CONTENTS

END OF SECTION

PART1 – GENERAL

1.1 WORK INCLUDED IN THIS SECTION

.1 Demolition work will include but not limited to:

1. Demolition of the existing heating plant c/w piping, equipment, materials, etc. as detailed on the drawings.
2. Demolition of the existing domestic hot water system c/w piping, equipment, materials, etc. as detailed on the drawings.

.2 Refer to drawings for detailed demolition scope of work.

.3 All existing building services not affected by this work shall be maintained in operation during and after the demolition work is complete. Any accidental interruption of existing building services not required by this project will be promptly repaired at no additional cost to the Board.

.4 Prior to removing any piping, ensure the system is completely isolated and is not live.

1.2 QUALIFICATIONS

.1 Work of this section shall be executed by trades personnel having a minimum of five years' experience in the demolition field and capable to deploy adequate equipment to complete the work in an efficient and orderly manner.

1.3 EXAMINATION

.1 Examine existing property. Determine the nature of materials to be removed.

1.4 SALVAGE

.1 The Board Representative will review the Site prior to commencement of demolition and instruct the Contractor, in writing, as to the items to be retained for re-use or be turned over to the Board. In the absence of such specific instructions, materials from demolition shall become property of Mechanical Contractor who shall promptly remove all salvageable material and debris from Site.

.2 Remove and store indicated items for future use by the Board. Remove, handle and transport such items to storage area designated by the Board Representative. Perform such work carefully and with diligence to prevent any damage to the items during removal and in storage. Store material to be salvaged, neatly on wooden pallets, where directed by Board.

1.5 MAINTAINING TRAFFIC

.1 Maintain and preserve Board's access requirements within, to and from existing building in areas where demolition and removal work is being carried out.

.2 Do not close, obstruct, place or store material in Board's driveways and passageways. Conduct operations with minimum interference with roads, streets, driveways, user traffic and passageways.

1.6 HAULING OPERATIONS

.1 Maintain roadways and paving in the hauling areas clean on a daily basis and as required by Municipal Authorities.

1.7 INTERRUPTIONS TO BOARD'S OPERATIONS

.1 There will be absolutely no interruptions to the School schedule during demolition work. Therefore, it is imperative that operations and machine and equipment movements, deliveries and removals are executed at time or times that will permit uninterrupted Board's operations in and around the school, including parking, receiving areas, deliveries and site and access and egress.

.2 Where interruptions of domestic cold and hot water are necessary, coordinate with the School Representatives the timing and duration of such interruptions.

1.8 SAFETY REQUIREMENTS

.1 Coordinate posting of danger signs conspicuously around property. Close doorways and thoroughfares giving access to area of demolition with barricades.

.2 Provide a competent, experienced supervisor in charge of the Work and on Site while work is in progress.

.3 Should any suspect designated substance not already identified, be encountered, cease work in the immediate area and immediately report, to the Board. Board is responsible for removal of designated substances.

1.9 PROTECTION

.1 Prevent movement, settlement or damage of adjacent structures, services, walks, paving, parts of existing building to remain. Make good any collateral damage caused by demolition.

.2 Take precautions to support affected structures and, if safety of building being demolished or adjacent structures or services appears to be endangered, cease operations and notify Board.

.3 Prevent debris from blocking drainage systems (floor drains) or other mechanical and electrical systems that must remain in operation.

.4 Protect building floors against damage from demolition work. Use ½" plywood covers over floor where lifting, moving, rolling of removed equipment is anticipated. Be responsible for repairing any damage to flooring caused by the work defined in this section. Execute repairs to the satisfaction of the Board at no cost to the Board.

PART2 - PRODUCTS

Not applicable

PART3 – EXECUTION

3.1 DEMOLITION

.1 At the end of each day's work, leave site in a safe condition and erect safety barriers and lights as required. Ensure that no parts of the existing building are in danger of collapsing.

.2 Review the requirements of new equipment to be installed. Perform all demolition work required to allow for the new equipment to be installed, whether shown on the drawings or not.

.3 Control dust and dirt produced during demolition.

.4 Provide any additional labour, materials and services not specifically indicated on the drawings but required to complete the work.

.5 Dispose of demolished materials in accordance with the requirements of Authorities Having Jurisdiction.

.6 At the end of demolition work, leave site in broom-clean condition. Clean existing surfaces specified to receive new applied finishes to ensure proper adherence.

.7 Do not disturb adjacent structures or equipment designated to remain in place.

.8 Confine operations and workers to those parts of the building which are defined on the drawings and exercise great care not to damage existing construction beyond that necessary for the carrying out of new work. Make good any such damage in every respect, to the satisfaction of the Board.

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL

.1 This section of the specification is an integral part of the Contract Documents and shall be read accordingly.

.2 Where applicable, all portions of the Mechanical Supplementary Tender Form shall be submitted by bidders.

1.2 DUTIES OF MECHANICAL CONTRACTOR

.1 The mechanical contractor shall assume the responsibilities and duties including but not limited to the ones described below:

.2 Superintendence

.1 Provide full time on-site superintendent personnel and supporting staff with proven experience in project of similar value and complexity.

.2 Site superintendent shall have over-all authority to speak for and represent the mechanical contractor.

.3 Coordination

.1 Coordinate the work with all the sub-trades involved to ensure that the work will be carried out on schedule and in proper sequence.

.2 Take complete responsibility for all remedial work that results from failure to coordinate any aspect of the mechanical work prior to its fabrication and/or installation.

.3 Take responsibility for the delivery of equipment necessary to complete the work in accordance with the approved schedule.

.4 Staffing and Scheduling

.1 Within seven days after the award of the contract, the Mechanical Contractor shall provide to the Owner’s representative the following information:

1 Appointment of official representatives in the project.
2 Schedule of work.
3 Delivery schedule for specified equipment.
4 Requirements for temporary facilities, site signs, storage, etc.

.5 Work Completion Meeting

.1 Prior to application for Substantial Performance of the Work, the mechanical contractor shall participate in the take-over meeting. Agenda to include the following:

1 Review of outstanding deficiencies.
2 Submission of maintenance manuals, warranties and as-built drawings.
3 Results of performance tests and described further in this section.
4 Scheduling of training to Owner's personnel.

1.3 INTENT

.1 Bidders for this work shall include for all labor, material, equipment and all other related cost including all applicable taxes (except HST) and fees to provide the work as indicated on the drawings..

.2 Misinterpretation of any requirement of the drawings and specifications will not relieve the Mechanical Contractor of responsibility. If in any doubt, the Mechanical Contractor shall contact the Consultant for written clarification prior to submitting a bid for the Work.

1.4 INTERFERENCES

.1 The mechanical drawings do not show all the architectural and structural details, and any information involving accurate measuring of the building shall be taken from the building drawings or at the building. Make without additional change, any necessary changes or additions to the runs of drains, pipes, ducts, etc., to accommodate the above conditions. The location of equipment may be altered without charge providing the change is made before installation and does not necessitate major additional material.

.2 Wherever differences occur between specifications, riser diagrams or schematics and drawings, the maximum conditions shall govern and the bid shall be based on whichever information indicates the greater cost.

.3 Field verifications of dimensions on plans shall be made since actual locations, distances, and levels will be governed by actual field conditions.

.4 Discrepancies between different plans, or between plans and actual field conditions, or between plans and specifications shall promptly be brought to the attention of the Consultant for a decision.

.5 Install all mechanical services including but not exclusive to drains, pipes, and ducts, to conserve headroom and interfere as little as possible with the free use of the space through which they pass. All drains, pipes, ducts, etc., particularly those which may interfere with the inside treatment of the building, or conflicting with other trades, shall be installed only after the locations have been approved by the Consultant. Special care shall be taken in the installation of all mechanical services including, but not exclusive to drains, pipes, and ducts, which are to be concealed, to see that they come within the finished lines of floors, walls, and ceilings. Where such drains, pipes, ducts, etc., have been installed in such a manner as to cause interference, they shall be removed and re-installed in suitable locations without extra cost to the Owner.

.6 Before commencing work, check and verify all grade and invert elevations, stacks, levels, and dimensions, to ensure proper and correct installation of the work.

.7 In every place where there is space indicated as reserved for future or other equipment, leave such space clear, install blank offs, shut off valves with blind flanges and other work so that the necessary connections can be made without any stoppages to the system. Consult with the consultant whenever necessary for this purpose.

.8 In addition to the work specifically mentioned in the Specifications and shown on the drawings, provide all other items that are obviously necessary to make a complete working installation, including those required by the Authorities Having Jurisdiction over the work.

.9 The mechanical plans show approximate locations for wall mounted devices. Obtain Consultant's approval of mounting heights and locations before commencement of work.

1.5 EXAMINE SITE

.1 Examine the site and the local conditions affecting the work. Examine carefully all drawings and the complete specifications to ensure that the work can be satisfactorily carried out as shown. No allowance will be made later for any expenses incurred through the failure to make these examinations or to report any such discrepancies in writing to the Consultant.

1.6 SUBCONTRACTOR'S SHOP

.1 Provide Job site office, work-shop, tools, scaffolds, material storage, etc., as required to complete the work.

1.7 CLEANING

.1 During the performance of the work and on the completion, remove from the place of the work all debris, rubbish and waste materials caused by the performance of the work. Remove all tools and surplus materials after completion and acceptance of the work.

.2 All equipment shall be thoroughly vacuumed out at the time of final acceptance of the work.

1.8 DELIVERY, STORAGE AND HANDLING

.1 Protection of Equipment:

.1 Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the Owner has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage.

.2 Place damaged equipment in first class, new operating condition; or, replace same as determined and directed by the Consultant. Such repair or replacement shall be at no additional cost to the Owner.

.3 Protect interiors of new equipment and piping systems against entry of foreign matter. Clean both inside and outside before painting or placing equipment in operation.

.4 Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.

.2 Cleanliness of Piping and Equipment Systems:

.1 Exercise care in storage and handling of equipment and piping material to be incorporated in the work. Remove debris arising from cutting, threading and welding of piping.

.2 Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.

.3 Clean interior of all tanks prior to delivery for beneficial use by the Owner.

.4 Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

1.9 INSTALLATION OF WORK

.1 Be responsible for:

.1 The layout of the work shown on the drawings and specified herein, and for any damage caused to the Owner by improper location or carrying out of this work.

.2 The prompt installation of the work in advance of concrete pouring or similar work.

.3 The condition of all material and equipment supplied and for the protection and maintenance of work completed.

.2 Coordinate with other trades and schedule all work to suit the date for the substantial performance established in the construction contract.

.3 Furnish items to be "built-up" in ample time and give necessary information and assistance in connection with the building in of the same.

.4 Proceed with the work as quickly as practical so that construction may be completed in as short a time as possible and in accordance with the building schedule.

.5 Ensure that all equipment and material is ordered in time to meet the building schedule. Provide a schedule of equipment deliveries to the Owner within the time limit stipulated.

.6 Furnish promptly information required for the construction schedule.

.7 Manufactured products supplied with instructions for their installation shall be installed in strict accordance with those instructions.

1.10 CODES, PERMITS, FEES AND CONNECTIONS

.1 Conform to Federal, Provincial and Municipal regulations and perform work in accordance with requirements of By-Laws and Regulations in force in area where the building is to be erected.

.2 Apply for, obtain, and pay for all permits, fees and service connections for the work and the inspections required by Authorities Having Jurisdiction in the area where the building is to be erected.

.3 In particular, coordinate with and pay for the local gas supply company to adjust/modify/replace the existing gas meter assembly and PRV as required to ensure that the available gas pressure is adequate for all gas fired equipment to operate simultaneously at maximum capacity. The minimum gas pressure at the boiler shall not be less than 8" w.g. under simultaneous maximum operating condition of all gas-fired equipment.

.4 For information, a specific code or standard might be mentioned. This information must not be taken as the only code or standard applicable.

.5 When part of equipment does not bear the required CSA label, the contractor shall obtain from CSA or Hydro Electric Power Commission, when that part of the equipment is an electric component, a special approval and pay the applicable fees.

.6 Furnish necessary certificates as evidence that the work installed conforms with laws and regulations of Authorities having jurisdiction. Changes in work requested by an Authority having jurisdiction shall be carried out without charge.

1.11 MATERIALS

.1 Where materials, equipment, apparatus, or other products are specified by the manufacturer, brand name, type or catalogue number, such designation is to establish standards of desired quality style or dimensions and shall be the basis of the Bid. Materials so specified shall be furnished under this Contract, unless changed by mutual agreement. Where two or more designations are listed, the contractor shall choose one of those listed and state the choice made on the Bid Form or Supplementary Tender Form (where applicable)

1.12 EQUIVALENTS AND ALTERNATES

.1 Unless requests for changes in base bid specifications are received and approved min. 5 days prior to the opening of the bids, the Contractors will be held to furnish specified items under the base bid. After the Contract is awarded changes in specifications will be made only as defined in this section (see Material Substitutions below)

.2 Equipment of the Contractors' choice may be offered as alternates to the items named in the specifications. Alternate proposals must be accompanied by full descriptive and technical data on the article proposed, together with a statement of the amount of addition or deduction from the base bid if the alternate is accepted. Prior approval from the Consultant is not required on submitting alternative items, but the decision on acceptance of the alternate(s) will rest with the Consultant and the Owner Representative.

.3 Unspecified materials and/or rejected alternates built into the work shall be replaced with specified or accepted materials at no additional cost to the Owner.

1.13 MATERIAL SUBSTITUTIONS

.1 After execution of the Contract, requests for substitution of materials of makes other than those specifically named in the Contract Documents may be approved by the Consultant, subject to owner’s review and acceptance of the financial credits involved.

.2 In the absence of such express approval by the Consultant, the Mechanical Contractor will be held to furnish specified items under the base bid.

1.14 SHOP DRAWINGS AND SAMPLES

.1 Submit to the Consultant detailed dimension shop drawings and installation wiring diagrams for all mechanical equipment. Further details and special requirements called for in these specifications shall be shown on the shop drawings.

.2 Ensure that copies of all reviewed shop drawings are available on the job site for reference.

.3 Provide samples of mechanical equipment as requested in the specification at the same time as the shop drawing submission.

1.15 AS-BUILT DRAWINGS

.1 Maintain up to date “as built” drawings on site.

.2 At the conclusion of the project, the Consultant will forward to the Contractor a set of electronic files of the project. The Contractor shall modify the files as required, to reflect the as-built conditions, mark them conspicuously in the title block as “as-built drawings” and submit the modified files to the Consultant for review.

.3 Upon certifications by the Consultant that the as-built files are correct, the files shall be transferred on a CD and handed over to the Owner as part of the Operations and Maintenance manuals.

.4 Any subsequent changes found by the Consultant shall remain the responsibility of the Contractor at no charge to the Owner.

1.16 TEMPORARY AND TRIAL USAGE

.1 After any part of the work has been completed, the Consultant will make an inspection, and performance tests of such parts shall be carried out under the direction of the Consultant. If deficiencies are found, they shall be immediately rectified to the satisfaction of the Consultant. After such deficiencies have been rectified, the work shall be placed in service at such time and in such order as the Consultant may direct. If, in placing a portion of the equipment in service, it is necessary to make temporary connections in the wiring in order to obtain proper operation, such connections shall be provided to the extent and in the manner required by the Consultant.

.2 Temporary or trial usage of any mechanical devices, machinery, apparatus, equipment or materials shall not be construed as evidence of the acceptance of same.

.3 No claims for damage will be considered for injury to, or the breaking of any parts of such work which may be used.

1.17 CONSULTANT’S INSTRUCTIONS

.1 During construction the Consultant will issue such instructions as may be necessary for verification and corrections of the work. These instructions shall be binding as part of the specification.

1.19 ADDITIONAL WORK AND CHANGES

.1 Unless a written order, reviewed by the Consultant and countersigned or otherwise approved by the Owner Representative, no additional work shall be undertaken by the Contractor.

1.19 WARRANTY

.1 The Mechanical Contractor shall guarantee all work and apparatus installed under his contract against all defects of workmanship and material for a period of one (1) year after the Substantial Performance of the Work , unless otherwise mentioned in the Specifications, and shall make good any and all defects developing during such time without expense to the Owner. Any materials shall be further guaranteed as may be called for in these specifications. Where warranties on equipment extend beyond one (1) year the Mechanical Contractor shall honor the extended warranty.

1.20 SCHEDULING OF WORK

.1 For all work to be performed under this contract, adhere to Construction Schedule agreed upon with the Owner Representative.

1.21 ENERGY CONSUMPTION

.1 The Consultant may reject equipment submitted for approval on basis of performance or energy consumed or demanded.

.2 All equipment installed on the project shall conform to the requirements outlined in ASHRAE 90.1 latest edition.

1.22 ELECTRIC MOTORS

.1 Provide motors for mechanical equipment as specified.

.2 If delivery of specified motor will delay delivery or installation of any equipment, install an acceptable motor for temporary use. Final acceptance of equipment will not occur until specified motor is installed.

.3 All motors shall be manufactured and installed in accordance with CSA requirements.

.4 Motor speed shall be 1750 rpm unless otherwise specified.

.5 All motors shall be "T" frame CEMA Standard Design "B" with Class "B" insulation, 40□C ambient, standard drip-proof with a 1.15 service factor, or as otherwise specified. Motors in air stream or exposed shall be TEFC type.

.6 Motors shall be of adequate size to operate associated equipment and drive mechanisms under all conditions of load and service and to bring equipment up to operating speed within 13 seconds without overloading, and be not less than the nameplate HP specified or indicated on the Drawings.

.7 Integral HP motor sizes ½ HP and above shall be squirrel cage induction motors rated 575 volt or 230volt, 3 phase, 60 hertz, unless noted otherwise.

.8 Fractional HP motors up to but not including ½ HP shall be rated 120 volt, single phase, 60 hertz and will be capacitor start, induction motors, with adequate thrust capacity when used with direct mounted equipment, and shall be provided with integral overload and overheating protection. Shaded pole starting devices will not be accepted.

.9 Multi-speed motors and associated switching devices shall be circuited to protect the motor at each speed.

.10 All motors, 1 HP and up shall comply with the Ontario Hydro EnerMark Motor Efficiency Level as tested either CSA 390 M 1985, or IEEE 112B, and be approved under the Canadian Electrical Safety Code.

.11 All starter panels shall be lockable and supplied with locks.

.12 Special Requirements:

.1 Where motor power requirements of equipment furnished deviate from power shown on plans, provide electrical service designed under the requirements of NFPA 70 without additional time or cost to the Owner.

.2 Assemblies of motors, starters, controls and interlocks on factory assembled and wired devices shall be in accordance with the requirements of this specification.

.13 Wire and cable materials specified in the electrical division of the specifications shall be modified as follows:

.1 Wiring material located where temperatures can exceed 71 degrees C (160 degrees F) shall be stranded copper with Teflon FEP insulation with jacket. This includes wiring on the boilers.

.2 Other wiring at boilers and to control panels shall be NFPA 70 designation THWN.

.3 Provide shielded conductors or wiring in separate conduits for all instrumentation and control systems where recommended by manufacturer of equipment.

.14 Select motor sizes so that the motors do not operate into the service factor at maximum required loads on the driven equipment. Motors on pumps shall be sized for non-overloading at all points on the pump performance curves.

.15 Motors utilized with variable frequency drives shall be rated “inverter-ready” per NEMA Standard, MG1, Part 31.4.4.2. Provide motor shaft grounding apparatus that will protect bearings from damage from stray currents.

.16 Insulation Resistance: Not less than one half meg-ohm between stator conductors and frame, to be determined at the time of final inspection

1.23 EQUIPMENT REQUIREMENTS AND INSTALLATION

.1 Permit equipment maintenance and disassembly by use of unions or flanges to minimize disturbance to connecting piping and duct systems and without interference from building structure or other equipment.

.2 Provide accessible means for lubricating equipment including permanent lubricated bearings.

.3 For all base mounted boilers, pumps, compressors, air handling units, fans and other rotating equipment, provide chamfered edge housekeeping pads a minimum of 4" high and 4" larger than equipment dimensions all around. Work shall be performed by the trades specializing in this work.

.4 Pipe drain lines, overflows and safety relief vents to drains. If the horizontal drains present a tripping hazard, use aluminum checkered plate covers.

.5 Line-up equipment, rectangular cleanouts and similar items with building walls wherever possible.

1.24 LIFTING ATTACHMENTS

.1 Provide equipment with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered, without bending or distortion of shape, such as rapid lowering and braking of load.

1.25 THERMOMETERS AND PRESSURE GAUGES

.1 General:

.1 Locate direct reading thermometers and gauges for reading from floor or platform.

.2 Provide remote reading thermometers and gauges where direct reading instruments cannot be satisfactorily located.

.3 Locate engraved lamacoid nameplate as specified in Section Identification, identifying medium adjacent to thermometers and gauges.

.2 Thermometers:

.1 Industrial, 9" adjustable angle cast aluminum case, CGSB standard CAN/CGSB-14.4-M88 red reading mercury, lens front tube, white scale black embossed figures, clear glass or acrylic window, tapered aluminum stem.

.2 Scale shall be suitable for 2 times the temperature range of service. Scale shall be combined Celsius and Fahrenheit.

.3 Standard of Acceptance: Weiss, Ashcroft, Trerice.

.3 Pressure Gauges:

.1 5" dial, solid front blow out back, fibreglass reinforced polypropylene case, phosphor bronze bourdon tube and brass 1/4" N.P.T. socket, bottom connection, stainless steel rotary type movement, gauge to be registered with the Provincial Boiler and Pressure Vessel Safety Branch with a registration number and conform to ANSI B40.1. Accuracy to be grade "A".

.2 On pumps liquid filled gauges shall be utilized.

.3 Standard of Acceptance: Weiss, Ashcroft, Trerice.

.4 Provide bronze stop cock, bronze bar stock 1/4" N.P.T. bronze porous core pressure snubber for pulsating operation and diaphragm for corrosive service.

.5 Use materials compatible with system requirements.

.6 Gauges shall have combined kilopascal and psi scales.

1.26 PIPE HANGERS AND SUPPORTS

.1 General

.1 Pipe Supports: Comply with MSS SP 58. Type Numbers specified refer to this standard. For selection and application comply with MSS SP 69.

.2 Attachment to Concrete Building Construction:

.1 Concrete insert: MSS SP-58, Type 18.

.2 Self drilling expansion shields and machine bolt expansion anchors: Permitted in concrete not less than 102 mm (four inches) thick when approved by the Consultant for each job condition.

.3 Power driven fasteners: Permitted in existing concrete or masonry not less than 102 mm (four inches) thick when approved by the Resident Engineer for each job condition.

.3 Attachment to Steel Building Construction:

.1 Welded attachment: MSS SP 58, Type 22.

.2 Beam clamps: MSS SP-58, Types 20, 21, 28 or 29. Type 23 C clamp may be used for individual copper tubing up to 23mm (7/8 inch) outside diameter.

.4 Attachment to Metal Pan or Deck:

.1 As required for materials specified Steel Decking section of the specification.

.5 Attachment to Wood Construction:

.1 Wood screws or lag bolts.

.6 Hanger Rods

.1 Hot rolled steel, ASTM A36 or A575 for allowable load listed in MSS SP 58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turn buckles shall provide 38 mm (1 1/2 inches) minimum of adjustment and incorporate locknuts. All thread rods are acceptable.

.7 Hangers Supporting Multiple Pipes (Trapeze Hangers):

.1 Galvanized, cold formed, lipped steel channel horizontal member, not less than 41 mm by 41 mm (1 5/8 inches by 1 5/8 inches), 2.7 mm (No. 12 gage), designed to accept special spring held, hardened steel nuts. Not permitted for steam supply and condensate piping.

.2 Allowable hanger load: Manufacturers rating less 91kg (200 pounds).

.3 Guide individual pipes on the horizontal member of every other trapeze hanger with 6 mm (1/4 inch) U bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 13mm (1/2 inch) galvanized steel bands, or preinsulated calcium silicate shield for insulated piping at each hanger.

.8 Supports for Piping Systems:

.1 Select hangers sized to encircle insulation on insulated piping.To protect insulation, provide Type 39 saddles for roller type supports or preinsulated calcium silicate shields. Provide Type 40 insulation shield or preinsulated calcium silicate shield at all other types of supports and hangers including those for preinsulated piping.

.9 Piping Systems (MSS SP 58):

.1 Standard clevis hanger: Type 1; provide locknut.
.2 Riser clamps: Type 8.
.3 Wall brackets: Types 31, 32 or 33.
.4 Roller supports: Type 41, 43, 44 and 46.
.5 Saddle support: Type 36, 37 or 38.
.6 Turnbuckle: Types 13 or 15. Preinsulate.
.7 U bolt clamp: Type 24.
.8 Copper Tube:

1 Hangers, clamps and other support material in contact with tubing shall be painted with copper colored epoxy paint, plastic coated or taped with non adhesive isolation tape to prevent electrolysis.

2 For vertical runs use epoxy painted or plastic coated riser clamps.

3 For supporting tube to strut: Provide epoxy painted pipe straps for copper tube or plastic inserted vibration isolation clamps.

.9 Insulated Lines:

1 Provide pre-insulated calcium silicate shields sized for copper tube.

.10 Supports for plastic or glass piping: As recommended by the pipe manufacturer with black rubber tape extending one inch beyond steel support or clamp.

.10 Piping with Vertical Expansion and Contraction:

.1 Movement up to 20 mm (3/4 inch): Type 51 or 52 variable spring unit with integral turn buckle and load indicator.

.2 Movement more than 20 mm (3/4 inch): Type 54 or 55 constant support unit with integral adjusting nut, turn buckle and travel position indicator. //

.11 Heat Exchanger and Expansion Tank Hangers:

.1 May be Type 1 sized for the shell diameter. Insulation where required will cover the hangers.

1.27 PIPE PENETRATIONS

.1 Install sleeves during construction for other than blocked out floor openings for risers in mechanical bays.

.2 To prevent accidental liquid spills from passing to a lower level, provide the following:

.1 For sleeves: Extend sleeve 25 mm (one inch) above finished floor and provide sealant for watertight joint.

.2 For blocked out floor openings: Provide 40 mm (1 1/2 inch) angle set in silicone adhesive around opening.

.3 For drilled penetrations: Provide 40 mm (1 1/2 inch) angle ring or square set in silicone adhesive around penetration.

.3 Penetrations are not allowed through beams or ribs, but may be installed in concrete beam flanges. Any deviation from these requirements must receive prior approval of Consultant.

.4 Sheet Metal: Provide for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.

.5 Cast Iron or Zinc Coated Pipe Sleeves: Provide for pipe passing through exterior walls below grade. Make space between sleeve and pipe watertight with a modular or link rubber seal. Seal shall be applied at both ends of sleeve.

.6 Galvanized Steel or an alternate Black Iron Pipe with asphalt coating Sleeves: Provide for pipe passing through concrete beam flanges, except where brass pipe sleeves are called for. Provide sleeve for pipe passing through floor of mechanical rooms. Except in mechanical rooms, connect sleeve with floor plate.

.7 Brass Pipe Sleeves: Provide for pipe passing through quarry tile, terrazzo or ceramic tile floors. Connect sleeve with floor plate.

.8 Sleeves are not required for wall hydrants for fire department connections or in drywall construction.

.9 Sleeve Clearance: Sleeve through floors, walls, partitions, and beam flanges shall be one inch greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation. Interior openings shall be caulked tight with fire stopping material and sealant to prevent the spread of fire, smoke, and gases.

1.28 SPECIAL TOOLS AND LUBRICANTS

.1 Furnish, and turn over to the Owner, special tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.

.2 Grease Guns with Attachments for Applicable Fittings: One for each type of grease required for each motor or other equipment.

.3 Tool Containers: Hardwood or metal, permanently identified for in tended service and mounted, or located, where directed by the Owner

.4 Lubricants: A minimum of 0.95 L (one quart) of oil, and 0.45 kg (one pound) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

1.29 WALL, FLOOR AND CEILING PLATES

.1 Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.

.2 Thickness: Not less than 2.4 mm (3/32 inch) for floor plates. For wall and ceiling plates, not less than 0.64 mm (0.025-inch) for up to 80 mm (3 inch pipe), 0.89 mm (0.035-inch) for larger pipe.

.3 Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, in finished areas only. Use also where insulation ends on exposed water supply pipe drop from overhead. Provide a watertight joint in spaces where brass or steel pipe sleeves are specified.

1.30 EXCAVATION AND BACKFILL

.1 Grade the bottom of the pipe trench excavation as required.

.2 In firm, undisturbed soil, lay pipes directly on the soil, and shape soil to fit the lower one-third segment of all pipes and pipe bells. Ensure even bearing along the barrels. Backfill excess excavation with 25 mPa concrete.

.3 Where rock or shale is encountered, arrange to have this excavated and removed. After excavation, backfill with a bedding of 10 mm crushed stone.

.4 Prepare new bedding under the pipe in unstable soil, in fill, and in all cases where pipe bedding has been removed in earlier excavation, particularly near perimeter walls of buildings, at manholes and catch basins. Compact to maximum possible density and support the pipe by 200 mm (8 inches) thick firm supports. Install reinforcing steel in cradle or construct piers every eight feet or closer, down to solid load bearing strata. Provide a minimum of one pier per length of pipe. Use same method where pipes cross.

.5 Where excavation is necessary in proximity to and below the level of any footing, backfill with 25 mPa concrete to the level of the highest adjacent footing. Proximity is determined by the angle of repose as established by the consultant.

.6 Provide support over at least the bottom one third segment of the pipe in all bedding methods.

.7 Do not open trench ahead of pipe laying and backfilling more than weather will permit. Keep walls of trenches straight to at least 450 mm (18") above the top of the pipe to keep the diameter load within the pipe design limits. Have excavations inspected at least once a week by authorities. .

.8 Before backfilling, obtain approval. Remove all shoring during backfill.

.9 Backfill trenches within building, with clean sharp sand or gravel in individual layers of maximum 150 mm (6") thickness, compacted to a density of 100% Standard Proctor. Hand compact the first layers up to a compacted level of minimum 300 mm (12") above the top of pipe. Hand or machine compact the balance up to grade, using approved equipment.

.10 Backfill trenches outside buildings, not under roads, parking lots, or traffic areas, up to a compacted level of 450 mm (18") above the pipes with individual layers of material 150 mm (6") thick, hand compacted to a density of 95% Standard Proctor, using approved 10 mm (3/8") crushed stone. Backfill the balance with 150 mm (6") layers of approved excavated material, compacted to 95% Standard Proctor, using approved equipment.

.11 Backfill all other trenches outside buildings with 150 mm (3/8") crushed stone in layers not exceeding 6" thickness, compacted to 100% Standard Proctor density up to grade level. Manual compaction up to 450 mm (18") above the pipe with approved equipment for the balance.

.12 Fill all depressions to a correct grade level with appropriate material. After a period has passed adequate to reveal any settlement, use maximum possible compaction. Pay all costs required to make good all damages caused by settlement.

.13 Dispose of excavated materials in accordance with the requirements of the Authorities having Jurisdiction.

1.31 TESTS

.1 Do not insulate or conceal work until tested and approved. Follow construction schedule and arrange for tests.

.2 Conduct tests in presence of Consultant.

.3 Bear costs including retesting and making good.

.4 Pipe pressure:

.1 Hydraulically test piping systems at 1.5 times system operating pressure or minimum 125 psi, whichever is greater.
.2 Maintain test pressures without loss for 4 hours unless otherwise specified.
.3 Test natural gas systems to requirements of authorities having jurisdiction and as per Ontario Gas Utilization Code O.Reg. 452/89.
.4 Test drainage, waste and vent piping to code.

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

1.32 PAINTING

.1 Apply at least one coat of corrosion resistant primer paint to supports, and equipment fabricated from ferrous metals.

.2 Touch-up paint all damaged equipment with products matching original finish in quality and appearance.

.3 Paint the entire gas line where with two coats of yellow paint.

1.33 SPECIAL TOOLS AND SPARE PARTS

.1 Furnish spare parts as follows:

.1 One set of packing for each pump.
.2 One glass for each gauge glass installed.
.3 One set of v-belts/bolts for each piece of machinery.
.4 One spare set of filters for each filter bank installed.

.2 Upon completion of project and immediately before hand-over, replace all filters.

1.34 DIELECTRIC COUPLINGS

.1 Provide wherever pipes of dissimilar metals are joined.

.2 Provide insulating unions for pipe sizes larger than 2" diam. and under; same for flanges of pipe sizes over 2" diam.

.3 Cast brass adapters may be used on domestic water systems and where approved by the Consultant.

.4 Provide rubber gaskets to prevent dissimilar metals contact.

1.35 INSTRUCTION OF OPERATING STAFF

.1 Supply certified personnel to instruct Owner operating staff on operation of new mechanical equipment. Supply maintenance specialist personnel to instruct operating staff on maintenance and adjustment of mechanical equipment and any changes or modification in equipment made under terms of guarantee.

.2 Provide min. 6 hrs of instruction time during regular work hours prior to acceptance and turn-over to operating staff for regular operation.

.3 Use operation and maintenance data manual for instruction purposes. On completion of instruction, turn manuals over to the Consultant.

.4 Scheduling of the timing for the training of the operating staff shall be arranged 10 days prior to the completion of the project.

.5 For training on controls, refer to section 15900

1.39 MAINTENANCE MANUALS

.1 Provide minimum of one (1) hard (hard cover binder) and three (3) soft (USB’s) copies of Mechanical Maintenance Manuals, in accordance to the following:

.1 Mechanical Maintenance Manuals to be delivered to the Consultant’s office 10 days prior to the substantial completion of the Contract.

.2 Manuals to be bound in a hard cover neatly labeled: "OPERATING AND MAINTENANCE INSTRUCTIONS".

.3 The Maintenance Manuals shall be divided into sections with neatly labeled and tabbed dividers between each section. The sections to be included in the manual are:

.1 Section I - General.
.2 Section II - Piping and Pump Systems, Plumbing Fixtures and Accessories.
.3 Section III - Boilers, Heat Exchangers, Pool Filters and Accessories
.4 Section IV - Automatic Controls
.5 Section V - Air and Water Balancing

.4 The following information shall be contained within the sections:

.1 SECTION I: A list giving name, address and telephone number of the Consultant, Engineers, General Contractor, Mechanical Trade and Controls Trade. Written guarantees for the Mechanical Systems. A copy of the Valve directory giving number, valve location, normal valve position, and purpose of valve (a framed copy of Valve Directory to be hung in Boiler Room). Equipment lists and certificates shall be provided - certificates shall be signed and sealed by the appropriate suppliers.

.2 SECTION II, III: A copy of all pressure tests and operational tests. A copy of Gas Operational Tests for gas fired equipment. A list giving name, address and telephone number of all suppliers. Details of chemical treatment equipment and substances. A copy of all reviewed Shop Drawings for all mechanical equipment and ancillary devices (valves, expansion tanks, pumps, strainers, plumbing, etc). Copies of warranties.

.3 SECTION IV: Complete Control Diagrams, Wiring Diagrams and description of Control system and the functioning sequence of the system. Also refer to section 15900.

.4 SECTION V: For balancing reports and formats, refer to section 15015 of these specifications.

1.40 CONCRETE

.1 All concrete work required to complete this project, wether shown on the drawings or not, shall be the Contractor’s responsibility.

.2 Refer to this specification section for requirements for housekeeping pad.

1.41 METALS

.1 All steel construction required for the completion of this project, wether shown on the drawings or not, shall be the Contractor’s responsibility.

1.42 CUTTING, PATCHING, ROOFING AND X-RAY

.1 All cutting, patching, roofing and X-Rays required for the completion of this project whether shown on the drawings or not, shall be the Contractor's responsibility. The cutting and patching work shall be performed in accordance with the following:

.1 All cutting and patching shall be done by the trades specializing in the materials to be cut.

.2 All flashing and equipment supports on the roof shall be done in strict accordance with the Owner standards by Owner-approved roofing contractors only.

.2 Should any cutting, roofing and/or repairing of finished surfaces be required, the Sub-trade contractor for the Contractor shall employ the particular trades engaged on the site for this type of work to do such cutting and/or repairing. Obtain the approval of the Consultant before doing any cutting. In the event that tradesmen required for particular cutting and/or repairing are not already on the site, bring to the site tradesmen to do this work.

.3 Supporting members of any floor, wall or the building structure shall be cut only in such a location and manner as approved by the Consultant.

.4 Where slabs in the portions of the building which are existing must be saw-cut or core drilled, all locations shall be x-rayed prior to saw-cutting or core-drilling. All x-raying shall be done by personnel qualified in the use of the type of equipment required to x-ray the saw-cuts shall be permitted to perform this work on the site. No allowance will be made later for expenses incurred through the failure of performing these x-rays.

1.43 MECHANICAL PROJECT COMPLETION

.1 10 (ten) days prior to substantial performance of work obtain documentation and/or prepare certification of the following items and submit them to the Owner's representative.

.1 All inspection certificates including drainage, Plumbing, and refrigeration.
.2 Guarantee certificates as called for under "Warranty".
.3 Record drawings.
.4 Operating and Maintenance Manuals.
.5 Test certifications as called for under "Testing".
.6 Provide a signed statement to the effect that all tests for mechanical systems and equipment have been completely carried out in the Trade Sections of these Specifications and to the manufacturer's recommendations, and in accordance with the requirements of all authorities having jurisdiction.

