have a drive sized for minimum of 150% of driven horsepower;
 - .5 a motor as specified in Section 15050, pre-wired to a disconnect switch mounted on the housing.
- .3 Model "CSP" fans shall be AMCA air and sound performance certified and bear the seal and shall be complete with:
- .1 a galvanized steel housing with 1/2" (12 mm) thick acoustic insulation and complete with polystyrene grille and mesh filter, adjustable mounting brackets, and duct connection collars with discharge backdraft damper;
 - .2 a removable motor-fan assembly consisting of a permanently lubricated, vibration isolated motor with power cord and plug connected to an internal terminal box with receptacle and direct connected to a dynamically balanced, forward curved centrifugal fan wheel.
- .4 Model "TCB" fans shall be AMCA air and sound performance certified and bear the seal and shall be complete with:
- .1 an aluminium housing with 1/2" (12 mm) thick acoustic insulation and complete with adjustable mounting brackets and duct connection collars with discharge backdraft damper;
 - .2 a removable, non-overloading, statically and dynamically balanced fan wheel;
 - .3 a motor as specified in Section 15050, pre-wired to a disconnect switch mounted on the housing.
- .5 Unless otherwise noted, all steel components except for galvanized components shall be finished with thermally fused powdered epoxy.
- .6 Acceptable manufacturers are Greenheck, Loren Cook, ACME, JennFan, Penn Ventilator of Canada Ltd., Carnes and Twin City Fans.

2.4 ROOF MOUNTED EXHAUST FANS

- .1 Greenheck roof mounted centrifugal fans each as per the drawing schedule, AMCA Air and Sound performance certified and bearing the seal and as specified below.
- .2 Model "GB", belt drive fans shall be complete with:
 - .1 a heavy-gauge spun aluminium housing and aluminium curb cap with welded corners for leakage protection. Fan to come complete with lifting lugs;
 - .2 a non-overloading, statically and dynamically balanced, all aluminium construction fan wheel and hub secured to an anti-corrosion treated shaft;
 - .3 permanently sealed and lubricated pillow block ball bearings selected for a minimum (L50) life of 200,000 hours at maximum catalogue conditions;
 - .4 a drive sized for minimum of 150% of driven horsepower;
 - .5 a motor as specified in Section 15050, mounted in a force cooled compartment isolated from the exhaust air stream and pre-wired to a disconnect switch mounted under the fan housing;

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- .6 a vinyl coated or galvanized heavy-gauge steel wire birdscreen;
 - .7 a gravity type, multi-leaf, felt-edged, spring loaded backdraft damper;
 - .8 a matching pre-fabricated roof mounting curb complete with wood nailer.
- .3 Acceptable manufacturers are Greenheck Fan Corp., Loren Cook, ACME, Carnes, JennFan, Breidert, Penn Ventilator Canada Ltd and Twin City Fans.

2.5 RANGE HOODS

- .1 Reversomatic Manufacturing Ltd., Series 3000 "Deluxe" ducted range hoods, each per the drawing schedule, CSA certified, rotary solid state speed control providing infinite range, rotary light control switch, backdraft damper, with light lens and permanent, washable aluminium mesh grease filter(s).
- .2 Acceptable manufacturers are Reversomatic Manufacturing, Broan, and Air King.

2.6 AIR FILTER GAUGES

- .1 Dwyer Industries Inc. Series 2000 differential pressure gauge with a 0-500 Pa range, accurate to within 2% of full scale and complete with all required mounting and connection accessories. The 120 mm diameter dial shall have a zero (0) point adjustment and graduations in inches of wc.

2.7 GAS FIRED UNIT HEATERS

- .1 Reznor V3 series gas-fired separated combustion unit heaters as per schedule.
- .2 The complete unit shall be approved for installation by the Canadian Standards Association with 82% thermal efficiency and complete with:
- .1 Stainless steel heat exchangers;
 - .2 Tcore2 single burner combustion system including a one-piece burner assembly;
 - .3 115/1/60 Supply voltage;
 - .4 Totally enclosed fan motor;
 - .5 Transformer for 24-volt controls;
 - .6 Integrated circuit board with diagnostic indicator lights and fan relay;
 - .7 Multi-try direct ignition with 100% lockout;
 - .8 field adjustable single-stage natural gas valve;
 - .9 Vibration/noise isolated fan and venter motors;
 - .10 Sealed control compartment houses all electrical components;
 - .11 2-pt and 4-pt Suspension;
 - .12 Built-in disconnect switch (20A @ 115V Rating);
 - .13 External terminal strip for 24-volt wiring;
 - .14 Sealed junction box for supply wiring;
 - .15 External gas connection;
 - .16 Fully gasketed door panel with safety door switch;
 - .17 Full fan guard;
 - .18 Vertical Combustion Air/Vent Kit including concentric adapter.

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- .3 Acceptable manufacturers are Reznor or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION OF ROOFTOP AIR HANDLING UNITS

- .1 Provide rooftop air handling units where shown on the drawings;
- .2 Install rooftop air handling units in wide roof curbs.
- .3 Provide condensate drainage piping for all sections with drain pans. Extend and terminate condensate drainage piping over the nearest roof drain.

3.2 INSTALLATION OF ROOFTOP HEATING VENTILATING UNITS

- .1 Provide rooftop heating ventilating units where shown on the drawings;
- .2 Install rooftop heating ventilating units in wide roof curbs.

3.3 INSTALLATION OF IN-LINE FAN

- .1 Provide in-line fans where shown.
- .2 Suspend each fan with hanger rods and where shown and/or scheduled, vibration isolation spring hangers, independent of ductwork connected hereto.

3.4 INSTALLATION OF ROOF MOUNTED EXHAUST FANS

- .1 Provide roof mounted exhaust fans where shown.
- .2 Supply a prefabricated mounting curb for each fan and hand the curbs to the roofing trade on site for installation and flashing into roof construction as part of the roofing work.
- .3 Install the fans on the curbs.

3.5 INSTALLATION OF RANGE HOODS

- .1 Provide range hoods where shown.
- .2 Secure range housing in place from the structure.
- .3 Install fan-motor assemblies and plug motor cord into the fan housing receptacle. Install exhaust grilles and other accessories.

3.6 INSTALLATION OF AIR FILTER GAUGES

- .1 Provide a filter gauge for each main air handling system. For systems with pre-filters and after-filters, install the gauge across the after-filters.
- .2 Secure gauges in place on the filter section casing in an easily readable location. Adjust each gauge to suit the design pressures of the system with new fresh filters in place.

3.7 INSTALLATION OF GAS FIRED UNIT HEATERS

- .1 Provide gas fired unit heaters where shown on the drawings;
- .2 Secure suspended heaters in place at the proper height by means of hanger rods attached to the structure. Ensure that the heaters are level and plumb.
- .3 Connect gas fired unit heaters with piping.

END OF SECTION

SECTION 15880 - AIR DISTRIBUTION

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SECTION 15880 - AIR DISTRIBUTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 Section 15010 in this Division of the Specification applies to and is a part of this Section of the Specification.
- .2 Section 15050 in this Division of the Specification also applies to and is a part of this Section of the Specification. The Section contains requirements, products, and methods of execution that apply to this Section as well as to other Sections of Division 15.

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

- .1 The following work which is related to the air distribution work is specified in other Sections of the Specification:
 - .1 all required starter interlock wiring and 115 volt control wiring;
 - .2 provision of control components and control connections, excluding control dampers. This Section is responsible for provision of dampers such as outdoor air, exhaust air and other dampers excluding those specified within air handling units;
 - .1 Note: Except as otherwise noted, dampers shall be provided by this Section and damper actuators will be provided by Division 17.
 - .3 provision of curbs for ducts penetrating water-proof floors;
 - .4 installation of roof construction of flashing accessories for flues and stacks penetrating the roof;
 - .5 provision of condensate drain and domestic water piping connections to equipment;
 - .6 provision of heat transfer piping connections to coils;
 - .7 provision of site applied thermal insulation;
 - .8 provision of products-of-combustion detectors in ductwork and/or casings for fire alarm system fan shut-down;
 - .9 provision of caulking around perimeter of exterior wall louvres;
 - .10 provision of air handling equipment;
 - .11 provision of air handling heating, adjusting and balancing;
 - .12 provision of exterior wall louvres and birdscreen.

1.3 SHOP DRAWINGS

- .1 Submit shop drawings for all products specified in Part 2.

PART 2 - PRODUCTS

2.1 GALVANIZED STEEL DUCTWORK

- .1 Rectangular or square ductwork shall be prime lock forming quality, galvanized sheet steel to ASTM 653/653M, with satin coated finish on all exposed ductwork, no coating on all other ductwork, with metal gauges in accordance with published SMACNA HVAC Duct Construction Standards Metal and Flexible, to suit the duct configuration and classification.
- .2 Alpha Industries Limited, "Free-Flow", round (spiral) ductwork shall be prime lock forming quality, galvanized sheet steel to ASTM A653/653M, satin coated finish on ductwork to be painted, G60 coating on all other ductwork, spiral lockseam, factory fabricated fittings with fully welded seams and joints, with metal gauges in accordance with published SMACNA HVAC Duct Construction Standards Metal and Flexible, to suit the duct configuration and classification.

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- .3 acceptable manufacturers are Alpha Industries Limited, Flexmaster Ltd., Don-Park, Ecco Manufacturing and United McGill Corp.
- .4 Ductmate Canada Limited, "DUCTMATE", "SpiralMate", gasketed, sealed, flanged joint system components are acceptable in rectangular galvanized steel duct construction:
- .5 acceptable manufacturers are Ductmate Canada Limited and Nexus PDQ.

2.2 BLACK STEEL DUCTWORK

- .1 Black sheet steel to ASTM A621/A621M-82, minimum No. 16 MSG gauge (1.5 mm thick), or as indicated.

2.3 SHEET ALUMINUM DUCTWORK

- .1 Lock forming grade, alloy No. 3003-H14 sheet aluminum to ASTM B209, spiral lockseam, with metal thickness in accordance with published SMACNA HVAC Duct Construction Standard Metal and Flexible, to suit the duct configuration and classification.
- .2 Alpha Industries Limited, "Free-Flow", round (spiral), aluminum ductwork constructed of lock forming grade, alloy No. 3003-H14 sheet aluminum to ASTM B209, spiral lockseam, factory fabricated fittings with fully welded seams and joints, with metal gauges in accordance with published SMACNA HVAC Duct Construction Standards Metal and Flexible, to suit the duct configuration and classification.
- .3 acceptable manufacturers are Alpha Industries Limited, Flexmaster Ltd., Don-Park, Ecco Manufacturing and United McGill Corp.

2.4 DUCT SEALER

- .1 Hardcast Inc. (Alpha Industries Ltd.), "Iron-Grip", UL Listed, Class 1 (not exceeding ratings of: flame spread 5; smoke developed 0; fuel contributed 0), water based duct sealer, to ANSI/NFPA 90A -1993, non-flammable wet or dry and flexible when cured.
- .2 Acceptable manufacturers are Alpha Industries Ltd., Flexmaster Canada Ltd., Dyn Air, Ductmate Canada Limited and Duro-Dyne.

2.5 FLEXIBLE CONNECTION MATERIAL

- .1 Duro-Dyne Ltd., "DUROLON", UL listed to NFPA 90A, fire resistive, weatherproof flexible vibration isolation fabric material unaffected by sunlight and Ozone, consisting of DuPont "Hypalon" coated woven fibreglass fabric 24 oz/yd.² (814 g/sq.m) mass, 0.015" (0.63 mm) thick, suitable for -40°F to 250°F (-40°C to 12°C).
- .2 Acceptable products are Duro-Dyne of Canada Ltd. as above, Ventfabrics Canada Ltd. and Elgen Engineering Ltd.

