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**END OF SECTION**

## **PART 1 – GENERAL**

### **1.1 WORK INCLUDED IN THIS SECTION**

- .1 Refer to drawings for detailed demolition scope of work.
- .2 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 Owner.
- .3 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 Owner 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 Owner. 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 Owner. Remove, handle and transport such items to storage area designated by the Owner 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 Owner.

### **1.5 MAINTAINING TRAFFIC**

- .1 Maintain and preserve Owner'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 Owner'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 OWNER'S OPERATIONS**

- .1 There will be absolutely no interruptions to the Owner's 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 Owner's operations in and around the Building, 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 Owner's 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 Owner. Owner 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 Owner.
- .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 Owner at no cost to the Owner.

## **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
  - a. 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 Owner.
- .9 Prior to commencing any demolition on site, site verify all existing services and conditions shown of the "Existing/Demolition" plans (ductwork, piping) for their routing, services and sizes and advise the Engineer of any discrepancy from the information noted on the Drawing prior to commencing demolition.

**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.
- .3 Supplementary to definitions established are:
  1. "Concealed" means hidden from normal sign in furred spaces, shafts, ceiling spaces, walls, or partitions.
  2. "Exposed" means work normally visible, including work in equipment rooms, tunnels, and similar spaces.
  3. "Provide" (and all tenses) means supply and install for a complete, operational, and code-compliant system, including all devices, equipment, materials, accessories and/or components as specified or as otherwise required for a complete, operational, and code-compliant installation.
  4. "Install" (and all tenses) means secure in position, connect as specified, test, and verify.
  5. "Supply" means to supply all devices, equipment, materials, accessories and/or components to the responsible trade.
  6. "Remove" means to isolate, disconnect, disassemble, remove, and dispose of all devices, equipment, materials, accessories and/or components. Patch and make good all surfaces affected by the removal. Remove and dispose of all redundant material off site.
- .4 Where used, wordings such as "approved, to approval, as directed, permitted, permission, accepted, acceptance", shall mean: approved, directed, permitted, accepted, by authorized representative of the Owner.

### **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. Install as high as possible, unless otherwise directed by the Consultant. 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.
  - .10 Prepare and submit complete interference drawings (in PDF format) to avoid and/or resolve conflict of trades and to coordinate the work of the Mechanical Division with that of all other Trades. Submission of interference drawings shall be done no later than 10 business days after the Project has officially begun. The cost of producing the interference drawings shall be included for in the Base Tender Price.
  - .11 Include costs (in the Base Tender Price) for the services of a third-party to 3D scan the entire area of construction upon completion of demolition. System shall be Matterport or similar. The

intent to is capture and submit to the Consultant a full 3D perspective of the space. This model shall be used to identify any potential conflicts ahead of installation and ordering of equipment to allow for quick resolution of site conflicts. 3D Model shall capture all architectural, structural, mechanical and electrical conditions on site and all such conditions shall be part of the model. The model, along with site verifications, shall be used as the basis for interference drawings.

### **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.
- .8 All new ductwork and piping shall be supported from a secondary structure site supplied and installed by the Contractor consisting of unistruct (or alternate as necessary) structure fastened to the building OWSJ structure. No supporting of piping, conduits ductwork or equipment from the roof deck will be permitted.

## **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.
- .4 **The Mechanical Contractor is responsible for consolidating all Mechanical Shop Drawings and submitted them in no more than three (3) packages as per the following:**
  1. HVAC Equipment and Material.
  2. Plumbing Equipment, Fixtures and Material.
  3. Fire Protection Equipment, Fixtures and Material.

Individual shop drawings not consolidated will not be accepted.

### **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. Completion of the As-Built Drawings in AutoCAD will be the responsibility of the Mechanical Contractor at no extra cost to the project. The Mechanical Contractor is responsible for updating all Architectural Plans based on the Architectural As-Built while producing the Mechanical As-Built.
- .3 Put a digital copy of the as-built files (in AutoCAD 2017 format) 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.

#### **1.18 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, Terrice.

### **.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, Terrice.
- .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 intended 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, whether 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, whether 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 INTERFERENCE DRAWINGS**

- .1 The Mechanical Contractor is responsible for preparing detailed interference drawings once demolition work has proceeded to the point where all existing conditions are visible. Provide 2D plan view and 3D isometric view layouts for all project areas depicting site measurements of all floor areas, height, width and depth of all existing structural elements, new architectural walls, ceilings and floor assemblies, new structural elements and new mechanical ductwork and piping plans. Prior to proceeding with new work, ensure that any concerns of interference are alleviated; consult with the Engineer as necessary. Provide written notice to the Engineer of any potential interferences of concerns with existing conditions based on the site findings after demolition.