1.44 PERFORMANCE TESTS AND EQUIPMENT START-UP

.1 After all equipment has been installed, adjusted, balanced and started up, subject equipment to a series of performance tests, as soon as conditions permit.

.2 The timing of the tests shall be arranged to suit the convenience of the Consultant, and the manner and duration shall be as the Consultant deems necessary. Record the daily start and stop times, operating hours and functions performed. Ensure that the performance tests are witnessed by the Consultant.

.3 All major equipment including but not limited to boilers, pumps, sand filters are to be inspected by the manufacturer to ensure that the equipment has been installed in accordance with their recommendations.

.4 Operate equipment under varying load conditions, demonstrate start-up sequence, normal shutdown, simulated emergency shutdown, operation of temperature, etc., and safety controls. Operate switches and electrical devices for correct wiring sequences. Adjust components to achieve a proper functional relationship among all the components of all the systems. Repeat these functions as many times as deemed necessary by the Consultant to achieve reliable operation.

.5 Repair defects and repeat tests as necessary. During test maintain lubrication schedule, set, align and tension drives.

.6 At the successful completion of Performance Tests and all testing and balancing, make the systems ready for final inspection and subsequent acceptance of the Owner. Replace and clean filters, flush out lines and equipment, remove and clean strainers, fill liquid systems and purge air. Provide water treatment to pipes and report in accordance to Section 15602. Disinfect all domestic water as required by current by-laws and Authorities Having Jurisdiction.

.7 Conduct tests to demonstrate operation and ability to meet requirements of all equipment and freedom from undue noise and vibration at the time of final inspection, having ensured that it has previously been subjected to Performance Tests.

- END -

1 GENERAL

1.1 DESCRIPTION

.1 Testing, adjusting, and balancing (TAB) of heating, ventilating and air conditioning (HVAC) systems. TAB includes the following:

.1 Systems Inspection report.
.2 Duct Air Leakage test report.
.3 Balancing air and water distribution systems; adjustment of total system to provide design performance;
.4 Recording and reporting results.

1.2 DEFINITIONS

.1 TAB: Testing, Adjusting and Balancing; the process of checking and adjusting HVAC systems to meet design objectives.

.2 AABC: Associated Air Balance Council.

.3 Hydronic Systems: Includes heating hot water, domestic hot water recirculation, and glycol water systems, as applicable to the project.

.4 Air Handling Systems: Includes all central and distributed air handling equipment that provide outside air, supply air, return air, exhaust air and relief air to and from the building, as applicable to the project.

.5 Air distribution systems: Includes all grilles, diffusers, terminal units (by pass/VAV).

.6 Flow rate tolerance: The allowable percentage variation, minus to plus, of actual flow rate from values (design) in the contract documents.

1.3 QUALITY ASSURANCE

.1 Qualifications:

.1 TAB Agency: The TAB agency shall be a subcontractor of the General Contractor and shall report to and be paid by the General Contractor.

.2 The TAB agency shall be either a certified member of AABC to perform TAB service for HVAC and water balancing equipment. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the agency loses subject certification during this period, the General Contractor shall immediately notify the Consultant and the Owner and submit another TAB firm for approval.

.3 TAB Specialist: The TAB specialist shall be either a member of AABC or an experienced technician of the Agency.

.2 TAB Agency shall be identified by the General Contractor within 60 days after the award of the contract.

.3 The TAB specialist will be coordinating, scheduling and reporting all TAB work and related activities and will provide necessary information as required by the Consultant. The responsibilities would specifically include:

.1 Shall directly supervise all TAB work.
.2 Shall sign the TAB reports that bear the seal of the TAB Agency. The reports shall be accompanied by report forms and schematic drawings required by the TAB standard, AABC.
.3 Would follow all TAB work through its satisfactory completion.
.4 Shall provide final markings of settings of all HVAC adjustment devices.
.5 Permanently mark location of duct test ports.

.4 Test Equipment Criteria: The instrumentation shall meet the accuracy/calibration requirements established by AABC National Standards and or by the instrument manufacturer.

.5 Tab Criteria:

.1 Air Filter resistance during tests, artificially imposed if necessary, shall be at least 90 percent of final values for pre-filters and after-filters.

.2 Flow rate tolerance:

.1 Air handling unit and all other fans, cubic meters/min (cubic feet per minute): Minus 5% to plus l0%.
.2 Grilles, diffusers and air terminal units (maximum values): -5% to +l0%.
.3 Exhaust hoods/cabinets: 0 % to + l0 %.
.4 Minimum outside air: 0 % to +10 %.
.5 Individual room air outlets and inlets, and air flow rates not mentioned above: -5 % to +l0 % except if the air to a space is 100 CFM or less the tolerance would be 0 to plus 5 %.
.6 Heating hot water pumps and hot water coils: -5 % to +5 %.
.7 Heating hot water convectors, forced flow heaters, unit heaters: -5 % to +5 %.
.8 Chilled water and condenser water pumps: -5%t to +5 %.
.9 Chilled water coils: -5 % to +5 %.

1.4 SUBMITTALS

.1 Submit Following for Review to the Consultant:

.1 Systems inspection report on equipment and installation for conformance with design.

.2 Duct Air Leakage Test Report.

.3 Final TAB reports covering flow balance and adjustments, performance tests.

.4 Include in final reports uncorrected installation deficiencies noted during TAB and applicable explanatory comments on test results that differ from design requirements.

1.5 APPLICABLE PUBLICATIONS

.1 The following publications form a part of this specification to the extent indicated by the reference thereto. In text the publications are referenced to by the acronym of the organization.

.2 American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE): HVAC Applications ASHRAE Handbook, Testing, Adjusting, and Balancing

.3 Associated Air Balance Council (AABC): AABC National Standards for Total System Balance

.4 Sheet Metal and Air Conditioning Contractors National Association (SMACNA): HVAC SYSTEMS Testing, Adjusting and Balancing

2 Products

2.1 PLUGS

.1 Provide plastic plugs to seal holes drilled in ductwork for test purposes.

2.2 INSULATION REPAIR MATERIAL

.1 Coordinate with the mechanical Contractor the TAB activity such that it does take place before the insulation is installed on ductwork and piping.

.2 In the absence of such coordination, the mechanical contractor shall be responsible for the repair to the ductwork and or piping insulation removed for TAB purposes, including the integrity of the vapor barrier material and the insulation jacket.

3 Execution

3.1 GENERAL

.1 Obtain applicable contract documents and copies of approved submittals for HVAC equipment and automatic control systems.

3.2 SYSTEMS INSPECTION REPORT

.1 Inspect equipment and installation for conformance with design.

.2 The inspection and report is to be done after air distribution equipment is on site and duct installation has begun, but well in advance of performance testing and balancing work. The purpose of the inspection is to identify and report deviations from design and ensure that systems will be ready for TAB at the appropriate time.

.3 Verify that all items such as ductwork piping, ports, terminals, connectors, etc., that is required for TAB are installed. Provide a report to the Consultant.

.4 Reports: Follow check list format developed by AABC or SMACNA, supplemented by narrative comments, with emphasis on air handling units and fans. Check for conformance with submittals. Verify that diffuser and register sizes are correct. Check air terminal unit installation including their duct sizes and routing.

3.3 TAB REPORT

.1 Format to be in accordance with referenced standard listed above, but using design drawing units.

.2 Produce "as-built" full system schematics. Use as-built drawings for reference.

.3 Submit 1 copy of preliminary TAB reports, each in "D" ring binders, complete with index tabs for verification and approval of Consultant.

.4 Submit copies of final TAB reports after approval by the Consultant, to be incorporated into the Maintenance and Operations Manual, as indicated in section 15010.

3.4 PROCEDURES

.1 Tab shall be performed in accordance with the requirement of the Standard under which TAB agency is certified.

.2 Start final TAB only when building is essentially completed, including:

.1 Installation of ceilings, doors, windows and other construction affecting TAB.
.2 Application of sealing, caulking and weather-stripping.

.3 Normal operation of mechanical systems affecting TAB.

.3 General: During TAB all related system components shall be in full operation. Fan and pump rotation, motor loads and equipment vibration shall be checked and corrected as necessary before proceeding with TAB. Set controls and/or block off parts of distribution systems to simulate design operation of variable volume air or water systems for test and balance work.

3.5 AIR BALANCE AND EQUIPMENT TEST:

.1 Include all air handling units, fans, terminal units, fan coil units, room diffusers/outlets/inlets, as applicable to this project.

.2 Adjust fan speeds to provide design air flow.

.3 Test and balance systems in all specified modes of operation, including variable volume, economizer, and fire emergency modes. Verify that dampers and other controls function properly.

.4 Parameters to be Measured

.1 Air Flow
.2 Air velocity.
.3 Static pressure.
.4 Velocity pressure.
.5 Temperature:
.1 Wet bulb.
.2 Dry bulb.
.6 Cross sectional area.
.7 Fans RPM
.8 Electrical power:
.1 Voltage
.2 Current draw.

.7 Locations of Measurements

.1 Inlet and outlet of each
.1 Fan.
.2 Coil.
.3 Filter.
.4 Balancing damper.
.5 Other auxiliary equipment.
.2 Main ducts.
.3 Main branch ducts.
.4 Sub-branch ducts.
.5 Each supply, exhaust and return air inlet and outlet.
.6 Before and after the silencers.

3.6 WATER BALANCE AND EQUIPMENT TEST:

.1 Include all circulating pumps, heat exchangers, boilers, coils, as applicable to this project.

.2 Adjust flow rates for equipment to the values indicated on the drawings and schedules. Set balancing valves and circuit setters to the values on indicated on the equipment schedules

.3 Record final measurements for hydronic equipment on performance data sheets. Include entering and leaving water temperatures for heating and cooling coils, and for heat exchangers. Include entering and leaving air temperatures (DB/WB for cooling coils) for air handling units and reheat coils. Make air and water temperature measurements at the same time.

.4 Parameters to be Measured

.1 Water/Glycol Flow (as applicable to the project)
.2 Pressure.
.3 Temperature.
.4 Specific gravity.
.5 Pumps RPM
.6 Electrical power:
.1 Voltage
.2 Current draw.

.5 Locations of Measurements

.1 Inlet and outlet of each
.1 Pump.
.2 Coil.
.3 Boiler.
.4 Balancing valve.
.5 Automatic control valves
.6 Chiller.

3.7 VERIFICATION

.1 Reported measurements shall be subject to verification by Consultant. Provide instrumentation and manpower to verify results of up to 30 % of all reported measurements. Number and location of verified measurements to be at discretion of Consultant.

.2 Bear costs to repeat TAB, as required, to satisfaction of Consultant.

3.8 MARKING OF SETTINGS

.1 Following approval of TAB final Report, the setting of all HVAC adjustment devices including balancing valves, splitters and dampers shall be permanently marked by the TAB Specialist so that adjustment can be restored if disturbed at any time. Style and colors used for markings shall be coordinated with the Consultant.

3.9 IDENTIFICATION OF TEST PORTS

.1 The TAB Specialist shall permanently and legibly identify the location points of duct test ports. If the ductwork has exterior insulation, the identification shall be made on the exterior side of the insulation. All penetrations through ductwork and ductwork insulation shall be sealed to prevent air leaks and maintain integrity of vapor barrier.

END OF SECTION

1 GENERAL

1.1 Conform to Sections of Division 1 as applicable.

1.1.1 Conform to Section 15010, General Mechanical Requirements as applicable.

1.2 RELATED SECTIONS

1.2.1 Conform to Section 16010, General Electrical Requirements.

1.2.2 Installation of inserts, sleeves and anchors supplied by this Section: Section 04200, Masonry.

1.3 REFERENCES

ANSI B31.1 to B31.9 inclusive: Piping

CAN/CGSB-1.40-97	Primer, Structural Steel, Oil Alkyd Type
CSA B51-03	Boiler, Pressure Vessel, and Pressure Piping Code
CSA B52-99	Mechanical Refrigeration Code
CAN/CSA-G40.20/G40.21-98	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
CAN/CSA-S16-01	Limit States Design of Steel Structures
CSA W47.1-92(R2001)	Certification of Companies for Fusion Welding of Steel Structures
CAN/CSA W48-01	Filler Metals and Allied Materials For Metal Arc Welding.
CSA W59-M1989(R2001)	Welded Steel Construction (Metal Arc Welding)
CAN/CSA W117.2-01	Safety in Welding, Cutting and Allied Processes

1.4 SUBMITTALS

1.4.1 **Shop Drawings:** Prepare and submit shop drawings for equipment covered by this Section including upper, middle and pipe attachments, riser clamps, shields and saddles, and sway braces.

2 PRODUCTS

2.1 MATERIALS

2.1.1 **Welding Studs**

-Graham
-Omark
-Nelson

2.1.2 **Concrete Inserts and Anchors**

-Readhead by ITW
-SSS by Star
-Parabolt by USM
- Kwik-Bolt by Hilti

2.1.3 **Beam Clamps**

-Grinnell
-Myatt
- Hilti

2.1.4 **Concrete Grout:**

-Sikagrout 212 by Sika Canada Inc.
-Embeco 636 Grout by Master Builders
-Sealtight V-3 Grout by W.R. Meadows

2.1.5 **Pipe Hangers:**

- Grinnell
- Myatt
- Hilti

2.1.6 **Zinc-Rich Paint:** Galvafroid by W.R. Meadows.

2.1.7 **Primer**: CAN/CGSB-1.40-M.

3 EXECUTION

3.1 GENERAL CONSTRUCTION REQUIREMENTS

3.1.1 **Attachment to Building Construction**

3.1.1.1 Use welding studs of size not larger than 10 mm (3/8") for attaching miscellaneous materials and equipment to building steel. If weight of materials or equipment require bolts or studs larger than 10 mm (3/8") dia, use steel clips or brackets, secured to building steel by welding or bolting method of attachment as approved by Consultant.

3.1.1.2 Use self drilling expansion type concrete inserts for securing miscellaneous equipment and materials to masonry or concrete construction already in place, of sufficient number and size to prevent concrete from breaking away. Use of powder or power actuated fasteners will not be allowed unless prior written approval is obtained from Consultant.

Deleted:

3.1.1.3 Support rods for any suspended item must not be attached to or extended through steel pan type roofs or through concrete slab roofs.

3.1.1.4 Provide beam clamps of 2-bolt design and of such type that rod load is transmitted only concentrically to beam web centreline. Use of "C" and "I" beam side clamps and other similar items will not be allowed without written consent of Consultant.

3.1.1.5 Where roof or floor framing consists of open web or long span steel joists, ensure that hangers are located at or within 150 mm (6") of joist top or bottom chord panel points, otherwise provide additional structural steel as required where hanger spacing does not coincide with joist spacing. Design suspension assembly such that hanger load is transmitted only concentrically to

supporting joist. Do not use "C" and "I" beam side clamps, brackets and other similar, without written consent of Consultant.

3.1.1.6 Locate secondary structural steel members between joists at or within 150 mm (6") of top or bottom chord panel points. Where secondary structural steel member cannot be located at or near joist panel point, provide additional diagonal structural steel web member(s) designed for applicable load to nearest panel point in opposite chord member. This condition may be waived if load to be suspended between panel points is not in excess of 45 kg (100 lbs). Diagonal hangers which will induce lateral stresses in chord members of joist will not be permitted. Submit shop drawings of suspension assembly indicating location of suspension or support points, max load at each suspension point, location and size of hangers, brackets and intermediate framing members when required, and also details of connection to building structure.

Deleted:

3.2 PIPING CONSTRUCTION METHODS

3.2.1 General

3.2.1.1 Unless specified otherwise herein, construct and install piping in accordance with ANSI Sections B31.1 to B31.9 as applicable to service, except that soldered joints will not be permitted in compressed air piping.

3.2.1.2 To avoid unnecessary cutting of masonry, provide inserts, sleeves and anchors to other trades for building in as Work proceeds. Arrange with other trades to leave openings, slots and chases to accommodate later installation of mechanical work.

3.3 PIPE HANGERS AND SUPPORTS

3.3.1 General

3.3.1.1 Support or suspend piping with necessary hangers, structural supports and/or brackets as indicated on Drawings and/or as required, to prevent sagging, warping and vibration and to allow for movement due to expansion and contraction. Place hangers and supports close to fittings, valves and/or other heavy parts.

3.3.1.2 Do not allow loads of any nature to be transmitted through piping connections to equipment not specifically designed for such loads. Where flexible connections are not called for at connections to equipment, support pipe by stands attached to both pipe and supporting structure so that force in any direction is not transmitted to equipment.

3.3.1.3 Provide suitably dampened spring hangers for first 3 supports from equipment connection on piping subject to excessive movement or shock from any source, thermal expansion and contraction, selected in accordance with ANSI B31.1. Where it is evident that no undue loads will be transmitted to equipment by system concerned, i.e. small bore connections to comparatively large equipment, cold service piping not subject to shock, etc., then spring hangers may be omitted and standard hangers used.

3.3.1.4 Use trapeze type hangers where pipes are grouped together, unless specifically indicated otherwise on Drawings. Suspend horizontal member by adjustable rods with locking feature for

maintaining level and slope. Space trapeze type hangers based on closest interval required by any pipe supported thereon. Provide any auxiliary steel required to support trapeze between building steel.

3.3.1.5 Do not hang any pipe from another pipe unless specifically indicated on Drawings.

3.3.2 **Saddles and Roller Supports**

3.3.2.1 Provide saddles at roller supports for piping carrying liquids at 10.5 deg C (51 deg F) or higher. Weld saddles to black or galvanized steel piping. Refinish galvanized surfaces destroyed by welding with zinc rich paint.

3.3.3 **Hangers**

3.3.3.1 For insulated piping up to NPS 4 carrying liquids at temperatures 10.5 deg C (51 deg F) and higher, use standard weight clevis hangers with level adjustment and locknut.

3.3.3.2 For insulated lines of NPS 4 dia and larger carrying liquids at temperatures 10.5 deg C (51 deg F) or higher, use adjustable roller type hangers with locknuts, and rollers of sufficient width to clear outside diameter of insulation on piping. Support rollers at both ends, either by yoke, swivel type hanger or by 2 adjustable rods with locknuts.

3.3.3.3 For insulated piping carrying liquids at temperature of 10 deg C (50 deg F) or less, use elongated clevis type hangers, with clevis of sufficient width to fit over insulation bearing plate.

3.3.3.4 Provide insulation protection bearing plates at hangers and supports for piping carrying liquids at temperature of 10 deg C (50 deg F) or less. Install temporary spacers between plate and pipe equal to thickness of insulation specified. (Refer to Section 15081, Piping Insulation).

3.3.3.5 Bearing plates may be either shop fabricated, or manufactured plates of size required to properly fit outside diameter of pipe insulation.

3.3.3.6 Fabricate bearing plates conforming to following table for various pipe sizes:

Pipe Size (NPS) P	Length of Thickness of plate mm (in)	Plate mm (ga)
1/2 thr. 1-1/2	130 (5)	1.2 (18)
2	150 (6)	.52 (16)
2-1/2	200 (8)	1.52 (16)
3	230 (9)	1.52 (16)
4 and up	250 (10)	1.52 (16)

3.3.3.7 Form bearing plates to outside diameter of adjoining pipe insulation and extend plate up to horizontal centre line of pipe.

3.3.3.8 For non-insulated piping use clevis type of wrought steel construction with adjustable rod, level locking feature and backnuts.

3.3.3.9 For copper tubing provide copper coated hangers. Regulations of some municipalities require that copper tubing be taped with plastic tape at hanger location, or hanger be provided with plastic insert. Meet these requirements when required, in which case copper coating may be omitted on hanger.

3.3.3.10 Attach hanger rods to building structure by means of malleable iron beam clamps, concrete inserts, and/or approved anchors as hereinbefore specified.

3.3.4 **Hanger Spacing**

3.3.4.1 For horizontal runs of plumbing and drainage piping comply with hanger spacing requirements of OBC.

3.3.4.2 For horizontal runs of black or galvanized steel pipe, other than for plumbing service, do not exceed max distances between supports and with min dia rods as follows:

Pipe Size (NPS)	Distance m (ft)	Dia. of Rod mm (in)
Up thru 1-1/4	1.8 (6)	10 (3/8)
1-1/2	1.8 (6)	10 (3/8)
2	3.05 (10)	10 (3/8)
2-1/2 & 3	3.66 (12)	12 (1/2)
4	4.27 (14)	16 (5/8)
6	5.18 (17)	19 (3/4)
8	5.79 (19)	22 (7/8)
10 & 12	6.71 (22)	22 (7/8)

3.3.4.3 Provide additional hangers in locations where there are concentrated loads such as valves, specialties and other such items.

3.3.4.4 For horizontal runs of copper tubing for services other than plumbing, do not exceed 1.8 m (6 ft) between hangers for lines up to and including NPS 3/4 and 2.4 m (8 ft) for lines of NPS 1 and larger.

3.3.4.5 For horizontal runs of piping fabricated of PVC, use hanger spacing as recommended by manufacturer.

3.3.5 **Vertical Piping Supports**

3.3.5.1 Support vertical plumbing and drainage piping as required by OBC, unless more stringent requirements are specified herein.

3.3.5.2 Support cast iron soil pipe at every floor and other piping at every other floor unless otherwise required by expansion conditions or otherwise specified.

3.3.5.3 Support bottom of riser with base fitting set on concrete pier or by hanger located at top of riser pipe as close to riser as possible.

3.3.5.4 For supports at intermediate floors, use Grinnell Fig. 261 or approved equal steel extension pipe

clamp, bolted securely to pipe. Rest ends of clamp on pipe sleeve or on floor.

3.3.5.5 Provide lateral stability of vertical piping by fabricated brackets or malleable iron, extension type split hangers. Run vertical piping at columns in column webs, on either or both sides of column, unless otherwise directed.

3.3.6 **Anchors and Guides**

3.3.6.1 Supply and install anchors where indicated on Drawings and/or as required to maintain permanent location of pipe lines. Construct anchors for steel or galvanized pipe of approved steel straps and/or rods and for anchoring copper lines use copper plated anchors or provide insulation bands between tubing and clamps if steel straps or rods are used. Install anchors and guides in approved manner.

3.3.6.2 Acceptable Materials: Grinnell #256 or Myatt.

3.4 **MISCELLANEOUS STEEL**

3.4.1 **General**

3.4.1.1 Supply and install miscellaneous structural supports, platforms and braces as may be required to hang or support piping unless Drawings or other Sections of Specifications state otherwise.

3.4.1.2 Submit detailed shop drawings to structural engineer for review before commencing fabrication.

3.4.2 **Materials and Fabrication**

3.4.2.1 Conform to CAN/CSA-S16 for materials, design of details and execution of work.

Deleted: .1

3.4.2.2 Conform to CAN/CSA-G40.20/G40.21, grade 300W for structural shapes, plates, and other similar items.

Deleted: M

3.4.2.3 Use welded construction wherever practicable, with bolted joints allowed for field assembly using high strength steel bolts. Chip welds to remove slag, and grind smooth.

3.4.2.4 Conform to latest issue of following CSA Specifications.

CSA W47.1, for qualification of welders
CSA W48.1-M, for electrodes (only coated rods allowed)
CSA W59-M, for design of connections and workmanship
CSA W117.2, for safety

3.4.3 **Painting and Cleaning**

3.4.3.1 Touch up minor damage to finish on equipment with standard factory applied baked enamel finish. If, in Consultant's opinion, damage is too extensive to be remedied by touch up, replace damaged equipment.

3.4.3.2 Clean steel by scraping, wire brushing or other effective means to remove base scale, rust, oil,

dirt or other foreign matter.

3.4.3.3 Apply 1 coat of zinc chromate iron oxide primer, conforming to CAN/CGSB-1.40-M to miscellaneous steel.

3.4.3.4 In field, touch up bolt heads and nuts, previously unpainted connections and surfaces damaged during erection with primer as herein before specified.

3.4.3.5 Give 2 coats of primer to surfaces which will be inaccessible after erection.

3.4.3.6 Remove foreign matter from steelwork on completion of installation.

3.4.4 With exception of prime painting of miscellaneous steel or any other specific requirements as specified above or under respective Sections of Division 15, or equipment otherwise factory painted, painting will be provided under Division 9, Finishes.

3.5 **CONCRETE INSERTS**

3.5.1 Install inserts required for attachment of hangers, either for suspension of piping or equipment.

3.5.2 For masonry or poured concrete construction use expansion type units. Insert into concrete after concrete has cured. Anchors or inserts installed by explosive means shall not be used.

END OF SECTION

Deleted: .

PART 1 - GENERAL

1.1 GENERAL

1.1.1 This section of the specification shall be read in conjunction with and be governed by the requirements of Section 15010.

1.2 SHOP DRAWINGS

1.2.1 Submit shop drawings in accordance with Section 15010.

1.2.2 Submit for approval, manufacturer's catalogue literature related to installation and fabrication.

PART 2 - PRODUCTS

2.1 GENERAL

2.1.1 Supply access doors to the relevant building trade to provide access in furred ceilings for the following:

.1 Servicing equipment

.2 Access to plumbing cleanouts

.3 Access to shut off valves.

.4 Inspection of life safety equipment.

.5 Service of operating devices

.6 All locations where periodic maintenance is required.

2.1.2 Access door sizes shall be as follows:

.1 Body Entry: 24" x 24" (600 x 600 mm)

.2 For Hand Entry: 18" x 18" (450 x 450 mm)

.3 For Viewing Only: 12” x 12” (300mm x 300mm)

2.1.3 All doors shall open 180 degrees and have rounded safety corners

2.1.4 For fire rated ceilings or wall provide a fire rated access door that will match the fire rating of the wall that the access door is installed in. The Division 15 Contractor shall be responsible for reviewing the drawings and providing fire rated access doors where they are required.

2.1.5 Where body access is possible the access doors shall be provided with a releasing mechanism on both sides of the door.

2.2 RECESSED ACCESS DOOR FOR DRYWALL APPLICATIONS

2.2.1 Door shall be 16 gauge steel. Mounting frame shall be 14 gauge galvanized steel.

2.2.2 Door shall be provided with a 25 mm (1") recess or 14mm (5/8") to suit the thickness of the drywall ceiling.

2.2.3 The frame shall be provided with a galvanized steel drywall taping bead on all sides.

2.2.4 The hinge shall be a concealed pivoting rod.

2.2.5 The latch shall be a flush to the surface, screwdriver operated cam latch.

2.2.6 The steel finish shall be 5 stage iron phosphate preparation with prime coat of grey baked enamel.

2.2.7 Standard of Acceptance: Acudor DW-5015, Mifab, Zurn, Watrous, Williams Brothers

2.3 RECESSED ACCESS DOOR FOR PLASTER APPLICATIONS

2.3.1 Door shall be 16 gauge steel. Mounting frame shall be 14 gauge galvanized steel.

2.3.2 Door shall be provided with a 14mm (5/8") recess and shall be lined with self furring galvanized lath.

2.3.3 The frame shall be provided an expansion casing bead with 75 mm (3") wide galvanized lath, recessed 20mm (3/4") to receive plaster.

2.3.4 The hinge shall be a concealed pivoting rod.

2.3.5 The latch shall be a flush to the surface, screwdriver operated cam latch.

2.3.6 The steel finish shall be 5 stage iron phosphate preparation with prime coat of grey baked enamel.

2.3.7 Standard of Acceptance: Acudor AP-5010, Mifab, Zurn, Watrous, Williams Brothers

2.4 FLUSH ACCESS DOORS FOR TILED WALL APPLICATIONS

2.4.1 For doors 400mm x 400mm (16" x 16") and smaller the door shall be 16 gauge with 18 gauge mounting frame.

2.4.2 For doors over 400mm x 400mm (16" x 16") the door shall be 14 gauge with 16 gauge mounting frame.

2.4.3 Door shall be flush to frame with rounded safety corners.

2.4.4 The frame shall be one piece welded to the mounting frame.

2.4.5 The hinge shall be a continuous concealed hinge.

2.4.6 The latch shall be a stainless steel screwdriver cam latch.

2.4.7 The finish shall be type 304 #4 satin polish stainless steel.

2.4.8 Standard of Acceptance: Acudor UF-5000, Mifab, Zurn, Watrous, Williams Brothers

2.5 FIRE RATED ACCESS DOOR

2.5.1 Door shall be constructed of 20 gauge steel with a 16 gauge mounting frame.

2.5.2 Door shall be filled with 50mm (2") thick fire rated insulation.

2.5.3 The door frame shall be provided with a 25mm (1") wide flange and mounting frame to have anchor straps.

2.5.4 The hinge shall be concealed and shall be provided with a spring closer.

2.5.5 Door shall be UL/ULC rated for 1 ½ hour "B" label with 250 degree F temp rise in 30 minutes.

2.5.6 The latch shall be a universal self latching bolt, operated by either a knurled knob.

2.5.7 The steel finish shall be 5 stage iron phosphate prepared with a prime coat of grey baked enamel.

2.5.8 For drywall applications provide a galvanized steel drywall taping bead flange.

2.5.9 Standard of Acceptance: Acudor FB-5050, Mifab, Zurn, Watrous, Williams Brothers

2.6 FIRE RATED ACCESS DOOR WITH INSIDE LATCH RELEASE

2.6.1 Door shall be constructed of 16 gauge steel with a 16 gauge mounting frame.

2.6.2 Door shall be flush to frame with reinforced edges.

2.6.3 The door frame shall be provided with a 25 mm (1") wide flange and shall be provided with anchor straps.

2.6.4 The hinge shall be concealed and shall be provided with a spring closer.

2.6.5 The door shall be UL/ULC rated for 1 ½ hour "B" label or 2 hour "B" label as required where temperature rise is not a factor.

2.6.6 The latch shall be a universal self latching bolt, operated by either a knurled knob.

2.6.7 The steel finish shall be 5 stage iron phosphate prepared with a prime coat of grey baked enamel.

2.6.8 Door shall be provided with an interior latch release.

2.6.9 For drywall applications provide a galvanized steel drywall taping bead flange.

2.6.10 Standard of Acceptance: Acudor FB-5060, Mifab, Zurn, Watrous, Williams Brothers

2.7 VALVE BOX – SURFACE MOUNT

2.7.1 Door shall be stainless steel in public areas and steel in mechanical rooms and service areas.

2.7.2 Door and box shall be 16 gauge steel.

2.7.3 The door shall overlap the box, providing a tight and secure fit.

2.7.4 The box shall be fully enclosed, attached to the door.

2.7.5 The hinge shall be a continuous piano hinge.

2.7.6 The door shall be provided with a cylinder lock and key.

2.7.7 For steel doors the finish shall be 5 stage iron phosphate preparation with prime coat of grey baked enamel.

2.7.8 Stainless steel doors shall be #4 satin finish.

2.7.9 Standard of Acceptance: Acudor ASVB, Mifab, Zurn, Watrous, Williams Brothers

2.8 VALVE BOX – RECESSED

2.8.1 Door shall be stainless steel in public areas and steel in mechanical rooms and service areas.

2.8.2 Door and box shall be 16 gauge steel.

2.8.3 The door shall be flush to the frame with rounded safety corners.

2.8.4 The box shall be fully enclosed, completely attached to the frame.

2.8.5 The hinge shall be a continuous concealed hinge.

2.8.6 The door shall be provided with a cylinder lock and key.

2.8.7 For steel doors the finish shall be 5 stage iron phosphate preparation with prime coat of grey baked enamel.

2.8.8 Stainless steel doors shall be #4 satin finish.

2.8.9 Standard of Acceptance: Acudor ARVB, Mifab, Zurn, Watrous, Williams Brothers

PART 3 - EXECUTION

3.1 INSTALLATION

3.1.1 On some drawings, access door locations have been indicated for coordination. The drawings do not show all access doors required.

3.1.2 The Division 15 Contractor shall provide a set of drawings showing locations and types of all access doors located in public areas to the Consultant for approval, prior to commencing the installation of any piping or ductwork within these areas.

3.1.3 Access doors shall be turned over to the building trade that is responsible for finishing the wall or ceiling where the access door is required.

3.1.4 The Division 15 Contractor shall be responsible for providing the access doors required to be installed in ductwork. Refer to section 15820 for requirements.

END OF SECTION

1 GENERAL

1.1 GENERAL

.1 Section Includes:

.1 Valve Tags.
.2 Pipe Markers/Arrow Tape Above Ground.
.3 Underground Piping Warning Tape.
.4 Mechanical Equipment and HVAC Controls Identification.
.5 Safety Signs.
.6 Isolation Valves Numbering.

1.2 DEFINITIONS

.1 Exposed Areas

.1 Finished areas and other areas used by personnel in normal use of building, such as equipment rooms and storage rooms.

.2 Concealed Areas

.1 Duct or pipe tunnels, duct or pipe chases, spaces above accessible ceilings, and crawl spaces.

2 PRODUCTS

2.1 STANDARD OF ACCEPTANCE

.1 W. H. Brady Co. catalogue numbers are used as a basis of identification.

.2 Stock catalogue numbers are listed in these specifications. Subcontractor is responsible to review schedules and provide required markers. In some instances, "non-stock" markers (special) may be required.

2.2 MANUFACTURER'S NAMEPLATES

.1 Manufacturer's nameplates:

.1 Provide metal nameplate on each piece of equipment, mechanically fastened with raised or recessed letters.
.2 Provide Underwriters' Laboratories or CSA registration plates, as required by respective agency.
.3 Manufacturers nameplate to indicate size, equipment model, manufacturer's name, serial number, voltage, cycle, phase and power of motors.
.4 Locate nameplates so that they are easily read. Do not insulate or paint over plates.

2.3 VALVE TAGS

.1 Metal Tags: Brass or aluminium with stamped or engraved letters; tag sizes minimum 2 inches (round, square, or rectangle) with smooth edges. Thickness 19 gauge (.040 inches) minimum.

.2 Beaded Chain: Size 6, brass or aluminium, 4 1/2 inches long with locking link.

2.4 PIPE MARKERS/ARROW TAPE ABOVE GROUND

.1 Colour: Conform to ANSI A13.1.

.2 Self-Sticking Pipe Markers/Arrow Tape: Material B-946, flexible, vinyl film tape with pressure sensitive permanent adhesive backing and printed markings.

.3 Suitable for indoor/outdoor application.

.4 Temperature range: Minus 40 degrees to 180 degrees F.

2.5 UNDERGROUND PIPING WARNING TAPE

.1 Tracer wire and test station(s) required when burying cast iron, ductile iron, or non-metallic piping.

.2 Tracer Wire: #10AWG THHN/THWN, yellow, solid copper.

.3 Tracer Wire Test Station: C.P. Test Services. Test Station: Plastic Pipe, cast iron cover, 2-point terminal box.

2.6 CONTROLS IDENTIFICATION

.1 Refer to section 15900.

2.7 EQUIPMENT IDENTIFICATION

.1 Labelling shall be furnished and installed by the contractor

.2 Engraved signs shall be dark letters on light background.

.3 Identify mechanical equipment and HVAC controls, e.g., air handling units, pumps, heat transfer equipment, water treatment devices, controls instruments, stationary tanks/containers, and similar items, with nameplates or tags.

.4 Provide engraved nameplates made of rigid plastic laminate in which colored top and bottom layers of the material are thermoset with a contrasting color core. Minimum thickness 0.062 inch.

.5 Size: min. 1" x 3".

.6 Material Colour: White background/ black lettering.

.7 Manufacturer: Brady, No. B-1

.8 Provide lettering as follows:

.1 Size: 10 point minimum
.2 Spacing: 1/4 inch from top, 1/8 inch from bottom, 1/16 inch between lines.
.3 Provide nameplate with component nomenclature as noted in the Equipment Schedules. Coordinate with the controls sub-contractor.

.9 As a minimum, identify the system, e.g., HVAC (heating, ventilating, and air conditioning), the component, e.g., FGF (furnace, gas fired), and the sequence number.

2.8 **SAFETY SIGNS**

.1 Colors associated with specific words such as "Danger," "Warning," "Caution," or "Notice" shall conform to ANSI Z35.1.

3 EXECUTION

3.1 **PREPARATION**

.1 Degrease and clean surfaces to receive adhesive for identification materials.

3.2 **INSTALLATION**

.1 Valve Tags:

.1 Install with brass beaded chain.
.2 Steel stamp or engrave valve tag in accordance with schedule herein.
.3 Letter style block, 1/4-inch height minimum.
.4 Tag all valves in concealed or exposed areas except isolation and by-pass valves installed adjacent to the equipment they serve.
.5 Provide typewritten letter size list of applied tags and location. Frame under glass and hang where directed.

.2 Pipe Markers Above Ground:

.1 Install in accordance with manufacturer's instructions.
.2 Seal markers with clear lacquer.
.3 Identify piping in exposed or concealed areas in accordance with schedule herein.
.4 Pipe marker consists of pipe contents identification with flow direction arrow tape. Provide consistent color scheme, unless otherwise noted.
.5 Wrap arrow tape completely around pipe at both ends of pipe markers.
.6 Install in clear view and align with axis of piping.
.7 Label piping at intervals of not more than 20 feet on horizontal and vertical runs, at each branch connection, and where pipe penetrates walls, ceilings and floors (both sides).
.8 Size of label depends on outside diameter (OD) of pipe. Pipe OD includes insulation or protective coating.