2.6 FUSIBLE LINK FIRE DAMPERS

- .1 Nailor Industries Inc., ULC 1-1/2 hour rated, listed and labelled galvanized steel folding blade fire dampers as follows:
 - .1 Model No. 0120, Type B, in rectangular ductwork less than 355 mm minimum dimension;
 - .2 Model No. 0110, Type A, in rectangular ductwork 355 mm and larger minimum dimension;
 - .3 Model No. 0130, Type C, in round ductwork.
- .2 Each fire damper shall be complete with a replaceable 74°C fusible link, and a suitable galvanized steel sleeve.
- .3 Horizontally mounted fire dampers shall be complete with stainless steel closure springs and positive blade locking devices, and a pull-tab arrangement to permit resetting with access from either side of the damper.

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- .4 Fusible link fire dampers required in three (3) and four (4) hour rated construction shall be generally as specified above but 0500 Series ULC three (3) hour rated and labelled.
- .5 Acceptable manufacturers are Nailor Industries Inc., Ruskin Ltd., Greenheck Fan Corp., United Sheet Metal, and NCA Manufacturing Limited.

2.7 ROUND TO RECTANGULAR DUCT CONNECTIONS

- .1 Alpha Industries Ltd., type "PTR-D" galvanized steel spin-in connection collars for round to rectangular duct take-offs, each with an integral damper. Dampers shall be pivoted by means of two (2) pivot pins.
- .2 Acceptable manufacturers are Alpha Industries Ltd., Ductmaster Industries, and NCA Manufacturing Limited.

2.8 AIR TURNING VANES

- .1 For square duct elbows - multiple-radius turning vanes, interconnected with bars, adequately reinforced to suit the pressure and velocity of the system, and constructed of the same material as the duct they are associated with, and in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .2 For short branch ducts at grille and diffuser connections - air extractor type, each equipped with a matching bottom operated 90 degree opposed blade volume control damper, constructed of the same material as the duct it is associated with, and in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible.

2.9 VOLUME (BALANCING) DAMPERS

- .1 Nailor Industries Inc., opposed blade volume control dampers, Model No. 1020 for rectangular ductwork, Model No. 1021 for round ductwork, each complete with nylon blade shaft bearings, linkage shaft extension, and a suitable and secure damper operator with locking device and visual indication damper position from the duct exterior, and, unless otherwise noted, constructed of the same material as the ducts they are associated with.
- .2 Acceptable manufacturers are Nailor Industries Inc., Greenheck Fan Corp., NCA Manufacturing Limited, Ruskin Ltd., and Air Specialties Manufacturing Ltd.

2.10 MOTORIZED DAMPERS

- .1 Tamco Series 9000BF series low leakage/thermally broken frame, thermally insulated air foil damper capable of achieving a 6.7 cfm/sq. ft. (34 l/s/sq. m.) at - 40°F (- 40°C) leakage rate at 4" (1 kPa) differential pressure and bearing the AMCA certification seal for air leakage and complete with: 0.080" (2.03 mm) thick 4" (100 mm) deep extruded aluminium insulated frame with extruded TPE thermoplastic seals on the sides of the frame. Entire frame shall be thermally broken by means of polyurethane resin pockets, complete with thermal cuts;
 - .1 extruded aluminium, broken frame damper blade internally insulated with non-CFC expanded polyurethane foam, with EPDM gasketed blade seals integrally secured to the damper blade;
 - .2 acetal copolymer (Celcon) and polycarbonate bearings with no metal-to-metal contact;
 - .3 out-of-airstream linkages and crank arms constructed of aluminium and corrosion resistant, zinc & nickel plated steel, complete with cup-point trunnion screws.
- .2 Dampers shall be sized for "flanged" installation (damper blade area to be equal to duct or plenum cross section area).
- .3 Acceptable damper manufacturer is Tamco only.

2.11 BACKDRAFT DAMPERS

SECTION 15880 - AIR DISTRIBUTION

- .1 Nailor Industries Inc., 1300 Series gravity type dampers each complete with a galvanized steel frame, aluminum damper blades with neoprene edges, galvanized steel linkage, and lifetime lubricated nylon bearings.
- .2 Acceptable manufacturers are Nailor Industries Inc., Greenheck Fan Corp., NCA Manufacturing Limited, Ruskin Ltd., and Air Specialties Manufacturing Ltd.

2.12 DUCT ACCESS DOORS

- .1 In accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible with sizes suitable in all respects for the purpose for which they are provided, and, unless otherwise specified, constructed of the same material as the duct they are associated with.

2.13 CASING AND PLENUM MATERIAL

- .1 Galvanized (G90) sheet steel with metal gauges in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible, to suit the pressure construction standard of the system.

2.14 CASING AND PLENUM ACCESS DOORS

- .1 Gasketed access doors, factory insulated type in insulated casings or plenums, each constructed of galvanized steel (unless otherwise specified) in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible, to suit the pressure classification of the casing or plenum.
- .2 Access doors shall be minimum 36" x 18" (915 mm x 450 mm) but generally 48" x 18" (1450 mm x 450 mm) unless casing or plenum panel sizes do not permit, in which case the access doors shall be as large as possible.
- .3 Where access doors occur in casings and/or plenums constructed of materials other than galvanized steel, the doors shall be as above but constructed of material to match the casing and plenum material.

2.15 PLENUM AND CASING BAFFLES

- .1 Heavy-gauge sheet material to match casing and plenum material, reinforced as required to produce a rigid assembly.

2.16 INSTRUMENT TEST PORTS

- .1 Duro-Dyne of Canada Ltd., No. 1P1 or No. 1P2 or equivalent, (suiting insulation thickness where applicable), gasketed, leak-proof instrument test ports for round or rectangular ducts as required, each complete with a neoprene expansion plug and a plug securing chain.

2.17 ACOUSTIC LINING

- .1 Johns-Manville, "Linacoustic Permacote HP", 25 mm thick acoustic lining material meeting NFPA 90A and ASTM C1071, G21 and G22 requirements, not supporting microbial growth and flame spread and smoke developed fire hazard ratings of CAN4-S102, consisting of a bonded fibreglass mat coated on the inside (air side) face with a black fire-resistant coating.
- .2 Acceptable manufacturers are Johns-Manville, Fiberglas Canada Ltd., Manson Insulation Inc. and Knauf.

2.18 GRILLES AND DIFFUSERS

- .1 E.H. Price Ltd., of the type, size, capacity, finish and arrangement as shown on the drawings and as per the drawing schedule, each equipped with all required mounting and connection accessories to suit the application.
- .2 All diffusers shall be complete with a safety chain.
- .3 Acceptable manufacturers are E.H. Price Ltd., Titus, Nailor Industries, Tuttle & Bailey, Krueger, Carnes and Metal-Aire.

2.19 SILENCERS

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- .1 Vibro-Acoustics silencers per the drawing schedule and as specified hereinafter, each certified to ASTM E477-99 "Standard Method of Testing Duct Liner Materials and Prefabricated Silencers For Acoustical and Airflow Performance" completely prefabricated and as follows:
 - .1 Materials
 - .1 Type RFMB rectangular type silencers shall be constructed with a 22 gauge (0.78 mm) galvanized steel outer casing and 26 gauge (0.47 mm) galvanized perforated steel.
 - .2 Type REFMB elbow silencers shall be constructed with an 18 gauge (1.24 mm) galvanized steel outer casing and 22 gauges (0.78 mm) galvanized perforated steel. All acoustical splitters shall be internally radiused and aerodynamically designed for efficient turning of the air. Half and full splitters are required as necessary to achieve the scheduled insertion loss. All elbow silencers with a turning cross-section dimension greater than 48" (1200 mm) shall have at least two half splitters and one full splitter.
 - .2 Acoustic Media:
 - .1 Media for type RFMB and REFMB film lined MoldBlock Media™ silencers shall be Vibro-Acoustics® MoldBlock Media™ containing 100% natural cotton fibers treated with an EPA registered, non-toxic borate solution, and "flash dried" to provide resistance to mold, mildew and fungi. Media shall comply with UL181 and NFPA 90A. MoldBlock Media™ shall be packed with a minimum of 15% compression during silencer assembly. Media shall not cause or accelerate corrosion of aluminum or steel.
 - .3 Acoustic Media Protection
 - .1 Type RFMB and REFMB film lined silencers shall be as above with acoustic media completely wrapped with Tedlar film to prevent shedding, erosion and impregnation of glass fibre. The wrapped acoustic media shall be separated from the perforated metal by a factory installed ½" (12 mm) thick acoustically transparent spacer. The spacer shall be flame retardant and erosion resistant. A mesh, screen or corrugated liner will not be acceptable as a substitute for the specified spacer.
 - .4 HTL Casings
 - .1 Where indicated on the silencer schedule, silencers shall have a high transmission loss (HTL) walls externally applied and completely sealed to the silencer casing by the silencer manufacturer to assure quality controlled transmission loss. The HTL walls shall consist of media, airspace, mass and outer protective metal skin, as required to obtain the specified room noise criteria. Standard acoustical panels will not be accepted as HTL walls. Provide breakout noise calculations as part of the silencer shop drawing submissions for each air handling and fan system with HTL silencers. Breakout noise shall be based on the sound power levels of the specified equipment.
- .2 Manufacturer shall certify on shop drawings that silencer performance is per ASTM E477-99. Shop drawings submitted without same will be rejected.
- .3 Acceptable manufacturers are Vibro-Acoustics, J.P. Environmental Products Inc. and Vibron.

2.20 TERMINAL UNITS

- .1 E.H. Price Ltd., Model "LGB", single duct, variable air volume by-pass boxes as per the drawing schedule, each factory calibrated and set and complete with:
 - .1 a 22 gauge zinc coated steel casing, acoustically and thermally lined with 1/2" (13) insulation meeting NFPA 90A requirements, and complete with a gate valve with polyethylene bearings which slides in a metal track;

SECTION 15880 - AIR DISTRIBUTION

- .2 integral inlet and by-pass balancing dampers for field adjustment, static pressure taps to facilitate balancing, and a minimum air volume stop for field adjustment.
- .2 Controls shall be factory mounted in galvanized steel control shroud with removable cover, and shall be factory connected with control tubing and damper shaft linkage. The controllers and actuators shall be supplied by the Controls manufacturer and installed by the box manufacturer at its plant.
- .3 Noise attenuators for boxes as scheduled shall be selected and supplied by the box manufacturer. The sound power levels of boxes (with attenuators installed) shall not to exceed those indicated on the drawing schedule. At an inlet velocity of 2000 FPM (10.16m/sec.), the differential static pressure for any box with an attenuator must not exceed 0.11" (0.02kPa).
- .4 Acceptable manufacturers are E.H. Price Ltd., Titus, Carrier, ETI, Metalaire, Nailor Industries, Tuttle and Bailey and Krueger. All boxes must have published sound power levels for both generated and radiated noise less than or equal to those of the specified boxes and must meet or exceed the published flow performance of same.