.9 Minimum length of marker including arrows:

(a) 2" diam. pipe or smaller:	8"
(b) 2" to 8"	12"
(c) 8" to 10"	24"
(d) Over 10":	32"

.3 Safety Signs

.1 Install in clear view.

END OF SECTION

1 GENERAL

1.1 GENERAL

.1 This section of the specification shall be read in conjunction with and be governed by the requirements of Section 15010.

1.2 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 15010.

.2 Provide separate shop drawings for each isolated system complete with performance and product data.

.3 Submit type of isolator, size, height when uncompressed and maximum allowable static deflection weight of all isolated equipment, loads on each isolator and static deflection of each isolator under the specific design load.

.4 Submit marked up plans indicating all locations where pipes are to be isolated in mechanical rooms and as specified.

2 PRODUCTS

2.1 GENERAL

.1 Vibration isolator sizes and layout shall be determined by the vibration isolator supplier.

.2 Elastomeric elements that will be exposed to temperatures below freezing shall be fabricated from natural rubber instead of neoprene.

.3 All isolators to be installed outdoors or exposed to weather shall be hot dipped galvanized and shall be furnished with neoprene mounting sleeves for hold-down bolts to prevent any metal to metal contact.

.4 Standard of Acceptance: Kinetics Noise Control, Vibro-Acoustics.

2.2 FLEXIBLE PIPE CONNECTORS

.1 Flexible pipe connectors shall be used on all piping connected to rotating equipment (Chiller, pumps, air handling equipment) to reduce the transmission of noise and Vibration, and to eliminate stresses in piping systems due to misalignment and thermal movement of the piping.

.2 Flexible connectors shall be of the single- or double-sphere molded joint configuration and shall meet or exceed specifications of the Rubber Expansion Joint Division, Fluid Sealing Association.

.3 Connectors shall be made of molded neoprene reinforced with nylon tire cord and shall have mild steel floating flanges or female union ends.

.4 Control rods shall be used with unanchored systems or with spring-mounted equipment where the pressures and movements exceed those the connectors are designed to withstand.

.5 Standard of acceptance: Kinetics model Kinflex

2.3 FLEXIBLE DUCT CONNECTORS

.1 Flexible Connections

.1 Where duct connections are made to fans and air handling units (not internally isolated), install a non combustible flexible connection of 822 g (29 ounce) neoprene coated fiberglass fabric approximately 150 mm (6 inches) wide. For connections exposed to sun and weather provide hypalon coating in lieu of neoprene. Burning characteristics shall conform to NFPA 90A. Securely fasten flexible connections to round ducts with stainless steel or zinc coated iron draw bands with worm gear fastener. For rectangular connections, crimp fabric to sheet metal and fasten sheet metal to ducts by screws 50 mm (2 inches) on center. Fabric shall not be stressed other than by air pressure. Allow at least 25 mm (one inch) slack during operation to insure that no vibration is transmitted.

.2 Length of connection: 6"

.3 Minimum distance between metal parts when system in operation: 3"

.4 Install in accordance with recommendations of SMACNA.

2.4 ELASTOMERIC PADS

.1 Neoprene waffle or ribbed; 9mm minimum thick; 50 durometer; maximum loading 350kPa. Mason type W

.1 Application: between all floor-mounted pumps supports and the house-keeping pads

2.5 ELASTOMERIC MOUNTS

.1 Neoprene, moulded from oil-resistant compounds, with a cast-in-top steel load transfer plate for bolting to supported equipment and a bolt-down plate with holes provided for anchoring to the supporting structure. Isolator shall provide lateral load resistance for loads applied parallel to mounting surface. Neoprene vibration isolators shall be Model RQ, by Kinetics Noise Control, Inc.

.1 Application: between boilers support frames and house-keeping pads.

2.6 PIPE HANGERS

.1 Colour coded springs, rust resistant, painted box type hangers. Swivel arrangement to permit hanger box or rod to move through a 30 deg. arc without metal to metal contact. Unless specified otherwise, the static deflection shall be 9mm, with a strain not exceeding 15%, and spring hangers to have minimum static deflection of 2". A neoprene sleeve shall be provided where the lower hanger rod passes through the steel hanger box such that the hanger rod cannot contact the steel hanger. The diameter of the clear hole in the hanger box shall be at least 19mm larger than the diameter of the hanger rod.

.2 Standard of acceptance: Kinetics model SRH

3 EXECUTION

3.1 INSTALLATION

.1 Provide vibration isolation for new equipment as noted in the specification, listed in the schedule and shown on the drawings.

.2 Install vibration isolation equipment in accordance with manufacturer’s instructions and adjust mountings to level equipment.

.3 Ensure piping and electrical connections to isolated equipment do not reduce system flexibility.

.4 All suction and discharge from the pumps shall be provided with flexible pipe connections.

.5 Unless indicated otherwise, support all piping connected to the pumps and boilers withspring equipped hangers as described in these specifications, as follows:

.1 First 3 points of support.

.2 First point of support shall have a static deflection of twice deflection of isolated equipment, but not more than 2".

.6 Unless specified otherwise, all pump supports will be mounted on elatomeric pads.

.7 Unless specified otherwise, the boilers, indoor air handlers, indoor chillers will be mounted on elastomeric mounts

.8 All wiring connections to the pumps shall be made in a 360 degree loop; minimum conduit length: 3 ft. Cut any ties used to install this loop prior to adjusting the isolators.

.9 Provide suitable supports for all equipment which does not have a frame with adequate rigidity.

.10 There shall be a minimum of 4" clearance between isolated equipment and the walls, ceiling, floors, columns and any other equipment not installed on vibration isolators.

.11 Piping, ductwork, conduit or mechanical equipment shall not be hung from or supported on other equipment, pipes or ductwork installed on vibration isolators. Such elements shall be supported on or suspended from building structure**.**

END OF SECTION

1 GENERAL

1.1 GENERAL

.1 This section of the specification shall be read in conjunction with and be governed by the requirements of Section 15010.

1.2 QUALITY ASSURANCE

.1 Comply with OBC and NFPA 90A requirements, particularly paragraphs pertaining to the maximum flame spread index (currently set at 25) and maximum smoke development index (currently set at 50).

.2 All materials shall be compatible and suitable for service temperature, and shall not contribute to corrosion or otherwise attack surface to which applied in either the wet or dry state.

.3 Every package or standard container of insulation or accessories delivered to the job site for use must have a manufacturer's stamp or label giving the name of the manufacturer and description of the material.

1.3 SUBMITTALS

.1 Submit in accordance with Section 15010 shop drawings and product data

.2 Provide the following:

.1 Insulation materials: Specify each type used and state surface burning characteristics.
.2 Insulation facings and jackets: Each type used. Make it clear that white finish will be furnished for exposed ductwork, casings and equipment.
.3 Insulation accessory materials: Each type used.
.4 Manufacturer's installation and fitting fabrication instructions for flexible unicellular insulation.

1.4 STORAGE AND HANDLING OF MATERIAL

.1 Store materials in clean and dry environment, pipe covering jackets shall be clean and unmarred. Place adhesives in original containers. Maintain ambient temperatures and conditions as required by printed instructions of manufacturers of adhesives, mastics and finishing cements.

1.5 STANDARDS OF ACCEPTANCE

.1 Knauf Fiber Glass
.2 Owens/Corning Fiberglass
.3 Armstrong
.4 Johns Manville
.5 Rockwool Manufacturing

2 PRODUCTS

2.1 GENERAL

.1 K-factors (thermal conductivity) shown are expressed in BTU•in/hr•ft2•F.

2.2 FIBERGLASS PIPE INSULATION

.1 Insulation:

.1 Rigid molded in compliance with ASTM C547, Class 1, minimum density 3.5 pounds/cubic foot, K-factor of approximately 0.24 at 75 degrees F, suitable for temperatures from minus 20 degrees F to 450 degrees F.

.2 Vapor Barrier

.1 Factory applied vapor barrier all-service type with self-sealing lap and butt strips.

.3 Valves and Fitting Covers

.1 Pre-molded PVC covers with fiber glass insert. Manufacturers: Proto Corp., Ceelco.

.4 Applications

.1 All domestic cold water piping
.2 All hot water heating piping
.3 All DHW and recirculation piping

2.3 INSULATION THICKNESS

.1	Hot water heating, all piping sizes:	1”
.2	Domestic hot water less than 2"	1"
.3	Domestic hot water larger than 2"	1½”
.4	Domestic cold water, all piping sizes:	1"

2.4 ADHESIVE, MASTIC, CEMENT

.1 ASTM C449: Mineral fiber hydraulic setting thermal insulating and finishing cement.

.2 Other: Insulation manufacturers' published recommendations.

2.5 MECHANICAL FASTENERS

.1 Wire: 1.3 mm thick (18 gage) soft annealed galvanized or 1.9 mm (14 gage) copper clad steel or nickel copper alloy.

.2 Bands: 20 mm (3/4 inch) nominal width, brass, galvanized steel, aluminum or stainless steel.

2.6 CANVAS JACKETING

.1 Apply in concealed areas, compact, firm ULC listed heavy plain weave, cotton fabric at 220 g/m sq.

2.7 PVC JACKETING

.1 Apply in exposed areas on piping with operating temperatures less than 180°F. (80°C.).

.2 Piping: ULC listed PVC moulded type jacketing material, gloss white complying with 25 Flame Spread and 50 Smoke Developed ratings.

.3 Fittings: ULC listed PVC, gloss white, 1-piece, pre-moulded fittings complying with 25 Flame Spread and 50 Smoke Developed ratings.

.4 PVC Application: strictly in accordance with the requirements of Authorities having jurisdiction.

.5 Ultraviolet resistant.

.6 Fastenings: To manufacturer's standard(s).

2.8 METAL JACKETING

.1 At all locations where the pipe is located outdoors or in heavy abuse areas, use metal jacketing to protect piping or ductwork insulation.

.2 Jacketing: Aluminum, 0.016 inches thick, embossed surface, with factory bonded moisture barrier.

.3 Valve and Fitting Insulation Covers: Fabricate from same material as jacketing or use prefabricated insulation covers made in two matching halves.

.4 Metal Jacketing Bands: 1/2 inch wide, aluminum or stainless.

2.9 PROTECTION SADDLES AND SHIELDS

.1 Provide factory engineered galvanized steel hanger shields on horizontal insulated pipe complying with MSS SP-58 and MSS SP-59 standards for gauge and length of saddle.

2.10 SADDLES (PIPING/TUBING UP TO 2 INCHES)

.1 Use 180 degree saddle on systems utilizing teardrop type hangers.

.2 Use 360 degree saddle on systems utilizing trapeze hangers or clamps.

2.11 INSERTS AND SHIELDS (PIPING/TUBING OVER 2 INCHES)

.1 Use 360 degree calcium silicate insert with a 180 degree shield on systems utilizing clevis or teardrop type hangers.

.2 Use 360 degree calcium silicate with a 360 degree shield on systems utilizing trapeze hangers or clamps.

.3 The unit shall have an integral moisture barrier consisting of a tri-laminate All-Service Jacket equal and similar to the jacketing on the adjoining insulation.

.4 Insert: Calcium silicate, minimum density 9 pounds/cubic foot.

3 EXECUTION

3.1 EXAMINATION

.1 Verify that items to be insulated have been pressure tested and approved before applying insulation material.

.2 Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION - GENERAL

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

.2 Required pressure tests of piping joints and connections shall be completed and the work approved by the Consultant for application of insulation. Surface shall be clean and dry with all foreign materials, such as dirt, oil, loose scale and rust removed.

.3 Except for specific exceptions, insulate entire specified equipment, piping (pipe, fittings, valves, accessories). Insulate each pipe and duct individually. Do not use scrap pieces of insulation where a full length section will fit.

.4 Insulation materials shall be installed with smooth and even surfaces, with jackets and facings drawn tight and smoothly cemented down at all laps. Insulation shall be continuous through all sleeves and openings, except at fire dampers and duct heaters (NFPA 90A). Vapor retarders shall be continuous and uninterrupted throughout systems with operating temperature 16 degrees C (60 degrees F) and below. Lap and seal vapor barrier over ends and exposed edges of insulation. Anchors, supports and other metal projections through insulation on cold surfaces shall be insulated and vapor sealed for a minimum length of 150 mm (6 inches).

.5 Install vapor stops at all insulation terminations on either side of valves, pumps and equipment and particularly in straight lengths of pipe insulation.

.6 Insulation on hot piping and equipment shall be terminated square at items not to be insulated, such as access openings and nameplates. Cover all exposed raw insulation with white sealer or jacket material.

.7 Protect all insulations outside of buildings with aluminum jacket using lock joint or other approved system for a continuous weather tight system. Access doors and other items requiring maintenance or access shall be removable and sealable.

.8 Piping work not to be insulated:

.1 In hot piping: Unions, flexible connectors, control valves, PRVs, safety valves and discharge vent piping, vacuum breakers, thermostatic vent valves, exposed piping through floor for convectors and radiators. Insulate piping to within approximately 75 mm (3 inches) of uninsulated items.

.9 Plumbing work not to be insulated:

.1 Piping and valves of fire protection system.
.2 Chromium plated brass piping.
.3 Piping in pipe basement serving wall hydrants.
.4 Small horizontal cold water branch runs in partitions to individual fixtures may be without insulation for maximum distance of 900 mm (3 feet).

.10 Work shall be performed by qualified insulation journeymen.

.11 Apply insulation and coverings on hot piping while surface is between 50 to 60^{O}C

.12 Vapor barriers and insulation to be complete over full length of pipe or surface, without penetration for hangers, and without interruption at sleeves, pipe and fittings.

.13 Do not insulate factory-insulated equipment.

.14 Do not insulate nameplates.

.15 Fit insulation tightly against surface to which it is applied.

.16 For non-fire rated barriers (e.g., wall, floor, ceiling, or roof) continue insulation and vapor barrier through penetrations. For fire rated barriers, provide ULC/FM approved through penetration stop systems.

.17 Weatherproof outdoor installations of piping or ductwork covered with aluminum jacket. Provide watershed lap joints and seal with mastic as required.

.18 Do not install metal jacketing with raw edges; provide a safety edge.

3.3 INSTALLATION - PIPING

.1 On exposed piping located in finished areas, locate cover seams in least visible area.

.2 Provide continuous insulation through pipe hangers or supports. Do not notch insulation. Provide shields or saddles to prevent crushing insulation.

.3 Where insulation terminates, taper to pipe and finish with insulating cement or acrylic mastic.

.4 Cover insulated pipes located outdoors or in utility tunnels with aluminum jacket. Secure with aluminum bands and screws as required.

.5 Tape circumferential joints of pipe insulation with 3 inch wide white vinyl tape.

.6 Insulate fitting and valves where required with same material thickness as specified for adjacent pipe.

.7 Insulate potable and non-potable cold water piping within walls, chases, or ceiling plenums where return air is present.

.8 Insulate potable and non-potable cold water piping in equipment rooms.

.9 Do not insulate unions, flanges and valves in potable or non-potable piping systems of 140 degrees F or less, except for chilled water.

.10 Vertical pipe over 3" diameter: use insulation supports welded or bolted to pipe directly above lowest pipe fitting. Thereafter locate on 12 ft centers and at each valve and flange.

.11 Expansion joints: Terminate single layer and each layer of multiple layers in straight cut. Leave space of 1" between terminations. Pack void tightly with glass wool. Protect joints with aluminum sleeves.

.12 Use factory fabricated, easily disassembled insulation, for valves, fittings and process equipment requiring periodic maintenance of parts and sub-assemblies listed or indicated.

- END -

1 GENERAL

1.1 GENERAL

.1 This section of the specification shall be read in conjunction with and be governed by the requirements of Section 15010.

1.2 QUALITY ASSURANCE

.1 Comply with OBC and NFPA 90A requirements, particularly paragraphs pertaining to the maximum flame spread index (currently set at 25) and maximum smoke development index (currently set at 50).

.2 All materials shall be compatible and suitable for service temperature, and shall not contribute to corrosion or otherwise attack surface to which applied in either the wet or dry state.

.3 Every package or standard container of insulation or accessories delivered to the job site for use must have a manufacturer's stamp or label giving the name of the manufacturer and description of the material.

1.3 SUBMITTALS

.1 Submit in accordance with Section 15010 shop drawings and product data

.2 Provide the following:

.1 Insulation materials: Specify each type used and state surface burning characteristics.
.2 Insulation facings and jackets: Each type used. Make it clear that white finish will befurnished for exposed ductwork, casings and equipment.
.3 Insulation accessory materials: Each type used.
.4 Manufacturer's installation and fitting fabrication instructions for flexible unicellular insulation.

1.4 STORAGE AND HANDLING OF MATERIAL

.1 Store materials in clean and dry environment, pipe covering jackets shall be clean and unmarred. Place adhesives in original containers. Maintain ambient temperatures and conditions as required by printed instructions of manufacturers of adhesives, mastics and finishing cements.

1.5 STANDARDS OF ACCEPTANCE

.1 Knauf Fiber Glass
.2 Owens/Corning Fiberglass
.3 Armstrong
.4 Johns Manville
.5 Rockwool Manufacturing
.6 Armaflex.

2 PRODUCTS

2.1 GENERAL

.1 K-factors (thermal conductivity) shown are expressed in BTU•in/hr•ft2•F.

2.2 MINERAL FIBRE BLANKET WITH VAPOUR BARRIER

.1 Apply on all rectangular supply ductwork less than 30" wide, located in the mechanical rooms and ceiling plenums.

.2 Apply on all exhaust ductwork, min. 10 ft (3 m) upstream of the point of exit from the building

.3 Material:

.1 Mineral-Fiber Blanket Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II, for use to 450 deg. F, with a factory-applied jacket manufactured from foil, reinforcing scrim, and kraft paper (FSK). Minimum density of 3/4 lb./cu.ft., maximum conductivity of 0.43 (BTU-in./hr.-sq.ft.-deg. F) at 200 deg. F.

.2 Acceptable Material: Fiberglas, Knauf, Manson.

.3 Thickness: 1".

2.3 FIBROUS GLASS RIGID WITH VAPOUR BARRIER

.1 Apply on all indoor supply rectangular ductwork larger than 30" wide and on all ductwork located outdoors, regardless of size.

.2 Material:

.1 Mineral–Fiber Board Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IB, for use to 450 deg. F, with a factory-applied jacket manufactured from foil, reinforcing scrim, and kraft paper (FSK). Minimum density of 3 lb./cu.ft., maximum conductivity of 0.40 (BTU-in./hr.-sq.ft.-deg. F) at 300 deg. F.

.2 Acceptable products: Fiberglas AF 530, Manson, Knauf.

.3 Thickness: 1"

2.4 CANVAS JACKETS

.1 Apply in mechanical rooms where rigid insulation is applied: compact, firm ULC listed heavy plain weave, cotton fabric at 220 g/m sq.

2.5 **METAL JACKETING**

.1 At all locations where the ductwork is located outdoors or in heavy abuse areas, use metal jacketing to protect piping or ductwork insulation.

.2 Jacketing: Aluminum, 0.016 inches thick, embossed surface, with factory bonded moisture barrier.

.3 Metal Jacketing Bands: 1/2 inch wide, aluminum or stainless.

2.6 **EXTERIOR INSULATION**

.1 Cover all joints of the rigid insulation and fastener penetration with 3" wide pressure sensitive All Service Jacket (ASJ) tape. Rub tape hard with a nylon sealing tool. Over the entire surface apply a weave glass reinforcing cloth embedded between two 1/8" thick wet coats of Breather mastic, i.e., B. Foster Seal Fast 6 PM 35-00-4500.

2.7 **FASTENINGS**

.1 Tape: self adhesive, 100 mm wide rated under 25 for flame spread and under 50 for smoke development.

.2 Contact adhesive: quick-setting, non-flammable fire resistive adhesive to adhere fibrousglass to ducts. Flame spread 15 smoke development 0.

.1 Acceptable Products Foster 85-20 Asbestos Free, Armstrong 520.

.3 Lap Seal Adhesive: Quick-setting adhesive for joints and lap sealing of vapour barriers. Flame spread 10 smoke development 0.

.1 Acceptable Products Foster 85-75, Asbestos Free, Drion.

.4 For Canvas:

.1 Washable adhesive for cementing canvas lagging cloth to duct insulation.
.2 Acceptable Products: Foster 30-36 Asbestos Free.

.5 Pins:

.1 Weld pins 4 mm diameter, with 1½" diameter head for installation through the insulation. Length to suit thickness of insulation.
.2 Weld pins: If duct is over 24" wide, use on bottom of duct as well.
.3 Acceptable Products: Duro Dyne, Clip-Pin.

3 Execution

3.1 **APPLICATION**

.1 Apply insulation after required tests have been completed and approved by Consultant.

Insulation and surfaces shall be clean and dry when installed and during application of any finish.

.2 Work shall be preformed by insulation journeymen.

.3 Apply insulation and coverings on hot equipment while surface is between 50 to 60°C.

.4 Vapour barriers and insulation to be complete over full length of duct or surface, without penetration for hangers, standing duct seams and without interruption at sleeves.

.5 Install insulation with smooth and even surfaces.

.6 Apply insulation materials accessories and finishes to manufacturer's recommendations.

.7 Apply 1.0mm thick metal corners to all ductwork in mechanical rooms to a height of 7 ft.

.8 Use stand-offs for all duct mounted accessories.

3.2 DUCT INSULATION

.1 General:

.1 Adhere and seal vapour barrier using vapour seal adhesives.
.2 Stagger longitudinal and horizontal joints, on multi-layered insulation.

.2 Mechanical Fasteners:

.1 On rectangular ducts, use 50% coverage of insulating cement and weld pins at not more than 14" centres, but not less than 2 rows per side.

3.3 JACKETS

.1 Provide fire retardant coating on canvas jackets.

.2 Fire retardant coating shall be approved by authority having jurisdiction prior to application. Consultant reserves right to remove sample of covering for testing.

.3 Coat canvas covering exposed in finished spaces with diluted coat of lagging adhesive. As recommended by insulation manufacturer for priming. Dilution: 2 parts of water to 3 parts of lagging adhesive.

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL

1.1.1 This section of the specification shall be read in conjunction with and shall be governed by the requirements outlined in Section 15010.

1.1.2 All valves must have a valid CRN Number. Statutory declaration must be provided on request.

1.2 REFERENCE STANDARDS

1.2.1 Do the work in accordance with the Ontario Building Code Plumbing Code and local authority having jurisdiction.

1.2.2	ASTM B62-09	Specifications for Composition Bronze or Ounce Metal Castings.
1.2.3	ANSI/ASME B16.5-2005	Pipe Flanges and Flanged Fittings.
1.2.4	ANSI/ASME B16.11-2009	Forged Fittings, Socket Welding.
1.2.5	ASTM B88-03	Specifications for Seamless Copper Water Tube.
1.2.6	CSA B242-M80	Groove and Shoulder Type Mechanical Pipe Couplings.
1.2.7	MSS SP 67-2002	Butterfly Valves
1.2.8	MSS SP 70-2006	Cast Iron Gate, Globe, Angle and Check Valves
1.2.9	MSS SP 71-2005	Cast Iron Swing Check Valves Flanged and Threaded Ends.
1.2.10	MSS SP 80-2003	Bronze Gate, Globe, Angle and Check Valves

1.3 SHOP DRAWINGS

1.3.1 Submit product data in accordance with Section 15010.

1.3.2 Indicate following: valves.

1.3.3 Provide shop drawings for all grooved end components.

1.3.4 All grooved end components shall be provided by one manufacturer.

PART 2 - PRODUCTS

2.1 PIPING

2.1.1 Domestic hot, cold and recirc tubing, within building.

.1 Above ground: copper tube, hard drawn, type L: to ASTM B88M.

.2 Buried: copper tube, soft annealed, type K: to ASTM B88M.

2.1.2 All piping shall have certification markings for compliance with ASTM B88.

2.2 FITTINGS

2.2.1 Brass or bronze flanges and flanged fittings: to ANSI B16.24.

2.2.2 Brass or bronze threaded fittings: to ANSI B16.15.

2.2.3 Cast bronze to ANSI B16.18- 1984 or wrought copper and bronze to ANSI B16.22.

2.3 JOINTS

2.3.1 Rubber gaskets, 0.063" (1.6 mm) thick: to AWWA C111 -95.

2.3.2 Bolts, nuts, hex head and washers: to ASTM A307-92a-07b, heavy series.

2.3.3 For installation of the potable water system only lead free solder shall be used in accordance with Ontario Building Code Standards.

2.3.4 Solder, tin antimony, 95:5: to ASTM B32.

2.4 GROOVED COPPER METHOD

2.4.1 Application

.1 Grooved piping system may be used in lieu of flanged or sweated copper in size 2" (50 mm) and larger. Couplings shall be designed with angle bolt pads to provide a rigid joint, complete with EPDM flush seal gasket suitable for temperatures from -30°F to 230°F (-34°C to 110°C).

2.4.2 Fittings

.1 Housing: ductile iron conforming to ASTM-A536, Grade 65-45-12

.2 Coating: rust inhibiting lead free paint

.3 Bolts and nuts: heat treated, zinc electroplated carbon steel oval-neck track bolts conforming to ASTM A-183 and zinc electroplated carbon steel heavy hex nuts conforming to ASTM A-563,

.4 Hinge Pin: carbon steel

.5 Gaskets: in accordance with ASTM D-2000. Grade E: EPDM rated for service between -30°F to 230°F (-34°C to 110°C).

.6 Copper Fittings: Copper per ASTM B-75 and ASTM B-584.

.7 When connecting dissimilar metals in liquid systems from grooved end steel (IPS) to Copper (CTS) provide a dielectric waterway between the two materials.

2.4.3 Standard of Acceptance: Victaulic, Anvil

2.5 GROOVED END BUTTERFLY VALVES

.1 NPS 2 1/2 and over, grooved ends:

.1 Class 300, bubble tight shut off to 300 psi (2065 KPa) bronze body.

.2 Operators:

.1 NPS 4 and under, lever handle
.2 NPS 6 and over, gear operated.

.3 Standard of Acceptance: Victaulic Series 608, Grinnell. Mueller

2.6 GATE VALVES

2.6.1 Gate valves shall only be utilized where specifically noted on the drawings. For all other shut off valve applications utilize ball valves for 2" (50 mm) or smaller and butterfly valves for 2.6" (65 mm) and larger.

2.6.2 NPS 2 and under, soldered:

.1 Non-rising stem to MSS SP-80, Class 125, 860 kPa, bronze body, screw-in or bolted bonnet.

.2 Standard of Acceptance: Jenkins, Crane, Toyo 281, Kitz 41, Grinnell

2.6.3 NPS 2 and under, screwed:

.1 Rising stem: to MSS SP-80, class 125, 860 kPa, bronze body, solid wedge disc.

.2 Standard of Acceptance: Jenkins, Crane, Toyo 293, Kitz 24, Grinnell

2.6.4 NPS 2-1/2 and over, in mechanical rooms, flanged:

.1 Rising stem: to MSS SP-70, class 125, 860 kPa, FF flange, cast-iron body, OS&Y bronze trim.

.2 Standard of Acceptance: Jenkins, Crane, Toyo 421, Kitz 72, Grinnell

2.6.5 NPS 2-1/2 and over, other than mechanical rooms, flanged:

.1 Non-rising stem: to MSS SP-70, class 125, 860 kPa, FF flange, cast-iron body, bronze trim, bolted bonnet.

.2 Standard of Acceptance: Jenkins, Crane, Toyo 415, Kitz 75, Grinnell

2.7 GLOBE VALVES

2.7.1 NPS 2 and under, balancing, soldered:

.1 To MSS SP-80, Class 125, 860 kPa, bronze body, renewable composition disc, screwed over bonnet.

.2 Lockshield handles: as indicated.

.3 Standard of Acceptance: Jenkins, Crane, Toyo 222, Kitz 10, Grinnell

2.7.2 NPS 2 and under, balancing, screwed:

.1 To MSS SP-80, class 125, 860 kPa, bronze body, screwed over bonnet, renewable composition disc.

.2 Lockshield handles: as indicated.

.3 Standard of Acceptance: Jenkins, Crane, Toyo 220, Kitz 09, Grinnell

2.8 SWING CHECK VALVES

2.8.1 NPS 2 and under, soldered:

.1 To MSS SP-80, class 125, 860 kPa, bronze body, bronze swing disc, screw in cap, regrindable seat.

.2 Standard of Acceptance: Jenkins, Crane, Toyo 237, Kitz 23, Grinnell

2.8.2 NPS 2 and under, screwed:

.1 To MSS SP-80, class 125, 860 kPa, bronze body, bronze swing disc, screw in cap, regrindable seat.

.2 Standard of Acceptance: Jenkins, Crane, Toyo 236, Kitz 22, Grinnell

2.8.3 NPS 2-1/2 and over, flanged:

.1 To MSS SP-70, class 125, 860 kPa, cast iron body, FF flange, regrind renewable seat, bronze disc, bolted cap.

.2 Standard of Acceptance: Jenkins, Crane, Toyo 435, Kitz 78, Grinnell

2.9 BALL VALVES

2.9.1 NPS 2 and under, branch isolators, screwed:

.1 600 WOG, bronze body, solid chrome plated bronze ball, with Teflon seal.

.2 Ball valves shall have full port opening.

.3 Standard of Acceptance: Jenkins, Crane, Toyo 5044A, Kitz 58, Grinnell, Apollo.

2.10 AUTOMATIC CIRCUIT BALANCING VALVES

2.10.1 Circuit balancing valves shall be of the automatic variety. Manual circuit balancing valves will not be accepted.

2.10.2 Circuit Balancing Valves are required on the domestic hot water recirculation system.

2.10.3 Provide the following sizes:

.1 Provide 0.032 l/s (0.5 gpm) for 12 mm pipe size.

.2 Provide 0.063 l/s (1.0 gpm) for 20 mm pipe size.

2.10.4 Product Warranty and Performance Guarantee

.1 Valves shall be warranted by the manufacturer to be free of defects in material and workmanship for a period of five years.

.2 Valves shall control flow to within plus/minus 5 percent of design over an operating differential range of at least 14 times the minimum required for control. Four operating pressure ranges shall be available with the minimum range requiring less than 3 psid to actuate the mechanism.

.3 The valve flow curve shall be smooth over its entire nominal control range. Gaps, bumps and dips in flow curves shall not be acceptable.

2.10.5 Shop Drawing Submission

.1 The Balancing Valve Manufacturer shall submit a complete list of balancing valves, their location and their performance.

.2 The Balancing Valve Manufacturer shall mark up a set of full size plans showing the location of each balancing valve and assign an appropriate identification tag for the balancing valve.

.3 The Balancing Valve Manufacturer shall submit these drawings for the Consultant to review, incorporate any comments from the Consultant and then submit copies of this drawing to the Mechanical Contractor, Mechanical Consultant, Architect and Construction Manager.

.4 All balancing valves shall be shipped to site with this tag number firmly attached to the valve and the full size drawings shall be utilized to identify the location where they are to be installed.

2.10.6 Valve Flow Control Cartridge (Typical for all valves)

.1 The non adjustable flow control cartridge shall be 100% stainless steel. Parts made of soft

metals such as brass with only a coating of hard metal such as nickel shall not be allowed. Rubber based materials whose properties change with temperature and pressure shall not be allowed.

.2 The cartridges shall have segmented ports through which water can pass, rather than a continuous large port, to eliminate noise and full travel linear coil spring.

.3 The cartridge movement shall result in a shearing action that will dislodge or shear any particle that may tend to get stuck in a port.

.4 Cartridge shall be removable from the housing and shall be held in place in the housing without adhesive.

.5 All flow control cartridges shall be warranted by the manufacturer for five years from the date of sale.

2.10.7 Sizes 40mm and smaller

.1 Valves shall have forged brass bodies and stainless steel cartridge assembly rated for a minimum of 230 psi/250F.

2.10.8 Valve end connections shall be either female sweat or FPT.

2.10.9 Valves shall be provided with two pressure/temperature taps.

2.10.10 Valves shall be provided with a union tailpiece and built in isolation valve.

2.10.11 The body design shall allow for inspection or removal of the cartridge without disturbing piping connections.

2.10.12 The valve shall come fully assembled and shall be permanently marked to show direction of flow and shall have a body tag to indicated flow rate and model number.

2.10.13 Provide a shut off valve upstream of the valve to allow the system to be shut off and the balancing valve to be removed without shutting down the entire heating system.

2.10.14 Standard of Acceptance: Griswold Isolator R valve.

PART 3 - EXECUTION

3.1 INCOMING WATER MAIN

3.1.1 The products utilized to build the meter assembly shall be in accordance with the Local Authorities requirements.

3.1.2 Where the Local Authority requires that this assembly use gate valves with all soldered connections the Mechanical Contractor shall solder all of the joints and use gate valves as specified above.

3.1.3 When the local authority does not allow the use of grooved fittings the use of grooved fittings

shall only begin after the bypass around the meter is connected to the assembly.

3.2 INSTALLATION

3.2.1 Connect to fixtures and equipment in accordance with manufacturers instructions.

3.2.2 Install tubing close to building structure to minimize furring, conserve headroom and space. Group exposed piping and run parallel to walls.

3.2.3 Cut square, ream and clean tubing and tube ends, clean recesses of fittings and assemble without binding.

3.2.4 Lay buried tubing in accordance with AWWA Class "B" bedding.

3.2.5 Isolate equipment, fixtures and branches with ball valves.

3.2.6 New or repaired potable water systems shall be purged of deleterious matter and disinfected prior to utilization. The method to be followed shall be that prescribed by the health authority having jurisdiction or in the absence of a prescribed method as follows:

.1 The pipe system shall be flushed with clean, potable water until dirty water does not appear at the points of outlet.

.2 The system or part thereof shall be filled with a water/chlorine solution containing at least 50 parts per million (50 mg/L) of chlorine, and the system or part thereof shall be valved off and allowed to stand for 24 hours; or the system or part thereof shall be filled with a water/chlorine solution containing at least 200 parts per million (200mg/l) of chlorine and allowed to stand for three (3) hours.

.3 Following the required standing time, the system shall be flushed with clean potable water until the chlorine is purged from the system.

.4 The procedure shall be repeated where shown by a bacteriological examination that contamination remains present in the system.

3.2.7 Compression fittings are not acceptable.

3.2.8 All valves packing shall be asbestos free.

3.2.9 Provide isolation valves on all main branch feeds to each washroom group.

3.2.10 Install all grooved end components as per manufacturer’s latest recommendation.

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL

1.1.1 This section of the specification shall be read in conjunction with and shall be governed by the requirements outlined in Section 15010 of the specification.

1.2 REFERENCE STANDARDS

1.2.1 Do the work in accordance with the Ontario Building Code Plumbing Code and local authority having jurisdiction.

1.2.2	CSA B70 - 2006	Specifications for Cast Iron Soil Pipe Fittings and Means of Joining.
1.2.3	CSA B125 - 2005	Specifications for Plumbing Fittings
1.2.4	ASTM B32 - 2008	Specifications for Solder Metal
1.2.5	ASTM B306 - 2009	Specifications for Copper Drainage Tube (DWV)
1.2.6	ANSI B16.29	
1.2.7	ASTM B88, ASTM B88M - 2003	Specifications for Seamless Copper Water Tube
1.2.8	ASTM A74 - 2009	Specification for Cast Iron Soil Pipe and Fittings
1.2.9	ASTM C564 -2009	Specification for Rubber Gasket for Cast Iron Soil Pipe and Fittings

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

2.1.1 For all above grade vent, sanitary and storm piping, Type DWV to:

.1 ASTM B306 - Specification for copper drainage tube (DWV).

.2 CSA B158 for cast brass fittings.

.3 ANSI B16.29 for wrought copper fittings.

.4 Solder: tin-lead, 50:50, to ASTM B32, type 50A - Specification for solder metal.

.5 ASTM B88.

.6 ASTM C564

2.2 CAST IRON PIPING AND FITTINGS

2.2.1 For above grade storm, sanitary and vent piping, minimum NPS 3, to CSA B70, ASTM A74 with heavy bituminous coating.

2.2.2 For above grade storm, sanitary and vent piping 4" (100 mm) size and larger: Cast iron.

2.2.3 For storm, sanitary and vent piping joints.

.1 Mechanical joints.

.1 Neoprene of butyl rubber compression gaskets for all pipe connections.: to ASTM C564-2009.

.2 SS clamps.

2.3 PUMPED DRAINAGE

2.3.1 Pumped drains shall be galvanized steel.

2.4 SANITARY DRAINAGE AND VENTS

2.4.1 Piping And Fittings

2.4.2 For buried sanitary, storm and vent piping:

.1 ASTM D2665, ASTM D2949, ASTM B251

.2 ASTM D3034, ASTM F891

.3 CAN/CSA- B181.2 for PVC DWV or

.4 CAN/CSA B182.1- for plastic DWV.

2.4.3 Joints

.1 Solvent weld for PVC: to ASTM D2564.

.2 Solvent weld for ABS: to ASTM D2235.

.3 For sizes above 4" (100mm).

Provide Ring-Tite joints Canron Ring-Tite joints PVC DR35 gravity sewer pipe, with locked in rubber ring sealing feature providing tight flexible seal.

Spigot ends to be supplied complete with bevel.

2.4.4 All PVC piping below grade shall be a minimum of SDR 35.

PART 3 - EXECUTION

3.1 INSTALLATION

3.1.1 Install piping parallel and close to walls to conserve space, and to grade indicated, and to suit installation of related work.

3.1.2 Apply two coats of asphalt paint to pipe laid in, or passing through concrete.

3.1.3 Where piping passes through floor or wall below grade pack and seal in concrete complete with Link Seal in accordance with Specification Section 15010.

3.1.4 PVC piping shall not be utilized above grade. PVC piping as specified in Section 15415 is acceptable for below grade piping. The PVC piping shall convert to cast iron prior to the point where it penetrates the floor slab.

3.1.5 Provide venting to plumbing fixtures and fixture groups in accordance with the Ontario Building Code Plumbing Code and local authorities having jurisdiction.

3.1.6 Install buried pipe on 6" (150 mm) bed of clean sand, shaped to accommodate hubs and fittings, to line and grade as indicated. Backfill with clean sand.

3.1.7 Install piping parallel and close to walls to conserve space and to grade indicated, and to suit the installation of related work.

3.1.8 Apply solvent to male end of joints only.

3.1.9 Pipe installation: Pipe shall be installed as specified and indicated on the drawings.

3.1.10 The piping system shall be installed in accordance with the manufacturers current published installation procedures.

3.1.11 PVC piping shall not be utilized above grade. PVC piping as specified in Section 15415 is acceptable for below grade piping. The PVC piping shall convert to cast iron prior to the point where it penetrates the floor slab.

3.1.12 Where piping passes through floor or wall below grade pack and seal in concrete in accordance with specification Section 15010.

3.1.13 Provide venting to all plumbing fixtures and fixture groups in accordance to the Ontario Building Code - Plumbing Code and local authorities having jurisdiction.

3.1.14 If tests are required by an authority having jurisdiction, perform tests in presence of each governing authority and obtain certification. Repeat tests as often as necessary to obtain certification.

3.1.15 Test pressure shall not exceed 1-1/2 times the maximum rated pressure of the lowest related element in the system.

3.1.16 Remove all fittings which do not withstand test pressure, replace and retest.

3.1.17 Eliminate leaks, or remove and refit defective parts.

3.2 TESTING

3.2.1 The drainage and vent system shall be tested in accordance with the Ontario Building Code - Plumbing Code and tested in accordance with the requirements of the authority having jurisdiction, perform tests in the presence of each governing authority and obtain certification. Repeat tests as often as necessary to obtain certification.

3.2.2 Perform tests before piping is covered or concealed.

3.2.3 Remove all fittings which will not withstand test pressure, and replace after test.

3.2.4 Eliminate leaks, or remove and refit defective parts.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, copper-fin boilers, trim, and accessories for heating hot water.

B. Related Sections include the following:

1. Section 15881 for connections to breechings, chimneys, and stacks.

1.3 SUBMITTALS

A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For boilers, boiler trim, and accessories.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Wiring Diagrams: Power, signal, and control wiring.

C. Source quality-control test reports: Indicate and interpret test results for compliance with performance requirements before shipping.

D. Field quality-control test reports: Indicate and interpret test results for compliance with performance requirements

E. Warranty: Standard warranty specified in this Section.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

D. AHRI Compliance: Boilers shall be AHRI listed and must meet the minimum efficiency specified under AHRI BTS-2000 as defined by Department of Energy in 10 CFR Part 431.
E. ANSI Compliance: Boilers shall be compliant with ANSI Z21.13 test standards for US and Canada.
F. CSA Compliant: Boilers shall be compliant with CSA certification.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.7 WARRANTY

A. Standard Warranty: Boilers shall include manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period. Installing contractor shall provide one year of warranty parts and labor.
   1. Warranty Period for Commercial Copper Fin tube Boilers:
      a. Heat Exchanger, Pressure Vessel and Condensation Collection Basin shall carry a 10 year limited warranty against defects in materials or workmanship and failure due to thermal shock.
      b. All other components shall carry a one year warranty from date of boiler start up.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Lochinvar Power-Fin Boiler as specified on Drawings. All others must be submitted by Voluntary alternate.

2.2 CONSTRUCTION

A. Description: Boiler shall be natural gas fired and vertical water tubed design. The boiler shall be factory-fabricated, factory-assembled, and factory-tested, water-tube boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.

B. Heat Exchanger: The heater exchanger shall bear the ASME “H” stamp for 160 psi working pressure and shall be National Board listed. The heat exchanger shall be a “Fin Tube” design with 7/8” I.D. straight copper tubes having extruded integral fins spaced seven fins per inch. These tubes shall be “rolled” securely into glass-lined, cast iron headers. There shall be no bolts, gaskets or “O” rings in the head configuration. Removable access plugs shall be provided on the heat exchanger headers for the purposes of inspection, cleaning or repair.

C. Burner: Natural gas, forced draft single burner premix design. The burner shall be high temperature stainless steel with a ceramic fiber outer covering to provide modulating firing rates. The burner shall be capable of a 5:1 gas train turndown without loss of combustion

efficiency. The burner shall have an independent laboratory rating for Oxides of Nitrogen (NOx) to meet requirements of South Coast Air Quality Management District (SCAMD) as compliant with Rule 1146.2.

D. Blower: Boiler shall be equipped with a pulse width modulating blower system to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency. The burner firing sequence of operation shall include pre-purge, firing, modulation, and post-purge operation.
   1. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

E. Gas Train: The boiler shall be supplied with a gas train designed with negative pressure regulation and shall be capable of a minimum 5:1 turndown:

F. Ignition: Hot surface ignition with 100 percent main-valve shutoff with electronic flame supervision.

G. Casing:
   1. Jacket: 18 gauge pre-primed and painted steel jacket
   2. Control Compartment Enclosures: NEMA 250, Type 1A.
   3. Insulation: Minimum ½ inch thick, mineral fiber insulation surrounding the heat exchanger.
   4. Combustion-Air Connections: Inlet and vent duct collars.

H. Characteristics and Capacities:
   1. Heating Medium: Hot water.
   2. Design Water Pressure Rating: 160 psi working pressure.
   3. Safety Relief Valve Setting: 50 psi

2.3 TRIM

A. Safety Relief Valve:
   1. Size and Capacity: 50 psi
   2. Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.

B. Pressure Gage: Minimum 3-1/2 inch diameter. Gage shall have normal operating pressure about 50 percent of full range.

C. Drain Valves: (2) 3/4” NPS

2.4 CONTROLS

A. Refer to Division 23 Section "Instrumentation and Control for HVAC."

B. Boiler controls shall feature a standard, factory installed 8” LCD full color screen display with the following standard features:

1. Control module shall include the CON-X-US mobile communication platform for remote access via a smart phone or Tablet. This will allow the ability to monitor and manage multiple Crest boilers and send alerts via text or e-mail notifying of changes in system status. A user shall have the ability to check system status or re-program any boiler function remotely.
2. Password Security: Boiler shall have a different password security code for the User and the Installer to access adjustable parameters.
3. Outdoor air reset: Boiler shall calculate the set point using a field installed, factory supplied outdoor sensor and an adjustable reset curve.
4. Pump exercise: Boiler shall energize any pump it controls for an adjustable time if the associated pump has been off for a time period of 24 hours.
5. Ramp delay: Boiler may be programmed to limit the firing rate based on six limits steps and six time intervals.
6. Boost function: Boiler may be programmed to automatically increase the set point a fixed number of degrees (adjustable by installer) if the setpoint has been continuously active for a set period of time (time adjustable by installer). This process will continue until the space heating demand ends.
7. Domestic hot water priority: Boiler shall make the domestic hot water call for heat a priority over any space heating call and adjust the boiler set point to the domestic hot water boiler set point.
8. Domestic hot water modulation limiting: Boiler may be programmed to limit the maximum domestic hot water firing rate to match the input rating of the indirect tank coil.
9. Domestic hot water night setback: Boiler may be programmed to reduce the domestic hot water tank set point during a certain time of the day.
10. PC port connection: Boiler shall have a PC port allowing the connection of PC boiler software.
11. Time clock: Boiler shall have an internal time clock with the ability to time and date stamp lock-out codes and maintain records of runtime.
12. Service reminder: Boiler shall have the ability to display a yellow colored service notification screen based upon months of installation, hours of operation, and number of boiler cycles. All notifications are adjustable by the installer.
13. Three pump control: Boiler shall have the ability to control the boiler pump, system pump and the domestic hot water pump.
14. Anti-cycling control: Boiler shall have the ability to set a time delay after a heating demand is satisfied allowing the boiler to block a new call for heat. The boiler will display an anti-cycling blocking on the screen until the time has elapsed or the water temperature drops below the anti-cycling differential parameter. The anti-cycling control parameter is adjustable by the installer.
15. Night setback: Boiler may be programmed to reduce the space heating temperature set point during a certain time of the day.
16. Freeze protection: Boiler shall turn on the boiler and system pumps when the boiler water temperature falls below 45 degrees. When the boiler water temperature falls below 37 degrees the boiler will automatically turn on. Boiler and pumps will turn off when the boiler water temperature rises above 43 degrees.
17. 3-way valve control: Boiler shall have the ability to control a 3-way motorized control valve to maintain return water temperatures above 140°F.

18. BMS integration with 0-10V DC input: The Control shall allow an option to Enable and control set point temperature or control firing rate by sending the boiler a 0-10V input signal.
19. Data logging: Boiler shall have non-volatile data logging memory including last 10 lockouts, hours running and ignition attempts and should be able to view on boiler screen.

C. The boiler shall have a built in Cascade controller to sequence and rotate lead boiler to ensure equal runtime while maintaining modulation of up to 8 boilers of different btu inputs without utilization of an external controller. The internal cascade controller shall include:

1. Lead lag: The Control module shall allow the "Lead" boiler to modulate with demand to capacity. As demand increases, additional boilers fire and modulate to capacity. This continues, with additional boilers firing and modulating to capacity until all units are operating.
2. Efficiency optimization: The Control module shall optimize the modulation capabilities of all the Boiler Plant while evenly distributing run time across all cascaded boilers.
3. Cascade redundancy: If the Leader boiler shall loose communication with the members an alternate member will become the Leader until the original lead boiler regains communication.
4. Front end loading: The Control module shall allow a Condensing boiler to be cascaded with a non-condensing boiler with a Smart System control with no third party cascading or communication devices. A call for heat will allow the Condensing boiler to fire first and bring the non-condensing boiler on when the demand is needed.
5. Rotation of lead boiler: The Control module shall change the lead boiler every hour for the first 24 hours after initializing the Cascade. Following that, the leader will be changed once every 24 hours.

D. Boiler operating controls shall include the following devices and features:
1. Set-Point Adjust: Set points shall be adjustable.
2. Operating Pressure Control: Factory wired and mounted to cycle burner.
3. Sequence of Operation: Factory installed controller to modulate burner firing rate to maintain system water temperature in response to call for heat.
4. Sequence of Operation: Factory installed controller to control burner firing rate to reset supply-water temperature based on the outdoor-air temperature. At 10 deg F outside-air temperature, set supply-water temperature at 180 deg F; at 60 deg F outside-air temperature, set supply-water temperature at 140 deg F.

E. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
1. High Temperature Limit: Automatic and manual reset stops burner if operating conditions rise above maximum boiler design temperature. Limit switch to be manually reset on the control interface.
2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manually reset on the control interface.
3. High and Low Gas Pressure Switches: Optional pressure switches shall prevent burner operation on low or high gas pressure. Pressure switches to be manually reset on the control interface.
4. Blocked Drain Switch: Blocked drain switch shall prevent burner operation when tripped. Switch to be manually reset on the control interface.

5. Blocked Flue Switch: Pressure switches shall prevent burner operation on a blockage in the flue pipe. Switch to be manually reset on the control interface.
6. Audible Alarm: Optional factory mounted on control panel with silence switch; shall sound alarm for any lockout conditions.

F. Building Automation System Interface: Optional Modbus and BACnet MSTP communication protocols are available as well as gateways for Lon and BACnet IP to communicate with building automation system to monitor, control, and display boiler status and alarms.

2.5 ELECTRICAL POWER

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

B. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

C. Electrical Characteristics:
1. See Drawings
2. Standard Voltages
   a. 120 Volt, single phase
3. Frequency: 60 Hz

2.6 VENTING

A. Exhaust flue must be a Category I, II or V and dependent upon the orientation of the vent intake and exhaust locations and venting distances shown in the Installation and Operation manual.

B. Intake piping for all models must be of approved material as listed in the Installation and Operations manual.

C. Boiler venting and intake piping configuration shall be installed per one of the approved venting methods shown in the Installation and Operation manual.

D. Boiler shall come standard with a flue sensor to monitor and display flue gas temperature on factory provided LCD display.

E. Boilers using common venting must contact the factory for sizing.

F. Refer to manufacturer’s Installation and Operations manual for detailed venting instructions and approved manufacturers.

2.7 SOURCE QUALITY CONTROL

A. Burner and Hydrostatic Test: Factory ajust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
   1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in of piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

A. Install equipment on 4” concrete housekeeping pad.

B. Install gas-fired boilers according to NFPA 54.

C. Assemble and install boiler trim.

D. Install electrical devices furnished with boiler but not specified to be factory mounted.

E. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

A. Install boilers level on concrete bases. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.

B. Install piping adjacent to boiler to allow service and maintenance.

C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

D. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of equipment connection. Provide a reducer if required.

E. Connect hot-water piping to supply and return boiler tappings with shutoff valve and union or flange at each connection.

F. Install piping from safety relief valves to nearest floor drain.

G. Boiler Venting:
1. Install flue venting kit and combustion-air intake.
2. Connect full size to boiler connections. Comply with requirements in Division 23 Section “Breechings, Chimneys, and Stacks.

H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

I. Connect wiring according to Division 16 Specifications.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
1. Perform installation and startup checks according to manufacturer's written instructions. Complete startup form included with Boiler and return to Manufacturer as described in the instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
    a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
    b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

D. Performance Tests:
1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
3. Perform field performance tests to determine capacity and efficiency of boilers.
4. Repeat tests until results comply with requirements indicated.

5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
7. Notify Architect in advance of test dates.
8. Perform a combustion analysis after installation and adjust gas valve per the Installation and Operations manual and note in startup report.
9. Document test results in a report and submit to Architect.

3.5 DEMONSTRATION

A. Engage a factory representative or a factory-authorized service representative for boiler startup and to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

1 General

1.1 DESCRIPTION

.1 Water piping to connect HVAC equipment.

1.2 SUBMITTALS

.1 Submit in accordance with Section 15010, shop drawings, product data, and samples for the following:

.1 Pipe and equipment supports.
.2 Pipe and tubing, with specification, class or type, and schedule.
.3 Pipe fittings, including miscellaneous adapters and special fittings.
.4 Flanges, gaskets and bolting.
.5 Valves of all types.
.6 Strainers.
.7 Flexible connectors for water service.
.8 Pipe alignment guides.
.9 Expansion joints.
.10 Expansion compensators.
.11 Gages.
.1 Thermometers and test wells.
.2 Pressure Gauges

2 Products

2.1 PIPE AND TUBING

.1 2" diam and smaller:

.1 Schedule 40. Continuous weld or electric resistance welded black carbon steel conforming to ASTM A53-84a Grade B, with threaded ends.

.2 Type “L” hard drawn copper tubing conforming to ASTM B88.

.2 2½“ diam and larger

.1 Schedule 40. Continuous weld or electric resistance welded black carbon steel conforming to ASTM A53-84a Grade B, with bevelled ends.

2.2 FITTINGS FOR STEEL PIPE

.1 65 mm (2½ inches) and larger: Welded or flanged joints.

.1 Butt welding fittings: ASME B16.9 with same wall thickness as connecting piping. Elbows shall be long radius type, unless otherwise noted.

.2 Welding flanges and bolting: ASME B16.5

.3 Weld neck or slip on, plain face, with 6 mm (1/8 inch) thick full face neoprene

gasket suitable for 104 degrees C (220 degrees F).

.4 Flange bolting: Carbon steel machine bolts or studs and nuts, ASTM A307, Grade B.

.2 50 mm (2 inches) and Smaller: Screwed or welded.

.1 Butt welding: ASME B16.9 with same wall thickness as connecting piping. .2

Forged steel, socket welding or threaded: ASME B16.11.

.3 Screwed: 150 pound malleable iron, ASME B16.3. 125 pound cast iron, ASME B16.4, may be used in lieu of malleable iron. Bushing reduction of a single pipe size, or use of close nipples, is not acceptable.

.4 Unions: ASME B16.39.

.5 Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and threadolets may be used for branch connections up to one pipe size smaller than the main. Forged steel half couplings, ASME B16.11 may be used for drain, vent and gage connections.

2.3 FITTINGS FOR COPPER TUBING

.1 Solder Joint:

.1 Joints shall be made up in accordance with recommended practices of the materials applied. Apply 95/5 tin and antimony on all copper piping.

.2 Mechanically formed tee connection in water and drain piping: Form mechanically extracted collars in a continuous operation by drilling pilot hole and drawing out tube surface to form collar, having a height of not less than three times the thickness of tube wall. Adjustable collaring device shall insure proper tolerance and complete uniformity of the joint. Notch and dimple joining branch tube in a single process to provide free flow where the branch tube penetrates the fitting.

.3 Bronze Flanges and Flanged Fittings: ASME B16.24.

2.4 DIELECTRIC FITTINGS

.1 Provide where copper tubing and ferrous metal pipe are joined.

.1 50 mm (2 inches) and Smaller: Threaded dielectric union, ASME B16.39.

.2 65 mm (2 1/2 inches) and Larger: Flange union with dielectric gasket and bolt sleeves, ASME B16.42.

.3 Temperature Rating, 99 degrees C (210 degrees F).

2.5 UNIONS

.1 2" diam and smaller:

.1 All brass construction with ground joint and either solder joint or screwed ends as required.

.2 Class 150 black malleable iron construction with brass to iron ground joint and screwed ends, conforming to ASTM A197 and ANSI/ASME B1.20.1.

.3 Provide dielectric unions or couplings at all connections between copper tubing and ferrous piping or equipment.

2.6 FLANGES

.1 Class 150 forged steel slip-on or weldneck raised face type conforming to ASTM A181 Grade 1 and ANSI/ASME B16.5. Remove raised face where flanges connect to Class 125 cast iron valves.

.2 Hinged, two piece, shouldered or keyed cast malleable iron

.3 Conforming to ASTM A47 Grade 32510 with elastomeric gasket suitable for service and lock bolt.

2.7 GASKETS AND BOLTS

.1 Gaskets

.1 1.6 mm (1/16") Garlock 3200 with SBR binder or equivalent asbestos free material.

.2 Bolts

.1 Semi finished hex head machine bolts and semi finished hex nuts, both of carbon steel conforming. to ASTM A307 Class A.

2.8 PLUGS

.1 2" diam and smaller

.1 Class 3000 screwed, square head, machined from solid steel or forging to ASTM A105 Grade 2.

2.9 VALVES

.1 Asbestos packing is not acceptable.

.2 All valves of the same type shall be products of a single manufacturer. Provide gate and globe valves with packing that can be replaced with the valve under full working pressure.

.3 Provide chain operators for valves 100 mm (4 inches) and larger when the centerline

is located 2400 mm (8 feet) or more above the floor or operating platform.

.4 Standard of Acceptance: Crane, Jenkins, Toyo, Kitz.

.5 Gate Valves:

.1 50 mm (2 inches) and smaller: MSS SP80, Bronze, 1034 kPa (150 lb.), wedge disc, rising stem, union bonnet.

.2 65 mm (2½ inches) and larger: Flanged, outside screw and yoke.

.3 MSS SP 70, iron body, bronze mounted, 861 kPa (125 psig) wedge disc. .6 Globe,

Angle and Swing Check Valves:

.1 50 mm (2 inches) and smaller: MSS SP 80, bronze, 1034 kPa (150 lb.) Globe and angle valves shall be union bonnet with metal plug type disc.

.2 65 mm (2½ inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS SP 85 for globe valves and MSS SP 71 for check valves.

.3 Non Slam or Silent Check Valve: Spring loaded double disc swing check or internally guided flat disc lift type check for bubble tight shut off. Provide where check valves are shown in chilled water and hot water piping.

.1 Body: Cast iron, ASTM A126, Class B, or steel, ASTM A216, Class WCB, or ductile iron, ASTM 536, flanged, grooved, or wafer type.

.2 Seat, disc and spring: 18 8 stainless steel, or bronze, ASTM B62. Seats may be elastomer material.

.7 Butterfly Valves:

.1 May be used in lieu of gate valves. Provide stem extension to allow 50 mm (2 inches) of pipe insulation without interfering with valve operation.

.2 MSS SP 67, flange lug type (for end of line service) or grooved end rated 1205 kPa (175 psig) working pressure at 93 degrees C (200 degrees F).

.3 Body: Cast iron, ASTM A126, Class B. Malleable iron, ASTM A47 electro-plated, or ductile iron, ASTM A536, Grade 65 45 12 electro-plated.

.4 Trim: Bronze, aluminum bronze, or 300 series stainless steel disc, bronze bearings, 316 stainless steel shaft and manufacturer's recommended resilient seat. Resilient seat shall be field replaceable, and fully line the body to completely isolate the body from the product. A phosphate coated steel shaft or stem is acceptable, if the stem is completely isolated from the product.

.5 Actuators: Field interchangeable. Valves for balancing service shall have adjustable memory stop to limit open position.

.6 Valves 150 mm (6 inches) and smaller: Lever actuator with minimum of seven locking positions, except where chain wheel is required.

.7 Valves 200 mm (8 inches) and larger: Enclosed worm gear with handwheel, and where required, chain wheel operator.

.8 Ball Valves:

.1 50 mm (2") diam and smaller: May be used in lieu of gate valves or butterfly valves. Brass or bronze body with chrome-plated ball with full port and Teflon seat at 2760 kPa (400 psig) working pressure rating. Screwed or solder connections. Provide stem extension to allow operation without interfering with pipe insulation.

.9 Water Flow Balancing Valves

.1 65 mm (2½") diam and smaller:

.1 Valves are to be of the 'Y' pattern, equal percentage globe-style and provide three functions: 1) Precise flow measurement, 2) Precision flow balancing, 3) Positive drip-tight shut-off.

.2 Valve shall provide multi-turn, 360° adjustment with micrometer type indicators located on the valve handwheel. Valves shall have a minimum of five full 360° handwheel turns. 90° 'circuit-setter' style ball valves are not acceptable. Valve handle shall have hidden memory feature, which will provide a means for locking the valve position after the system is balanced.

.3 Valves shall be furnished with precision machined venturi built into the valve body to provide highly accurate flow measurement and flow balancing. The venturi shall have two, ¼" threaded brass metering ports with check valves and gasketted caps located on the inlet side of the valve. Valves shall be furnished with flow smoothing fins downstream of the valve seat and integral to the forged valve body to make the flow more laminar. The valve body, stem and plug shall be brass. The handwheel shall be high-strength resin.

.2 75 mm (3") diam and larger:

.1 Valves are to be of the 'Y' pattern, equal percentage globe-style and provide three functions: 1) Precise flow measurement, 2) Precision flow balancing, 3) Positive drip-tight shut-off.

.2 Valve shall provide multi-turn, 360° adjustment with micrometer type indicators located on the valve handwheel. Valves shall have a minimum of five full 360° handwheel turns. 90° 'circuit-setter' style ball valves are not acceptable. Valve handle shall have hidden memory feature, which will provide a means for locking the valve position after the system is balanced.

.3 Valve body shall ductile iron with industrial standard flanged ends. Valve stem and plug disc shall be bronze with ergonomically designed handwheel that permits multi-turn adjustments. Sizes 3" - 5 turns; sizes 4" to 6" - 6 turns; sizes 8" and 10" - 12 turns and size 12" - 14 turns. Armstrong flange

adapters shall be supplied, to prevent rotation.

.4 The valve shall be installed with flow in the direction of the arrow on the valve body and installed at least five pipe diameters downstream from any fitting, and at least ten pipe diameters downstream from any pump. Two pipe diameters downstream from the CBV should be free of any fittings. When installed, easy and unobstructed access to the valve handwheel and metering ports for adjustment and measurement are to be provided. Mounting of valve in piping must prevent sediment build-up in metering ports.

.3 Standard of Acceptance: Armstrong CBV series, Taco

2.10 AIR SEPARATORS

.1 Furnish and install as shown on the drawings an air separator with tangential inlet nozzles. The air separator shall be designed and constructed in accordance with Section VIII, Div 1 of the ASME Boiler and Pressure Vessel Code.

.2 The unit shall be fitted with an NPT vent connection for connection to a compression tank or an air vent. An additional NPT tapping shall be provided on the bottom of the air separator to facilitate blow-down.

.3 The air separator shall be equipped with a system strainer with a free area of not less than four (4) times the cross sectional area of the connecting piping. The strainer should be able to be removed for routine cleaning.

.4 Models up to 3" (75 mm) diam. are to be equipped with stainless steel strainers. Larger Models are to be equipped with carbon steel strainers

.5 Models up to 3" (75 mm) diam. shall be supplied with a cast iron body and NPT system connections, while larger models shall be supplied with a cast iron body and ANSI flanges. 8” to 24” models are to be supplied with a fabricated steel body and carbon steel ANSI flanges.

.6 Standard of Acceptance: Armstrong model Vortex VAS, Taco.

2.11 STRAINERS

.1 Basket or Y Type. Tee type is acceptable for water service.

.2 Screens: Bronze, monel metal or 18 8 stainless steel, free area not less than 2 1/2 times pipe area, with perforations as follows: 1.1 mm (0.045 inch) diameter perforations.

.3 100 mm (4 inches) and larger: 3.2 mm (0.125 inch) diameter perforations. .4 Suction

Diffusers: Specified in the “HVAC PUMPS” section.

2.12 EXPANSION TANKS

.1 Furnish and install, as shown on the drawings ASME certified bladder full acceptance

expansion tank, stamped 125 psi (862 kPa) working pressure. Each tank will be supplied with a heavy duty butyl diaphragm. Tanks shall be supplied with a ring base, lifting rings, NPT system connection. An air charging valve connection (standard tire valve) shall be provided to facilitate adjusting pre-charge pressure to meet actual system conditions.

.2 Standard of Acceptance: Amtrol ST series, Armstrong, Taco

2.13 EXPANSION JOINTS

.1 Factory built devices, inserted in the pipe lines, designed to absorb axial cyclical pipe movement which results from thermal expansion and contraction. This includes factory-built or field-fabricated guides located along the pipe lines to restrain lateral pipe motion and direct the axial pipe movement into the expansion joints.

.2 Manufacturing Quality Assurance: Conform to Expansion Joints Manufacturers Association Standards.

.3 Bellows Internally Pressurized Type:

.1 Multiple corrugations of Type 304 or Type A240-321 stainless steel. .2 Internal stainless steel sleeve entire length of bellows.
.3 External cast iron equalizing rings for services exceeding 340 kPa (50 psig).
.4 Welded ends.
.5 Design shall conform to standards of EJMA and ASME B31.1.
.6 External tie rods designed to withstand pressure thrust force upon anchor failure if one or both anchors for the joint are at change in direction of pipeline.
.7 Integral external cover.

.4 Bellows Externally Pressurized Type:

.1 Multiple corrugations of Type 304 stainless steel.
.2 Internal and external guide integral with joint.
.3 Design for external pressurization of bellows to eliminate squirm.
.4 Welded ends.
.5 Conform to the standards of EJMA and ASME B31.1.
.6 Threaded connection at bottom, 25 mm (one inch) minimum, for drain or drip point.
.7 Integral external cover and internal sleeve.

.5 Expansion Compensators:

.1 Corrugated bellows, externally pressurized, stainless steel or bronze.
.2 Internal guides and anti torque devices.
.3 Threaded ends.
.4 External shroud.
.5 Conform to standards of EJMA.

.6 Expansion Joint Identification

.1 Provide stamped brass or stainless steel nameplate on each expansion joint listing the manufacturer, the allowable movement, flow direction, design pressure and

temperature, date of manufacture, and identifying the expansion joint by the identification number on the contract drawings.

.7 Guides

.1 Provide factory-built guides along the pipe line to permit axial movement only and to restrain lateral and angular movement. Guides must be designed to withstand a minimum of 15 percent of the axial force which will be imposed on the expansion joints and anchors. Field-built guides may be used if detailed on the contract drawings.

.8 Standard of Acceptance: Flextronics, Flexhose.

2.14 PRESSURE/TEMPERATURE TEST PROVISIONS

.1 Pete's Plug: 6 mm (1/4 inch) MPT by 75 mm (3 inches) long, brass body and cap, with retained safety cap, nordel self closing valve cores, permanently installed in piping where shown, or in lieu of pressure gage test connections shown on the drawings.

.2 Provide one each of the following test items to the Owner:

.1 6 mm (1/4 inch) FPT by 3 mm (1/8 inch) diameter stainless steel pressure gage adapter probe for extra long test plug. PETE'S 500 XL is an example.

.2 90 mm (3 1/2 inch) diameter, one percent accuracy, compound gage, , -—100 kPa (30 inches) Hg to 700 kPa (100 psig) range.

.3 0 - 104 degrees C (220 degrees F) pocket thermometer one half degree accuracy, 25 mm (one inch) dial, 125 mm (5 inch) long stainless steel stem, plastic case.

2.15 GAGES, PRESSURE AND COMPOUND

.1 Refer to section 15010.

2.16 THERMOMETERS

.1 Refer to section 15010

2.17 VACUUM AND AIR RELIEF VALVES

.1 Vacuum and air relief valves shall be iron body with bronze trim, and stainless steel floats.

2.18 PIPE SUPPORTS

.1 Refer to sections 15010 and 15241.

.2 If support from ceiling slab not possible, provide metallic construction as needed to support piping and headers from floor or structural walls.

3 Execution

3.1 GENERAL

.1 The drawings show the general arrangement of pipe and equipment but do not show all required fittings and offsets that may be necessary to connect pipes to equipment, fan-coils, coils, radiators, etc., and to coordinate with other trades. Provide all necessary fittings, offsets and pipe runs based on field measurements and at no additional cost to the government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories to be connected on ceiling grid. Pipe location on the drawings shall be altered by contractor where necessary to avoid interferences and clearance difficulties.

.2 Store materials to avoid excessive exposure to weather or foreign materials. Keep inside of piping relatively clean during installation and protect open ends when work is not in progress.

.3 Support piping securely.

.4 Install piping generally parallel to walls and column center lines, unless shown otherwise on the drawings. Space piping, including insulation, to provide 25 mm (one inch) minimum clearance between adjacent piping or other surface. Unless shown otherwise, slope drain piping down in the direction of flow not less than 25 mm (one inch) in 12 m (40 feet). Provide eccentric reducers to keep bottom of sloped piping flat.

.5 Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawing. Install butterfly valves with the valve open as recommended by the manufacturer to prevent binding of the disc in the seat.

.6 For all isolation valves 150 mm (6" diam) and larger located at more than 2,400 mm (8 ft) above the floor, provide operating chain wheel operators.

.7 Offset equipment connections to allow valving off for maintenance and repair with minimal removal of piping. Provide flexibility in equipment connections and branch line take offs with 3 elbow swing joints where noted on the drawings.

.8 Tee water piping runouts or branches into the side of mains or other branches. Avoid bull-head tees, which are two return lines entering opposite ends of a tee and exiting out the common side.

.9 Provide manual air vent at all piping system high points and drain valves at all low points.

.10 Connect piping to equipment as shown on the drawings. Install components furnished by others such as:

.1 Water treatment pot feeders and condenser water treatment systems.
.2 Flow elements (orifice unions), control valve bodies, flow switches, pressure taps

with valve, and wells for sensors.

.11 Thermometer Wells: In pipes 65 mm (2½ inches) and smaller increase the pipe size to provide free area equal to the upstream pipe area.

.12 Firestopping: Fill openings around uninsulated piping penetrating floors or fire walls, with firestop material.

.13 Where copper piping is connected to steel piping, provide dielectric connections.

3.2 PIPE JOINTS

.1 Welded: Beveling, spacing and other details shall conform to ASME B31.1 and AWS B2.1.

.2 Screwed: Threads shall conform to ASME B1.20; joint compound shall be applied to male threads only and joints made up so no more than three threads show. Coat exposed threads on steel pipe with joint compound, or red lead paint for corrosion protection.

.3 125 Pound Cast Iron Flange (Plain Face): Mating flange shall have raised face, if any, removed to avoid overstressing the cast iron flange.

.4 Solvent Welded Joints: As recommended by the manufacturer.

3.3 EXPANSION JOINTS (BELLOWS AND SLIP TYPE)

.1 Anchors and Guides: Provide type, quantity and spacing as recommended by manufacturer of expansion joint and as shown.

.2 Cold Set: Provide setting of joint travel at installation as recommended by the manufacturer for the ambient temperature during the installation.

.3 Preparation for Service: Remove all apparatus provided to restrain joint during shipping or installation. Representative of manufacturer shall visit the site and verify that installation is proper.

.4 Access: Expansion joints must be located in readily accessible space. Locate joints to permit access without removing piping or other devices. Allow clear space to permit replacement of joints and to permit access to devices for inspection of all surfaces and for adding packing.

3.4 LEAK TESTING

.1 Inspect all joints and connections for leaks and workmanship and make corrections as necessary, to the satisfaction of the Consultant. Tests may be either of those below, or a combination, as approved by the Board.

.1 An operating test at design pressure, and for hot systems, design maximum temperature. The design maximum pressure would usually be the static head, or expansion tank maximum pressure, plus pump head

.2 A hydrostatic test at 1.5 times design pressure.

3.5 FLUSHING AND CLEANING PIPING SYSTEMS

.1 Water Piping: Clean systems as recommended by the suppliers of chemicals specified.

.2 Initial flushing:

.1 Remove loose dirt, mill scale, metal chips, weld beads, rust, and like deleterious substances without damage to any system component. Provide temporary piping or hose to bypass coils, control valves, exchangers and other factory cleaned equipment unless acceptable means of protection are provided and subsequent inspection of hide out areas takes place. Isolate or protect clean system components, including pumps and pressure vessels, and remove any component which may be damaged. Open all valves, drains, vents and strainers at all system levels. Remove plugs, caps, spool pieces, and components to facilitate early debris discharge from system. Sectionalize system to obtain debris carrying velocity of 1.8 m/s (6 feet per second), if possible. Connect dead end supply and return headers as necessary. Flush bottoms of risers. Install temporary strainers where necessary to protect down stream equipment. Supply and remove flushing water and drainage by various type hose, temporary and permanent piping and Contractor's booster pumps. Flush until clean as approved by the Consultant.

.3 Cleaning

.1 Using products supplied by the chemical treatment manufacturer, circulate systems at normal temperature to remove adherent organic soil, hydrocarbons, flux, pipe mill varnish, pipe joint compounds, iron oxide, and like deleterious substances not removed by flushing, without chemical or mechanical damage to any system component. Removal of tightly adherent mill scale is not required. Keep isolated equipment which is "clean" and where dead end debris accumulation cannot occur. Sectionalize system if possible, to circulate at velocities not less than 1.8 m/S (6 feet per second). Circulate each section for not less than four hours. Blow down all strainers, or remove and clean as frequently as necessary. Drain and prepare for final flushing.

.4 Final Flushing

.1 Return systems to conditions required by initial flushing after all cleaning solution has been displaced by clean make up. Flush all dead ends and isolated clean equipment. Gently operate all valves to dislodge any debris in valve body by throttling velocity. Flush for not less than one hour.

3.6 WATER TREATMENT

.1 Install water treatment equipment and provide water treatment system piping.

.2 Close and fill system as soon as possible after final flushing to minimize corrosion.

.3 Charge systems with chemicals specified in the chemical treatment specification section.

1 General

1.1 DESCRIPTION

.1 Fuel gas systems, including piping, equipment and all necessary accessories as designated in this section.

1.2 SUBMITTALS

.1 Submit in accordance with Section 15010 Mechanical General Requirements, shop drawings, product data, and samples.

.2 Manufacturer's Literature and Data:

.1 Piping.
.2 Strainers.
.3 All items listed in Part 2 - Products.
.4 Detailed shop drawing of clamping device and extensions when required in connection with the waterproofing membrane or the floor drain.

.3 At the onset of the project, the Mechanical Contractor is responsible for doing a thorough survey of the existing School and locating all existing gas-fired appliances (indoors and outdoors) and providing the following information to the Engineer in writing:

.1 Location and type (rooftop unit, gas unit heater, gas-fired domestic hot water heater, boilers, etc.) of each gas-fired appliance. Locations shall be identified on a large-format (36”x48”) print-out of the School Floor Plans and marked in red.
.2 Input and output BTU rating of each appliance.
.3 Existing gas pipe sizing and routing to all appliances (including what gas pressure is running in each line).
.4 Existing gas meter rating.
.5 Location of all PRVs.