PART 3 - EXECUTION

3.1 GENERAL RE: FABRICATION AND INSTALLATION OF DUCTWORK

- .1 Construct ductwork so that manufacturer's gauge markings are external, and, unless otherwise specified, construct, seal and install ductwork in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible to suit the duct pressure class designation. Sealing for ductwork with a pressure class less than 0.45 kPa shall be SMACNA Seal Class "C".
- .2 Ductwork leakage shall not exceed the following:
 - .1 ductwork to 2" W.C. Class - one (1) percent of the total air quantity handled by the respective fans;
 - .2 ductwork exceeding 2" W.C. Class - two (2) percent of the total air quantity handled by the respective fans.
- .3 Leakage testing shall be provided by the Testing, Adjustment and Balancing (TAB) Agency, in accordance with requirements of Section 15890. Be responsible for the following:
 - .1 preparing ductwork 25' (7.5 m) and longer, for leakage testing prior to installation of external insulation including capping duct runouts and provision of tap-in for test equipment;
 - .2 schedule testing with TAB Agency, in advance, and ensuring notice is given to Consultant so that they may witness testing. Be present for all testing;
 - .3 resealing and/or replacement of defective ductwork;
 - .4 bearing all costs associated with retesting ductwork which has failed to pass leakage testing.
- .4 Ensure that control dampers located in aluminium ductwork are constructed of type 316 stainless steel and are non-corrosive.
- .5 Where watertight horizontal ductwork is required inside the building, construct the ducts without bottom longitudinal seams. Solder or weld the joints of bottom and side sheets. Seal all other joints with duct sealer. Slope horizontal duct to hoods, risers, or drain points. Provide watertight ductwork for:
 - .1 outdoor air intakes;
 - .2 wherever else shown.

3.2 FABRICATION AND INSTALLATION OF GALVANIZED STEEL DUCTWORK

- .1 Provide all required galvanized steel ductwork. Unless otherwise noted, construct all ductwork of galvanized sheet steel, round, oval, or rectangular as shown and/or required.

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- .2 Round or oval ductwork and fittings shall be factory made and joints shall be slip type secured with properly sized sheet metal screws.
- .3 Factory made flanged joint system components are acceptable in rectangular duct installations. Install the components in strict accordance with the manufacturer's printed instructions and recommendations.
- .4 Seal ductwork using duct sealer reinforced with embedded tape where required, in accordance with sealant manufacturer's instructions and requirements of SMACNA "HVAC AIR DUCT LEAKAGE TEST MANUAL".

3.3 FABRICATION AND INSTALLATION OF BLACK STEEL DUCTWORK

- .1 Provide black sheet steel ductwork for all exhaust ductwork connecting exhaust hoods over cooking equipment, except for ductwork exposed in finished areas and ductwork outside the building.
- .2 Construct ductwork watertight with continuous externally welded seams and joints, cleanouts, duct expansion provisions, riser residue traps, etc., in accordance with requirements of the latest edition of NFPA Booklet No. 96, "Vapour Removal for Cooking Equipment", and in accordance with requirements of all Governing Authorities.
- .3 Provide a minimum of 6" (150 mm) of fibreglass reinforced, neoprene coated, asbestos cloth flexible connection material in ductwork at fan connections and wherever else shown.

3.4 FABRICATION AND INSTALLATION OF ALUMINUM DUCTWORK

- .1 Provide sheet aluminum ductwork for all the ductwork serving and/or in Water Feature room and Zamboni room.
- .2 Wherever bare aluminum ductwork comes in contact with ferrous metal or copper, paint the ferrous metal or copper surface with a heavy 100% covering coat of zinc chromate paint, asphalt paint or otherwise isolate direct contact with the bare aluminum.
- .3 Slope branch aluminum ductwork down to mains and/or the riser wherever possible. Provide an aluminum drain plug in the bottom of the riser, and at all other low points. Where it is not possible to slope aluminum branch ductwork down to mains or risers, slope the ductwork down to exhaust grilles.
- .4 Seal all joints to Seal Class "A" requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible using ULC listed sealer.
- .5 Do not use drive and S cleats for waterproof ductwork. Use the following SMACNA joining methods:
 - .1 T-21 welded flange;
 - .2 T-22 companion angle and gasket;
 - .3 T-23 flanged.
- .6 Keep longitudinal joints at the top surface of horizontal runs. Provide proper transverse supports to prevent deflection of ductwork. Ensure that the duct is rigid.
- .7 When mastic is used for sealing such as sealing longitudinal joints, apply the mastic to both surfaces before they are mated. When dry, apply mastic again for a watertight seal.
- .8 Seal ductwork using duct sealer reinforced with embedded tape where required, in accordance with sealant manufacturer's instructions and requirements of SMACNA "HVAC AIR DUCT LEAKAGE TEST MANUAL".

3.5 INSTALLATION OF FLEXIBLE CONNECTION MATERIAL

- .1 Provide a minimum of 6" (150 mm) of flexible connection material where ducts, plenums and/or casings connect to fans, and wherever else indicated.
- .2 Install flexible connection material in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible.

3.6 INSTALLATION OF FUSIBLE LINK FIRE DAMPERS

- .1 Provide fusible link fire dampers where shown on the drawings. Ensure that each fire damper is suitable for the fire rating of the fire barrier it is associated with.
- .2 Supply dampers which are factory secured within a galvanized steel sleeve, or supply the sleeves and install at the site. Install the dampers by means of No. 14 gauge, $\frac{3}{4}$: (20 mm) sheet metal screws at 6" (150 mm) OC.
- .3 Secure 1-1/2" x 1-1/2" x 1/8" (38 mm x 38 mm x 3 mm) black steel angles by means of tack welding or bolts to the perimeter of one (1) side of the damper sleeves. Install the sleeves in the opening; then secure angles to the perimeter of the sleeve at the opposite side of the barrier penetrated by the duct.
- .4 Provide expansion clearances between the damper sleeve and the opening in which the damper is required. Ensure that the openings are properly sized and located, and that all voids between the damper sleeve and the opening are properly sealed to maintain the rating of the fire barrier.
- .5 Connect and secure ductwork to fire dampers in accordance with the damper manufacturer's recommendations and to NFPA requirements.
- .6 Where sectionalized fire damper assemblies are required in large ducts or wall openings, provide multiple fusible link dampers bolted together in a properly sized assembly or bolted to a heavy-gauge black structural steel angle or channel framework which is properly sized.
- .7 When fire damper installations have been completed, an inspections team will inspect each and every fire damper installation to ensure that the dampers have been installed properly, that the connecting ductwork, if applicable, is attached properly, and that the space between the wall or slab opening and the damper sleeve has been sealed properly to maintain the fire rating of the fire barrier. Be responsible for:
 - .1 inspecting fire damper installations yourself prior to official inspection to ensure that the dampers are installed properly and that ductwork is connected properly;
 - .2 being present during all official inspection tours;
 - .3 all fire damper corrective work resulting from inspections.

3.7 INSTALLATION OF TURNING VANES

- .1 Provide turning vanes in ductwork elbows where shown on the drawings and wherever else required where, due to site installation routing and duct elbow radius, turning vanes are recommended in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .2 Provide volume extractor type turning vanes in short branch supply duct connections off mains to grilles and diffusers where shown and/or specified.

3.8 INSTALLATION OF BACKDRAFT DAMPERS

- .1 Provide backdraft dampers where shown.
- .2 Install and secure such that the dampers cannot move or rattle.

3.9 INSTALLATION OF VOLUME (BALANCING) DAMPERS

- .1 Provide volume type dampers in all open end ductwork, in all supply and return air duct mains, and wherever else shown and/or specified. Install balancing dampers in open end ductwork a minimum of 1m downstream of opening, to ensure accurate measurement during TAB work.
- .2 Install the dampers such that the operating mechanism is positioned for easy operation, and that the dampers cannot move or rattle.
- .3 Where a duct for which a volume damper is required has dimensions larger than the dimensions of the maximum size volume damper available, provide multiple dampers bolted together in a properly sized assembly or bolted to a heavy-gauge black structural steel angle or channel framework which is properly sized. Seal to prevent air by-pass, and provide connecting linkage.

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- .4 Confirm exact volume damper locations with personnel doing air quality balancing and testing work and install dampers to suit.

3.10 INSTALLATION OF MOTORIZED DAMPERS

- .1 Provide all dampers except for recirculation dampers inside of air handling units.
- .2 Where a duct for which a motorized damper is required has dimensions larger than the dimensions of the maximum size volume damper available, provide multiple dampers bolted together in a properly sized assembly or bolted to a heavy-gauge black structural steel angle or channel framework which is properly sized. Seal to prevent air by-pass, and provide connecting linkage.
- .3 Where ever possible, locate dampers not to exceed 3.6m A.F.F.

3.11 INSTALLATION OF DUCT ACCESS DOORS

- .1 Provide access doors in ductwork for access to all duct system components which will or may need maintenance and/or repair, including booster heating coils. Install in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .2 Identify access doors provided for fusible link damper maintenance with "FLD" painted or marker type red lettering and ensure that the doors are properly located for damper maintenance.
- .3 When requested, submit a sample of proposed duct access doors for approval.
- .4 Where sectionalized fusible link dampers are provided in large ducts, provide multiple access doors to suit and adequately reinforce the ductwork to suit the number of access doors installed.

3.12 FABRICATION AND INSTALLATION OF CASINGS AND PLENUMS

- .1 Provide all required casings and plenums. Construct casings and plenums of the same material as the connecting duct system, unless otherwise noted.
- .2 All sheet metal work, whether workshop or site fabricated, for housing fans and equipment and all air passage barriers connected to building surfaces shall be considered casings and/or plenums.
- .3 Construct and install casings and plenums in accordance with SMACNA HVAC Duct Construction Standards Metal and Flexible to suit the systems static pressure and velocity. Ensure that plenums and casings secured to building structure are gasketed air-tight and equipped with angle iron reinforcing.
- .4 Provide all required access doors in casings and plenums. Access doors shall be constructed of the same materials as the casing or plenum. Install in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible.

3.13 INSTALLATION OF CASING AND PLENUM Baffles

- .1 Provide reinforced baffles in casings and plenums wherever required to prevent stratification or other air movement or mixing problems.
- .2 Construct baffles of the same material as the casing or plenum.
- .3 Exactly locate and arrange baffles as per directions of personnel performing system testing and balancing work.

3.14 INSTALLATION OF INSTRUMENT TEST PORTS

- .1 Provide instrument test ports in all main ducts at connections to fans, plenums or casings, in all larger branch duct connections to mains, and wherever else required for proper air quantity balancing and testing of the systems.
- .2 Locate test ports where recommended by personnel performing air quantity testing and balancing work.

3.15 INSTALLATION OF ACOUSTIC LINING

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- .1 Provide acoustic lining to the extent shown and/or specified on the drawings.
- .2 Install lining in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible.

3.16 INSTALLATION OF SILENCERS

- .1 Provide silencers where shown and as scheduled on the drawings.
- .2 Secure and support each silencer rigidly in place, independent of the ductwork or casings connected thereto.
- .3 Where silencers penetrate partition walls, seal the joint between the perimeter of the silencer and the wall, on both sides of the wall, with proper acoustic caulking.

3.17 INSTALLATION OF GRILLES AND DIFFUSERS

- .1 Provide grilles and diffusers where shown on the drawings. Wherever possible, grilles and diffusers shall be the product of one (1) manufacturer. Unless otherwise specified, connect grilles and diffusers in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .2 Exactly locate grilles and diffusers to conform to the final architectural reflected ceiling plans and detailed wall elevations, and to conform to the final lighting arrangement, ceiling layout, ornamental and other wall treatment.
- .3 Equip supply diffusers having a basic 4-way or all round air pattern for operation in one (1), two (2) or three (3) way pattern where so directed on the drawings.
- .4 Confirm grille and diffuser finishes prior to ordering.

3.18 INSTALLATION OF TERMINAL UNITS

- .1 Provide variable air volume boxes where shown.
- .2 Secure each box in place from the structure by means of hanger rods, independent of connecting ductwork.
- .3 Connect each variable air volume box with ductwork as indicated. Provide straight inlet duct the same size as the box inlet and of a length equal to a minimum of four (4) duct diameters.
- .4 When installation is complete, check and test the operation of each bypass box and adjust as required. Coordinate final box adjustments and settings with personnel doing system testing and balancing work.