1.3 APPLICABLE PUBLICATIONS

.1 The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

.1 CAN1-B149.1-M80 for natural gas

.2 Ontario Natural Gas Code

.3 American National Standards Institute (ANSI):

.4 American Society of Mechanical Engineers (ASME): (Copyrighted Society)

.1	A13.1-96	Scheme for Identification of Piping Systems
.2	B16.3 98	Malleable Iron Threaded Fittings ANSI/ASME
.3	B16.9 01	Factory-Made Wrought Steel Butt welding Fittings ANSI/ASME
.4	B16.11 01	Forged Steel Fittings, Socket-Welding and Threaded

ANSI/ASME
.5 B16.15-85(R 1994) Cast Bronze Threaded Fittings ANSI/ASME
.6 B31.8-01 Gas Transmission and Distribution Piping Systems ANSI/ASME

.5 American Society for Testing and Materials (ASTM):
.1 A47-99 Ferritic Malleable Iron Castings Revision 1989
.2 A53-02 Pipe, Steel, Black And Hot-Dipped, Zinc-coated Welded and Seamless
.3 A183-83(R1998) Carbon Steel Track Bolts and Nuts
.4 A536-84(R1999) E1 Ductile Iron Castings
.5 A733-03 Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
.6 B687-99 Brass, Copper, and Chromium-Plated Pipe Nipples

.6 National Fire Protection Association (NFPA)

2 Products

2.1 FUEL GAS PIPING ABOVE-GROUND

.1 Pipe: Black steel, ASTM A53, Schedule 40, seamless as follows:

.1 ½" to 1½" dia., screwed.

.2 2" to 10" welded, plain end.

.2 Nipples: Steel, ASTM A733, Schedule 40.

.3 Pipe fittings, screwed, flanged or welded as follows:

.1 Malleable iron screwed fittings (banded): Class 150 to ANSI B16.3-1977.
.2 Steel pipe flanges and flanged fittings: to ANSI B16.5-1977.
.3 Steel butt-welding fittings: to ANSI B16.9-1978.

.4 Unions, malleable iron, brass to iron, ground seat: to ANSI B16.3-1977.
.5 Bolts and nuts: to ANSI B18.2.1-1972 and ANSI B18.2.2-1972.
.6 Nipples, Schedule 40: to ASTM A53-82.

.4 Joints: Provide welded or threaded joints

2.2 JOINTING MATERIAL

.1 Screwed fittings: pulverized lead paste.

.2 Welded fittings: to CSA W47.1-1983.

.3 Flange gaskets: to ANSI B16.21-1978, ANSI B16.20-1973 or ANSI A21.11-1979.

2.3 WATERPROOFING

.1 Provide at points where pipes pass through membrane waterproofed floors or walls in contact with earth.

.2 Floors: Provide cast iron stack sleeve with flashing device and a underdeck clamp. After stack is passed through sleeve, provide a waterproofed caulked joint at top hub.

2.4 STRAINERS

.1 Provide on high pressure side of pressure reducing valves, on inlet side of indicating and control instruments and equipment subject to sediment damage and where shown on drawings. Strainer element shall be removable without disconnection of piping.

.2 Gas Lines: "Y" type with removable mesh lined brass strainer sleeve.
.3 Body: Smaller than 80 mm (3 inches), brass or bronze; 80 mm (3 inches) and larger, cast iron or semi steel.

2.5 DIELECTRIC FITTINGS

.1 Provide dielectric couplings or unions between ferrous and non ferrous pipe.

2.6 GAS EQUIPMENT CONNECTORS

.1 Flexible connectors with teflon core, interlocked galvanized steel protective casing, AGA certified design.

2.7 GAS PRESSURE REGULATOR VALVE (PRV)

.1 Supply and install Gas PRVs as shown on the drawings. PRVs shall be reduce pressure from the upstream gas pressure noted on the drawings to the downstream gas pressure noted on the drawings. Provide all piping and accessories necessary to suit connection of the piping to the PRV. PRVs shall be located in strict accordance with the Manufacturer’s Recommendations in terms of location of adjacent elements.

.2 Provide a gas piping support (see Drawing for support detail) within 8” upstream of the regulator as well as within 8” downstream of the regulator.

3 Execution

3.1 INSTALLATION

.1 General: Comply with the following:

.1 Install natural gas piping in accordance with CAN1-B149.1-M80

.2 Install branch piping for fuel gas and connect to all fixtures, valves, cocks, outlets, casework, cabinets and equipment.

.3 Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe, except for plastic and glass, shall be reamed to full size after cutting.

.4 All pipe runs shall be laid out to avoid interference with other work.

.5 Slope piping down in direction of flow to low points.

.6 Use eccentric reducers at pipe size change installed to provide positive drainage.

.7 Provide clearance for access for maintenance of equipment, valves and fittings.

.8 Ream pipes, clean scale and dirt, inside and out.

.9 Cap open ends during construction to prevent entry of foreign material.

.10 Make connection to equipment with unions or flanges. Install piping to minimize pipe dismantling for equipment removal.

.11 Provide vents for all gas piping shafts in accordance to code.

.12 Install valves with stem in horizontal position whenever possible. All valves shall be easily accessible.

.13 Install union and shut-off valve on pressure piping at connections to equipment.

.14 Provide cathodic protection on jackets for all buried steel pipes, as per local gas supply company.

.15 Subcontractor installing buried gas piping shall be approved by the local gas supply company.

.16 Coordinate with the local gas supply company and the General Contractor the location of gas meter and isolation valves.

3.2 PURGING

.1 Purge after pressure test in accordance with applicable codes.

3.3 PIPE HANGERS, SUPPORTS AND ACCESSORIES

.1 All piping shall be supported AS per Section 15010 and Ontario Gas Code recommendations.

.2 Shop Painting and Plating: Hangers, supports, rods, inserts and accessories used for Pipe supports shall be shop coated with red lead or zinc Chromate primer paint. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.

.3 Floor, Wall and Ceiling Plates, Supports, Hangers:

.1 Solid or split un-plated cast iron.

.2 All plates shall be provided with set screws.

.3 Pipe Hangers: Height adjustable clevis type.

.4 Adjustable Floor Rests and Base Flanges: Steel.

.5 Concrete Inserts: "Universal" or continuous slotted type.

.6 Hanger Rods: Mild, low carbon steel, fully threaded or Threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.

.7 Riser Clamps: Malleable iron or steel.

.8 Rollers: Cast iron.

.9 Self-drilling type expansion shields shall be "Phillips" type, with case hardened steel expander plugs.

.4 Hangers and supports utilized with insulated pipe and tubing shall have 180 degree (min.) metal protection shield Centered on and welded to the hanger and support. The shield shall be 4 inches in length and be 16 gauge steel. The shield shall be sized for the insulation.

.5 Miscellaneous Materials: As specified, required, directed or as noted on the drawings for proper installation of hangers, supports and accessories. If the vertical distance exceeds 6 m (20 feet) for cast iron pipe additional support shall be provided in the center of that span. Provide all necessary auxiliary steel to provide that support.

.6 Install cast escutcheon with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.

3.4 PENETRATIONS

.1 Fire Stopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases. Completely fill and seal clearances between raceways and openings with the fire stopping materials.

.2 Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant

.3 Piping shall conform to the following:

.1 Entire fuel gas piping installation shall be in accordance with requirements of NFPA 54.

.2 Install fuel gas piping with plugged drip pockets at low points.

3.5 GAS PRESSURE

.1 Refer to section 15010 for gas pressure requirements and associated actions to ensure the adequate operation of the HVAC and heading equipment.

3.6 TESTS

.1 General: Test system either in its entirety or in sections.

.2 Fuel Gas System: NFPA 54.

3.7 PAINTING

.1 Paint the entire gas line yellow; where exposed to the outdoors, use outdoor-grade paint.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL

.1 This section of the specification shall be read in conjunction with and be governed by the requirements of Section 15010.

.2 Submit shop drawings of the pumps, complete with pump curves, for review.

.3 Indicate piping, valves and fittings shipped loose by packaged equipment supplier, showing their final location in field assembly.

1.2 MAINTENANCE DATA

.1 Provide maintenance data for incorporation into maintenance manual specified in Section 15010.

PART 2 PRODUCTS

2.1 VERTICAL IN-LINE CENTRIFUGAL PUMPS

.1 Furnish and install, as indicated on the plans and specifications, Optional Integrated Technologic design split coupled vertical in line pumps. Capacity and power supply: as indicated on the equipment schedule.

.2 Supply and install as shown on plans and specifications, The pumps shall be single stage, single suction type, vertical inline design with integrated variable speed drive and controls. The seal shall be serviceable without disturbing the motor or the piping connections. The capacities and characteristics shall be as outlined in the plans and specifications. The complete pump unit shall be labeled with ETL listing certification that the product conforms to UL Std 778 and is certified to CSA Std C22.2 No.108.

.3 Pump casing shall be constructed of ASTM A48 class 30 cast iron with ANSI 125 / PN16 flanges for working pressure below 175 psig (12 bar) at 150°F (66°C) and ASTM A536 ductile iron with ANSI 250 / PN25 flanges for working pressures to 375 psig (25 bar) at 150°F (66°C). The casing shall be hydrostatically tested to 150% maximum working pressure. The casing shall be radially split to allow removal of the rotating element without disturbing the pipe connections. The pump casing shall be drilled and tapped for gauge ports on both the suction and discharge connections and for a drain port at the bottom of the casing. The casing shall have an additional tapping on the discharge connection to allow for the installation of a seal flush line.

.4 The pump shall have a factory installed vent/flush line to insure removal of trapped air from the casing and mechanical seal cooling. The vent/flush line shall run from the seal chamber to the pump discharge.

.5 The impeller shall be bronze, fully enclosed type. The impeller shall be dynamically balanced to ANSI Grade G6.3 and shall be fitted to the shaft with a key. Two-plane

balancing is required where installed impeller diameter is less than 6 times the impeller width.

.6 The pump shaft shall be stainless steel.

.7 The coupling is to be rigid spacer type constructed of high tensile aluminum alloy. The coupling is to be designed to be easily removed on site to reveal a space between the pump and motor shafts sufficient to remove all mechanical seal components for servicing and to be replaced without disturbing the pump or motor.

.8 The pump shall be fitted with an outside balanced type mechanical seal, with Viton elastomers and antimony carbon (or resin-bonded carbon for potable water applications) vs. silicon carbide faces rated up to 250°F (121°C). A 316 stainless steel gland plate shall be provided with a factory installed flush line with manual vent.

.9 All split coupled pumps shall be provided with a lower seal chamber throttle bushing to ensure seals maintain positively cooling and lubrication.

.10 If required to improve seal chamber cleanliness, supply in the flush line to the mechanical seal a 50 micron cartridge filter and sight flow indicator, to suit the working pressure encountered. Filters shall be changed, by the installing contractor, after system is flushed and on a regular basis until turned over to the Board.

.11 Alternately, supply in the flush line to the mechanical seal a maintenance-free sediment separator, with sight flow indicator for pump differential pressures exceeding 30 psig (or 200 kPa).

.12 The motor frame shall be NEMA TC type. Motor enclosure is to be TEFC with NEMA Premium Efficiency 12.12 rating.

.13 The variable frequency drive & controls shall be rated UL Type 12 or UL Type 4X and be an integral component of the pumping unit.

.14 The integrated VFD shall be of the VVC-PWM type providing near unity displacement power factor (cos Ø) without the need for external power factor correction capacitors at all loads and speeds. The VFD shall incorporate DC link chokes for the reduction of mains borne harmonic currents and to reduce the DC link ripple current thereby increasing the DC link capacitors lifetime. RFI filters will be fitted as standard to ensure the VFD meets low emission and immunity requirements.

.15 VFD and motor protection shall include: motor phase to phase fault, motor phase to ground fault, loss of supply phase, over-voltage, under-voltage, motor over-temperature, inverter overload, over-current.

.16 VFD shall have Sensorless control software to provide automatic speed control in variable volume systems without the need for pump mounted (internal/external) or remotely mounted differential pressure sensor. The default operating mode under Sensorless control shall be Quadratic Pressure Control (QPC) whereby head reduction with reducing flow will be according to a quadratic control curve, the head at minimum

flow being 40% of the design duty head. Control mode setting and minimum/maximum head setpoints shall be user adjustable via a built-in programming interface.

.17 If the quantity of pumps in a system is 2 to 4-maximum, including any standby, a Sensorless controller shall be added to a pumping unit and set up at the factory to operate in parallel Sensorless mode. The pump controls, which will be linked on site by the control contractor, will automatically stage the units, as appropriate, to maintain the best efficiency pumping and minimum operating cost. The standby unit will be brought into the rotation to exercise and equalize wear. The sequence of controls and staging points will be submitted to the engineer for approval at the time of order.

.18 The VFD shall have the following additional features:

a. Sensorless override for BAS/BMS control signal
b. Manual pump control or closed loop PID control
c. Programmable skip frequencies and adjustable switching frequency for noise and vibration control
d. Auto alarm reset
e. Four programmable digital inputs, two analog inputs, one programmable analog /digital output
f. One volt-free contact
g. One RS485 port for serial communications to building management systems
h. The communication protocol to be coordinated with the control contractor ALC to ensure compatibility.

.19 Standard of Acceptance: Amstrong 4300 Design Envelope Series, Bell & Gosset series E-80SC with ITSC option, Taco, Grundfos

2.2 SUCTION GUIDES

.1 Furnish and install on the suction of each pump a suction guide, with outlet flow stabilizing guide vanes, removable stainless steel strainer and fine mesh start-up strainer.

.2 For 150 psig flanged pipe: Supply valve with Cast Iron body with 125 psig flanged ports.

.3 For 300 psig flanged pipe: Supply valves with Ductile Iron body and 250 psig flanged ports.

.4 Standard of Acceptance: Armstrong SG Series, Taco

2.3 TRIPLE DUTY VALVES

.1 The valve stem shall be stainless steel with flat surfaces provided for adjustment with open-end wrench.

.2 Flange adapters, where necessary, are to be Armstrong ArmgripTM PN16 or PN25 ductile iron flanges with antirotation lugs and EPT gaskets.

.3 For Welded Flange Piping: For 10 bar flanges: Valve body shall be Cast Iron with PN16 flanged ports. For 20 bar flanges: Valve body shall be Ductile Iron with PN25 flanged ports.

.4 The valve shall be selected and installed in accordance with the manufacturer's instructions and be suitable for the pressure and temperature specified.

.5 Insulation

a. Each valve shall be furnished with a pre-formed removable PVC insulation jacket to meet ASTM D1784 Class 14253- C, MEA #7-87, ASTM-E-84 and ASTM136 with a flame spread rating of 25 or less and a smoke development rating of 50 or less. There will be provided sufficient mineral fiberglass insulation to meet ASHRAE 90.1-1989 specifications in operating conditions with maximum Fluid Design Operating Temperature Range of 141°F-200°F (60°C-93°C) and Mean Rating Temperature of 125°F (52°C).

.6 Standard of Acceptance: Armstrong FTV Flo-Trex series, Taco

PART 3 EXECUTION

3.1 INSTALLATION

.1 Install with bearing lubrication points accessible. Check rotation.

.2 Supply and install a strainer and isolation valve upstream of each pump.

.3 Supply and install an isolation valve, check valve and balancing valve downstream of each pump.

.4 Ensure that pump body does not support piping or equipment. Provide stanchions or hangers for this purpose. Refer to drawings and manufacturer's installation instructions for details.

.5 Provide vibration isolation between the pumps and pipes, and between the pumps and the concrete housekeeping pads. Refer to section 15241.

.6 Pipe drain tapping to floor drain.

.7 Install volute venting pet cock in accessible location.

.8 Change cartridge filter on regular basis prior to, and at turn over to owner.

.9 Contractor to provide and install one pressure gauge, piped to pump suction, pump discharge and strainer inlet. Pressure gauge tappings with necessary isolating valves to enable differential pressure reading across pump and strainer to be taken.

.10 Contractor shall cover motor during construction and have area clean of construction debris before starting the motor.

.11 Contractor to follow the manufacturer's instructions for start-up and venting of mechanical seal.

.12 If pump is used during temporary heating or flushing of system, contractor shall be responsible for changing mechanical seal or replacing motor bearings if so instructed by the board representative.

.13 The pump manufacturer shall coordinate with the hydronic balancer to balance the system to the required flows.

.14 Provide drip pan and piped to nearest drain for each pump. Drip pan shall be sized to suit pump dimensions.

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL

1.1.1 This section of the specification shall be read in conjunction with and be governed by the requirements of Section 15010.

1.2 DESCRIPTION

1.2.1 Ductwork and accessories for HVAC including the following:
1.2.2 Supply air, return air, outside air, exhaust, and relief systems.

1.3 DEFINITIONS

1.3.1 SMACNA Standards as used in this specification means the HVAC Duct Construction Standards, Metal and Flexible.
1.3.2 Seal or Sealing: Use of liquid or mastic sealant, with or without compatible tape overlay, or gasketing of flanged joints, to keep air leakage at duct joints, seams and connections to an acceptable minimum.
1.3.3 Duct Pressure Classification: SMACNA HVAC Duct Construction Standards, Metal and Flexible.
1.3.4 Exposed Duct: Exposed to view in a finished room, and/or exposed to weather.

1.4 QUALITY ASSURANCE

1.4.1 Fire Safety Code: Comply with NFPA 90A.
1.4.2 Duct System Construction and Installation: Referenced SMACNA Standards are the minimum acceptable quality.
1.4.3 Duct Sealing, Air Leakage Criteria, and Air Leakage Tests: Ducts shall be sealed as per duct sealing requirements of SMACNA HVAC Air Duct Leakage Test Manual for duct pressure classes shown on the drawings.
1.4.4 Duct accessories exposed to the air stream, such as dampers of all types (except smoke dampers) and access openings, shall be of the same material as the duct or provide at least the same level of corrosion resistance.

1.5 SUBMITTALS

1.5.1 Submit in accordance with Section 15010, Manufacturer's Literature and Data:
- .1 Rectangular ducts:
  - .1 Schedules of duct systems, materials and selected SMACNA construction alternatives for joints, sealing, gage and reinforcement.
  - .2 Sealants and gaskets.
  - .3 Access doors.

1.5.2 Round and flat oval duct construction details:
- .1 Manufacturer's details for duct fittings.
- .2 Sealants and gaskets.

1.5.3 Access sections.
1.5.4 Volume dampers, back draft dampers.
1.5.5 Upper hanger attachments.

1.5.6 Fire dampers, fire doors, and smoke dampers with installation instructions.
1.5.7 Sound attenuators, including pressure drop and acoustic performance.
1.5.8 Flexible ducts and clamps, with manufacturer's installation instructions.
1.5.9 Flexible connections.
1.5.10 Instrument test fittings.
1.5.11 Details and design analysis of alternate or optional duct systems.

1.6 APPLICABLE PUBLICATIONS

1.6.1 The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
1.6.2 Air Moving and Conditioning Association (AMCA):
.1 500D 98 Laboratory Method of Testing Dampers for Rating
.2 500L-99 Laboratory Method of Testing Louvers for Rating
1.6.3 American Society for Testing and Materials (ASTM):
.1 A653-01 Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy coated (Galvannealed) by the Hot-Dip process
.2 A1011-02 Standard Specification for Steel Sheet and Strip Hot rolled Carbon structural, High-Strength Low- Alloy and High Strength Low-Alloy with Improved Formability
.3 B209 01 Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate
.4 C1071-00 Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
.5 E84-01 Standard Test Method for Surface Burning Characteristics of Building Materials
1.6.4 National Fire Protection Association (NFPA):
.1 90A-99 Standard for the Installation of Air Conditioning and Ventilating Systems
.2 96-01 Ventilation Control and Fire Protection of Commercial Cooking Operations
1.6.5 Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
.1 2nd Edition – 1995 HVAC Duct Construction Standards, Metal and Flexible
.2 1st Edition - 1985 HVAC Air Duct Leakage Test Manual
.3 6th Edition – 1992 Fibrous Glass Duct Construction Standards

PART 2 - PRODUCTS

2.1 DUCT MATERIALS

2.1.1 General: Except for systems specified otherwise on drawings, construct ducts, casings, and accessoriesof galvanized sheet steel, ASTM A527, coating G90.

2.2 GALVANIZED STEEL - RECTANGULAR DUCTWORK

2.2.1 G-90 coated galvanized of lock-forming grade conforming to ASTMA653 and A924 Standards. Minimals yield strength for steel sheet and reinforcements shall be 30,000 PSI(207 kPa).
2.2.2 Thickness: to ASHRAE and SMACNA.
2.2.3 Fabrication: to ASHRAE and SMACNA.
2.2.4 Joints: to ASHRAE and SMACNA or proprietary manufactured duct joint. Proprietary manufactured flanged duct joint shall be considered to be a class B seal.
.1 Standard of Acceptance: Namasco Ductmate; Exanno Nexus.

2.2.5 Fittings
.1 Fabrication: to SMACNA.
.2 Radiused elbows: standard radius.
.3 Square elbows: over 16" with double thickness vanes. Not to be used unless specifically shown on drawings.
.4 Main supply duct branches with splitter damper. If splitter damper is not used, provide branch and main duct balancing damper.
.5 Sub branch duct with 45° entry and balancing damper on branch.

2.2.6 Transitions:
.1 Diverging: 20° maximum included angle.
.2 Converging: 30° maximum included angle.

2.2.7 Offsets: radiussed elbows as indicated.

2.2.8 Obstruction deflectors: maintain full cross- sectional area. Maximum included angles as for transitions.

2.3 SEALING CLASSIFICATION

.1 Sealing classification as follows:

Seal Class	Sealing Requirements	Applicable Static Pressure Construction Class	Allowable Leakage Rate
A	All traverse joints, longitudinal seams and duct wall penetrations	4" w.g. (1000 Pa) -4" w.g. (-1000 Pa)	1% of total system design at system operating pressure 4"(1000 Pa)
B	All transverse joints and longitudinal seams	Up to 3" w.g. (750 Pa) -3" w.g. (-750 Pa) and less	1% of total system design at 3" w.g. (750 Pa)
C	All transverse joints only	Up to 2" w.g. (500 Pa) -2" w.g. (500 Pa) and less	1.5% of total system design at 2" w.g. (500 Pa)
D	Not sealed	Up to 1" w.g. (250 Pa) -1" w.g. (-250 Pa) and less	5% of total system design at 1" w.g. (250 Pa)

2.4 PRESSURE CLASSIFICATIONS

.1 Ductwork material shall be constructed in accordance with SMACNA ratings for the following pressure classifications. Seal classifications shall be in accordance with the following table:

Ductwork	Operating Pressure	Seal Classification	Remarks
All supply ductwork	Up to 2". w.g. (500 Pa)	B	

All return ductwork	Up to 1 " w.g. (250 Pa)	B	
All exhaust ductwork	Up to -1" w.g. (-250 Pa)	B	
All Other Ductwork	Up to 0.5" w.g. (125 Pa)	D	

2.5 SEALANT AND TAPE

2.5.1 Joint Sealing: Refer to SMACNA HVAC Duct Construction Standards, paragraph S1.9.

2.5.2 Sealant: Elastomeric compound, gun or brush grade, maximum 25 flame spread and 50smoke developed (dry state) compounded specifically for sealing ductwork as recommended by the manufacturer. Generally provide liquid sealant, with or without compatible tape, for low clearance slip joints and heavy, permanently elastic, mastic type where clearances are larger. Oil base caulking and glazing compounds are not acceptable because they do not retain elasticity and bond.

2.5.3 Tape: Use only tape specifically designated by the sealant manufacturer and apply only over wet sealant. Pressure sensitive tape shall not be used on bare metal or on dry sealant.

2.5.4 Gaskets in Flanged Joints: Soft neoprene.

2.5.5 Approved factory made joints such as DUCTMATE SYSTEM may be used.

2.6 DUCT CONSTRUCTION AND INSTALLATION

2.6.1 Follow SMACNA HVAC Duct Construction Standards.

2.6.2 Where specified, all ductwork shall be made liquid tight with continuous external weld for all seams and joints. Provide neoprene gaskets at flanged connections. Where ducts are not self-draining back to the equipment, provide low point drain pocket with copper drainpipe to sanitary sewer. Provide access door in side of duct at drain pockets.

2.6.3 Casings and Plenums

.1 Construct in accordance with SMACNA HVAC Duct Construction Standards Section 6, including curbs, access doors, pipe penetrations, eliminators and drain pans. Access doors shall be hollow metal, insulated, with latches and door pulls, 500 mm (20 inches)wide by 1200 - 1350 mm (48 54 inches) high. Provide view port in the doors where shown. Provide drain for outside air louver plenum. Outside air plenum shall have exterior insulation. Drain piping shall be routed to the nearest floor drain.

2.6.4 Volume Dampers

.1 Opposed blade, multi louver type as detailed in SMACNA Standards. Refer to SMACNA Detail Figure 2-12 for Single Blade and Figure 2.13 for Multi-blade Volume Dampers.

2.7 HANGERS AND SUPPORTS

2.7.1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.

2.7.2 Hanger configuration: to ASHRAE and SMACNA. Maximum size duct supported by

straphanger: 500mm.

2.7.3 Hangers: galvanized steel angle with black galvanized steel rods to ASHRAE and SMACNA following table:

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25 x 25 x 3	6
751 to 1500	40 x 40 x 3	10
1501 to 2400	50 x 50 x 5	10
2401 and over	50 x 50 x 6	10

2.7.4 Upper hanger attachments:

.1 For concrete: manufactured concrete inserts.

.1 Standard of Acceptance: Myatt fig 485.

.2 For concrete after concrete pour:

.1 Expanded concrete anchors shall be made of steel.
.2 Powder actuated fasteners shall only be utilized for slabs that are thicker than 100 mm (4") and shall not be utilized in lightweight aggregate concretes.
.3 Holes for expanding fasteners shall be drilled either by a carbide bit or by the teeth on the fastener itself. Expansion shield shall be “set" by driving it into the hole and expanding it with a conical plug.

2.7.3 For steel joist: manufactured joist clamp or steel plate washer.
.1 Standard of Acceptance: Grinnell fig 61 or 86 for joist clamps.

2.7.4 For steel beams: manufactured beam clamps:
.1 Standard of Acceptance: Grinnell fig. 60

2.7.5 For round ductwork the duct shall be supported as follows:
.1 For duct dimensions 900 mm (36") single hangers are acceptable.
.2 For duct dimensions over 900 mm (36") hanger rods shall be provided on both sides of the duct.
.3 Minimum hanger sizes shall be in accordance with table 4-2 of SMACNA.

2.7.6 Loading on trapeze bars shall be in accordance with Table 4-3 of SMACNA.

2.8 DUCT ACCESS DOORS, PANELS AND SECTIONS

2.8.1 Provide access doors, sized and located for maintenance work, upstream and downstream of:
.1 Each duct mounted coil.
.2 Each fire damper (for link service), smoke damper and automatic control damper.
.3 Each duct mounted smoke detector.

2.8.2 Openings shall be as large as feasible in small ducts, 300 mm by 300 mm (12 inch by 12inch) minimum where possible. Access sections in insulated ducts shall be double wall, insulated. Transparent shatterproof covers are preferred for un insulated ducts.

2.8.3 For rectangular ducts: Refer to SMACNA HVAC Duct Construction Standards (Figure 2 12).

2.8.4 For round and flat oval duct: Refer to SMACNA HVAC duct Construction Standards (Figure2-11).

2.9 FIRE DAMPERS

2.9.1 Galvanized steel, interlocking blade type, UL listing and label, 1 1/2 hour rating, 70 degrees C (160 degrees F) fusible line, 100 percent free opening with no part of the blade stack or damper frame in the air stream.

2.9.2 Fire dampers in wet air exhaust shall be of stainless steel construction, all others may be galvanized steel.

2.9.3 Provide sleeves and mounting angles, minimum 1.9 mm (14 gage), required to provide installation equivalent to the damper manufacturer's UL test installation.

2.9.4 Submit manufacturer's installation instructions conforming to ULC rating test.

2.9.5 Combination fire and smoke dampers: Multi louver or curtain type units meeting all requirements of both dampers shall be used where shown and may be used at the Contractor's option where applicable.

2.9.6 Standard of Acceptance: Nailor, Ruskin

2.10 OPERATING DAMPERS

1. Opposed or Parallel blade type. Two position dampers to be parallel, modulating dampers to be opposed blade type.
2. Damper frame shall be of extruded aluminum not less than 0.08" (2.03mm) in thickness. Damper frame to be 4" (101.6mm) deep and shall be insulated with Styrofoam on four sides. Entire frame shall be thermally broken by means of polyurethane resin pockets, complete with thermal cuts.
3. Blades to be of extruded aluminum, internally insulated with expanded polyurethane foam and shall be thermally broken. Complete blade shall have an insulating factor of R-2.29 and a temperature index of 55.
4. Blade and frame seals shall be of extruded silicon and be secured in an integral slot within the aluminum extrusions.
5. Bearings to be comprised of a Celcon inner bearing fixed to a 7/16" aluminum hexagon blade pin rotating within a polycarbonate outer bearing inserted in frame.
6. Linkage hardware shall be installed in frame side and be constructed of aluminum and corrosion resistant, zinc and nickel plated steel, complete with cup point trunnion screws for slip proof grip.
7. Dampers to be designed for operation in temperatures ranging between - 40^{o}F and 212^{o}F (-40 C to 100 C).
8. Damper actuator shall be provided by the Controls Contractor.
9. Performance: leakage in closed position to be less than 4.9 cfm/ft^2 against 4” differential static pressure at -40 °F.
10. Air leakage through a 48” x 48” (1220mm x 1220mm) damper shall not exceed 4.12 cfm/ft^2 against 4” w.g. differential static pressure at standard air. Standard air leakage data to be certified under the AMCA certified ratings program.
11. Pressure drop of a fully open 48” x 48” (1220mm x1220mm) damper shall not exceed 0.03” w.g. at 1000 fpm.
12. Dampers shall be made to size and shall not be limited to standard sizes.
13. Standard of Acceptance: Tamco Air Foil Series 9000 BF, Ruskin CDTI-50 BF Series, Arrow AFDTI-25LT insulated.

2.1 GRILLES & DIFFUSERS

1. Provide standard product to meet capacity, throw, noise level, throat and outlet velocity.
2. Where grilles, registers and diffusers penetrate fire walls and fire partitions, provide approved steel sleeve secured to structure in accordance with NFPA 90A-2009 and required fire damper.
3. Frames:
   .1 Steel: primed cold rolled steel with exposed welded joints and mitred corners.
   .2 Aluminum: extruded satin finish with mechanical fasteners and mitred corners.
   .3 Provide plaster frames as plaster stops where set into plaster or gypsum board.
   .4 Provide concealed fasteners and balancing operators in all finished areas.
   .5 Final finish to be selected by Architect from standard manufacturer finishes at shop drawing stage.
4. Sizes and capacities: as indicated in the schedule.
5. Standard of Acceptance: EH Price, Titus, Nailor

6. Supply Grilles &Registers
   .1 1-1/4" (32 mm) border double deflection with airfoil shape horizontal face and vertical rear bars, opposed blade dampers (OBD) where indicated with concealed manual operator, and gaskets.
7. Return and Exhaust Grilles
   .1 1-1/4" (32 mm) border, single deflection, air foil shape, horizontal bar type 35E max turn up, when shown on the schedule opposed blade damper with concealed operator and rubber sealing strips.
   .2 Egg crate to be ½" x ½" x 1" (12 x 12 x 25), type as per schedule.
8. Diffusers
   .1 Diffusers shall consist of a precision formed back cone of one piece seamless construction which incorporates a round inlet collar of sufficient length for connecting rigid or flexible duct.
   .2 Refer to schedule for finish.
   .3 As indicated on the schedule, Circular, square or perforated type, having adjustable fixed pattern, and volume control dampers with flow straightening devices and blank-off quadrants.
   .4 For plaque diffusers an inner plaque assembly shall be incorporated that drops no more than 1/4" below the ceiling plane to assure proper air distribution performance. The inner plaque assembly shall be completely removable from the diffuser face to allow full access to any dampers or other ductwork components located near the diffuser neck.

2.11 INSTALLATION

2.11.1 Fabricate and install ductwork and accessories in accordance with referenced SMACNA Standards:

2.11.2 Drawings show the general layout of ductwork and accessories but do not show all required fittings and offsets that may be necessary to connect ducts to equipment, boxes, diffusers, grilles, etc., and to coordinate with other trades. Fabricate ductwork based on field measurements. Provide all necessary fittings and offsets at no additional cost to the Owner. Coordinate with other trades for space available and relative location of HVAC equipment and accessories on ceiling grid. Duct sizes on the drawings are inside dimensions which shall be altered by Contractor to other dimensions with the same air handling characteristics where necessary to avoid interferences and clearance difficulties.

2.11.3 Provide duct transitions, offsets and connections to dampers, coils, and other equipment in accordance with SMACNA Standards, Section II. Provide streamliner, when an obstruction cannot be avoided and must be taken in by a duct. Repair galvanized areas with galvanizing

repair compound.

2.11.4 Supply and install volume control dampers on all branch take-offs (applicable to supply, return and exhaust ductwork) whether shown on the drawing or not.

2.11.5 Provide bolted construction and tie rod reinforcement in accordance with SMACNA Standards.

2.11.6 Construct casings, eliminators, and pipe penetrations in accordance with SMACNA Standards, Chapter 6. Design casing access doors to swing against air pressure so that pressure helps to maintain a tight seal.

2.11.7 Install duct hangers and supports in accordance with SMACNA Standards, Chapter 4.

2.11.8 Install fire dampers in accordance with the manufacturer's instructions to conform to the installation used for the rating test.

2.11.9 Seal openings around duct penetrations of floors and fire rated partitions with fire stop material as required by NFPA 90A.

2.11.10 Where diffusers, registers and grilles cannot be installed to avoid seeing inside the duct, paint the inside of the duct with flat black paint to reduce visibility.

2.11.11 Control Damper Installation:

.1 Provide necessary blank off plates required to install dampers that are smaller than duct size. Provide necessary transitions required to install dampers larger than duct size.

.2 Assemble multiple sections dampers with required interconnecting linkage and extend required number of shafts through duct for external mounting of damper motors.

.3 Provide necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified. Locate baffles by experimentation, and affix and seal permanently in place, only after stratification problem has been eliminated.

.4 Install all damper control/adjustment devices on stand-offs to allow complete coverage of insulation.

2.11.12 Air Flow Measuring Devices (AFMD): Install units with minimum straight run distances, upstream and downstream as recommended by the manufacturer.

2.11.13 Protection and Cleaning: Adequately protect equipment and materials against physical damage. Place equipment in first class operating condition, or return to source of supply for repair or replacement, as determined by the Consultant. Protect equipment and ducts during construction against entry of foreign matter to the inside and clean both inside and outside before operation and painting. When new ducts are connected to existing ductwork, clean both new and existing ductwork by mopping and vacuum cleaning inside and outside before operation.

2.12 DUCT LEAKAGE TESTS AND REPAIR

2.12.1 Ductwork leak test shall be performed for the entire air distribution supply and return system including fans, coils and filter section designated as static pressure class 750 Pa (3 inch W.G.) and above.

2.12.2 All supply ductwork less than 500 Pa (2 inch W.G) shall also be tested to the air distribution equipment or terminal device (where applicable).

2.12.3 Test procedure, apparatus and report shall conform to SMACNA Leakage Test manual. The maximum leakage rate allowed is 4 percent of the design air flow rate.

2.12.4 All ductwork shall be leak tested first before enclosed in a shaft or covered in other inaccessible areas.

2.12.5 All tests shall be performed in the presence of the Consultant and the TAB agency. The

Test and Balance agency shall measure and record duct leakage and report to the Consultant and identify leakage source with excessive leakage.

2.12.6 If any portion of the duct system tested fails to meet the permissible leakage level, the Contractor shall rectify sealing of ductwork to bring it into compliance and shall retest it until acceptable leakage is demonstrated to the Consultant.

2.12.7 All tests and necessary repairs shall be completed prior to insulation or concealment of ductwork.

2.12.8 Make sure all openings used for testing flow and temperatures by TAB Contractor are sealed properly.

- END -

PART 1 GENERAL

1.1 GENERAL

.1 This section of the specification shall be read in conjunction with and be governed by the requirements of Section 15010.

1.2 PRODUCT DATA

.1 Submit product data in accordance with Section 15010.

.2 Indicate the following: Louvers, Style and Performance.

1.3 CERTIFICATE OF RATINGS

.1 Catalogued or published ratings shall be those obtained from tests carried out by the Manufacturer or those ordered by him from an independent testing agency signifying adherence to codes and standards.

PART 2 PRODUCTS

2.1 STATIONARY LOUVERS

.1 Louvers shall be by Mechanical Contractor.

.2 Frame: 102 mm deep, 6063T5 extruded aluminum. 3.2 mm nominal wall thickness. Downspouts and caulking surfaces included.

.3 Blades: 6063T5 extruded aluminum. 3.2 mm nominal wall thickness. Drainable blades are positioned at 45 degree angle and spaced approximately 102 mm center to center.

.4 Screen: 19 mm X 1.3 mm expanded, flattened aluminum bird screen in removable frame. Screen adds approximately 13 mm to louver depth. Also provide insect screen.

.5 Finish: Factory-applied Kynar 500 or equivalent, colour, selected at shop drawing stage.

.6 Features:

a. Published performance ratings based on testing in accordance with AMCA Publication 511.
b. High performance frame system with drainable head collects and removes water to provide excellent water penetration performance.
c. Drain gutter in each blade minimizes water cascade between blades.
d. All aluminum construction for low maintenance and high resistance to corrosion.
e. All welded construction.

.7 Performance:

a. .1 52% minimum free area.

b. .2 Beginning point of water penetration at 0.01 oz./sq. ft. is 1075 fpm
c. .3 Pressure drop: 0.15" w.g. at 870 fpm (Intake) and 900 fpm (exhaust).

.8 Size of louvers shall be coordinated with the brickwork pattern. Minimum louver size shall be 305mm x 305 mm.

.9 Standard of Acceptance: E.H.Price, Ruskin.

PART 3 EXECUTION

3.1 INSTALLATION

.1 Install in accordance with manufacturers recommendations and in accordance with recommendations of SMACNA.

.2 Reinforce and brace air vents, intakes and gooseneck hoods for wind speed in accordance with NBC for location.

.3 Blank off and insulate with sheet metal, 2" of insulation and sheet metal, all unused portions of louvres.

END OF SECTION

PART 1 - General

1.1 GENERAL

.1 This section of the specification shall be read in conjunction with and will be governed by the requirements outlined in section 15010

.2 Submit shop drawings in accordance with Section 15010.

.3 Clearly indicate: Proposed routing, fittings, etc.

1.2 CERTIFICATION OF RATINGS

.1 Catalogued or published ratings shall be those obtained from test carried out by the manufacturer or those ordered by him/her from an independent testing agency signifying adherence to codes and standards.

1.3 SUBMITTALS - BOILERS VENTS

.1 System vendor shall coordinate equipment product data submittal sheets with the boiler, burner, heater and chimney manufacturer and shall provide a comprehensive set of drawings and stack design calculations, which shall serve as the basis for system evaluation by the Consultant.

.2 Submit a comprehensive set of mechanical venting calculations based on the Chimney Design Equation published in the ASHRAE Handbook. Calculations must show flue gas volumes, pressure losses, fluctuations in natural draft at different loads and seasonal temperatures. The calculations must show the draft over the entire firing range at low, medium and high design temperatures. Calculations must be stamped by a Professional Engineer (HVAC) in the Province of Ontario

.3 At shop drawings stage, the boilers vent manufacturer shall decide if draft control devices such as barometric dampers are required. Such equipment shall be supplied installed and adjusted at no additional cost to the Board.

.4 Submit all other information, literature, calculations and certificates required by the Authorities Having Jurisdiction, including TSSA. Apply for and pay all fees for local variances if necessary.

PART 2 - Products

2.1 DOUBLE WALL CHIMNEY - SEALED

.1 Application: all heating hot water boilers.

.2 Vent shall be factory-built special gas type, double wall, engineered and designed for use on Category I, II, III, and IV appliances, fully ULC listed.

.3 Maximum continuous flue gas temperature not to exceed 550°F (288°C) for gas burning appliances.

.4 Vent shall be constructed with an inner conduit constructed of AL29-4C® superferritic stainless steel with a minimum thickness of .015" for diameters 3"-8", .020" for diameters 10"-16", .025" for diameters 18"-24", and .035" for 26" and greater.

.5 Vent shall be listed for an internal static pressure of 15" w.g. and tested to 37" w.g.

.6 All inner wall conduit components shall be manufactured from AL29-4C® or 29-4 (S44735). The joint closure system shall be an Inner Wall Mechanical Locking Strap design. Joints shall not use screws or fasteners that penetrate the inner conduit.

.7 Vent shall be constructed with a factory installed gasket used to seal the joint for diameters 4"-16". Use of gasket lube, available from the factory, should be used for maximizing gasket life and ease of installation. For diameters 18"- 32", joints shall be sealed with factory supplied RTV sealant.

.8 Inner wall joints shall be designed with a male and female overlapping metal-metal connection to maintain condensate on the AL29-4C stainless steel. Proper ¼" per foot pitch must be maintained at all times and condensate should flow back toward the appliance to the required number of drains.

.9 The outer wall casing shall be constructed of 430 stainless steel that shall not require additional surface preparation, such as painting, in order to withstand the outdoors or high humidity environments.

.10 Inner conduit and outer wall casing shall be constructed with a one-inch air space between them and in such a fashion that prevents cross-alloy contamination.

.11 Tees and elbows shall provide a pressure drop less than 15 feet equivalent horizontal vent.

.12 Fittings that increase or decrease vent diameter shall be asymmetric in construction with a flat wall that maintains a straight line with adjoining parts in order to facilitate the unobstructed flow of all condensate.

.13 All parts shall be compatible with other single wall and double wall products of the same manufacturer.

.14 System is to be sized in accordance with the appliance manufacturer's specifications, NFPA 54-National Fuel Gas Code (ANSI Z223.1), ASHRAE recommendations, and other applicable codes.

2.2 SEALANT

.1 General Electric RTV106 (aka Momentive) or Dow Corning 736 High Temperature Sealant shall be used to seal all joints on systems where the maximum flue gas temperature will not exceed 550°F.

.2 A factory installed 550°F compatible silicone rubber gasket shall be used to seal joints.

2.3 ACCESSORIES

.1 All chimney supports, roof penetrations, terminations, appliance adapters, drain fittings and expansion joints required to install the chimney shall be included and shall be ULC listed products of the chimney manufacturer.

.2 Accessories: cleanouts (bolted-gasketted type), expansion joints, roof flashing, radiation shield, storm collar, hanger and supports, weather cap, conforming to applicable codes and TSSA requirements.

.3 Standard of acceptance: Heat-Fab model Saf-T-CI, Cheminee Lining, Security Chimney

PART 3 - Execution

3.1 INSTALLATION

.1 Extend the metallic boiler vent as noted on the drawing and terminate with approved weather cap, by the chimney manufacturer. Coordinate roofing work with the Roofing Contractor.

.2 All sections of the heating boilers venting system shall be double-wall construction.

.3 Follow manufacturer's and SMACNA installation recommendations for shop fabricated components.

.4 Support chimneys at bottom, roof and intermediate levels as required. Install thimbles where penetrating roof and floor. Provide guy-wire supports as necessary.

.5 Use 45 deg. fittings where possible.

.6 Allow for a drip pocket at the bottom of the stack and at each boiler connection and make allowances for condensate drainage; the condensate shall be directed to the nearest floor drain using PVC piping. Prior to discharging, supply and install an acid neutralizing kit (supply by boiler manufacturer). Ensure that a min. 2" deep trap is provided where the condensate drain connects to the bottom of the stack.

.7 At the shop drawings stage, the Boiler Manufacturers shall review on site with the contractor the final venting routing and lengths, and shall confirm the vent sizes. No allowances shall be made for the contractor and manufacturer's representatives failure to examine the site condition and the final routing of the boilers venting. The Manufacturer is responsible for providing written confirmation that the proposed venting is acceptable for use with the proposed Boilers.

.8 The Boiler Manufacturer together with the chimney representative shall site inspect the final venting arrangement. Provide a letter confirming inspection and compliance with all Applicable Codes, AHJ Requirements and Manufacturer's Requirements.

.9 For heating boilers, draft control dampers shall be supplied and installed if and where required for the optimal performance of the boiler plant. All costs for draft control dampers, start-up and adjustments shall be included in the project cost.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL

.1 Provide all wiring, raceways and temperature sensors, flow switches and terminations at the equipment side. All terminations at the panel side shall be completed by DCDSB only. All programming and Graphics modifications will be completed by DCDSB.

.2 Perform an in-depth review of all existing control components (e.g. control valves, control dampers, linkages, actuators, etc.) to be re-used on the existing BAS. Immediately report any defective or inoperative components to the Engineer.

.3 Co-ordinate the work of the Mechanical Contractor (see Section 3.1) and all sub-contractors required to complete the scope of work as specified in the contract documents.

.4 The Controls Contractor and all sub-contractors shall employ only certified tradespersons to carry out all applicable work.

.5 Provide hand-off-auto (H-O-A) switches for existing equipment starters where specified.

.6 Provide all necessary power wiring and hardware to complete the entire project, including but not limited to, wiring, fittings, connectors, conduits, hangers/supports, box covers and all other accessories required to ensure complete, safe and fully operational systems. This shall include the power wiring for all the equipment installed by the Mechanical Contractor.

.7 Arrange for Electrical Authority inspection of all electrical work. Arrange for a separate inspection of any field assembled electrical panels or systems that have not been pre-approved by CSA/ULC. Submit the Certificate of Inspection and Product Approval Certificate with the as-built documentation.

.8 It is the responsibility of the Contractor to provide written notification to the DCDSB, prior to tender closing, of any errors, omissions, discrepancies or ambiguities contained in these documents. Following the award of the contract, DCDSB reserves the right to act as the sole arbiter of any disputes arising from the interpretation of these contract documents.

1.2 APPROVED CONTROL SYSTEM MANUFACTURERS

.1 All terminations at the panel side shall be completed by DCDSB only. All programming and Graphics modifications will be completed by DCDSB.

1.3 SHOP DRAWING SUBMITTALS

.1 None required.

1.4 AS—BUILT DOCUMENTATION

.1 None required.

1.5 WARRANTY

.1 All labour and material (hardware/wiring) supplied under this contract shall be warranted free from defects for a period of **two (2) years** after final completion and acceptance. Final completion and acceptance is defined as the date of the project turnover meeting or the date of the final completion certificate issued by the DCDSB BAS Coordinator, whichever occurs first. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost to DCDSB. The Contractor shall respond to DCDSB's request for warranty service within one (1) business day.

.2 The final completion and acceptance date shall be the date of the project turn-over meeting.

.3 All work shall have a single warranty date, even when the Owner has received beneficial use of part of the system in advance of the final completion date.

.4 The contractor shall be responsible for correcting any deficiencies, errors or omissions in operating strategies, programming code, system functionality or parameters and operator workstation graphics during the warranty period.

1.6 OWNERSHIP OF PROPRIETARY MATERIAL

.1 All project-developed software and documentation shall become the property of DCDSB. These include, but are not limited to:
1. Project graphic images
2. Record drawings
3. Project database
4. Project application programming code
5. All documentation

1.7 FACILITIES WITH EXISTING BAS

.1 Where a facility has an existing BAS that is to be replaced, modified or upgraded, the Controls Contractor shall be responsible for ensuring that the entire system (hardware, wirng, etc.) and all integral parts (new and re-used) function as an integrated and seamless system. Specifically, the interactive workstation graphics shall be created for both the new and re-used parts of the BAS using the latest and most up-to-date version of the manufacturer's graphics software (see also 1.7.4, 1.7.5, 1.76).

.2 Provide current generation products only. The supply of out-of-date or obsolete products shall not be accepted. The supply of discontinued products or products no longer supported by the manufacturer shall not be accepted.

.3 Provide new labelling for wiring, devices and equipment where existing labelling does not meet the requirements of these specifications or where panel hardware addressing is modified as a result of the new project work.

1.8 INTEROPERABILITY WITH THIRD PARTY DEVICES

.1 Where the BAS is interfaced to third party devices (i.e. VFDs, chiller panels, equipment controllers, etc.), use only hard-wired, physical I/O's to achieve desired interoperability.

.2 To facilitate and simplify post-construction servicing of equipment and systems by DCDSB staff, the use of industry standard communication protocols (i.e. BACnet, LONWorks MODBUS) shall **not** be used to interface the BAS to third party devices, unless specifically approved by the DCDSB.

1.9 TESTING, ADJUSTING AND BALANCING (TAB)

.1 Where specified, provide the services of an approved TAB company. Ensure that all applicable site personnel employed by the TAB company meet DCDSB trades certification and registration requirements.

.2 The Controls Contractor shall provide test holes and covers, drive changes, additional dampers, pipe corrections, access through ceiling, etc as required by the TAB Engineer. Provide stepladders, lifters, scaffolds where required to access for testing of equipment. Replace all temporarily removed parts to their original position.

.3 The TAB work shall be performed to ANSI/ASHRAE-III-1988 and 62-1989. Other standards are as listed in the NBCTA 1995 Directory, AABC and NEBB publications.

.4 The TAB report shall be based on true tests which are properly documented. The report shall have all elements of description, design, equipment supplier and testing data. The testing method (set up), applied testing instruments, achieved accuracy and comfort level need to be described and commented.

.5 Where applicable, the TAB report shall have the following structure:

- Front Title Sheet
- Table of Content
- Systems Description, Testing Method and Comments
- Performance Table, which includes all systems
- Equipment Test Sheet c/w S.P. profile
- Autocad Schematics
- Report Certification
- Performance Curves
- Building Pressurization Diagnosis
- Deficiencies

PART 2 PRODUCTS

2.0 SYSTEM HARDWARE

2.1 GENERAL

2.1.1. Fail State Position of Outputs

.1 Unless specified otherwise, configure BAS output points for the following fail state (e.g. device position upon panel failure):

All Fans	OFF
Heating Valves	Full heat to terminal device
Mixing Dampers	Full recirculation air
Face/Bypass Dampers	Full heat
Zone Dampers	Full heat
Heating Pumps	ON (except boiler belly pumps)
Boiler Belly Pumps	OFF
Variable Frequency Drives	ON, minimum programmed speed
Lighting Relays	Last State
Boilers (1 stage)	ON
Boilers (Multi-stage)	LOW ON, HIGH OFF
Cooling Equipment	OFF
Electric Heating	OFF
Domestic Hot Water Pumps	OFF
Roof-top Gas Burners	OFF

2.2 SYSTEM SOFTWARE

2.2.1 BAS Workstation Software

.1 By DCDSB.

2.2.2 Trend Logs and Totalizers

.1 By DCDSB.

2.2.3 User Access

.1 By DCDSB.

2.2.4 Alarms

.1 By DCDSB.

2.2.5 BAS Alarm Output / Surveillance System Armed Status

.1 By DCDSB.

2.3 BAS DYNAMIC GRAPHICS

.1 By DCDSB.

2.4 FIELD DEVICES (SUPPLIED & INSTALLED BY THE MECHANICAL CONTRACTOR)

2.4.1 Automatic Control Valves

.1 Automatic control valves shall be supplied by the Controls Contractor and installed by the Mechanical Contractor.

.2 Automatic control valves, unless otherwise specified, shall be globe type valves. The use of ball valves in sizes 1-1/2" (40mm) and smaller shall also be acceptable. Valves and actuators shall be ordered as one factory-assembled and tested unit.

.3 Submit to the Engineer for review, a valve schedule containing the following information for each valve:

a. Valve type and size
b. Connection type
c. Line size
d. Valve manufacturer and model number
e. Valve flow coefficient
f. Design flow
g. Pressure drop across valve
h. Maximum close-off pressure
i. Actuator manufacturer and model number
j. Actuator maximum torque

.4 Valves 2" (50mm) and smaller shall be constructed of bronze. Valves 2 1/2" (65mm) and larger shall have iron bodies and bronze mountings.

.5 All control valves shall have stainless steel stems. Ball valves shall be equipped with stainless steel balls and stems.

.6 The bronze in bodies and bonnets of all bronze valves shall conform to ASTM B62 for valves rated up to 150psig (1035 Kpa) working pressure and to ASTM B61 for valves rated at 200 psig (1380 Kpa) working pressure.

.7 The bodies and bonnets of iron body valves shall conform to ASTM A126, Class B.

.8 Control valve discs and seats shall be of bronze for 100 °C or less fluid temperature and of stainless steel for fluid temperatures above 100 °C.

.9 The control valves shall have tight shut-off. Flat disk valves are not acceptable.

.10 Control valves 2" (50mm) and smaller shall be complete with screwed ends type, except for bronze valves installed in soldered copper piping which shall be complete with soldering ends. Control valves larger than 2" (50mm) shall be complete with flanged end type and proper flanged adapters to copper shall be provided where flanged valves are installed in copper piping.

.11 The water control valves shall be sized for a pressure drop of 6 ft. water column or as indicated on mechanical drawings.

.12 The zone steam control valves shall be sized for the respective steam flows and pressure drop of 25% of the inlet absolute maximum operating pressure.

.13 Each automatic control valve must provide the design output and flow rates at pressure drops compatible with equipment selected.

.14 Each automatic control valve must be suitable for the particular system working pressure.

.15 Each automatic control valve shall be fitted with a position indicator.

.16 All the same type control valves shall be the products of a single manufacturer and have the manufacturer's name, pressure rating and size clearly marked on the outside of the body.

.17 Unless otherwise indicated and except the steam zone control valves, control valves for proportional operation shall have equal percentage characteristics, while the control valves for open/shut two-position operation shall have straight line flow characteristics.

.18 The zone steam control valves shall have linear characteristics.

.19 Heating valves shall be normally open and cooling valves are to be normally closed, unless otherwise specified.

.20 Standard of Acceptance

a. Siemens Flowrite Globe Valve with SKC/SKD actuators
b. Belimo B2/B3 Series CCV Ball Valve, stainless steel, (sizes 1" and smaller)
c. Belimo B2-HT (high temperature) Ball Valve, stainless steel, for low pressure steam applications (sizes 1" and smaller)

2.4.2 Automatic Control Valve Actuators

.1 Each automatic control valve shall be fitted with a "fail-safe" operator capable of tight shut-off against the differential imposed by the system.

.2 For interior zone applications such as perimeter radiation, VAV box coils and force flow units where there is minimal risk of equipment freezing due to actuator failure, the use of non-spring return actuators shall be allowed.

.3 Operators for valves in electric-electronic control systems shall be single phase AC, 24V electric motor operators.

.4 Valve actuators on valves 2 in. dia. and larger shall be provided with a manual position override.

.5 Valve actuators shall accept a 0-10VDC or 4-20mA control signal for all proportional applications

.6 Floating point control of valves is not acceptable under any circumstances.

2.4.3 Butterfly Valves – Motorized and Supervised Manual Actuators

.1 This contractor shall provide motorized butterfly valves and/or supervised manual butterfly valves where specified.

.2 The standard of acceptance for motorized butterfly valves shall be either of the following:

Bray Series 30, cast iron body, ASTM A126 Class B, aluminium bronze disk ASTM B148-954, stainless steel stem ASTM 416 and EPDM seat. Bray R4 Series 70 proportional (4 to 20mA) electric actuator, manual override hand wheel, position display visible from any angle at a distance, end switches for both open and closed positions

Challenger Butterfly Valve with cast iron body, ductile iron/brite nickel full rated disk, stainless steel stem and EPDM seat. OM electric actuator, proportional (4 to 20mA), manual override handwheel, position display visible from any angle at a distance, end switches for both open and closed positions and local/remote switch.

.3 The standard of acceptance for supervised manual butterfly valves shall be:

Challenger Butterfly Valve with cast iron body, ductile iron/brite nickel full rated disk, stainless steel stem and EPDM seat. Equipped with a manual, handwheel and worm gear actuator. Complete with valve position transmitter and position display visible from any angle at a distance. Provide chain and padlock to lock the valve in place, complete with minimum of 3 keys with lamicoid labels on key rings to identify the keys or combination lock and show combination on the summary page of the site as-built documentation.

2.4.4 Automatic Control Dampers

.1 The automatic control dampers not provided as part of the packaged equipment shall be supplied by the Control Subcontractor and install by the Mechanical Contractor.

.2 The automatic control dampers shall be opposed blade type for mixing and parallel blade type for “on-off” service.

.3 Maximum damper blade length shall be 4’-0”(1.2m). Maximum permissible leakage shall not exceed 1% of the total flow based on an approach velocity of 1,500fpm(7.5m/s) over a temperature range of –30 °F (–34.4 °C) to 100 °F (37.7°C)

and a pressure of 3 in H20 (0.75 kpa). Unless otherwise noted, blades are to be constructed of formed galvanized steel with neoprene seal edges, continuous stops and seals on all sides, oil impregnated bronze bearings and galvanized steel channel frames.

.4 Centre bar linkage connectors shall be used wherever possible but where centre bar linkage cannot be used due to space limitations, external linkage connectors may be used.

2.4.5 Automatic Control Damper Actuators

.1 All new actuators for control dampers shall be electric type and be powered by a single phase AC 24V overload-proof synchronous motor.

.2 All newly provided actuators shall be direct-coupled type for both modulating or two position control dampers.

.3 Damper actuators shall accept a 0-10VDC control voltage signal for all proportional applications

.4 All damper actuators shall be selected to operate maximum damper loads of 28 sq.ft. (2.6 sq.m.)

.5 Each actuator shall be “fail safe”, complete with external adjustable stops to limit the length of stroke in either direction and mounted on an adjustable bracket. Operating arms shall have double yoke linkages and double set of screws for fastening to the damper shaft.

.6 The standard of acceptance shall be Belimo.

2.4.6 Space Temperature Sensors

.1 Sensors shall utilize a 10Kohm thermistor to sense temperature.

.2 Standard temperature sensors shall use a ventilated design incorporating a two-piece ABS case.

.3 Provide stainless steel, ventilated plate-type temperature sensors for installation in public areas such as stairways, vestibules, lobbies, gymnasiums and pools.

.4 Mount sensors at a height of 60” above the finished floor. Unless indicated otherwise, mount new sensors adjacent to the existing thermostat in the space.

.5 End-to-end accuracy +/- 0.3 °Cover the entire operating range.

.6 Provide a heavy-duty metal guard for existing zone thermostats that remain in service. In a typically classroom, this would be a pneumatic thermostat controlling a perimeter heating valve. In this situation, the space sensor is monitoring temperature only and not directly controlling an end device.

.7 Do not mount sensors on outside walls or other locations influenced by external thermal sources (e.g. computers, boiler rooms).

.8 Standard of acceptance:

Enercorp , Greystone

2.4.7 Heating/Cooling Thermostats (Low Voltage)

.1 Provide new thermostats to replace existing where specified.

.2 Unless indicated otherwise, thermostats shall be equipped with coiled bimetal sensing elements and mercury switches, individual heating and cooling setpoint levers, multiple stages of heating and cooling as required, adjustable heating anticipator and fixed cooling anticipator, system and fan switching subbase (off-heat-cool-auto) and key lock cover with internal thermometer.

.3 Mount new thermostats in the same location as existing.

.4 The standard of acceptance shall be Honeywell T874 with Q674E subbase and TG504A1025 key lock cover with internal thermometer.

.5 The use of a fully programmable, Native BACnet, digital room controller shall be accepted as an alternate to the thermostat in 2.4.7.d. The controller shall be equipped with a stylized housing suitable for wall mounting in finished areas, an LCD display and keypad. The standard of acceptance shall be Delta DNT-T305.

.6 Return existing thermostats, where replaced, to the Engineer.

2.4.8 Electric to Pressure Transducers (EPT)

.1 Provide electric to pneumatic transducers with the following minimum characteristics:

a. Input range of 2 - 10 vdc or 4 - 20 mA.
b. Directly proportioned output range of 3 to 15 psi.
c. Dust-proof housing unless panel mounted.
d. Combined non-linearity, repeatability and hysteresis effects not to exceed +/- 2% of full scale over entire range of operation
e. Integral zero and span adjustment
f. Temperature effect of +/-2% full scale at 50 °C or less

.2 Provide a 1-1/2” diameter pressure gauge (0-30psi) on the input and output air lines for each transducer.

.3 For <u>each</u> transducer, provide a separate, dedicated supply air line filter rated at 0.2 microns that changes colour when contaminated by oil.

.4 Standard of acceptance:

Enercorp, Greystone

2.4.9 Current Sensors (Analog)

.1 Current sensors (CT) shall be used for status monitoring of all motor-driven equipment, where specified.

.2 Technical Performance – Output should be only 4-20mA only. Voltage output will not be accepted. End-to-end accuracy +/- 1% of full scale at each range.

.3 The current sensors shall be mounted inside the starter cabinets whenever possible. If this is not possible due to space limitation, provide an enclosure to house the sensor.

.4 Standard of Acceptance:

Enercorp, Greystone

2.4.10 Status Relays (Solid State)

.1 The status relays shall be mounted inside newly provided enclosures mounted near the respective equipment starter cabinets.

.2 Standard of Acceptance:

a. Omron G7L-1A

2.4.11 Duct Humidity Sensors

.1 Provide humidity sensors with the following minimum characteristics:

a. Operating range from 10% - 90%RH over 0-60 °C temperature range.
b. End-to-end accuracy of +/- 2% of operating range, with maximum temperature dependence of 0.2% per °C change.
c. 200mm long probe, with enclosure for mounting in duct.
d. 4-20mA output only. Voltage output is not acceptable

.2 Standard of Acceptance:

Enercorp, Greystone

2.4.12 Space Humidity Sensors

.1 Provide space RH sensors with the following minimum characteristics:

a. Minimum operating range from 10% - 90%RH over 0-60 degrees C temperature range.
b. End-to-end accuracy of +/- 2% of operating range, with maximum temperature dependence of 0.2%per °C change.

c. Assembly shall be complete with a base plate for wall mounting, and a rigid circuit board for all circuitry and sensing element.
d. Assembly shall be complete with a ventilated enclosure.
e. 4-20mA output only. Voltage output is not acceptable.

.2 Humidity sensors installed in swimming pool areas shall be supplied with a conformal coating to protect electronic components from corrosion.

.3 Standard of Acceptance:

Enercorp, Greystone

2.4.13 Liquid and Steam Pressure Transmitters

.1 Provide liquid and steam pressure transmitters with the following minimum characteristics:

a. Minimum pressure operating range from 0 – 60 psi over 0-85 degrees C ambient/medium temperature range, for the liquid type.
b. Minimum pressure operating range from 0 – 30 psi over 0-85 degrees C ambient/medium temperature range, for the steam type.
c. End-to-end accuracy of +/- 1% of operating pressure range over 0-85 degrees C ambient/medium temperature range.
d. Wetted parts shall be stainless steel 316L complete with SS304 for the case.
e. 4-20mA output

.2 Provide a 3-valve manifold assembly (optional kit to be ordered with sensor) to facilitate sensor servicing and maintenance.

.3 Provide a pressure gauge (Winters P1S 100 series, 3-1/2" dia.) to measure the pressure of the high and low side piping connected to the transducer. Consult with the Engineer for suitable gauge pressure range. The tap point(s) for the gauge shall be the same as those used by the pressure transducer and the gauge shall be installed adjacent to the transducer. For single pressure applications, provide a manual shut-off valve. For differential pressure applications, provide a t-connection and manual shut-off valves for the high and low side lines so that the gauge can display either pressure.

.4 Coordinate with the mechanical contractor to provide a pressure tap complete with shut-off valve and "pig tail" tubing (primed with water) for each sensor used to monitor steam pressure.

.5 Standard of Acceptance:

Setra model 230
Greystone PGS100A (for low pressure steam monitoring)

2.4.14 Air Differential Pressure Transmitter

.1 Provide air pressure transmitters with the following minimum characteristics:

a. Solid State design.
b. Operating on capacitance principle.
c. With non-interactive fine resolution zero and span adjustments.
d. End-to-end accuracy +/- 1% of full scale pressure range, including temperature compensation.
e. 4-20mA output only. Voltage output is not acceptable.

.2 Provide a pitot-tube style static or velocity pressure probe (8" nominal) and fitting for insertion into ductwork. Follow manufacturer's instructions for correct installation method.

.3 Standard of Acceptance:

Setra model 264

2.4.15 Duct Temperature Sensors

.1 Provide duct mounted temperature sensors (DTS) with the following minimum characteristics:

a. Sensor encapsulated in a 200mm long, 6mm OD copper or stainless steel probe.
b. Operating range 0-60 degrees C.
c. End-to-end accuracy +/- 0.3 °C.
d. Assembly complete with wiring housing and mounting flange.

.2 Standard of Acceptance:

.3 Enercorp, Greystone

2.4.16 Duct Averaging Temperature Sensors

.1 Provide plenum mounted mixed air temperature averaging type sensors with the following minimum characteristics:

a. Constructed of FT6 plenum rated cable incorporating a minimum of 9 temperature sensors encapsulated at equal distances along the 24 foot length of the element. The assembly acts as a single sensor reporting the average temperature from all individual sensors.
b. End-to-end accuracy +/- 0.3 °C.
c. Mount in a zigzag manner to provide continuous coverage of the entire duct cross-sectional area.
d. The use of thermistor type sensors is acceptable.

.2 Standard of Acceptance:

Enercorp, Greystone

2.4.17 Outdoor Air Temperature Sensors

.1 Provide outdoor air temperature sensors with the following minimum characteristics:

a. Each sensor shall be 10Kohm thermistor probe
b. Provide two sensors for each site.
c. Both sensors shall be mounted inside a heavy-duty (blow-proof) solar shield.
d. Provide a heavy-duty, metal, wire guard.

.2 Standard of Acceptance:

.3 Enercorp, Greystone

2.4.18 Immersion Temperature Sensors

.1 Use immersion temperature sensors with thermwells for all applications where a temperature of a fluid in a pipe is being sensed.

.2 Provide well-mounted water temperature sensors with the following minimum characteristics:

a. The sensors shall be 10k ohm thermistor encapsulated in a 6mm OD, 50m long probe, with screw fitting for insertion into a standard thermowell.
b. Operating range -10 to +100 degrees C.
c. End-to-end accuracy +/- 0.3 °C over the entire operating range.
d. The sensors shall be complete with brass thermowell. Provide a stainless steel thermowell where exposed to corrosive liquids.
e. Use thermal conductive gel when mounting the sensor in the thermowell.
f. Sensors mounted on insulated piping shall be installed clear of the insulation.

.3 Standard of Acceptance:

Enercorp, Greystone

2.4.19 Strap-On Temperature Sensors

.1 Obtain written approval of the Engineer before using any strap-on type sensor.

.2 Where approved, provide strap-on type water temperature sensors with the following minimum characteristics:

a. The sensors shall be 10k ohm thermistor encapsulated in a 6mm OD, 50mm long probe to be strapped-on the pipe.
b. Operating range -10 - +100 degrees C.
c. End-to-end accuracy +/- 0.3 °C over the entire operating range.

.3 Standard of Acceptance:

.4 Enercorp, Greystone

2.4.20 Push Buttons

.1 Where specified, provide a push button with the following minimum characteristics:

a. The push button shall be surface mounted.
b. The unit shall have a button that is flush with casing.
c. The casing shall be heavy-duty and abrasion-proof.

.2 Standard of Acceptance:

a. Klockner Moeller RD-111/KC/I

2.4.21 Spring-Wound Timers

.1 Where specified, provide a spring-wound timer without a hold feature for the time interval indicated.

.2 Where the timer is used to directly switch the power supply to an air conditioning unit, provide a time delay relay (set to 3 minutes delay on make) and horsepower rated relay. Wire the devices such that the air conditioning compressor will have a minimum off time of 3 minutes between any timer activation. Mount all devices within an electrical enclosure complete with hinged door and key lock. Provide a lamicoid label to describe the timer operation. Consult with the DCDSB for exact wording to be used in the label.

.3 Standard of Acceptance:

a. Intermatic FF series

2.4.22 Current Switches

.1 The current switch shall induce power from the monitored load
.2 The current sensor shall provide on/off status indication of electrical loads from 0.15 to 60A (minimum).

.3 The current sensors shall be mounted inside the starter cabinets whenever possible. If this is not possible due to space limitation, provide an enclosure to house the sensor.

.4 The current sensor shall be isolated to 600VAC RMS (UL ratings), 300VAC RMS (CE ratings)

.5 The current sensor output shall be N.O., Solid State, 1A @30VAC/DC

.6 Standard of Acceptance:

a. Veris Industries – Hawkeye H300/H600

2.4.23 Occupancy Sensors

.1 General

The Occupancy Sensor system shall sense the presence of human activity within the desired space and fully control the on/off function of the loads automatically. Sensors shall turn on the load within 2 feet of entrance and shall not initiate on outside of entrance.

Approved manufacturer shall be Sensor Switch or WattStopper.

Sensing technologies shall be completely passive in nature, in that the occupancy sensor system shall not emit or interfere with any other electronic device, or human characteristic. Acceptable known technologies are Passive Infrared (PIR), or Microphonic.

Upon detection of human activity by the detector, a Time Delay shall be initiated to maintain the light on for a pre-set period. The Time Delay setting shall be factory preset for typical applications, and field adjustable from 30 seconds to 20 minutes. The timing circuit shall be analog providing adjustment by simple rotation only. All sensors shall have non-adjustable factory calibrated sensitivity for maximum performance. Time Delay and Photocell field adjustments shall be provided as needed.

The installing contractor shall be responsible for a complete and functional system. Satisfactory performance shall be determined by the owner and the engineer. Proper coverage of the area for all types of human activity, and any necessary relays or miscellaneous devices is the responsibility of the contractor.

System installation shall be in accordance with all national and local electrical codes.

Installation shall be warranted for a period of one year from completion, and product shall be warranted for 5 years.

All sensors, power packs, and relays shall be UL Listed under either Industrial Control Equipment, or Energy Management Equipment. Appliance Control listing shall not be accepted.

.2 Substitutions

All substitutions shall be submitted to the engineer no less than 5 days prior to bid date. To be fair to all bidding contractors, substitutions after the bid will not be allowed unless directed in writing by the specifying engineer. Acceptable substitutes shall be available to all bidding contractors prior to the bid date.

All product substitutions must be made in writing and be accompanied by technical literature, working samples, and at least 5 relevant installation references. Data sheets

shall show all coverage patterns to scale and detail small motion detection, except for hallway or warehouse aisle way sensors.

Active Ultrasonic sensors producing sound wave transmissions known to cause interference with hearing aids will not be accepted.

Any technology requiring sensitivity set-up or maintenance adjustments shall not be allowed.

Acceptance of one particular sensor does not constitute acceptance of all of that manufacturer's equipment. In some cases, multiple sensors may be required in place of the sensor specified.

The contractor shall take full responsibility of system performance and acceptance if a substitute product is used.

All substitutions must clearly identify any and all exceptions to the specifications with a detailed analysis of the exception.

.3 Low Voltage Ceiling and Wall Sensors

Sensors must be designed to work in conjunction with remote power packs, relays, or other control systems. Sensors must operate with a Class 2, low voltage wiring strategy. Sensors must be capable of being parallel wired for multi-sensor applications.

Sensors must accept 12 to 24 volts AC or DC. Sensor must provide a transistor output, returning the voltage input rectified to DC, to control remote power packs, relays, or other control systems.

Sensor must have optional single pole, double throw signal relay capable of being wired open on occupancy, or closed on occupancy.

Sensor must also provide optional photocell output for daylight override. Sensor shall not consume more than 14 milliamps of current.

Sensor Time Delay shall be factory set for typical applications, and field adjustable from 30 seconds to 20 minutes.

Photocell override shall be factory set in the off mode, but be field adjustable. All adjustments shall be concealed once installed.

Sensor shall provide a green LED motion indicator. Red LED denoting life safety shall not be permitted.

2.4.24 Firestopping and Smoke Seal Materials

.1 Asbestos-free elastomeric materials tested, listed and labelled by ULC in accordance with CAN4-S115-M85, for installation in U.L.C. designated firestopping and smoke seal Systems. These Systems shall provide a positive fire, water and smoke seal and

a fire- resistance rating (flame, smoke hose stream and temperature) not less than the fire resistance rating of surrounding construction.

.2 Materials shall form ULC listed or UL classified assemblies and be compatible with abutting dissimilar materials and finishes.

.3 Standard of Acceptance:

a. 3M Canada Limited
b. A/D Fire Protection System Ltd.
c. Fire Stop System

2.4.25 Well Opening Covering Plates

.1 All hole covering plates used on this project shall be stainless steel 18-8 chrome metal alloy, type 302, non-magnetic type for finished areas and pressed steel for unfinished areas. Finish brush marks shall be run in a vertical direction.

2.4.26 Access Doors

.1 Access doors installed in unfinished areas shall be constructed of 12 ga prime coated steel and of stainless steel for all areas finished with tile or marble surfaces.

.2 Access doors shall be complete with 180° opening door, round safety corners, concealed hinges, screwdriver latches, plaster lock and anchor straps.

.3 Access doors shall be 24’x 24’ or 12’x 18’ as per site condition.

.4 Access doors in fire rated construction shall be ULC listed and labeled and of a rating to maintain the fire separation integrity.

.5 Standard of Acceptance:

a. Zurn Industries Canada Limited
b. LeHage Industries Limited
c. Acudor Acorn Limited.

2.4.27 Motor Starters and Accessories

.1 Starters shall be CSA and ULC approved.

.2 Starters shall be full voltage, non-reversing magnetic starters. Full protection is to be provided in the starters by means of one thermal overload relay per phase per starter with manual reset button to suit the service factor and acceleration time of the motor served.

.3 Starters shall be equipped with auxiliary contacts to satisfy interlocking and automatic control requirements, “Hand-Off-Automatic” switches, pilot lights (green-

On; red-Off), thermal overloads, necessary fuses and control transformer (if required) for operation of all controls on 120V single phase.