3.19 TESTING, ADJUSTING AND BALANCING

- .1 Testing, adjusting and balancing of air distribution work shall be performed by a balancing contractor retained directly by the TON and is not included in the mechanical contracts.
- .2 The mechanical contractor shall co-operate with the balancing contractor and provide whatever assistance the balancing contractor may require in order to complete the work.
- .3 Prepare the systems for balancing as follows:
 - .1 check the operation of fan equipment, automatic dampers, and similar air flow control devices and ensure that they are operating properly;
 - .2 ensure that air filters are new and clean;
 - .3 ensure that any required duct leakage testing has been completed and that the duct systems are air-tight within tolerances specified in this Section.

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- .4 Perform all corrective work such as fan sheave replacement and duct sealing recommended by the Balancing Personnel.

END OF SECTION

SECTION 15890 - TESTING, ADJUSTING AND BALANCING

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SECTION 15890 - TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 REFERENCES

- .1 Section 15010 this Division of the Specification applies to and is a part of this Section of the Specification.

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

- .1 The following work which is related to the testing, adjusting and balancing work is specified in other Sections of the Specification:
 - .1 provision of heat transfer equipment, testing and balancing devices in heat transfer piping, and preparation of systems for balancing;
 - .2 provision of balancing devices in duct systems, and preparation of systems for balancing;
 - .3 provision of air handling equipment, and replacement of fan sheaves for fan speed adjustment;
 - .4 testing of automatic control systems and setting of all control system motorized dampers, valves, thermostats, and similar items.

1.3 QUALITY ASSURANCE

- .1 Testing, adjusting and balancing work shall be performed by a specialist company who is a member in good standing of the Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB).

1.4 SUBMITTALS

- .1 Submit five (5) copies of the completed testing and balancing report to the Consultant for review. If, after verification spot checks, the Consultant rejects the report, submit five (5) copies of a new report outlining results of rebalancing procedures. Unless otherwise specified, repeat until report data is verified to be substantially the same as spot check readings.

PART 2 - PRODUCTS

NIL

PART 3 - EXECUTION

3.1 SITE VISITS DURING CONSTRUCTION

- .1 After careful review of the mechanical work drawings and specifications, the testing and balancing agency shall visit the site at frequent, regular intervals during construction of the mechanical systems to observe routing of services, locations of testing and balancing devices, workmanship, and anything else which will affect testing, adjusting and balancing.
- .2 After each site visit, the agency shall report results of the site visit to the Consultant, in writing, with a copy to the Project Manager, indicating the date and time of the visit, and detailed recommendations for any corrective work required to ensure proper adjusting and balancing.

3.2 TESTING, ADJUSTING AND BALANCING WORK

- .1 Testing, adjusting and balancing work, as specified herein, shall be performed for the following:
 - .1 new supply, return and exhaust air handling systems.
- .2 Test, adjust and balance the complete mechanical systems over the entire operating range of each system in accordance with the most stringent requirements of the AABC National Standards for Total System Balance or NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems, as applicable, in order to obtain optimum systems performance.
- .3 Do not begin testing, adjusting and balancing work until:

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- .1 building construction work is substantially complete;
- .2 mechanical systems are complete in all respects, and have been checked, started, adjusted, and then performance tested in the presence of and to the satisfaction of the Consultant;
- .3 the mechanical systems have been prepared for testing and balancing work, as specified in Section 15880.
- .4 All mechanical systems to be tested, adjusted and balanced must be maintained in full, normal operation during each day of testing, adjusting and balancing.
- .5 Balance all systems with due regard to objectionable noise which shall be a factor when adjusting fan speeds and performing terminal work such as adjusting grille and diffuser air quantities. Should objectionable noise occur at design conditions, immediately report the problem to the Consultant and submit data, including sound readings, to permit the Consultant to make an accurate assessment of the noise problem.
- .6 Check all air handling system mixing plenums for stratification, and where the variation of mixed air temperature across coils is found to be in excess of plus or minus 5% of design requirements, report to the Consultant and issue a detail sketch of plenum baffle(s) required to eliminate the stratification. Provide the baffles in accordance with the reviewed sketches.
- .7 Perform testing, adjusting and balancing to within plus or minus 5% of design values, and make and record measurements using instruments with minimum accuracy of within plus or minus 2% of required values.
- .8 Wherever possible, lock all balancing devices in place at the proper setting, and permanently mark settings on all devices.
- .9 Leak test the following ductwork in accordance with the requirements of SMACNA "HVAC Air Duct Leak Test Manual". Coordinate your work with the work of Section 15880. Provide detailed sketch(es) identifying ductwork not in accordance with acceptable leakage values specified in Section 15880. Forward sketches to Sheet Metal Contractor, on-site, with copies to the Consultant. Retest corrected ductwork.
- .10 Co-operate and work with the controls contractor in the verification of the operation of all systems. Work shall include but not be limited to: adjustment of variable air volume boxes at minimum and maximum settings on a call for heating or cooling from the thermostat.

3.3 TESTING, ADJUSTING AND BALANCING REPORT

- .1 Prepare and submit to the Consultant, when the work is complete, bound, identified copies of a testing and balancing report as specified in the article entitled "SUBMITTALS" in PART 1 of this Section. Prepare the report using standard AABC, NEBB or equal forms to indicate all measurements required by the referenced balancing standard, including, but not limited to, the following:
 - .1 air handling system measurements for:
 - .1 air velocity;
 - .2 static pressure;
 - .3 velocity pressure;
 - .4 temperatures (wet bulb and dry bulb);
 - .5 cross-sectional area;
 - .6 RPM;
 - .7 electrical power voltage and current draw;
 - .2 air handling system location of equipment measurements for the inlet and outlet of each fan, coil, filter, damper, and other auxiliary equipment;

SECTION 15890 - TESTING, ADJUSTING AND BALANCING

- .3 air handling system location of system measurements at:
 - .1 main ducts;
 - .2 main branch ducts;
 - .3 sub-branch ducts;
 - .4 each supply, return and exhaust air inlet and outlet;
 - .5 all other auxiliary equipment;
 - .6 all areas served by the system;
- .4 domestic hot water recirc. system location of equipment measurement for the inlet and outlet of each tank, heater and pump, and location of system measurements at each piping main, branch main, branch and sub-branch.
- .2 Include for each system to be tested, adjusted and balanced, a neatly drawn, identified (system designation, plant equipment location, and area served) schematic "As-built" diagram indicating all equipment and accessories.
- .3 Include report sheets indicating building comfort test readings for all rooms.
- .4 Prepare report sheets using the units of measurement (SI or Imperial) as used on the project construction documents.

3.4 VERIFICATION OF TESTING, ADJUSTING AND BALANCING REPORT

- .1 When the testing, adjusting and balancing report has been received, the Consultant will schedule a site visit or visits for the purpose of verifying balancing results contained in the report. In addition to spot checking equipment performance, a maximum of 30% of all terminal equipment will be checked.
- .2 The testing and balancing agency shall accompany the Consultant during report verification, and shall supply all required tools and instruments to take measurements. Instruments used shall be the same instruments used in performing the testing and balancing work.
- .3 If, during the verification procedures, testing and balancing results indicated in the report are found to differ substantially with the results of spot checks, the report will be rejected by the Consultant, and testing, adjusting and balancing procedures shall be repeated and a new report issued for review and verification.
- .4 Testing, adjusting and balancing must be complete and accepted by the Consultant prior to application for a Certificate of Substantial Performance of the Work.
- .5 Include a copy of the accepted testing and balancing report in each copy of the operating and maintenance instruction manuals.

3.5 WARRANTY

- .1 When testing, adjusting and balancing work is complete and the balancing report has been accepted, submit to the Project Manager, in the name of the Owner, an AABC National Guaranty Certification or NEBB Certificate of Conformance Certification, as applicable, and in addition, submit to the Project Manager, in the name of the Owner, a written extended warranty covering one (1) full heating season and one (1) full cooling season, during which time any balancing problems which occur in the building, with the exception of minor revision work done during scheduled site visits, will, at no cost, be investigated by your personnel and reported on to the Project Manager. If it is determined that the problems are a result of improper testing, adjusting and balancing, they shall be immediately corrected without additional cost to the Owner.

3.6 SITE VISITS AFTER COMPLETION OF TESTING AND BALANCING

- .1 After completion of testing, adjusting and balancing work and acceptance of the report, make the following follow-up site visits:

SECTION 15890 - TESTING, ADJUSTING AND BALANCING

- .1 once during the first month of building operation;
 - .2 once during the third month of building operation;
 - .3 once between the fourth and tenth months in a season opposite to the first or third month visit.
- .2 During each visit and accompanied by the Project Manager's representative, spot rebalance terminal units as required to suit building occupants and eliminate complaints.
 - .3 Schedule each visit with the Consultant.
 - .4 After each follow-up site visit, issue to the Consultant a report indicating any corrective work performed during the visit, all abnormal conditions and complaints encountered, and recommended corrective action.

END OF SECTION

SECTION 17002 - FORM OF SUPPLEMENTARY CONTROLS TENDER

NAME OF BIDDING SUBCONTRACTOR: _____

DATE: _____

PROJECT: **Phase 3 – Newmarket Community Centre Addition and Renovation**
MMM No. 1810061-000

To: MMM Group Limited
100 Commerce Valley Drive West
Thornhill, Ontario
L3T 0A1

Attn: Mr. Yang Zhang
Email: zhangy@mmm.ca

Submit document in accordance with Document 00200 - Instructions to Bidders and submit a copy directly to MMM Group Limited by means of e-mail, as addressed above within twenty-four (24) hours after the Bid closing.

Note: Specifications shall govern over this list. Where names are added/deleted by addenda, it shall be understood that this list will reflect the respective changes. Failure to complete and submit this document as directed may result in your Bid being ruled informal.

DIVISION 17 LIST OF MANUFACTURERS/SUPPLIERS

We submit, herein, typed or neatly printed, the names of the manufacturers upon whose products our Bid Price is based and which we will supply. If no name is indicated, or if name identified is not listed in issued documents, or if more than one name is indicated for a particular product, we will if requested, provide the base specified manufacturer's product. Where products are named in the specifications with only one (1) manufacturer/supplier, or are not listed herein, we are also prepared to provide the base specified named product. We will provide Canadian manufactured products if costs and quality are similar.

We understand that the first manufacturer specified for any product is the manufacturer upon whose product the design is based, and that the other manufacturers specified for a particular product are manufacturers acceptable to the Owner and whose product produces equivalent quality, performance and size. We further understand if we indicate a manufacturer other than the manufacturer whose product is the basis of the design, we are responsible for ensuring that the product supplied is equivalent in quality, performance and size to the base design product, and that any additional costs incurred as a result of use of such products will be borne by us. Acceptance of non-base specified manufacturers with respect to their equivalency shall be as sole discretion of Consultant.

SECTION	PRODUCT	MANUFACTURER/SUPPLIER & CATALOGUE NUMBER
17900	Dampers Actuator	
17900	Gas Detection System	
17900	Central Direct Digital Control System Equipment	

END OF SECTION

CONTRACTOR'S AUTHORIZED SIGNATURE: _____

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PART 1 - GENERAL

1.1 REFERENCES

- .1 Section 15010 applies to and is a part of this Section of the Specification.
- .2 Section 15050 also applies to and is a part of this Section of the Specification. The Section contains requirements, products, and methods of execution that apply to this Section.

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

- .1 The following work which is related to the controls and instrumentation work is specified in other Sections of the Specification:
 - .1 fire alarm shut-down connections, wiring and provision of duct or plenum mounted products of combustion detectors;
 - .2 supply and mounting of operators for terminal units and fan powered terminal units;
 - .3 mounting of control dampers. This division is responsible for provision of damper actuators, linkages, etc.;
 - .4 provision of gas meter and transmitters;
 - .5 provision of junction boxes and power wiring to same, for BAS Panels.

1.3 SHOP DRAWINGS

- .1 Submit shop drawings for the following:
 - .1 all control system components;
 - .2 identified schematic control diagrams with component catalogue numbers and typed operational sequences for all systems;
 - .3 an identified riser diagram showing the physical location of Building Automation System (BAS) control system equipment, the system architecture, and communication trunk;
 - .4 a complete list of connected data points to which they are connected and input/output devices (sensors, transducers, etc.);
 - .5 drawings of each system showing all connected devices, all wiring, all connections, all data (connected and calculated) point addresses and operator notations;
 - .6 BAS central system configuration complete with all peripheral devices, batteries, power supplies, modems, etc., with interconnection diagrams;
 - .7 technical specification data sheets for each system component and software module;
 - .8 descriptive data and sequence of operation of all operating, user, and application software including a complete Operator's Manual and Programmer's Manual tailored to the job;
 - .9 graphic hierarchy and penetration paths, and a copy of each graphic with dynamic data window identified.

1.4 SUBMITTALS

- .1 Submit the following to the Consultant for review:
 - .1 an identified sample of each type of thermostat and room temperature sensor to be used.

1.5 EQUIPMENT AND MATERIALS

- .1 Provide Canadian manufactured products wherever possible and where required quality and performance is obtainable. Unless otherwise specified, all materials and apparatus shall be new and shall comply with applicable Canadian Standards Association (CSA) Standards and/or Underwriters Laboratories of Canada (ULC) Standards and the requirements of the authorities having jurisdiction. Unless otherwise specified, similar products i.e.: all valves, all control components, all vibration isolation, etc., shall be the product of one (1) manufacturer.
- .2 Materials and equipment scheduled and/or specified, have been selected to establish a performance and quality standard, and, in some instances, a dimensional standard. In most cases, base specified manufacturers are stated for material and equipment, specified by manufacturer's name and model number. Unless otherwise noted, the Bid Price may be based on materials and equipment supplied by any of the manufacturers named as acceptable for the particular material or equipment. If acceptable manufacturers are not stated for a particular material or piece of equipment, base the Bid Price on material supplied by the base specified manufacturers.
- .3 If materials or equipment supplied by a manufacturer named as acceptable are used in lieu of the manufacturer specified, be responsible for ensuring that the substituted material or equipment is equivalent in quality, performance and operating characteristics (including energy consumption if applicable) to the specified materials or equipment, and, it shall be understood that any additional costs, and changes to associated or adjacent work resulting from provision of materials supplied by a manufacturer other than the specified manufacturer is included in the Bid Price. In addition, in equipment spaces where equipment named as acceptable is used in lieu of specified equipment and the dimensions of such equipment differs from the specified equipment, prepare and submit for review, accurately dimensioned layouts of rooms affected.
- .4 In addition to the manufacturers specified or named as acceptable, other manufacturers of materials or equipment may be proposed to the Consultant for acceptance, listing in each case a corresponding credit for each alternative proposed, however, the Bid Price must be based on equipment or materials specified or named as acceptable. Certify in writing to the Consultant that the proposed alternative meets all space, power, design, energy consumption, and all other requirements of the specified or acceptable material or equipment. In addition, it shall be understood that there will be no increase in the contract Price by reason of any changes to associated equipment, mechanical and/or electrical, required by acceptance of proposed alternatives. The Consultant has sole discretion in accepting any such proposed alternative material or equipment.
- .5 Where products you intend to provide are proposed as "an equal" and/or "or approved equal", to specified products, certify in writing that the proposed product to be used in lieu of specified product, at least meets space, power, design, energy consumption, noise criteria and other requirements of the specified product and thus shall be equivalent to or better than the specified product. When requested by the Consultant, provide full design detail drawings and specifications of proposed products. Acceptance of these "or equal" and/or "or approved equal" products shall be at the sole discretion of the Consultant. The Consultant's decision shall be final and shall not require explanation. There shall be no increase in the contract Price due to the Consultant's rejection of a proposed equivalent product.
- .6 Only base specified products, specified acceptable products or equipment listed as alternate will be considered for acceptance. No proposed substitutions will be accepted.
- .7 Indicate on Document 17002, "Form of Supplementary Controls Tender", the names of the manufacturers for materials and equipment that you will supply, and which were specified or scheduled with a manufacturer's name. Note: The names of manufacturers on the list must be one (1) of the names stated as acceptable for the particular products, unless prior written permission has been given for use of products by alternative manufacturers. Submit as directed in Document 17002, and unless otherwise specified, submit a copy of Document 17002 with the Bid.

PART 2 - PRODUCTS

2.1 GENERAL RE: CONTROL COMPONENTS AND SYSTEMS

- .1 The existing building is equipped with Andover control system supplied/installed by Robinson Solutions Inc. The intent is that the new systems installed under this contract be controlled via an extension of the existing control system. A new PC workstation will not be required. New graphics shall be created on the existing workstation for all new DDC controlled systems installed under this contract.

2.2 DAMPER ACTUATORS

- .1 Each operator shall be "fail safe" and complete with external adjustable stops to limit the length of stroke in either direction. Operators shall be mounted on adjustable brackets. Operating arms shall have double yoke linkages and double set screws for fastening to the damper shaft. Damper operators shall be selected to operate maximum damper loads of 20 sq. ft. (1.9 sq.m). Where damper sizes exceed this area rating, multiple damper operators shall be provided.
- .2 Damper operators shall be spring return to fail safe position.
- .3 Damper actuators associated with air handling units shall operate on a 0-10 VDC signal only.
- .4 Acceptable actuator manufacturers are Schneider Electric and Belimo.

2.3 FIELD DEVICES

- .1 Damper Status Switches:
 - .1 Lever operated switches secured to damper frames, rated 5.0 amp, 120/1/60 Hz. AC full load, ULC listed and CSA approved, and activated by damper blade movement.
- .2 Temperature Sensors:
 - .1 Temperature sensors shall be factory calibrated, precision thermistors or resistant temperature type (RTD) of 100, 1000 or 3000 ohm platinum or 5000 ohm Balco with ± 0.5 degrees C. accuracy over a range of 0 degrees C. to 100 degrees C.
 - .2 Temperature sensors utilized for measuring duct temperatures shall incorporate an averaging style temperature element (Thermistor or RTD) of sufficient length to ensure a proper average of the variation across the full cross section of the duct.
 - .3 Temperature sensors utilized for measurement of fluid temperatures shall incorporate a separate well of a material suitable for the service.
 - .4 Water service - brass.
 - .5 Where temperature sensors are specified to measure outdoor ambient temperature, they shall be installed so as not to be affected by exhaust air or reverse flow of warm air through supply units.
 - .6 Room temperature sensors controlled by the Building Automation System (BAS) will not have setpoint adjustment.
 - .7 Temperature sensors utilized for wall mounting in occupied spaces shall be mounted at a maximum height of 5' (1.5 m) above the finished floor and with vandal-proof cover and screws.
- .3 Electronic Humidity Sensors:
 - .1 Humidity sensors shall be capacitance type, suitable for operating ranges of 10 to 90% RH with a sensor accuracy shall be $\pm 5\%$ at full scale for space and $\pm 3\%$ for duct and outside air applications over a range of 10 to 90% RH.
- .4 Current Sensing Relays:

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- .1 Current sensing relays used for proof-of-loading for fans and pumps shall be suitable for 2 to 200 amp and shall have adjustable trip thresholds of $\pm 2\%$ of range. Each relay shall be provided with an LED to allow ready observation of the relay status.
- .2 All current sensing relays serving supply and return fans shall display amperage readings (AI) to the BAS and not an On/Off Signal (DI).
- .3 Current sensing relays serving exhaust fans shall be On/Off (DI) signals.
- .5 Carbon Dioxide Sensor:
 - .1 Vulcain Model 90 DM2 or equivalent infra-red carbon dioxide transmitter sensor capable of monitoring return air concentration of CO₂.
 - .1 Method: I.R.;
 - .2 Gas: Carbon Dioxide;
 - .3 Range: 0-2000 PPM;
 - .4 Accuracy: +/- 3% of full VDC;
 - .5 Power Source: 12 VDC;
 - .6 Output Signal: 4-20 mA DC Linear (Zero drift at ambient. Less than 0.02% CO₂ per degree centigrade.);
 - .7 Operating Temp: 32°F - 100°F (10°C - 60°C).
- .6 Photo Sensor:
 - .1 Greystone model PSR-1 sensor or equivalent, CSA approved, light sensitive resistor, mounted on a weatherproof enclosure. The unit shall produce a 4-20mA output signal, coupled with a transmitter.
- .7 Occupancy Sensor:
 - .1 WattStopper model CB-100 or equivalent passive infrared occupancy sensor, CSA approved device to provide automatic control of HVAC equipment with the following components:
 - .1 gasketed, watertight enclosure capable of preventing moisture and dust from entering the sensor;
 - .2 temperature compensated, dual element sensor and multi-element Fresnel lens;
 - .3 single pole, double throw isolated relay with normally open, normally closed, and common outputs rated for 1 Amp at 24 VDC for use with HVAC control, data logging and other control options;
 - .4 dip switch controlled digital time delay setting, adjustable from 15 seconds to 10 minutes;
 - .5 mounting hardware concealed under a removable cover to prevent tampering of adjustments and hardware.

2.4 GAS DETECTION SYSTEM

- .1 Vulcain (Honeywell Analytics, Mr. Paul Bava, telephone number 905-605-0200) or equivalent, toxic gas detection system with programming capability consisting of:
 - .1 stand-alone dual sensors;
 - .2 audible/visual alarm devices that can monitor two different gases Remote gas sensors.
- .2 Detectors

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- .1 E3Point Model or equivalent:
 - .1 Single point - E3SA, E3SAH or equivalent Propane
 - .2 Dual point - E3SAR, E3SARH or equivalent Carbon Monoxide with E3SRM remote Propane
- .2 Transmitter will be powered by 24 V AC/DC or 120 Vac The gas transmitter must be capable of monitoring a second gas when equipped with a remote sensor. The gas transmitter will incorporate an electrochemical cell for toxic gas monitoring and catalytic bead sensor for combustible gases. Unit sensing cell must compensate for variations in relative humidity and temperature to maintain high levels of accuracy.
- .3 The transmitter will be capable of transmitting gas concentrations to a DDC system through its 4-20 mA output. For local activation of fans or louvers (or other equipment), two on-board DPDT relays 5 A, 30 Vdc or 250 Vac (resistive load) will be activated at programmable set points (and programmable time delays). An LCD display will provide local gas concentration readings.
- .4 Transmitter will be capable of operating within relative humidity ranges of 5-95% non-condensing and temperature ranges of -4° F to 104° F (-20° C to 40° C).
- .5 Unit will be certified to ANSI/UL 61010-1 label and CAN/CSA-C22.2 No. 61010-1. Transmitter must be manufactured in an ISO 9001-2000 production environment.
- .6 The transmitter should have a plug-in capability for a gas cartridge with a smart sensor capable of self-testing.
- .7 For local activation of audible alarms, the transmitter shall have an on-board device able to generate an audible output of 85 dBA @ 10 ft (3m).
- .8 Detector alarm levels are to be activated and the unit is to be installed in accordance with the following parameters:

GASES	1st ALARM SET POINT (TLV-TWA)	2nd ALARM SET POINT (TLV-STEL)	MOUNTING HEIGHT	COVERAGE RADIUS
Carbon Monoxide (CO)	25 PPM	100 PPM	900mm – 1200mm (3ft – 4 ft) above finished floor	15 m (50 ft)
Propane (C3 H 8)	25% LEL	50% LEL	Low Level 300mm (1 ft) above the floor and as indicated	6 Meters (20ft)

- .3 Accessories
 - .1 Strobe and Horn
 - .1 Strobe & Horn unit will be capable of operating within relative humidity ranges of 0-100% and temperature ranges of -30° F to 150° F (-35° C to 66° C). Rating of horn will be no less than 72dBA at 10 feet. Intensity of light will be no less than 40W and will flash at a frequency of 1 per second. Unit will be certified by CSA. Honeywell Analytics.
 - .2 Power Transformer

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- .1 Transformer shall have an input voltage of 120 V AC and an output voltage of 24 Vac with a VA range of 50-300. Operating frequency shall be 60 Hz. Unit will provide insulation systems up to 130° C (50-1300 VA). Unit will operate at sound levels of less than 40 dBA.
- .3 Detector Guards
 - .1 The grid is made of a 9-gauge steel wire. The guard must be designed to allow calibration without removing the guards.
- .4 Splash Guard NEMA 4X Enclosure (If Required)
 - .1 Provide NEMA 4X rated splash guard for gas sensors in ice melt pit and all areas subject to exposure to water spray.