.4 Where required by applicable codes, starters shall be equipped with "quick-make" and "quick-break" fused disconnects.

.5 Standard of Acceptance:

a. Square D Co. Ltd.
b. Allen-Bradley Canada Ltd.
c. Siemens
d. Eaton/Cutler-Hammer
e. Moeller

.6 Fuses in starters to be CSA certified Form 1, current and energy limiting type 200,000 ampere interrupting capacity with NEMA Class "J" rejection type mountings.

.7 Size fuses installed in starters or in disconnect switches used in conjunction with magnetic starters, for motor and branch circuit protection in accordance with fuse manufacturer's recommendations. Provide one spare set of three fuses for each rating and type of fuse used.

.8 Standard of Acceptance:

a. Appleton Electric Company
b. Chase Shawmutt-Amp. Trap
c. English Electric Company of Canada

.9 Enclosures for loose starters are to be EEMAC 1A, unless otherwise specified.

2.4.28 Variable Frequency Motor Drives

.1 Products

1. Environmental operating conditions: 0 to 40 C continuous. VFD's that can operate at 40 C intermittently (during a 24 hour period) are not acceptable and must be oversized. Altitude 0 to 3300 feet above sea level, less than 95% humidity, non-condensing.
2. Enclosure shall be rated UL type 1 and shall be UL listed as a plenum rated VFD. VFD's without these ratings are not acceptable.
3. For 600V networks, the input voltage of the VFD shall be rated 500V -10% to 600V + 10% minimum. VFD rated for 575V +/- 10% or less are not acceptable.
4. All VFDs shall have the following standard features:
    1. All VFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for

uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.

2. The keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate "bumpless transfer" of speed reference when switching between "Hand" and "Auto" modes. There shall be fault reset and "Help" buttons on the keypad. The Help button shall include "on-line" assistance for programming and troubleshooting.
3. There shall be a built-in time clock in the VFD keypad. The clock shall have a battery back up with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the VFD shall automatically revert to hours of operation since initial power up. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output relays. The VFD shall have a digital input that allows an override to the time clock (when in the off mode) for a programmable time frame. There shall be four (4) separate, independent timer functions that have both weekday and weekend settings.
4. The VFD's shall utilize pre-programmed application macro's specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time. The VFD shall have two user macros to allow the end-user to create and save custom settings.
5. The VFD shall have cooling fans that are designed for easy replacement. The fans shall be designed for replacement without requiring removing the VFD from the wall or removal of circuit boards. The VFD cooling fans shall operate only when required. To extend the fan and bearing operating life, operating temperature will be monitored and used to cycle the fans on and off as required.
6. The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).
7. The VFD shall have the ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between attempts shall be programmable.
8. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430-150 for 4-pole motors.
9. The VFD shall have an integral 5% impedance line reactors to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. VFD's with only one DC reactor shall add AC line reactors.
10. The input current rating of the VFD shall be no more than 3% greater than the output current rating.

11. The VFD shall include a coordinated AC transient protection system consisting of 4-120 joule rated MOV's (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.
12. The VFD shall be capable of sensing a loss of load (broken belt / broken coupling) and signal the loss of load condition. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay outputs shall include programmable time delays that will allow for drive acceleration from zero speed without signalling a false under-load condition.
13. If the input reference (4-20mA or 2-10V) is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communication bus.
14. The VFD shall have programmable "Sleep" and "Wake up" functions to allow the drive to be started and stopped from the level of a process feedback signal.

5. All VFDs to have the following adjustments:

    a. Three (3) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed.
    b. Two (2) PID Setpoint controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the VFD, using the microprocessor in the VFD for the closed loop control. The VFD shall have 250 ma of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. The PID setpoint shall be adjustable from the VFD keypad, analog inputs, or over the communications bus. There shall be two parameter sets for the first PID that allow the sets to be switched via a digital input, serial communications or from the keypad for night setback, summer/winter setpoints, etc. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain setpoint of an independent process (ie. valves, dampers, etc.). All setpoints, process variables, etc. to be accessible from the serial communication network. The setpoints shall be set in Engineering units and not require a percentage of the transducer input.
    c. Two (2) programmable analog inputs shall accept current or voltage signals.
    d. Two (2) programmable analog outputs (0-20ma or 4-20 ma). The outputs may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, and other data.
    e. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices, typically programmed as follows:

f. There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, input contact closure, time-clock control, or serial communications) the VFD shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate).
g. When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to an VFD digital input and allows VFD motor operation. Two separate safety interlock inputs shall be provided.
h. When either safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close. The keypad shall display "start enable 1 (or 2) missing". The safety status shall also be transmitted over the serial communications bus. All digital inputs shall be programmable to initiate upon an application or removal of 24VDC.
i. Three (3) programmable digital Form-C relay outputs. The relays shall include programmable on and off delay times and adjustable hysteresis. Default settings shall be for run, not faulted (fail safe), and run permissive. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating 2 amps RMS. Outputs shall be true form C type contacts; open collector outputs are not acceptable.
j. Seven (7) programmable preset speeds.
k. Two independently adjustable acceleration and deceleration ramps with 1 – 1800 seconds adjustable time ramps.
l. The VFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and audible motor noise.
m. The VFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual VFD temperature that allows the highest carrier frequency without de-rating the VFD or operating at high carrier frequency only at low speeds.
n. The VFD shall include password protection against parameter changes.

6. The Keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable). The keypad shall utilize the following assistants:

    a. Start-up assistants
    b. Parameter assistants
    c. Maintenance assistant
    d. Troubleshooting assistant

7. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):

    a. Output Frequency
    b. Motor Speed (RPM, %, or Engineering units)
    c. Motor Current
    d. Calculated Motor Torque
    e. Calculated Motor Power (kW)
    f. DC Bus Voltage
    g. Output Voltage

8. The VFD shall include a fireman's override input. Upon receipt of a contact closure from the fireman's control station, the VFD shall operate at an adjustable preset speed. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands) and force the motor to run at the adjustable, preset speed. "Override Mode" shall be displayed on the keypad. Upon removal of the override signal, the VFD shall resume normal operation.

9. Serial Communications

    a. The VFD shall have an RS-485 port as standard. The protocols shall be **BACnet**. Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be “certified” by the governing authority. Use of non-certified protocols is not allowed.

    b. The BACnet connection shall be an RS485, MS/TP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:

        a. Data Sharing – Read Property – B.
        b. Data Sharing – Write Property – B.
        c. Device Management – Dynamic Device Binding (Who-Is; I-AM).
        d. Device Management – Dynamic Object Binding (Who-Has; I-Have).
        e. Device Management – Communication Control – B.

    If additional hardware is required to obtain the BACnet interface, the VFD manufacturer shall supply one BACnet gateway per drive. Multiple VFDs sharing one gateway shall not be acceptable.

c. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, acceleration/deceleration time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (re-settable), operating hours (re-settable), and drive temperature.

d. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus – keypad "Hand" or "Auto" selected, bypass selected, the ability to change the PID setpoint, and the ability to force the unit to bypass (if bypass is specified). The DDC system shall also be able to monitor if the motor is running in the VFD mode or bypass mode (if bypass is specified) over serial communications. A minimum of 15 field parameters shall be capable of being monitored.

e. The VFD shall allow the DDC to control the drive's digital and analog outputs via the serial interface. This control shall be independent of any VFD function. For example, the analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive's digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the drive's digital and analog inputs shall be capable of being monitored by the DDC system.

f. The VFD shall include an independent PID loop for customer use. The independent PID loop may be used for cooling tower bypass value control, chilled water value control, etc. Both the VFD control PID loop and the independent PID loop shall continue functioning even if the serial communications connection is lost. The VFD shall keep the last good set-point command and last good DO & AO commands in memory in the event the serial communications connection is lost.

10. All VFD's through 60HP shall be protected from input and output power mis-wiring. The VFD shall sense this condition and display an alarm on the keypad.

11. OPTIONAL FEATURES to be provided are:

    1. Optional features to be furnished and mounted by the drive manufacturer. All optional features shall be UL Listed and CSA Approved by the drive manufacturer as a complete assembly and carry a UL508 and CSA label.

2. A complete factory wired and tested bypass system consisting of an output contactor and bypass contactor. Overload protection and shall be provided in both drive and bypass modes.
3. Door interlocked, padlockable circuit breaker that will disconnect all input power from the drive and all internally mounted options.
4. Fused VFD only disconnect (service switch). Fast acting fuses exclusive to the VFD – fast acting fuses allow the VFD to disconnect from the line prior to clearing upstream branch circuit protection, maintaining bypass capability. Bypass designs, which have no such fuses, or that incorporate fuses common to both the VFD and the bypass will not be accepted. Three contactor bypass schemes are not acceptable.
5. The drive / bypass shall provide single-phase motor protection in both the VFD and bypass modes.

The following operators shall be provided:

a. Bypass Hand-Off-Auto
b. Drive mode selector
c. Bypass mode selector
d. Bypass fault reset

6. The following indicating lights (LED type) shall be provided. A test mode or push to test feature shall be provided.

a. Power-on (Ready)
b. Run enable (safeties) open
c. Drive mode select damper opening
d. Bypass mode selected
e. Drive running
f. Bypass running
g. Drive fault
h. Bypass fault
i. Bypass H-O-A mode
j. Automatic transfer to bypass selected
k. Safety open
l. Damper opening
m. Damper end-switch made

7. The following relay (form C) outputs from the bypass shall be provided:

a. System started
b. System running
c. Bypass override enabled
d. Drive fault
e. Bypass fault (motor overload or under-load (broken belt))
f. Bypass H-O-A position

8. The digital inputs for the system shall accept 24V or 115VAC (selectable). The bypass shall incorporate internally sourced power supply and not require an external control power source.
9. Customer Interlock Terminal Strip – provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in Hand, Auto, or Bypass modes (not functional in Fireman's Override 2). The remote start/stop contact shall operate in VFD and bypass modes.
10. Dedicated digital input that will transfer motor from VFD mode to bypass mode upon dry contact closure for fireman's override. Two modes of operation are required.

    a. One mode forces the motor to bypass operation and overrides both the VFD and bypass H-O-A switches and forces the motor to operate across the line (test mode). The system will only respond to the digital inputs and motor protections.
    b. The second fireman's override mode remains as above, but will also defeat the overload and single-phase protection for bypass and ignore all keypad and digital inputs to the system (run until destruction).

11. The VFD shall include a "run permissive circuit" that will provide a normally open contact whenever a run command is provided (local or remote start command in VFD or bypass mode). The VFD system (VFD or bypass) shall not operate the motor until it receives a dry contact closure from a damper or valve end-switch. When the VFD system safety interlock (fire detector, freezestat, high static pressure switch, etc) opens, the motor shall coast to a stop and the run permissive contact shall open, closing the damper or valve.
12. Class 20 or 30 (selectable) electronic motor overload protection shall be included.
13. There shall be an internal switch to select manual or automatic bypass.
14. There shall be an adjustable current sensing circuit for the bypass to provide loss of load indication (broken belt) when in the bypass mode.

2.4.29 LAN Cabling

.1 All LAN cabling shall be Category V as defined by EIA/TIA 568A. The contractor shall test all cabling to verify that 100Mb bandwidth is supported. See commissioning requirements.

.2 Cabling shall be 4 pair, 100 ohm UTP, #24 AWG solid copper conductor PVC insulated, with blue or grey colour coded jacket. FT6 rated cable shall be used unless otherwise required to meet building codes or by-laws.

.3 Data outlets shall be RJ45, 8 pin connectors, with 50 microns of hard gold over nickel, minimum durability of 750 mating cycles and contact pressure of 100 grams per contact. Transmission characteristics shall meet TSB-40 Category V.

.4 Provide one RJ45 data outlet adjacent to each device to be terminated (e.g. workstation PC, DDC panel, hub, etc.) Use a flexible patch cable to connect from the data outlet to the end device. For Delta Controls installations, provide a duplex data outlet at the workstation PC to accommodate the remote security key wiring. LAN cabling shall not be directly terminated to any device.

.5 Provide protection from EMI sources in accordance with CSA-T530 article 4

.6 The contractor shall test all cabling to verify conformance with TIA /EIA TSB-67 - Basic Link Test using a Level 2, bi-directional tester. See commissioning requirements.

.7 Where there are more than 2-90 degree in a conduit run, provide a pull box between sections so that there are two bends or less in any one section.

.8 Where a conduit run requires a reverse bend, between 100 degrees and 180 degrees, insert a pull box at each bend having an angle from 100 degrees to 180 degrees.

.9 Ream all conduit ends and install insulated bushings on each end.

.10 Terminate all conduits that protrude through the structural floor 2" above the concrete base.

.11 Do not use a pull box in lieu of a conduit bend. Align conduits that enter a pull box from opposite ends with each other.

2.4.30 Lighting Relays

.1 All relays used for switching lighting loads shall be the latching type. Maintained relays or contactors shall not be accepted.

.2 Provide custom lighting enclosures to house all lighting relays. The enclosures shall be equipped with barriers to separate the control and load wiring.

.3 Provide local ON pushbuttons at each lighting relay enclosure to allow for manual operation of all lighting relays in the case of BAS panel failure. Pressing the pushbutton shall turn on all lighting relays by applying voltage directly to the relay (i.e. bypass the BAS). If a lighting panel is located in an area accessible by students or teaching staff, provide momentary key switches in lieu of pushbuttons. The key type shall be designated by the Engineer. Deliver all keys to the Engineer at the completion of the project.

.4 The standard of acceptance shall be G.E. RR-7 and RR-8 relays.

2.4.31 CO2 Sensors

.1 Provide CO2 sensors for either wall or duct mounting applications as specified. Provide a heavy duty metal guard to protect the sensor when mounted on walls. Provide the factory-supplied duct mounting kit for all duct mount applications.

.2 The sensor shall be microprocessor controlled, fully digital, non-dispersive dual wavelength infrared technology with temperature compensation. The device output shall be 4 to 20mA.

.3 The sensor shall have a measurement range of 0 to 2000ppm with an accuracy of +/- 30ppm.

.4 Install the sensor in accordance with all manufacturer's instructions. Wall mounted sensors shall be installed at a minimum height of 60" above the finished floor. Sensors shall not be mounted on an outside wall, close to a window, door or in draft areas with direct airflow.

.5 The sensor shall be auto calibrating for a guaranteed interval of 5 years.

.6 The standard of acceptance shall be Greystone CCD4A.

2.4.32 Thermostat Guards

.1 Provide a heavy duty, metal thermostat guard for specified existing, stand-alone thermostats.

.2 The guard shall be have a minimum 18 guage metal cover and 22 guage ring base. The unit shall be tamper-resistant and equipped with a lock and key. The colour of the unit shall be beige.

.3 The standard of acceptance shall be White Rodgers Model #F29-0222.

2.4.33 Thermostats for Force Flow Heaters (Fan Cut-Out)

.1 Where indicated, provide thermostats to disable fan operation of force flow heaters when the unit supply water temperature is less than 35C. This will prevent the fan from operating when the building heating system is off or operating in setback mode. The thermostat shall be equipped with a remote capillary which shall be attached to the heating supply water piping serving the heating coil.

.2 Ensure that the bulb of the thermostat is rated for a minimum temperature of 93C (200F).

.3 Install the thermostat within the force flow enclosure in a manner that facilitates servicing. Adhere to manufacturer's installation instructions.

.4 The standard of acceptance shall be Honeywell T675A1540 or Johnson A19AAF-12C.

2.4.34 Cold Alarm Aquastat Wired to Building Surveillance System

.1 Provide a low temperature aquastat (strap-on type) and affix to the boiler primary loop piping at a location where the boiler supply water temperature from all boilers in the plant can be measured. The aquastat shall be set to trip at temperatures below 40C to indicate that the boilers have failed.

.2 Provide an additional thermostat with remote bulb and capillary to measure the outdoor air temperature. Wire the outdoor air thermostat in parallel with the low temperature aquastat so that the aquastat contact is bypassed when the outdoor air temperature is above 5C.

.3 Provide wiring from the cold alarm aquastat to the designated building surveillance panel. Termination to the surveillance panel shall be performed by DCDSB. Ensure sufficient spare cabling is provided to allow for termination by others.

.4 Test trip the aquastat and verify that a correct alarm signal is received by the building surveillance system.

.5 Refer to section 3.8 for work in existing boiler plants.

PART 3 EXECUTION

3.1 COORDINATION WITH NEW MECHANICAL WORK

.1 In a facility where mechanical retrofits are planned, obtain and review the mechanical drawings and mechanical specifications for each site. Coordinate all site work with the mechanical contractor.

.2 Provide all specified labour and material as indicated in the Mechanical Drawings and/or Specifications. Provide written installation instructions for all supplied equipment and devices to be installed by the Mechanical Contractor.

.3 The Controls Contractor shall supply all required valves, dampers and thermowells to the Mechanical Contractor for installation, where specified. If a separate Mechanical Contractor has not been hired by DCDSB to work on the project, the Controls Contractor shall be responsible for the installation of these devices.

.4 The Mechanical Contractor is responsible for coordination new hardware supply (sensors, etc.) with the DCDSB Energy Engineer to ensure compatibility with the existing BAS. Provide new wiring to suit the device requirements.

.5 The Controls Contractor shall be responsible for identifying and marking the location of new thermowells to be installed in piping. Make arrangements to have the Mechanical Consultant or DCDSB Engineer (where applicable) review and approve all thermowell locations prior to installation.

.6 The Controls Contractor shall provide all material and labour to carry out all the electrical work (power and controls) associated with the new mechanical work.

3.2 GENERAL – INSTALLATION OF CONTROLS

.1 Remove all existing field and panel mounted control devices (e.g. transducers, controllers, thermostats, etc.) that have been made redundant or inoperative by the new BAS control strategies. Remove any other controls as specified or directed by the Engineer.

.2 Ensure that all systems remain operative at all times, whether under the existing controls or under the new controls. Do not leave any system without some form of automatic control. Do not disconnect or modify existing equipment until ready to energise same under the new work.

.3 Properly cut and cap all remaining active control air lines.

.4 Provide properly sized cover plates for all openings resulting from the removal of redundant control devices. This shall be applicable to walls, ductwork and control panels. In occupied areas, cover plates shall be stainless steel.

.5 The control sequences indicate only the principal items of equipment controlling the systems. Supplement each control system with relays and auxiliaries to enable each system to perform as specified and to permit proper operation and supervision of it.

.6 Provide complete identification and labelling for new and existing devices and equipment.

.7 Provide new cabling, conduits, control cabinets, power supplies and other auxiliary equipment, as required for a complete operational system.

3.3 POWER SOURCES AND WIRING METHODS

.1 All wiring shall be installed in EMT conduit unless specified otherwise. Exposed wiring in finished areas (e.g. corridors, classrooms, gymnasiums, etc.) shall be installed in wiremold (colour to match surrounding area).

.2 Wiring from DDC controllers to sensors and actuators and control system network and low voltage wiring running in accessible ceilings may be installed using LVT cable. Where the ceiling is used as a return air plenum, plenum rated cable shall be used in lieu of LVT cable.

.3 Install EMT and cable at right angles to building lines, securely fastened, and in accordance with current electrical codes and standards.

.4 Power and control wiring shall be copper conductor (RW90). For power wiring, provide #12 AWG (minimum) with a 3% maximum voltage drop in accordance with CEC requirements. Control wiring shall be a minimum of #14 AWG, unless otherwise specified.

.5 **Wiring smaller than 18 gauge shall not be accepted on the project.** Exceptions are made for wiring between terminal computer devices, wire in standard communication cables, such as printers and short haul modems, wire used in communication networks, i.e. any cable transferring digital data, using twisted shielded pairs.

.6 The wiring from panels to devices shall be installed without splices. The use of crimp connectors is not allowed when connecting field wiring to sensor or device leads. The use of wire nuts is acceptable in this application.

.7 Power for control system shall not be obtained by tapping into miscellaneous circuits that could be inadvertently switched off. Only dedicated circuit(s) shall power the control system. Provide additional breakers or electrical panels as required.

.8 Mount transformers and other peripheral equipment in panels located in serviceable areas. Provide line-side breakers/fuses for each transformer.

.9 All 120 VAC power for any controls equipment shall be from dedicated circuits. Provide a breaker lock for each breaker used to supply the control system. Update the panel circuit directory.

.10 A dedicated power circuit may be used to power DDC panels and equipment within the same or adjoining mechanical rooms. The use of one power circuit to power DDC panels distributed throughout the building is not acceptable.

.11 The controller may be powered from the equipment that it is directly controlling (i.e. heat pump, rooftop unit) only if the controller controls no other equipment and the power supply to the controller remains energized independently of unit operation or status.

.12 Provide all required code gauge boxes, connectors and other wiring accessories.

.13 For all DC wiring, positive conductors shall be WHITE or RED in colour while negative conductors shall be BLACK in colour.

.14 On exterior building surfaces, wiring shall be rated for 90C and wet environments. Conduit shall be rigid metal or rigid PVC with waterproof joints and connectors used throughout.

3.4 INSTALLATION OF TEMPERATURE SENSORS IN PIPING

.1 The Controls Contractor shall supervise and direct the Mechanical Contractor to ensure that thermowells are installed as described herein.

.2 For each immersion sensor, provide a compatible thermowell to the Mechanical Contractor for installation. Provide stainless steel thermowells where installed in piping carrying corrosive or chemically reactive fluids.

.3 Install thermowells in piping such that the bottom of the well does not make contact with the pipe. Install the well at a 90 degree elbow or tee where the pipe diameter is less than the well length.

.4 If the use of strap-on sensors has been approved by the Engineer, use metal clamps to securely fasten the sensor to the piping. Apply heat transfer compound to the contact area between the sensor and piping. Re-insulate all piping.

3.5 INSTALLATION OF STANDARD CONTROL DAMPERS AND ACTUATORS

.1 Supply new automatic control dampers where specified.

.2 The new ducts and/or plenums-mounted dampers shall be installed as part of the air distribution Work specified in a different section of the Specification.

.3 The dampers shall be made available at the site at the location where they are required.

.4 Ensure that each damper assembly is properly mounted.

.5 The linkage and motors shall be provided and completely connected for all control dampers, including for dampers factory supplied with equipment.

.6 Where newly installed damper sizes exceed 28 sq. ft. (2.6 sq. m) multiple operators shall be provided.

.7 Wherever possible, the new damper actuators shall be installed so they are accessible from outside ducts, plenums and equipment casings.

3.6 INSTALLATION OF AUTOMATIC CONTROL VALVES AND ACTUATORS

.1 All control valves shall be supplied by the Controls Contractor and installed by the Mechanical Contractor, unless specified otherwise.

.2 Each control valve shall be equipped with its own actuator.

.3 The Controls Contractor shall ensure that each control valve assembly is properly connected and installed.

.4 The Controls Contractor shall test, adjust and verify the operation of each control valve to ensure that it is properly functioning, as required and left in safe working order.

.5 Motorized butterfly valves (usually installed for boiler isolation) shall be supplied and installed by the Mechanical Contractor but shall be wired up by the Controls Contractor. The valve details are in the Mechanical specifications.

3.7 INSTALLATION OF OUTDOOR AIR TEMPERATURE SENSORS

.1 N/A

3.8 COLD ALARM AQUASTATS IN EXISTING BUILDINGS

.1 N/A

3.9 PNEUMATIC FAIL SAFE INTERLOCKS

.1 Existing pneumatic damper actuators under BAS control shall be physically interlocked (e.g. solenoid air valve exhausts control air when fan is off) to return to their fail safe positions when their respective fan is off, regardless of BAS command.

.2 The Controls Contractor shall immediately report to the Engineer any situation in which an existing pneumatic damper actuator to be placed under BAS control is not pneumatically interlocked to the fan starter or where an existing pneumatic interlock is inoperative or defective.

.3 If the Controls Contractor fails to report to the Engineer any abnormalities as described in 3.9.b, it shall be assumed that all pneumatic interlocks were present and functioning at the time of the Controls installation. Any subsequent deficiencies related to missing or defective pneumatic interlocks shall be corrected by the Controls Contractor at no additional cost to DCDSB.

.4 Unless specified otherwise, pneumatic heating valves under BAS control in air handlers shall not be physically interlocked (e.g. solenoid air valve exhausts control air when fan is off) to the respective fan starter.

.5 Provide labour and material, as required, to ensure that all new and existing electric-to-pressure transducers (EPT) controlling heating valves are supplied with non-switched main control air.

3.10 BOILER SELECTOR SWITCHES

.1 Provide a two-position selector switch (toggle or rotary) for each boiler under BAS control. Provide lamicoid labels to indicate “Local” and “BAS” positions.

.2 Where modulating burner controls are present, provide an additional two-position selector switch (toggle or rotary) to switch between the local potentiometer and the BAS modulation signal. Provide lamicoid labels to indicate “Local” and “BAS” positions.

.3 Mount the override switch on the boiler panel adjacent to the existing on-off switch.

.4 Wire the override switch such that in the “BAS” position, the boilers operate under normal BAS control. Wire the “Local” position such that the boilers are forced to the ON position regardless of the signal from the BAS. For multi-stage boilers, the “Local” position shall be wired to force low fire ON and high fire OFF.

3.11 INSTALLATION OF FIRESTOPPING AND SMOKE SEAL MATERIALS

.1 Where conduits penetrate the fire rated construction, ULC listed and labelled firestopping and smoke seal materials shall be supplied and installed in accordance with ULC Firestop System requirements to seal holes and voids in the walls or slabs and as follows:

1. Conduit through a floor with a sleeved or core drilled circular opening – ULC System SP115.
2. Conduit through a floor with a cast or cut rectangular opening – ULC System SP116.
3. Conduit through a wall with a sleeved or core drilled circular opening – ULC System SP114.
4. Conduit through a wall with a rectangular cast or cut opening – ULC System SP107.

.2 Select thickness and arrangement of back-up materials to suit size of service, length of sleeve and anticipated movement.

.3 At time of application all surfaces shall be properly cleaned, dried and free from dust, oil, grease, loose or flaking paint and foreign materials.

3.12 INSTALLATION OF WALL OPENING COVER PLATES

.1 All existing wall openings of the removed electrical and control devices shall be covered with properly sized plates in an approved manner so that the finished Work presents a neat and clean appearance.

3.13 CUTTING AND PATCHING

.1 All cutting, patching, painting and making good for the installation of the BAS work shall be done by the BAS Contractor. All cutting shall be performed in a neat and true fashion, with proper tools and equipment to the Engineer and/or DCDSB Project Representative approval. The surfaces shall be made good to reasonably match existing finishes to the Engineer and/or DCDSB Project Representative approval.

.2 Location of the existing services concealed in the construction, if any, shall be determined prior to drilling or cutting an opening. If required, the Contractor is to x-ray the walls or slabs and in any case he shall not drill or cut any surface without the DCDSB project representatives approval.

.3 The Contractor shall be responsible for the repair of any damage to existing services, exposed or concealed, caused as a result of this Work.

3.14 PACKING AND SEALING CORE DRILLED CONDUIT OPENINGS

.1 The void between the conduit opening and the conduit shall be packed and sealed 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 watertight seal.

2. Pack and seal openings in fire rated walls and slabs as specified in this Section and as per article entitled “Installation of Firestopping and Smoke Seal Materials”

3.15 ACCESS DOORS INSTALLATION

.1 All access doors shall be flush mounted.

.2 Access doors shall be installed such as to give proper access to all newly installed electrical and control equipment and other similar electrical Work which may need maintenance or repair but which are concealed in inaccessible construction.

.3 All access doors shall be installed by the professional trades specialized in working on the particular type of construction in which the doors are required.

3.16 ELECTRICAL WIRING AND ACCESSORIES

.1 Install all electrical materials and equipment conform to Canadian Electrical Code as amended to date and as specified below.

.2 Provide conduit, electrical wiring and fittings from load side of starters and/or disconnects to motor or electrical connected item, including the connections to all mechanical equipment.

.3 Provide control wiring, conduit and relays to interlock starters and connect safety and operating controls as required.

.4 Wire final 12 in to 18 in of motor connections with flexible liquid tight conduit, with insulated throat connectors.

.5 Use thin wall conduit up to and including 1 ¼ in size for wiring in ceiling, furred spaces and where not exposed to mechanical injury. Use rigid galvanized steel conduit for exposed wiring and for conduit 1 ½ in size and larger.

.6 Provide branch circuit wiring and an outlet for each motorized damper control.

.7 Conduit shall be in accordance with the following CSA standards:

1. C22.2 No.813 - 1976 - Electric Metallic Tubing
2. C22.2 No.56 - 1977 - Flexible Metal Conduit and Liquid Tight Flexible Metal Conduit
3. C22.2 No.136 - 1966 - Rigid PVC Conduit

.8 Install all wiring in conduit, unless otherwise specified.

.9 Conduit accessories, condulets and fittings shall conform to C.S.A. Standard C22.2 No.18 - M1987.

.10 Use thin wall conduit for branch circuit and signal wiring in ceiling, furred spaces and where not exposed to mechanical injury.

.11 Conduit shall be of sufficient size to permit easy removal of conductors at any time. Do not bend conduit over sharp objects. Do not use bends and fittings together.

.12 All conduit connections made to enclosures housing electrical devices (e.g. DDC panels, transformers, etc.) shall be made on the sides or bottom end of the enclosure. No openings of any kind shall be made to the top side of such enclosures.

3.17 INSTALLATION OF MOTOR STARTERS AND ACCESSORIES

.1 Provide magnetic starters for new motorized equipment.

.2 Provide an identification nameplate for each motor starter.

3.18 INSTALLATION OF VARIABLE FREQUENCY DRIVES

.1 Install each VFD in accordance with manufacturer's recommendations and local, provincial and national safety codes.

.2 Use motors with a minimum of CLASS F insulation. Motor shall be rated for inverter duty.

.3 Provide verification and start-up certificate from the VFD supplier for each unit supplied. Incorporate these certificates in the Documentation Manuals.

.4 Install floor mounted units on 100mm (4”) thick concrete pad extending a minimum of 100mm (4”) beyond the foot print of the unit. Chamfer all pad edges to avoid spalling.

3.19 EQUIPMENT ENCLOSURES AND LOCATIONS

.1 Provide new enclosures for <u>all</u> field equipment (e.g. DDC panels, transducers, relays, etc.). Enclosures shall be equipped with a hinged door and latch. Provide a DCDSB-standard key/lock set for each enclosure.

.2 Obtain written approval of the Engineer prior to re-using existing enclosures or cabinets. Provide a DCDSB-standard lockset for all re-used enclosures or cabinets.

.3 Mount all enclosures in serviceable areas of mechanical rooms, storage rooms or janitor closets. Obtain written approval of the Engineer prior to mounting any enclosure in ceiling spaces or more than 5’-6” above the finished floor.

.4 All transformers and power supplies for control equipment shall be installed in new dedicated metal cabinets with hinged, lockable covers located in the proximity of their dedicated controller cabinets.

.5 Include within a DDC panel enclosure one 120 VAC duplex receptacle for portable PC power, if the controller cabinet is located further than 5’-0” from the nearest wall receptacle.

.6 Ensure that enclosures are sized to allow for ease of servicing of all equipment contained within. Enclosures containing DDC panels shall be sized to allow for the installation of the

maximum allowable number of expansion panels/boards. Do not mount other equipment in a manner that may interfere with the future installation of expansion panels/boards.

.7 For enclosures containing pneumatic transducers or devices, provide one pressure gauge (1-1/2" dial, 0-30psi) for the main air line supply.

3.20 IDENTIFICATION AND LABELLING OF CONTROL EQUIPMENT

.1 All panels must have a lamicoid tag (min. 3"x1") affixed to the front face indicating panel designation and function (i.e. "BAS Panel 1" or "Relay Panel 3").

.2 All field sensors or devices must have a lamicoid tag (min. 3"x1") attached with tie-wrap or adhesive indicating the point software name and hardware address (i.e. S1_MAT, 2.IP4). Tags must be secured by screws where mounted outside of the building, in un-heated spaces, in high humidity areas or where subject to vibration.

.3 Room sensors or other sensors in finished areas must have a lamicoid tag affixed to the front cover. This tag shall be minimum 1"x ½" and indicate the point software name and hardware address.

.4 All devices within a field enclosure shall be identified via a label or tag.

.5 All BAS panel power sources must be identified by a label (min. 3"x1") indicating the source power panel designation and circuit number (i.e. "120vac fed from LP-2A cct #1).

.6 All field control equipment panels fed from more than one power source must have a warning label on the front cover.

.7 All wires shall be identified with the hardware address with a band-type self-adhesive strips or clip-on plastic wire markers at both ends.

.8 All rotating equipment controlled by the BAS shall have a tag or label affixed indicating that the equipment may start without warning.

.9 The location of the phone line manager shall be indicated via a label affixed to the inside cover of the modem enclosure or BAS panel.

.10 All BAS panels will be supplied with a point's list sheet (within a plastic sleeve) attached to the inside door.

.11 The points list shall identify the following for each point:

a. Panel number.
b. Panel location.
c. Hardware address.
d. Software name.
e. Point description.
f. Field device type.
g. Point type (i.e. AI or DO).

h. Device fail position.
i. Device manufacturer.
j. Model number or reference.
k. Wire tag reference.

.12 Provide laminated wiring diagrams for all field mounted relay enclosures. Securely attach to the inside door. Identify power panels and circuit numbers of the equipment being controlled.

.13 Provide laminated wiring diagrams or modify existing equipment wiring diagrams wherever the BAS interfaces to other equipment. (e.g. boilers, chillers, etc.). Securely attach to the inside of the respective control cabinet.

.14 Provide lamacoid labels indicating the required operating sequences, on the boilers and valves, where the boiler plants have manual or automatic isolating valves. Submit actual wording to the engineer for approval prior to fabrication and installation.

.15 Provide lamicoid or machine labels (as outlined above) for all interposing relays or contactors used in control circuits. The labels shall include the related point software name and hardware address

.16 Provide a lamicoid label to identify the location of concealed devices above the ceiling space. Mount the label on the ceiling grid t-bar or a permanent surface adjacent to the devices. The label shall contain the wording “BAS Devices Above”.

.17 Provide lamicoid labels for all auxiliary HVAC equipment (e.g. force flow cabinets, unit ventilators, unit heater, window AC units, etc.) controlled by the BAS. Mount the labels in the vicinity of the existing thermostat or power switch for the unit. The label shall contain the wording “Under BAS Control”.

.18 Where directed by the Engineer, provide any and all additional labelling, diagrams. schematics or instructions as may be required to facilitate the correct operation and maintenance of controlled building systems.

3.21 SYSTEMS HARDWARE COMMISSIONING

.1 By DCDSB.

3.22 SUBSTANTIAL COMPLETION INSPECTION

.1 At the completion of the site hardware inspection, the Contractor shall test and verify that the system programming, graphics and alarm software is operating correctly and is in compliance all requirements of the specifications.

.2 The Contractor shall provide written notification to the DCDSB Project Supervisor that the site is ready for the Substantial Completion Inspection by the Engineer. At the request of the Engineer, the contractor shall arrange for qualified staff to be present during the Substantial Completion Inspection and any subsequent inspections that may be scheduled.

.3 The Substantial Completion Inspection should not yield anything more than a small number of minor deficiencies related to the project work. It is the responsibility of the contractor to thoroughly review the project work to ensure that this is the case prior to requesting a Substantial Completion Inspection.

.4 At the conclusion of the Substantial Completion Inspection, the Engineer shall issue a comprehensive site deficiency report to the Contractor for his immediate action.

.5 The Contractor shall correct all items noted in the site deficiency report within ten (10) business days of receiving the inspection report.

.6 The Contractor shall provide written notification to the DCDSB Project Supervisor that all items on the Engineer's site deficiency report have been corrected.

3.23 TRAINING

.1 To be completed by DCDSB.

END OF SECTION

CONTENT

END OF SECTION

PART 1 GENERAL

1.1 REFERENCES

.1 Division 1, General Requirements, is a part of this Section and shall apply as if repeated here.

1.2 APPLICATION

.1 This section applies to and is a part of all Sections of Division 16.

1.3 WORK INCLUDED

.1 Sections of these Electrical Specifications are not intended to delegate functions nor work and supply to any specific trade and the work shall include all labour, materials, equipment and tools required for a complete and working installation as described.

1.4 INTENT

.1 Mention herein or indication on drawings of articles, materials, operations or methods requires: supply of each item mentioned or indicated, of quality, or subject to qualifications noted; installation according to conditions stated and; performance of each operation prescribed with furnishing of necessary labour, equipment and incidentals for Electrical Trade, Division 16.

.2 Supplementary to definitions established are: `Supply' shall mean furnishing to site in location required or directed complete with accessory parts. `Install' shall mean set in place and secured or affixed to building structure as noted or directed. `Provide' shall mean supply and install as each is described.

.3 Where used, wordings such as "approved, to approval, as directed, permitted, permission, accepted, acceptance", shall mean: approved, directed, permitted, and accepted, by authorized representative of the Owner.