2.5 NAMEPLATES

- .1 Engraved, laminated, black-white Lamacoid nameplates, sized to suit wording requirements and complete with bevelled edges and stainless steel securing screws.

2.6 NETWORKING COMMUNICATIONS

- .1 The BAS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN), sharing a single file server. This enables workstations to manage a single LAN (or building), and/or the entire system with all devices being assured of being updated by and sharing the most current database. In the case of a single workstation system, the workstation shall contain the entire database – with no need for a separate file server.
- .2 The Building Automation System (BAS) shall consist of Network Control Units (NCUs), a family of Standalone Digital Control Units (SDCUs), Operator Workstations (OWs), and one File Server to support system configurations where more than one operator workstation is required. The BAS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility, and Wide Area Network (WAN) if applicable, from a single ODBC-compliant database.
- .3 Remote Communications
 - .1 In addition to the above LAN/WAN architecture support, the same workstation software (front end) must be capable of managing remote systems via standard dial-up phone lines as a standard component of the software. Front-end “add-on” software modules to perform remote site communication shall not be acceptable.
 - .2 The remote system architecture shall consist of two levels providing control, alarm detection, reporting and information management for the remote facility. Level 1 shall contain the Remote Site Control Unit, communicating to the remotely located, Operator Workstation(s) through the use of a modem and a standard dial-up phone line. Level 2 shall consist of one or more field buses controlled by the RSCU. The field buses may consist of one or both of two types:
 - 1) An RS485, token passing bus that supports up to 127 Standalone Digital Control Units (SDCUs) for operation of HVAC equipment and lighting, or
 - 2) An RS485 field bus that supports up to 32 devices from a family of plug-in, IOU modules that may be mounted within the RSCU enclosure or remotely mounted on a single, twisted, shielded pair of wires.

2.7 DDC CONTROLLER NETWORK

- .1 Level 1, the main backbone of the system, shall be an Ethernet LAN/WAN. Network Control Units, Operator Workstations, and the Central File Server shall connect directly to this network without the need for Gateway devices.
- .2 Level 2 of the system shall consist of one or more field buses managed by the Network Control Units. The Level 2 field buses may consist of one or both of the following types:

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- .1 An RS485, token passing bus that supports up to 127 Standalone Digital Control Units (SDCUs) for operation of HVAC equipment and lighting, or
- .2 An RS485 field bus that supports up to 32 devices from a family of plug-in, IOU modules.
- .3 These IOU modules may be mounted within the NCU enclosure or remotely mounted via a single, twisted, shielded pair of wires.

2.8 DDC CONTROLLER NETWORK CONTROL UNITS (NCU)

- .1 Network Control Units shall be microprocessor based, multi-tasking, multi-user, and employ a real time operating system. Each NCU control panel shall consist of modular hardware including power supply, CPU board, and input/output modules. A sufficient number of NCUs shall be supplied to fully meet the requirements of this specification and the attached point list.
- .2 NCUs for telephone dialup sites shall be of the same design as the Ethernet control units but without the plug-in Ethernet network interface card (NIC), i.e., NCUs, which include a NIC, shall be interchangeable whether used on a LAN/WAN or a dialup site.
- .3 Each NCU Controller shall have sufficient memory to support its own operating system and databases, including:
 - .1 control processes;
 - .2 energy management applications;
 - .3 alarm management applications including custom alarm messages for each level alarm for each point in the system;
 - .4 historical/trend data for points specified;
 - .5 maintenance support applications;
 - .6 custom processes;
 - .7 operator I/O;
 - .8 dial-up communications;
- .4 Each NCU Controller shall support firmware upgrades without the need to replace hardware.
- .5 Provide all processors, power supplies and communication controllers so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.
- .6 NCU Controllers shall provide a minimum two RS-232 serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals. NCU Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers or terminals.

2.9 NCU CONTROLLER RESIDENT SOFTWARE FEATURES

- .1 General:
 - .1 The NCU shall contain flash ROM as the resident operating system. Application software will be RAM resident. Application software will only be limited by the amount of RAM memory. There will be no restrictions placed on the type of application programs in the system. Each NCU shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.
- .2 Control Software Description:
 - .1 The NCU shall have the ability to perform the following pre-tested control algorithms:

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- .1 Proportional, Integral plus Derivative Control (PID)
 - .2 Self Tuning PID
 - .3 Two Position Control
 - .4 Digital Filter
 - .5 Ratio Calculator
 - .6 Equipment Cycling Protection
- .3 NCU Controllers shall provide the following energy management routines for the purpose of optimizing energy consumption while maintaining occupant comfort.
- .1 Start-Stop Time Optimization (SSTO) shall automatically be coordinated with event scheduling. The SSTO program shall start HVAC equipment at the latest possible time that will allow the equipment to achieve the desired zone condition by time of occupancy. The SSTO program shall also shut down HVAC equipment at the earliest possible time before the end of the occupancy period, and still maintain desired comfort conditions.
 - .1 The SSTO program shall operate in both the heating and cooling seasons.
 - .1 It shall be possible to apply the SSTO program to individual fan systems.
 - .2 The SSTO program shall operate on both outside weather conditions as well as inside zone conditions and empirical factors.
 - .2 The SSTO program shall meet the local code requirements for minimum outside air while the building is occupied.
 - .2 Event Scheduling: Provide a comprehensive menu driven program to automatically start and stop designated points or groups of points according to a stored time.
 - .1 It shall be possible to individually command a point or group of points.
 - .2 For points assigned to one common load group, it shall be possible to assign variable time delays between each successive start or stop within that group.
 - .3 The operator shall be able to define the following information:
 - .1 time, day;
 - .2 commands such as on, off, auto, and so forth;
 - .3 time delays between successive commands;
 - .4 there shall be provisions for manual overriding of each schedule by an appropriate operator;
 - .4 It shall be possible to schedule events up to one year in advance.
 - .1 scheduling shall be calendar based;
 - .2 holidays shall allow for different schedules.
 - .3 Enthalpy switchover (economizer) .The Energy Management Control Software (EMCS) will control the position of the air handler relief, return, and outside air dampers. If the outside air dry bulb temperature falls below changeover set point the EMCS will modulate the dampers to provide 100 percent outside air. The user will be able to quickly changeover to an economizer system based on dry bulb temperature and will be able to override the economizer cycle and return to minimum outside air operation at any time.
 - .4 Temperature-compensated duty cycling.

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- .1 The DCCP (Duty Cycle Control Program) shall periodically stop and start loads according to various patterns;
- .2 The loads shall be cycled such that there is a net reduction in both the electrical demands and the energy consumed.
- .5 Automatic Daylight Savings Time Switchover: The system shall provide automatic time adjustment for switching to/from Daylight Savings Time.
- .6 Night setback control: The system shall provide the ability to automatically adjust setpoints for night control.
- 4 NCU Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
 - .1 A single process shall be able to incorporate measured or calculated data from any and all other NCU Controllers on the network. In addition, a single process shall be able to issue commands to points in any and all other NCU Controllers on the network. Database shall support 30 character, English language point names, structured for searching and logs.
 - .2 Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of a dial-up connection to a remote device such as a printer or pager.
 - .3 NCU Controller shall provide a HELP function key, providing enhanced context sensitive on-line help with task orientated information from the user manual.
 - .4 NCU Controller shall be capable of comment lines for sequence of operation explanation.
- .5 For each system point, alarms can be created based on high/low limits or conditional expressions. All alarms will be tested each scan of the NCU and can result in the display of one or more alarm messages or reports.
- .6 Up to 8 alarms can be configured for each point in the controller.
- .7 Messages and reports can be sent to a local terminal, to the front-end workstation(s), or via modem to a remote-computing device.
- .8 Alarms will be generated based on their priority. A minimum of 255 priority levels shall be provided.
- .9 If communication with the Operator Workstation is temporarily interrupted, the alarm will be buffered in the NCU. When communications return, the alarm will be transmitted to the Operator Workstation if the point is still in the alarm condition.
- .10 Each controller shall be capable of logging any system variable over user defined time intervals ranging from 1 second to 1440 minutes. Any system variables (inputs, outputs, math calculations, flags, etc.) can be logged in history. A maximum of 32767 values can be stored in each log. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logs can be automatic or manual. Logged data shall be downloadable to the Operator Workstation for long term archiving based upon user-defined time intervals, or manual command.

2.10 STANDALONE DIGITAL CONTROL UNITS (SDCU)

- .1 Standalone Digital Control Units shall provide control of HVAC and lighting. Each controller shall have its own control programs and will continue to operate in the event of a failure or communication loss to its associated NCU.
- .2 Each SDCU shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. The SDCU shall be a microprocessor-based, multi-tasking, real-time digital control processor. Provide the following types of SDCU as a minimum:
 - .1 air handling unit controllers;
 - .2 extended digital controllers;

- .3 unitary controllers.
- .3 Each SDCU shall have sufficient memory to support its own operating system and data bases including:
 - .1 control processes;
 - .2 energy management applications;
 - .3 operator I/O (portable service terminal).
- .4 SDCUs shall provide a communication port to the field bus. In addition, a port shall be provided for connection of a portable service tool to support local commissioning and parameter changes with or without the NCU online. It shall be possible from a service port on any SDCU to view, enable/disable, and modify values of any point or program on any controller on the local field bus, any NCU or any SDCU on a different field bus.
- .5 SDCU shall directly support the temporary use of portable service terminal that can be connected to the ASC via zone temperature or directly at the controller. The capabilities of the portable service terminal shall include, but not be limited to, the following:
 - .1 display temperatures;
 - .2 display status;
 - .3 display set-points;
 - .4 display control parameters;
 - .5 override binary output control;
 - .6 override analog set-points;
 - .7 modification of gain and offset constants.
- .6 All system set-points, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the controller.
- .7 The SDCU must contain a communication outlet to allow a portable operator terminal to connect to.

2.11 PERSONAL COMPUTER OPERATOR WORKSTATION (OW) HARDWARE

- .1 The DDC system must be capable of interfacing with an on site Personal Computer (PC). The operating system for the PC shall be Windows XP SP2. The PC shall be installed as to not effect the operation of the DDC system when taken off line.
- .2 The PC, monitor and printer are existing.
- .3 Ensure the compatibility of the workstation operation system with the provided software programs.
- .4 Ensure the current backup of the software systems are properly maintained offsite during the warranty period.

2.12 WORKSTATION OPERATOR INTERFACE

- .1 Basic Interface Description
 - .1 Operator workstation interface software shall minimize operator training through the use of English language prompting, 30-character English language point identification, on-line help, and industry standard PC application software. Interface software shall simultaneously communicate with up to 4 Building Level Networks and share data between any of the 4 networks. The software shall provide, as a minimum, the following functionality:
 - .1 real-time graphical viewing and control of environment;

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- .2 scheduling and override of building operations;
- .3 collection and analysis of historical data;
- .4 point database editing, storage and downloading of controller databases;
- .5 alarm reporting, routing, messaging, and acknowledgment;
- .6 display dynamic data trend plot:
 - .1 must be able to run multiple plots simultaneously;
 - .2 each plot must be capable of supporting 10 pts/plot minimum;
 - .3 must be able to command points directly off dynamic trend plot application.
- .7 definition and construction of dynamic colour graphic displays;
- .8 program editing;
- .9 transfer trend data to 3rd party software;
- .10 scheduling reports;
- .11 operator Activity Log;
- .12 open communications via OPC Server;
- .13 open communications via BACnet Client & Server.
- .2 Provide a graphical user interface which shall minimize the use of keyboard through the use of a mouse or similar pointing device and "point and click" approach to menu selection.
- .3 The software shall provide a multi-tasking type environment that allows the user to run several applications simultaneously. BAS software shall run on a Windows XP SP2 operating system. These Windows applications shall run simultaneously with the BAS software. The mouse or Alt-Tab keys shall be used to quickly select and switch between multiple applications. The operator shall be able to work in Microsoft Word, Excel, and other Windows based software packages, while concurrently annunciating on-line BAS alarms and monitoring information.
 - .1 Provide functionality such that any of the following may be performed simultaneously on-line, and in any combination, via user-sized windows. Operator shall be able to drag and drop information between applications, reducing the number of steps (i.e. Click on a point on the alarm screen and drag it to the dynamic trend graph application to initiate a dynamic trend):
 - .1 dynamic colour graphics and graphic control;
 - .2 alarm management, routing to designated locations, and customized messages;
 - .3 year in advance event and report scheduling;
 - .4 dynamic trend data definition and presentation;
 - .5 graphic definition and construction;
 - .6 program and point database editing on-line.
 - .2 Software shall be capable of displaying several different types of displays at the same time.
 - .3 Report and alarm printing shall be accomplished via Windows Print Manager, allowing use of network printers.

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- .4 Operator specific password access protection shall be provided to allow the user/manager to limit workstation control, display and data base manipulation capabilities as deemed appropriate for each user, based upon an assigned password. Operator privileges shall "follow" the operator to any workstation logged onto.
- .5 Reports shall be generated on demand or via pre-defined schedule and directed to CRT displays, printers or disk. As a minimum, the system shall allow the user to easily obtain the following types of reports:
 - .1 a general listing of all or selected points in the network;
 - .2 list of all points currently in alarm;
 - .3 list of all points currently in override status;
 - .4 list of all disabled points;
 - .5 list of all points currently locked out;
 - .6 list of user accounts and access levels;
 - .7 list all weekly schedules;
 - .8 list of holiday programming;
 - .9 list of limits and deadbands;
 - .10 custom reports from 3rd party software;
 - .11 system diagnostic reports including, list of DDC panels on line and communicating, status of all DDC terminal unit device points;
 - .12 List of programs.
- .6 Scheduling and override
 - .1 Provide a calendar type format for simplification of time-of-day scheduling and overrides of building operations. Schedules reside in the PC workstation, DDC Controller, and HVAC Mechanical Equipment Controller to ensure time equipment scheduling when PC is off-line, PC is not required to execute time scheduling. Provide override access through menu selection or function key. Provide the following spreadsheet graphic types as a minimum:
 - .1 weekly schedules;
 - .2 zone schedules, minimum of 200 unique zones;
 - .3 scheduling for up to 365 days in advance;
 - .4 schedule reports to print at PC.
- .7 Collection and Analysis of Historical Data
 - .1 Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-based intervals or change of value, both of which shall be user-definable. Trend data may be stored on hard disk for future diagnostics and reporting. Additionally, trend data may be archived to network drives or removable disk media for future retrieval.

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- .2 Trend data reports shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or predefined groups of at least six points. Provide additional functionality to allow predefined groups of up to 250 trended points to be easily transferred on-line to Microsoft Excel. DDC contractor shall provide custom designed spreadsheet reports for use by the owner to track energy usage and cost, equipment run times, equipment efficiency, and/or building environmental conditions. DDC contractor shall provide setup of custom reports including creation of data format templates for monthly or weekly reports.
 - .3 Provide additional functionality that allows the user to view real-time trend data on trend graph displays. A minimum of ten points may be graphed, regardless of whether they have been predefined for trending. The dynamic graphs shall continuously update point values. At any time the user may redefine sampling times or range scales for any point. In addition, the user may pause the graph and take "snapshots" of screens to be stored on the workstation disk for future recall and analysis. Exact point values may be viewed and the graphs may be printed. A minimum of 8 true graphs shall run simultaneously. Operator shall be able to command points directly on the trend plot by double clicking on the point.
- .2 Dynamic Colour Graphic Displays
 - .1 Main Graphical Screen (Opening Screen)
 - .1 The graphics package installed at the on-site workstation will allow the operator the ability to either choose to look at classroom controls or mechanical equipment (HVAC, boilers, etc.). This selection will be done through icons on the screen. The main opening screen will show important information for the building, average room temperature by floor, AHU status, heating/cooling loop temperatures and outside air temperature. Basically a snap shot of the building.
 - .2 Halls, Administration, and Public Areas
 - .1 The graphics package installed at the on-site workstation will allow the operator the ability to move to any controlled part of the facility through a floor plan layout. When the operator clicks on a specific room a mechanical graphic showing the ducting, heating and end devices (dampers, valves, etc.) will be displayed. All inputs/outputs and system variables relevant to the room will be visible on this graphic. These points will be able to be controlled from the graphic. Set points that effect the mechanical equipment will be visible and be adjustable. The ability to navigate to any of the floor plans from an individual graphic will be provided. The ability to navigate to the heating system and supply air unit graphic for that room will be provided.
 - .3 Ventilation System
 - .1 The graphics package installed at the on-site workstation will allow the operator the ability to choose a mechanical system to view from a master mechanical graphic page that will show all major mechanical components (Boilers, Air Handling Units, etc.). This master graphic will be linked to a mechanical graphic of every AHU and the complete heating system. The graphics shall be accurate to how the mechanical equipment is installed. (i.e. heating coils, heating loops, number of pumps, etc.). All inputs/outputs/system variables relevant to the mechanical equipment will be displayed in their correct locations on the mechanical graphics. These points will be able to be controlled from the graphic. Set points that effect the mechanical equipment will be visible and be adjustable. Time of Day schedules will be available from the graphic. Links to the floor plans and Main screen shall be available from every graphic giving the operator the ability to move seamlessly through the system.
 - .4 Lighting Control
 - .1 A separate graphic linked from the Main Graphical screen will display the Exterior lighting information with links to the schedules. It will allow the operator the ability to control the lighting outside.

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- .5 General
 - .1 The graphics package will work seamlessly with other components of the automation software package. The graphics page will be dynamic (live with the system). The graphics package will have the same level of security as the rest of the automation software limiting overrides and set point changes on the graphics. The graphics package will use a graphical format that is standard within the graphic industry allowing the owner ability to make their own graphics and insert them within the system. The graphics package will enable the owner to modify and create their own graphics. The same package used to create and setup the graphics will be available to the operator on the workstation.
- .3 System Configuration & Definition
 - .1 Network wide control strategies shall not be restricted to a single NCU controller, but shall be able to include data from any and all other network panels to allow the development of Global control strategies.
 - .2 Provide automatic backup and restore of all NCU controller databases on the workstation hard disk. In addition, all database changes shall be performed while the workstation is on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate NCU Controller. Changes made at the NCU Controllers shall be automatically uploaded to the workstation, ensuring system continuity.
 - .3 System configuration, programming, editing, graphics generation shall be performed on-line.
- .4 Alarm Management
 - .1 Alarm Routing shall allow the user to send alarm notification to selected printers or PC location based on time of day, alarm severity, or point type.
 - .2 Alarm Notification shall be provided via two alarm icons, to distinguish between routine, maintenance type alarms and critical alarms. These alarm icons shall be displayed when user is working in other Windows programs. The BAS alarm display screen shall be displayed when the user clicks on the alarm icon.
 - .3 Alarm Display shall list the alarms with highest priority at the top of the display. The alarm display shall provide selector buttons for display of the associated point graphic and message. The alarm display shall provide a mechanism for the operator to sort alarms.
 - .4 Alarm messages shall be customizable for each point to display detailed instructions to the user regarding actions to take in the event of an alarm.

PART 3 - EXECUTION

3.1 GENERAL RE: INSTALLATION OF CONTROLS AND INSTRUMENTATION

- .1 Provide complete systems of control and instrumentation to control and supervise operation of the new environmental systems.
- .2 The control systems shall be installed by the control component manufacturer or under direct supervision of the control component manufacturer.
- .3 The control systems generally shall be as outlined on the control diagrams on the drawings and shall have all the elements and perform all the sequences therein indicated or implied.
- .4 The control diagrams show only the principal items of equipment controlling the systems. Supplement each control system with multiple-pole relays, transformers, sensors, etc., as required to enable each system to perform as specified and to permit proper operation and supervision of same.
- .5 Provide new software, software as required at Operator's Terminal (front end), to interface with new Controls Work.

3.2 INSTALLATION OF CONTROL DAMPER OPERATORS

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- .1 Provide all required automatic control damper operators.
- .2 Provision of dampers in air handlers and in ductwork will be done by Division 15. Inspect each damper assembly and ensure that it is properly mounted, accessible for damper operator installation, complete, damage free and provides satisfactory operation. Report defects in writing to Consultant. Installation of your work shall constitute acceptance of dampers being satisfactory.
- .3 Locate damper motors so they are accessible from outside ducts, plenums and equipment casings wherever possible. Where sequence operation is indicated, or where multiple operators drive a series of dampers, provide equipment pilot positioners to couple their action.
- .4 Unless otherwise indicated, provide one (1) controller per function or system. Equip controllers with a separate shut-off so they may be serviced without interruption of other system components.
- .5 Bracket mount controllers on ducts or plenums out clear of the insulation and ensure that they are vibration free.

3.3 SUPPLY OF ACTUATORS AND CONTROLLERS FOR TERMINAL UNITS

- .1 Supply required actuators and controllers for terminal units.
- .2 Deliver actuators and controllers to successful terminal unit manufacturer's factory.
- .3 Co-ordinate delivery of product with contractor and successful terminal unit manufacturer.

3.4 INSTALLATION OF GAS DETECTION SYSTEM

- .1 Provide gas detection system equipment where shown on the drawings.
- .2 Install the gas sensors and control panel where shown and in accordance with the manufacturer's instructions.
- .3 Provide strobe light and horn in the following locations:
 - .1 Zamboni Room;
 - .2 Extend and connect wiring from the control panel to the strobe and horns and the above locations. The exact location of the strobe and horn shall be coordinated on site with the Owner and Consultant. All wiring shall be in conduit. Conduit and wiring shall be to the standards of Division 16.
- .4 Extend and connect wiring from control panel to Building Automation System (BAS) to initiate a general alarm condition and the BAS operator workstation, whenever a system trouble or alarm condition is generated. Provide all required graphics and programming to illustrate the alarm condition at the operator workstation. All graphics shall match existing graphics standards for the University.
- .5 The controls contractor shall be responsible for providing any step-down transformers required for operating this system. Power wiring shall be extended and connected from the controller through the applicable transformer to a 15A-1P circuit breaker dedicated for the gas detection system application in an adjacent branch circuit panelboard. Refer to the electrical drawings for the location of the branch circuit panelboard with the dedicated circuit for the gas detection application. All wiring shall be in conduit. Conduit and wiring shall be to the standards of Division 16.
- .6 When installation is complete, check and test all system functions and adjust as required.