.4 Equipment and installation provided under this Division shall conform to applicable standards and regulations of the following organizations:

Canadian Standards Association (CSA)
Underwriter's Laboratories of Canada (ULC)
Ontario Electrical Safety Code (OESC)
Electrical Safety Authority (ESA)
Ontario Building Code (OBC)

1.5 WORKMANSHIP

.1 Workmanship and method of installation shall conform to best standards and practice. Where required by local or other By-Laws and Regulations, tradesmen shall be licensed in their trade.

1.6 TEMPORARY & TRIAL USAGE

.1 Temporary or trial usage of any equipment or materials shall not be construed as evidence of acceptance of same and no claim for damage shall be made for injury to or breaking of any part of such work which may be so used.

1.7 BY-LAWS & REGULATIONS

.1 Work shall conform to the latest rules, regulations and definitions of the Canadian Electrical Code and applicable Municipal and Provincial Codes and Regulations, and with requirements of other authorities having jurisdiction in the area where work is to be performed. Minor changes required by an authority having jurisdiction shall be carried out without change to the Contract amount. Standards established by drawings and specifications shall not be reduced by applicable codes or regulations.

1.8 PERMITS & FEES

.1 File Contract Drawings with proper authorities and obtain their approval of installation and permits for same before proceeding with work. Prepare and submit necessary detailed shop drawings as required by Authorities.

.2 Pay all fees in connection with examination of drawings, permits, inspections and final certificate of approval.

1.9 CERTIFICATES

.1 Finish necessary certificates as evidence that work installed conforms to laws and regulations of authorities having jurisdiction.

1.10 GUARANTEE-WARRANTY

.1 Guarantee and warranty requirements of the Contract shall apply except for incandescent lamps which shall be guaranteed for a period of ninety days after acceptance by the Owners.

1.11 SPECIFICATIONS, DRAWINGS, AND JOB CONDITIONS

.1 Electrical Drawings do not show structural and related details. Take information involving accurate measurement of building from building drawings, or at building. Make, without additional charge, any necessary changes or additions to electrical work or equipment locations to accommodate structural conditions. Equipment locations may be altered by Engineer without extra charge provided change is made before installation and does not necessitate major additional material.

.2 Examine site and local conditions. Examine carefully all drawings and complete specifications to ensure that work can be satisfactorily carried out as shown. Before commencing work, examine the work of other Sections and report at once any defect or interference affecting the work, its completion or warranty. No allowance will be make later for any expense incurred through failure to make these examinations or to report any such discrepancies in writing.

.3 Relocate equipment and/or material installed but not coordinated with work of other Sections as directed, without extra charge.

.4 Furnish "built-in" items in ample time and give necessary information and assistance in connection with building-in of same. Notify Section concerned in writing of size and location of recesses, openings and chases at least 48 hours before walls are erected, floors poured and similar work.

1.12 TENDER & SUBSTITUTIONS

.1 Tender shall be submitted based on specified manufacturer or "approved manufacturers" and equipment only.

.2 Substitutions for materials may be proposed by submitting details with Supplementary Tender Form together with price difference to Stipulated Sum Tender amount under the following conditions:

1. Product name shall be stated together with price difference, if any, to stipulated sum for each substitution proposed.

2. Material or equipment substituted shall not exceed space requirements allocated. Extra charges will not be allowed for any additional installation cost resulting from acceptance of proposed substitutions.

3. If an item of material specified is unobtainable or unavailable to meet proposed completion, state in tender the proposed substitute and amount to be added or deducted for its use. Extra charges will not be allowed for substitutions after the Contract has been awarded.

1.13 INTERFERENCE DRAWINGS

.1 Prepare and submit composite interference drawings if required to avoid and/or resolve conflict of trades and to co-ordinate work of Electrical Division with all other trades.

.2 Interference drawings shall indicate exact arrangements, of all areas and equipment to scale with dimensions.

.3 Co-operate with work of Division 15 and provide data requested and as required in the preparation of interference drawings for the work of Division 15.

.4 Make interference drawings in conjunction with all parties and trades concerned showing sleeves and openings and passage of electrical work through building structure. Drawings

shall also show inserts, special hangers and other features to indicate routing through confined spaces, installation of equipment in such areas.

.5 Provide detail drawings, fully dimensioned, of equipment in Boiler and Mechanical Equipment Rooms, Electrical Rooms, Fan Rooms, etc. Base equipment drawings on approved Shop Drawings and include, but do not necessarily limit to, details pertaining to access, clearances, sleeves, connections, etc.

.6 Provide detailed drawings of pulling pits, equipment bases, anchors, floor and roof curbs, etc., pertaining to Electrical work.

1.14 SHOP DRAWING MATERIAL & LISTS

.1 Prepare and submit shop drawings and lists of materials for review in accordance with Architectural Sections. Make submittals of more than two pages in booklet form. Individual and loose drawings will not be accepted for review.

.2 Prior to equipment fabrication, delivery or installation, submit complete lists of materials proposed, indicating manufacturer, catalogue numbers and complete performance data.

.3 Review of Shop Drawings by Consultant is for sole purpose of ascertaining conformance with general design concept. This review shall not mean that Architect and/or Engineer approves detail design inherent in Shop Drawings, responsibility for which shall remain with Contractor and such review shall not relieve Contractor of his responsibility for meeting all requirements of Contract Documents. Contractor is responsible for dimensions to be confirmed and correlated at site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of work with all trades.

.4 Shop drawings transmitted via facsimile (fax) machines, or copies of same, will not be accepted for review.

1.15 RECORD DOCUMENTS

.1 Conform to General Requirements. Maintain at least 2 sets of documents and clearly mark on same as job progresses, changes and deviations from work shown so that on completion Owner will have records of exact location of ducts and equipment and record of material and equipment changes.

.2 Record all homerun conduits, junction boxes for complete lighting, power and systems on As-Built Drawings.

.3 Contractor shall obtain clean set of prints from Consultant at start of Contract Work and shall keep these prints up-to-date at jobsite, accurately recording all changes made on project and locating all services, equipment, etc. which may have been shown only diagrammatically on Contract Documents.

.4 Contractor shall ensure that as-built information is accurately recorded and shall check same. As-Built drawings shall be reviewed with Consultant at each jobsite meeting.

.5 Upon completion of Contract Work, prior to Substantial Performance inspection and after final review with Consultants, Contractor shall neatly transfer recorded information and make final As-Built submission to Consultant in the following form:

- One (1) set of clean, legible prints.
- Updated ACAD R2010 drawings.

.6 Consultants shall be responsible for reviewing As-Built information provided by Contractor. Revise drawings to suit any comments until acceptable for submission to owner.

1.16 JOB SITE WORK SHOP AND STORAGE

.1 Supply job site office, workshop, tools, scaffolds and material storage as required to complete the work of this Division. Location of temporary buildings, use of space on site or within building shall be to later direction.

1.17 PROTECTION

.1 Securely plug or cap open ends of electrical raceways or equipment to prevent entry of dirt, dust, debris, water, snow or ice. Clean all equipment inside and outside before testing.

.2 Equipment stored on site shall be protected from weather and kept dry and clean at all times. Take care to avoid corrosion of metal parts.

.3 Protect work installed from damage. Secure all unfinished or loose work to prevent movement.

1.18 INSTRUCTIONS TO OPERATOR

.1 Instruct Building Operators in repair, maintenance and operation of Electrical Systems and associated equipment.

.2 Supply three (3) full Operation and Maintenance Instructions each in stiff cover, three-ring binder suitably indexed, separated and labeled. Operate each item of equipment in presence of Operators to ensure understanding of working parts and function of each item of equipment. Supply one complete set of "Reviewed" Shop Drawings in separate hard cover binder suitably separated and labelled for Owner's use.

.3 Operation and maintenance manuals shall be carefully prepared in co-operation with equipment manufacturers and include miscellaneous parts necessary for proper, efficient operation of all equipment.

.4 Manuals shall also include spare parts list for each type of equipment, component, control and device installed together with manufacturer's name and address so such items can be suitably identified and purchased. Include list of recommended spares.

1.19 CLEANING, LUBRICATION AND ADJUSTMENT

.1 Immediately prior to completion of work:

1. Remove all dust, dirt and other foreign matter from internal surfaces of enclosed electrical apparatus and equipment.

2. Remove all temporary protective coverings and coatings, temporary labels.

3. Clean, repair, lubricate and adjust all mechanism and moveable parts of apparatus and equipment leaving it in new condition and operating properly.

4. Balance demand loads for service and distribution feeders within 5 percent upon completion of work and after the building is in full operation.

1.20 INSPECTION & TESTING

.1 Systems, equipment, and all major items of material shall be tested to the satisfaction of the Architect, and as required to establish compliance with plans and specifications, and with the requirements for the Supply and Inspection Authorities.

.2 Faulty and defective equipment shall be replaced with new materials. Conductors which are found to be shorted or grounded, or to have less than proper insulation resistance, shall be replaced with new conductors.

.3 Tests shall include but are not limited to the following:

1. Test of secondary voltage cables shall include megger tests to establish proper insulation resistance, and phase-to-ground resistance of cables.

2. Proper functioning of all systems.

3. Polarity tests - to establish proper polarity connections to all sockets and receptacles.

4. Test of system neutral to establish proper insulation resistance and isolation of neutral from ground except for required ground connection at Service.

1.21 CERTIFICATE OF TESTS

.1 When work is complete submit three copies of test results and a signed statement listing all tests that have been performed as required by specifications and manufacturer's instructions.

1.22 COMPLETION

.1 Provide receipts from designated representative of Owner for portable and loose materials (e.g. spare fuses, fixture re-lamping equipment and the like).

.2 Provide copy of final inspection certificate from Electrical Inspection Authority and fire alarm verification report.

.3 Provide manufacturers corrected "as built" shop drawings for all major electrical items and systems, including all shop drawings returned for modifications.

1.23 ALTERATIONS TO EXISTING BUILDING

.1 Note that certain alterations and structural changes are to be made to existing building. Architectural drawings and site are to be examined to determine extent of alterations affecting existing electrical systems. Where existing conduits and wires run through areas to be altered, to feed other parts of existing building, they shall be re-routed and reconnected to maintain their original function. Drawings do not necessarily indicate outlets, switches, receptacles, and the like, and other electrical equipment which are required to be relocated or abandoned. Provide decorative blank cover plates for obsolete outlet boxes remaining.

.2 Electrical services and auxiliary services (fire alarm, P.A. intercom, and the like) shall be maintained continuously without interruption. Interruptions to services shall be confined to periods of time to be designated by Architect, and/or Owner's designated representative. Include in tender for temporary connections, overtime labour charges, and such related allowances in order to conform to these conditions.

.3 The Electrical Contractor is responsible for removal, reinstallation, cutting and patching of ceiling and walls as required in the existing building.

.4 Cutting directly related to electrical work, regardless of whether such work occurs in new or existing construction, shall be coordinated and paid for by Electrical Subcontractor involved, under supervision of Contractor.

.5 Where existing electrical items or systems are demolished and removed from existing construction assemblies, Electrical Subcontractor involved shall be responsible for infilling entire hole left after removal of item or system with new construction assembly to match existing. Where new electrical items or systems are installed through existing construction assemblies, Electrical Subcontractor involved shall be responsible for properly sized and accurate cutting of existing construction assembly to allow installation of new work.

1.24 PROJECT SPECIFIC NOTES

.1 Obtain all approvals from public authorities having jurisdiction prior to commencing any work. Include, in the tender price, for all ESA permit and inspection fees. Arrange for and attend all inspections required as per requirements of the electrical safety authority and the building department.

.2 The Electrical Contractor shall furnish all labour, material, tools, equipment, etc. required to complete all work shown on the drawings and as specified in the contract documents. The work shall be performed in accordance with rules and regulations of all authorities having legal jurisdiction over the work. This contractor shall provide any small items of work not specifically called for but required to complete the intended installation and/or required to achieve the desired intent or functional utility.

.3 Perform all work in full accordance with the Ontario Building Code, Ontario Electrical Safety Code, DCDSB standards and good practices and the requirements of all other authorities having jurisdiction. All work performed by this division shall be done in accordance with all manufacturer's recommendations. Obtain all available manufacturer's recommendations and comply.

.4 All cutting, patching, coring, scanning, xraying, making good and fire stopping required for the work of this division shall be carried out by this division. The electrical contractor is responsible for and shall pay for any and all damage to the building and/or surrounding area incurred by work of this division.

.5 Review the designated substances survey provided by the Board in detail prior to commencing any work.

.6 The Electrical Contractor must review and submit shop drawings for the proposed heating plant replacement in conjunction with the Mechanical Contractor to the Electrical Consultant prior to ordering. Order only upon receipt of approval. Order, supply and install as per all comments.

.7 All materials used throughout shall be new, of best quality, C.S.A. approved, and of one manufacturer. Wherever trade names are not used to describe materials, these materials shall be of the best available quality. Obtain and pay for special ESA inspections of specified non-C.S.A. electrical equipment.

.8 Provide all wiring, raceways, electrical boxes, and such components as required for a complete and operational installation.

.9 All conduit shall be rigid steel or EMT with gland watertight connectors and compression type couplings, unless otherwise noted. Exposed raceways in finished areas shall be wiremold channels installed neatly in appearance, run parallel to building lines, and concentric right angle bends only shall be used. Exterior exposed conduit shall be rigid galvanized steel. Supply and install access doors as necessary due to the proposed work. All access panel ratings shall match that of the surface in which it is being installed.

.10 All wiring shall be of minimum #12 gauge copper, except as otherwise noted. All wiring shall be 600 Volt type RW90. All wiring shall be run in conduit from the source to the load. BX cable may be used where permitted by code in ceiling space for final connections only and for a maximum length of 5'. Maximum voltage drop shall not exceed 2 percent.

.11 Coordinate with all other trades present on site throughout the full course of construction. Lay out of all work so as not to conflict with the work of other trades. Carry out work promptly which may interfere with the work and/or schedule of any other trades.

.12 After completion of the work, provide the consultant with a set of 'as-built' record drawings in pdf format prior to submission to the owner. Incorporate all changes in the pdf drawings.

.13 Alterations and additions: contractors shall note that this contract is an alteration to an existing building and as such the contractor shall thoroughly investigate the existing

electrical installation and electrical, mechanical, structural, and architectural conditions prior to pricing and construction.

.14 Demolition: remove all exposed conduits, branch wiring, outlets, etc. from surfaces being demolished.

.15 Cleanup and garbage: the contractor is responsible for maintaining as clean of a work area as possible during construction. The contractor is responsible to clean-up and remove tools from the site at the end of every working day. Disposal of all redundant materials, devices, and equipment is the responsibility of the contractor on a daily basis.

.16 All work shall be done with minimum possible interruption to the existing building systems and in the time schedule permitted by the school board. Consult with the Project Manager prior to pricing. Complete the project within the allocated schedule.

.17 Paint all exposed conduit and backboxes, inside and outside of the building, to match the surrounding colour. Minimize exterior conduit run where feasible.

.18 All backboxes installed indoors shall be wiremold or approved equal. All backboxes installed outside shall be of cast aluminum finish.

.19 For all panels where new circuits are added, provide a new typed panel directory based on the new loads. Incorporate all existing circuit information from the existing panel directory on site in the new panel directory.

1.25 CLOSEOUT DOCUMENTS

.1 Coordinate with the General Contractor to submit a comprehensive Closeout Document Package incorporating documents from all trades in one consolidated package. Closeout Documents shall consist of one (1) 3-ring binder hard copy and 3 USBs/CDs. The Electrical Section of the Closeout Documents shall consist of the following:

(a) Electrical Contractor Warranty Letter, signed and dated. Warranty shall be for a period of twelve (12) months starting on the Date of Substantial Completion.
(b) Electrical Reviewed Shop Drawings (copy with the Consultant's Review Transmittal).
(c) ESA Inspection & 'Final' Certificates.
(d) O&M Manual for all equipment.
(e) Red-Line As-Builts (completed by the Electrical Contractor).
(f) CAD As-Builts (prepared by the Electrical Consultant based on the red-line as-builts).

END OF SECTION

PART 1 GENERAL

1.1 REFERENCES

.1 Conform to Section 16010 - Electrical General Requirements.

1.2 MATERIALS

.1 Materials shall be new, of Canadian manufacture where available, first quality and uniform throughout. Submit tender based on the use of materials and equipment specified, or on the listed acceptable alternate equipment as further detailed.

.2 Electrical materials shall be C.S.A. approved and be so labeled. Material not C.S.A. approved shall receive acceptance for installation by Electrical Safety Authority (ESA) Special Inspections Branch before delivery, and modifications and charges required for such acceptance shall be included in work of this Section. Material shall not be installed or connected to the source of electrical power until approval is obtained.

.3 Confirm capacity, ratings and characteristics of equipment items being provided to supply power to equipment provided under other Sections of the work. Resolve discrepancies before such items are purchased.

1.3 MATERIAL ACCEPTANCE

.1 Acceptance of materials installed presumes that materials have not been damaged or exposed to conditions that would adversely affect performance and life expectancy.

.2 If in the opinion of the Consultant, materials have sustained damage, or have been exposed to abnormal conditions it shall be the responsibility of the Contractor to have such tests performed as deemed necessary by the Consultant to establish condition and therefore, acceptability of installed materials.

PART 2 PRODUCTS

2.1 RACEWAYS

.1 Rigid galvanized steel conduit shall comply with CSA Specification C22.2 No. 45.

.2 Electrical metallic tubing (EMT) shall comply with CSA Specification C22.2 No. 83. Connectors and couplings to be forged steel and rain tight in sprinklered areas. Connectors to have factory-installed insulated throats.

.3 Rigid PVC conduit shall comply with CSA Specification C22.2 No. 136.

.4 Watertight flexible conduit: "Sealtite" PVC jacketed flexible steel with Hubbell-Kellum strain relief grips; shall comply with CSA Standard C22.2 No. 56.

.5 Surface wall-mounted raceways shall be Wiremold No. 4000 metallic type complete with two channels and all necessary fittings, closers, device modules, etc. Wiremold or approved equal only.

2.2 WIRE & CABLE

.1 Branch wire and cable shall comprise copper conductors, sized as noted, rated 75 deg. C., 600 volt minimum flame retardant insulation, and CSA approved for application.

.2 Wire and cable installed in conduit shall be PVC insulated Type TWH - Flame retardant and comply with CSA Specification C22.2 No. 75.

.3 Use Electrovert "Z-Type" code markers for control & communication conductors.

.4 All branch wiring shall be RW90.

2.3 DEVICES

.1 Wiring devices unless otherwise specified herein, or noted, shall be as manufactured by Hubbell, Leviton or Pass & Seymour.

.2 Switches for 120 volt branch lighting circuits, generally shall be A.C. "Quiet Type" rated 20 Ampere, 120 Volt, totally enclosed phenolic housing Hubbell 1200 Series, beige toggle handle.

.3 Double Pole lighting switches shall be connected to 2 pole circuit breakers.

.4 Key-operated switches shall be Hubbell 1221-L Series of the types listed above, except key-operated, and shall be keyed-alike.

.5 Standard 15 Ampere, 125 volt duplex receptacles generally shall be specification grade Hubbell Cat. No.5262, beige, CSA #5-15R.

.6 Receptacles with integral ground fault interrupter shall be Hubbell No. GF-5252 or approved equal.

.7 Service receptacle shall be Hubbell No. 5262-RD.

2.4 DEVICES-SPECIALIZED

.1 Flush floor boxes shall be Hubbell Cat. No. 3SFB-SSC 3-service box complete with devices shown on drawings.

.2 Provide low-voltage lighting control, as detailed.

2.5 DEVICE COVER PLATES

.1 Switch and receptacle and other device faceplates for flush mounted devices, generally shall be single or multi-gang as required, type 301, stainless steel, #4 brushed finish with removable protective covering.

.2 Weatherproof enclosures for outdoor receptacles shall be P & S 4600 with 4600-26 Mounting Plate, duplex ground fault receptacles and two #4609 Keys.

.3 Cover plates for other devices such as flush fan controls, telephone, etc., shall be stainless steel to match above.

PART 3 EXECUTION

3.1 EQUIPMENT LOCATIONS

.1 Approximate locations of electrical equipment, fixtures switches, outlets, and the like, are given on the drawings. Refer to the architectural drawings and room elevations for application. In absence of definite detail exact location of outlets shall be determined on site as work progresses.

.2 Device plates shall cover opening left for outlet box, and plates shall be attached to boxes in an approved manner. Outlets and fixtures are to be located symmetrically, (i.e. centered in wall panels, ceiling panels or tiles, columns, between and above doors and the like).

.3 The right is reserved to alter the location of equipment and outlets a distance of up to 3 metres without involving a change to the Contract amount, providing notice is given prior to installation.

3.2 MOUNTING HEIGHTS

.1 Mounting heights of outlets, top of outlet to finished floor, except for exposed masonry construction, shall generally be as follows:

Lighting/Exhaust Fann Switches - 1100 mm (to the center of the switch)
Receptacles - 400 mm above finished floor
Television Outlets - 400 mm
Telephone Outlets - 400 mm
Manual Fire Alarm Stations - 1200 mm
Automatic Fire Alarm Stations - ceiling
Panelboards - 2000 mm to top of trim for standard panels.
Clocks - 2000 mm or 300 mm below ceiling.
Thermostats - 1200 mm
Fire Alarm Audible Temporal Pattern Horn/Strobes – 2300 mm

3.3 HOLES & DRILLING

.1 Pneumatic hammers and percussion drills are prohibited.

.2 Where not sleeved, make holes through concrete walls and floors by core-drill only. Obtain Architect's approval before drilling.

.3 Seal holes and sleeves through floors to serve as water dam.

3.4 CUTTING & PATCHING

.1 Layout and install work in advance of other Sections for all new work. Bear all costs resulting from failing to comply with this requirement.

.2 Pay for cutting and patching and making good as required for work of this Division by reason of faulty or late work. Employ appropriate trades already engaged on the site to perform such cutting, patching and making good existing walls, floor, ceiling, etc. Before commencing, obtain Architect's approval for extent and nature of cutting. Make good, disturbed surfaces to the Architect's approval.

3.5 HANGERS & INSERTS

.1 Provide necessary hangers and inserts for work of this Division.

.2 Fasten to cast-in place concrete by suitable drilled or cast-in inserts.

.3 Fasten to structural steel using bolts or welded fasteners.

.4 Do not use wood, chain, wire lashings, strap or grappler bar hangers except where noted or detailed.

.5 Support fixtures independently of ceiling suspension systems. Provide additional supports as required, which shall be fastened to building structure steel members, joists, beams, etc., but not metal pan or roof decking. Material for additional supports and their installation shall comply with requirements of U.L.C. Refer to "List of Equipment and Materials" Vol. 2, and "Supplement" for application to rated assemblies.

.6 Support outlet and junction boxes independently of the conduits running to them where required by electrical code and where deemed necessary by the Architect, use steel angle brackets or steel rods to support outlets and fixtures, to the building structure.

.7 Drilled fastenings to concrete shall be self-drilling concrete anchors, Phillips 'Red-Head' or approved equal. The maximum weight per fastening shall not exceed 25% of manufacturer's 'pull-out' load data.

.8 Surface mounted or stem suspended fixtures fastened to non-removable ceilings, 2 hr. fire rated ceiling assemblies, or mounted between metal suspension of exposed T-grid ceilings, shall be provided with minimum of two points of attachment for each 300 mm x 1200 mm (1' x 4') luminaire, using metal `channel-bar' fastened to building structure. Attach luminaires to `channel-bar' by means of threaded steel rods. Channel-bar shall be adequately supported and of a construction to prevent deflection under load, as selected from manufacturer's published data, and to Architect's approval. `Channel-bar' shall be Unistrut, Burndy, Flexibar, Cantrough, or Canadian Strut Products or approved equal.

.9 Use support clips (e.g. Caddy Type IDS) for suspension of fixtures attached to exposed T-grid ceilings. Clips shall be supported directly from building structure and not from suspended ceiling system.

.10 Provide recessed fluorescent fixtures with support frames, and plastering frames where applicable.

.11 Chain where permitted and specified for the installation of fluorescent lighting fixtures shall be No. 4, 2 mm (.080") Tenso Pattern coil steel chain, plated with a strength of 82 kg (180 lbs.) as manufactured by Dominion Chain Co. Ltd. or approved equal. Where 'S' hooks are used with chain, they shall be No. 6 type with open strength of 82 kg (180 lbs.) minimum. Attachment of chain at both ends of support shall develop full strength of chain.

.12 Support outlet boxes, junction boxes, conduit and the like, mounted on exposed steel deck roofing by means of self-tapping minimum #10 gauge screws, secured through bottom member of deck corrugation. Do not pierce top of steel deck.

3.6 PAINTING

.1 Hangers, support framing and all equipment fabricated from ferrous metals which are not protected with zinc or other suitable corrosion-resistant finish shall have at least one coat of a corrosion-resistant paint applied before shipment or immediately on arrival at the site.

.2 After installation, touch up all scratches, chips, other damage and defects in paint, using zinc chromate primer or paint or special enamels as necessary to match the original.

.3 Finish and colour of all equipment shall be coordinated to provide uniform appearance.

.4 Painting of conduits and supports and other exposed surface work will be done under Painting Section except as noted. Install materials in time to be painted together with mounting surfaces.

.5 Do not paint over nameplates.

.6 Refer to other Sections for special paint finishes of equipment.

3.7 NAMEPLATES & SCHEDULES

.1 Identify electrical equipment supplied under this Division with 3 mm thick black laminated plastic nameplate to indicate equipment controlled to provide instruction or warning. Fasten each plate with two chrome plated screws. Lettering shall be 6 mm high for small devices such as control stations and at least 13 mm high for all other equipment. Submit a list of proposed nameplates for approval before manufacture.

.2 Provide panelboards with typewritten schedules identifying outlets and equipment controlled by each branch circuit including existing panels being changed. Protect schedules with non-flammable clear plastic.

.3 Identify junction boxes, pull boxes, cover plates, conduits and the like, provided for future extension, indicating their function (e.g. power, fire alarm, communication).

.4 Verify room names and numbers prior to listing on nameplates and schedules.

3.8 BRANCH CIRCUIT WIRING & FEEDER CABLES

.1 Provide branch circuit wiring, conduits and feeders as required for Lighting, Power and Auxiliary Systems. Separate conduit systems shall be provided for feeder, lighting and power systems, for exit light system and auxiliary communication systems.

3.9 CONDUIT, RACEWAYS AND WIREWAYS

.1 Wire and cable shall be installed in conduit as follows:

Rigid galvanized steel conduit with threaded IPS fittings to be used:

1. Where noted and required by regulations.
2. Where subject to mechanical damage.
3. For all exposed conduit work.

.2 Conduit embedded in concrete or buried below grade floors shall be CSA approved rigid PVC type.

.3 Electrical metallic tubing (EMT) may be used in place of rigid conduit in dry locations subject to governing regulations, embedded in masonry walls, and concealed above suspended ceilings. Connectors shall be provided with factory-installed insulated throats.

.4 Use flexible metallic conduit for connections to chain suspended and recessed fixture drops, motors and similar equipment to prevent transmission of vibration. A code-gauge green grounding conductor shall be provided for all such connections. Use "Sealtite" conduit with Hubbell-Kellum Sealtite conduit strain relief grips for all such connections at motors.

.5 Fasten every conduit and cable to structure by means of approved conduit clamps or clips. Wire lashing is not acceptable.

.6 Conceal conduits and wiring except where noted. Run exposed conduits parallel to building lines and to other conduits. Provide every empty conduit with a pull rope (3 mm polypropylene rope) and identify to designate its function (Power, Telephone, Fire Alarm and the like).

.7 Where conduit is installed in concrete slabs, obtain general approval, prior to commencing the work, on both maximum dimension and cross-overs which may be used therein.

.8 Install conduits in such a manner as to conserve head room and interfere as little as possible with free use of space through which they pass. Obtain approval for routing of same. Keep conduits at least 150 mm clear high temperature work.

.9 Conduits installed at the roof level of exposed structures, shall be run tight to roof deck, above purlins and beams.

.10 Conduit and cables for electrical work in demountable type and drywall type partitions shall enter from above, from a junction box concealed in the ceiling above and shall comprise a flexible conduit connection.

.11 All branch wiring shall be provided with a separate code gauge supplementary grounding conductor run in each conduit or duct, terminating at ground block at panelboards.

.12 Run conduit exposed in mechanical equipment rooms, electrical rooms, fan rooms, and the like, and installed after mechanical and other equipment is completed. Install fixtures, outlets, starters, etc., to clear and to suit application.

.13 Wiring, boxes, conduit fittings, etc., in hazardous areas shall conform to the Ontario Electrical Code, covering explosion-proof areas. Provide conduit seals where required by these regulations.

.14 Provide housekeeping curbs around exposed conduits feeding panels, disconnect switches, starters, etc. penetrating floors in front of walls.

3.10 WIRE & CABLE

.1 Wire and cable shall not be installed at temperatures below 20^{o}C unless "minus 40" type is used. Wiring to heating equipment shall be rated 90^{o}C minimum, the ampacity of which shall be limited to 75^{o}C value.

.2 Conductors used for all auxiliary systems (e.g. Fire Alarm) shall be tagged and/or colour-coded, and where applicable shall agree with manufacturer`s wiring diagrams.

.3 Minimum wire size for power wiring shall be No. 12 AWG gauge unless specified otherwise. Minimum wire size for "Common" neutral conductors shall be No. 10 AWG. Control wiring shall be #14 AWG red insulation. Maximum voltage drop between furthest outlet of any circuit, when fully energized, and panel to which it is connected shall not exceed two percent except for electric heating circuits which shall not exceed one percent.

.4 Cables shall be terminated with moisture-proof connectors, clamped to sheet metal enclosure by a single non-ferrous locknut and grounding bushing.

.5 Sheaths of multi-conductor cables shall be grounded at both cable ends.

.6 Sheaths of single conductor cables shall be grounded at supply end only. Provide a Code Gauge Grounding Conductor with each feeder cable run.

.7 Numbers of wires indicated for lighting and power, motor and motor control, alarm, signal, communications, and auxiliary systems is intended to show general scheme only. The required number and types of wires shall be installed in accordance with equipment manufacturer's diagrams and requirements, and with requirements of the installation, except that specification standards shall not be reduced.

.8 Solderless connectors with nylon-jacketed "Vibration-proof" screw-on wire connectors ideal "Wing Nuts", rated 600 volts shall be used for joints in Branch Wiring.

.9 Use compression joints and terminals for all control wiring; and all conductors #4 AWG and larger. Mechanical connections are acceptable at panelboards and circuit breakers where these are part of factory-assembly.

.10 Wire or cables in feeders, sub-feeders and branch circuits shall be colour-coded in accordance with Ontario Electrical Safety Code. Each end of feeder terminations (e.g. in Switchboard, Panelboards, switches, splitters and the like) Code Phase A - Red, Phase B - Black, Phase C - Blue, Neutral – White.

.11 Use C.G.E. Vulcan X-Link insulated cables for circuits protected by ground fault circuit interrupters.

.12 Include in each conduit, tubing and raceway, a code gauge green supplementary grounding conductor which shall be connected to suitable ground bus in equipment.

.13 Armoured or sheathed cables may be used only for wiring within demountable and dry wall type partitions and if additionally specified or detailed; however it shall not be directly buried in or below concrete slabs. Once out of the wall, the run shall not exceed 5’-0”. All wiring after transition shall be run in conduits c/w junction boxes. No exposed run of BX cables in finished or unfinished areas will be acceptable.

3.11 OUTLET, JUNCTION, & PULL BOXES

.1 Use suitable electrical boxes for terminations and junctions on conduit work. Install pull boxes where necessary to permit installation of conductors. Support pull boxes, outlet boxes, panels and other cabinets independently of conduit.

.2 Provide each light switch, wall receptacle and other device with an outlet box of suitable dimensions and a faceplate. Outlet boxes shall be adapted to their respective locations.

.3 "Thruwall" and "Utility" type boxes shall not be used.

.4 Electrical boxes and panels shall be CSA approved, code-gauge sheet metal, galvanized or with suitable protective treatment. Secure covers with screws or bolts.

.5 Outlet boxes shall not be installed "Back-to-Back" in walls; separate by a minimum of 150 mm.

.6 Use "Masonry Type" outlet boxes for flush installation in masonry walls as detailed on standard Detail Drawings attached hereto. Standard sectional boxes, 1004, 1104 and the like, shall not be used.

.7 Install surface mounted devices, in cast conduit fittings, with threaded hubs and suitable stainless steel faceplates.

.8 Main pull and junction boxes (excluding obvious outlet boxes) shall be clearly identified by painting the outside of the cover in accordance with the following schedule:

- Lighting Yellow
- Power Blue
- Fire Alarms Red
- Telephone Cream
- Control Brown
- Intercom & Sound Green

.9 In addition, each box shall be identified with a system and service designator of logic reference to the service.

3.12 ACCESS DOORS & ACCESS MARKERS

.1 Supply access doors for installation under the work of other Division where electrical equipment requiring maintenance or adjustment or inspection is located above ceilings, within walls or behind furring; except ceilings of lay-in removable panel type.

.2 Access doors shall be 12 gauge hinged metal Stelpro Ltd. or equal #722 flush type, minimum size 300 mm x 300 mm (12" x 12") "Reach-in" 300 mm x 600 mm (12" x 24") "Crawl-in", with prime coat finish, concealed hinges, screwdriver lock and plaster key. Access doors in finished masonry or drywall construction shall be #722 less plaster key. Access doors shall be #726 in acoustic tile ceilings; #704 in drywall ceiling and #726E in plaster ceilings.

.3 Access doors in fire rated ceiling assemblies, all fire rated walls, duct shaft or in corridor walls shall be UL, ULC or WHI listed 1-1/2 hour fire rated access doors equal to LeHage #L1010 or Acudor #150B with screwdriver lock.

.4 Where lay-in removable panel ceilings requiring hold-down clips are used, access doors are not required but panels shall be secured with accessible hold-down clips and marked with Buildemup #6 RH brass paper fasteners inserted through acoustic panel and bent over. Paint heads with blue enamel before installation.

.5 Obtain approval for sizes and locations.

3.13 ELECTRIC WORK FOR OTHER DIVISIONS

.1 Examine Architectural and Mechanical (Plumbing, Heating, Ventilating and Air Conditioning) plans and specifications to determine extent of electrical work in connection with these Divisions which is to be done under the work of the Electrical Division.

.2 In general, all loose motor starters and associated controls for mechanical equipment will be supplied under Division 16 for installation and connection to both source and load side of the equipment.

.3 Co-ordinate the exact location and verify characteristics of electrical provisions for the work of the Mechanical Division.

.4 Coordinate locations of starters, motors and associated equipment with the work of the Division 15 Mechanical Trade Sections to ensure proper location of equipment. The exact locations of conduit terminations at Mechanical units shall be determined from equipment manufactures' approved shop drawings. Conduits must be installed to enter only in the locations designated by equipment manufactures.

.5 Provide safety switches required for disconnection of remotely controlled motors, and where required at motors by C.E.C. regulations whether shown on the drawings or not. Where required at fan motors, they shall be concealed in the fan housing if possible.

.6 Provide for the 120 volt mechanical equipment where noted, all necessary wiring and connections including wiring and installation of starters, thermostats, aquastats, speed controllers and time switches controlling equipment.

.7 Where motor starters, switches and the like, are grouped together, a suitable 19 mm (3/4") thick plywood panelboard shall be provided to which all such equipment shall be secured. Provide all necessary angle iron supports for support of panelboard and paint entire assembly with two coats of fire retardant type enamel acceptable to Building Inspection Department.

.8 Provide weatherproof un-fused safety disconnect switches, fastened to exterior of roof mounted units, to approval.

.9 Connect high temperature thermostats "Firestats" provided in ductwork by Division 15, to exhaust fan systems, to provide fan shutdown on activation.

3.14 GROUNDING – GENERAL

.1 Ground all electrical systems in accordance with provisions of the Ontario Electrical Code.

.2 Provide a grounding electrode in accordance with Section 10 of the Canadian Electrical Code.

.3 Install grounding conductors to permit the shortest and most direct path from equipment to ground. Install grounding conductors in rigid galvanized conduit with both conductor and conduit bonded at both ends. Provide bonding jumpers with approved clamps to maintain ground continuity of metallic raceway systems at all expansion joints.

.4 Ground connections to grounding conductors shall be accessible for inspection and made with approved solderless connectors bolted to the equipment of structure to be grounded.

Clean contact surface prior to making connections to ensure proper metal to metal contact. Connections shall be of the type that grounds both conduit and conductor, and cap screws, bolts, nuts and washers shall be silicon bronze.

3.15 FIREPROOFING & SEALING

.1 Make watertight seal at sleeves and other openings through floors above grade. Sleeves to extend minimum 25 mm (1 inch) above finished floors.

.2 Provide Fireproofing protection of openings through floors and fire rated walls. Refer to Architectural Drawings for rated surfaces.

.3 Caulk spaces between conduit, cables, bus ducts, raceways, and cable trays with "Cerafibre" 2300 F packing to Building Department approval. Pack and seal both sides of openings with Electrovert "Flameseal" putty, minimum thickness 25 mm (1"). Install in accordance with Electrovert Instruction Bulletin #3601.

END OF SECTION