3.5 INSTALLATION OF DIRECT DIGITAL CONTROL SYSTEM COMPONENTS

- .1 Provide all required direct digital control system components. Refer to the drawing control diagrams and schedule of miscellaneous control points issued as an Appendix at the end of this Section.
- .2 The DDC work shall be performed by skilled technicians, properly trained and are qualified for this work.

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- .3 All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems, and not custom designed especially for this project. All systems and components shall have been thoroughly tested and proven in actual use.
- .4 The system shall be modular, permitting expansion by adding hardware and software without changes in communication or processing equipment.
- .5 Provide new communications bus as required complete with required ancillaries.
- .6 Provide one (1) AHU controller per cabinet fan (air handler). Provide the necessary SDCUs.
- .7 Provide the necessary quantity of SDCUs to accomplish the requirements of this specification, and to minimize the number of mechanical systems that would be inoperative in the event of a ASC failure. No more than two (2) major mechanical systems shall be controlled by one (1) SDCU.
- .8 Surface wall mount stand-alone control units in Mechanical Rooms ensuring that they are not mounted on vibrating surfaces, and connect to 15A-1P circuit breakers dedicated for control system applications, in branch panel circuit boards in adjacent spaces. All power wiring from the control units to the circuit breakers shall be the responsibility of the controls contractor. All wiring shall be in conduit and all conduit and wiring shall be in accordance with the standards and requirements of Division 16. Refer to the electrical drawings for the locations of branch circuit panelboards with dedicated circuits for controls system applications. Indicate via number, the systems controlled by the control units. Indicate via a Lamacoid label mounted inside the panel the identification number of the electrical panel supplying power to the SDCU.
- .9 Submit schedule(s) of input/output points to Consultant for review. Directly connect each SDCU to point devices in accordance with the control diagrams and schedule of miscellaneous control points issued as an Appendix at the end of this Section. Sensor wires for each analogue input shall be No. 18 AWG twisted-shielded cable. Other types of wire required are to be as recommended by the system supplier.
- .10 Provide all required sensors, remote devices, etc., and all required interface accessories. Mount duct and/or plenum sensors half-way across the duct or plenum.
- .11 Differential pressure sensor used to provide space pressurization control through regulation of return air quantities shall be mounted with snubbers on the indoor pressure leg to prevent sudden fluctuations caused by door openings, etc. Mount outdoor air port in a location which is least likely to be affected by abnormal surface flow conditions and wind gusts.
- .12 Supply and turn over to the Consultant prior to application for a Certificate of Substantial Performance of the Work, reports to be used in assisting the Owner in defining and debugging all DDC programs. These reports shall consist, as a minimum, of the following:
 - .1 process control language (PCL) logs;
 - .2 control loop logs;
 - .3 PCL master point.
- .13 Submit Point Data Input forms to the Consultant which the Owner will fill out with the DDC system supplier's assistance. Input this point data into the system.
- .14 Contacts will be supplied as part of the mechanical work or the electrical work of Division 16 for alarm and status points for systems and equipment other than building environmental systems and equipment. Connect to the DDC system as per the point schedule.

3.6 CONTROL COMPONENT IDENTIFICATION

- .1 Unless otherwise noted, identify control system components as follows:
 - .1 Panels:
 - .1 Engraved, laminated, black-white Lamacoid nameplates, sized to suit wording requirements and complete with bevelled edges and stainless steel securing screws.

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- .2 Each DDC controller shall have a list of all points either directly or indirectly controlled by the DDC controller inserted in a plastic pocket or folder inside the panel door of the DDC controller.
- .2 End Devices:
 - .1 Mechanical Rooms:
 - .1 End devices (sensor, switch, transducer etc.) installed in mechanical, electrical or any other service room shall be labeled with the name, point descriptor and point address on a plastic tag mechanically fastened (tie-wrap acceptable) to the device.
 - .2 Ceiling Spaces Outside of Service Rooms:
 - .1 End devices (sensor, switch, transducer etc.) installed in ceiling spaces outside of service rooms, shall be labelled with the name, point descriptor, location of ASC that the end device is connected to and location of power supply serving the end device on a yellow sticker tag installed on the T-bar ceiling grid.
 - .3 Wiring:
 - .1 Each wire shall be labelled with it's point descriptor at the point where it attaches to the panel and terminal device.
 - .2 All control wiring shall have a yellow jacket.
 - .4 Provide wiring diagrams for each panel and install plastic laminated copy inside each panel or provide folder inside cabinet door with wiring diagrams.
 - .5 A sample of each type of control component identification, as specified above, shall be submitted to the Consultant for approval prior to installation.

3.7 INSTALLATION OF CONTROL WIRING

- .1 The controls contractor shall provide all required control wiring work for control systems except:
 - .1 power wiring connections to equipment and panels, except as noted below;
 - .2 control wiring associated with mechanical plant equipment and systems whose control is not part of the work specified in this Section.
- .2 120 volt power wiring shall be extended from junction boxes provided by Division 16, to each NCU and SDCU. Power serving NCUs and SDCUs must be on a dedicated circuit. Refer to electrical drawings for the location of the junction boxes.
- .3 All control wiring shall be in conduit in accordance with the standards and requirements of Division 16 except for horizontal control wiring above the ceiling grids of classrooms which may be in FT6 plenum rated cable. FT6 plenum rated cable in classroom ceilings must be tied up and secured off of ceiling tiles. The controls contractor shall provide all required boxes, connectors, and other wiring accessories. All vertical drops to temperature sensors and valves must be in conduit.
- .4 Where plenum rated cable is used and where plenum rated cable passes through walls on any kind, the cable shall be installed in a conduit sleeve complete with bushings at both ends of the conduit.
- .5 All control wiring in mechanical rooms shall be in conduit with final three (3) feet to all devices in seal-tight flexible conduit.
- .6 Use flexible conduit where conduits run across flexible duct connectors.
- .7 All control wiring in corridors must be in either cable trays or in conduits provided by Division 16.
- .8 Control wiring shall be in conduit where control wiring penetrates through walls.

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- .9 Control wiring shall be neatly installed and run parallel to building lines. Multiple wires shall be grouped together.

3.8 CONTROL WORK TESTING

- .1 Arrange for the automatic control systems to be adjusted, calibrated, set and tested by a qualified member of the control component manufacturer's personnel, after which obtain from the manufacturer and forward to the Consultant a letter stating that the control systems have been adjusted, calibrated, set and tested and are in perfect operating condition.
- .2 In addition, arrange for the control system manufacturer to supply at the site, qualified control system technicians to make adjustments to control systems to suit air and water balancing and testing.
- .3 Arrange for the control system supplier to completely train a minimum of two (2) designated Owner's representatives in operation and maintenance of the system. Include all costs for such training in your Tender Price.

3.9 "AS-BUILT" DRAWINGS AND OPERATOR MANUALS

- .1 The record drawings for this project will be prepared on a CAD system utilizing AutoCAD Release 2004 Software.
- .2 On completion of the Contract Work, the Contractor shall provide a set of CAD produced reproducible contract drawings and associated diskettes of relevant approved, "As-built" controls documentation. This documentation must identify and show all controls work for each phase or project.
- .3 "As-built" documentation shall also include the following as a minimum:
 - .1 schematic outline of the BAS for quick reference of overall system scope;
 - .2 adequate record of the Work as installed, including its exact location and the wiring and route;
 - .3 system hardware specification manual, which provides a functional description of all hardware components;
 - .4 system operator's manual which provides concise instructions for the operation of the system and an explanation and recovery route for all system alarms;
 - .5 system engineering manual which provides all of the information, for system set up, definition and application;
 - .6 system data manual which provides the applications data programmed into the system;
 - .7 system servicing and maintenance manuals for central unit components including:
 - .1 video monitor;
 - .2 printer;
 - .3 Network Control Units (NCU);
 - .4 Standalone Digital Control Units (SDCU);
 - .5 field devices (sensor, switches).
 - .8 all data specified in the shop drawings section in its final "As-built" form;
 - .9 system software documentation;
 - .10 list of equipment supplied, including its make, model number, name of local suppliers, and quantity;
 - .11 all manuals will be constructed in the following manner:

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- .1 3-ring binders complete with index pages indexing tabs and cover identification at front and side;
- .2 size of the manuals will be 8-1/2" x 11" (215 mm x 280 mm) extension type catalogue binders bound with heavy weight yellow fabric hot stamped in black lettering front and spine;
- .3 each spine shall be lettered with full identification of the project, the front face of each binder shall contain the following:
 - .1 full identification title of the Project and Project No.;
 - .2 full identification title of the Consultant;
 - .3 full identification title of the Contractor;
 - .4 should there be more than one (1) volume for each type of application, then each volume will be so identified;
 - .5 a detailed description and configuration of these manuals will be submitted to the Engineer for approval.

3.10 OPERATOR TRAINING

- .1 The Contractor shall provide training programs for the Owner's personnel. Training will be coordinated with the owner. The Owner will assign the personnel to participate in these training programs prior to commencing with work and during the start-up of the system. The training shall consist of a minimum of forty (40) hours. This training shall allow the Owner's operator(s) to understand the operation and programs of the BAS including the Operator Workstation and its controllers.
- .2 The Operator training program phase shall be divided into two (2) parts namely project inception and completion. During the inception stage the Contractor shall dedicate four (4) workshop days to review the systems and familiarize the Owner with required operating functions in order that the Owner is prepared to operate the system. During the start-up of the system and upon completion of the project, the Contractor shall provide six (6) workshop days for training. The Contractor shall supply an Engineer or Certified Engineering Technologist for these workshop days. The Contractor shall also supply a working prototype of the BAS for each workshop day.
- .3 The training program shall include the following:
 - .1 system configuration of the environmental control system;
 - .2 treatment units operation concepts;
 - .3 system data reading;
 - .4 equipment operation and software commands;
 - .5 operator monitoring and control intervention;
 - .6 calibration of data acquisition devices;
 - .7 preventive maintenance;
 - .8 trouble shooting of the environmental control system;
 - .9 programming.
- .4 A training program for the Owner's maintenance personnel shall provided. This training shall allow the maintenance personnel to understand the basic operations of the BAS and also the basic commands both on the Operator Workstation, Network Control Units, Standalone Digital Control Units. The training program shall review the basic maintenance requirements for the BAS. The Contractor shall be responsible for delivering the maintenance training session. In the allowed time, the training program shall consist of the basic maintenance needs of all this equipment.

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- .5 Notwithstanding the above, the contractor will provide a minimum of fourty hours of training to be used at the discretion of the owner in however way they deem fit.
- .6 All documentation related to the training program shall be submitted in three (3) copies.

3.11 CONTROLS CONTRACTOR'S RESPONSIBILITIES

- .1 The Controls Contractor shall comply with applicable responsibilities specified below:
 - .1 provide start-up, test procedures and O & M manual;
 - .2 provide a print-out of all points connected to the BAS;
 - .3 provide a detailed consolidate wiring diagram showing the interface of the BAS controls with packaged controls;
 - .4 responsible for component and point-to-point testing;
 - .5 responsible for sensor calibration and actuator adjustment;
 - .6 provide calibration procedure for each analog sensor;
 - .7 operate systems during testing;
 - .8 provide training and instruction;
 - .9 responsible for the acceptance test for a 21 day period;
 - .10 set-up trend logs and group logs which shall be stored on hard disk;
 - .11 re-visit site during the first year of operation to review BAS performance.

END OF SECTION