#### **1.44 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.

#### **1.45 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.

#### **1.46 PROJECT SPECIFIC NOTES**

1. Obtain all approvals from public authorities having jurisdiction prior to commencing any work. Include, in the tender price, for all permit and inspection fees required by

Authorities having Jurisdiction. Arrange for and attend all inspections required as per requirements of the Building Department or an Authority having Jurisdiction.

2. Examine architectural drawings and specifications and all contract documents before proceeding with the work. Any discrepancies between the drawings and specifications of all disciplines must be referred to the architect before any affected work is commenced.
3. The Mechanical 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.
4. Perform all work in full accordance with the Ontario Building Code, All Applicable Codes, City of Toronto 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.
5. 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 Mechanical 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.
6. Review the designated substances survey provided by the Owner in detail prior to commencing any work.
7. The Mechanical Contractor must review and submit shop drawings for all materials to be supplied as a part of the Contract in conjunction with the General Contractor to the Architect and Mechanical Consultant prior to ordering. Order only upon receipt of approval. Order, supply and install as per all comments. The Shop Drawings must be reviewed and ensured for compliance with the Contract Documents by the Mechanical Contractor and General Contractor prior to submission; confirmation of review and confirmation that the submittal is in compliance with the Contract Documents is the responsibility of the Mechanical Contractor and General Contractor to include in writing with each Shop Drawing Submittal. Any non-conformance of the Submittal with the Contract Documents identified by the Mechanical Consultant will require a resubmission of the Shop Drawing Submittal by the Mechanical Contractor prior to review. The Mechanical Contractor shall bear all costs of any review by the Mechanical Consultant beyond the Original Shop Drawing Submission at a cost of \$250.00 CAD + HST per resubmission.
8. All access panel ratings shall match that of the surface in which it is being installed. All access panels requiring supply/install as a part of the project work shall be included for in the Base Tender Price.
9. 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.

10. 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.
11. All work shall be done with minimum possible interruption to the existing building systems and in the time schedule permitted by the Owner. Consult with the project supervisor prior to pricing. Complete the project within the allocated schedule.
12. Unless otherwise explicitly stated in writing in the Contract Documents, all materials, labour, scope and descriptions of work described in the Contract Documents is the responsibility of the Mechanical Contractor to supply and install as a part of the Base Tender Price. No materials and/or labour is to be completed under the Project Allowances unless explicitly noted as such in the Contract Documents.
13. All demolition and new work shall be completed in strict accordance with the Contract Documents with no deviations unless instructed by the Mechanical Consultant in writing prior to execution of the work. The Mechanical Consultant is not responsible, nor required, to accept any work (regardless of its compliance with code) not completed in accordance with the Contract Documents. The Mechanical Contractor will be responsible, at his/her cost, of furnishing a Sealed Letter from a Professional Engineer licensed in the Province of Ontario to accept and assume responsibility for all work not completed in accordance with the Contract Documents. The cost of obtaining this letter and the retaining of the Engineer, including all associated inspection charges, is the sole responsibility of the Contractor.
14. Unless otherwise noted, all devices, equipment, material, supplies, etc. shown on the drawings or otherwise required for a fully operational system as described/illustrated on the Drawings shall be supplied and installed under this Project. It shall not be assumed that any of the devices, equipment, material, supplies, etc. shown on the Drawings are to be provided (in part or in whole) by any other Party.
15. The Mechanical Contractor is responsible for taking pictures of work completed at the end of each week for record purposes. Pictures shall be taken throughout the work space and shall demonstrate all work completed that past week. When requested, share the pictures with the Mechanical Consultant. Pictures may be used for review of the monthly draws, conflicts identified on site, etc.

#### **1.47 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 Mechanical Section of the Closeout Documents shall consist of the following:

- (a) Mechanical Contractor Warranty Letter, signed and dated. Warranty shall be for a period of twelve (12) months starting on the Date of Substantial Completion.
- (b) Project Shop Drawings, in consecutive order of the Consultant's number scheme.
- (c) O&M Manuals for all equipment supplied on the project.
- (d) AHJ Inspection Certificates & All Test Certificates.
- (e) Fire Damper installation letter from the Sheet Metal Contractor stating 'All fire dampers and fire flaps have been installed in strict accordance with the Manufacturer's recommendations and requirements as well as Code Requirements.'
- (f) Start-Up Reports for all Equipment.
- (g) Red-Line As-Builts and CAD As-Builts (both completed by the Mechanical Contractor).

**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 25 20 11.

### **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.

## **2.9 DUCTWORK IDENTIFICATION**

- .1 Provide a yellow label (with black text) on all ductwork at intervals of 10' on the bottom and the two sides of the ductwork with the following:
  - .1 Equipment Name ('HRU-1').
  - .2 Service ('Supply')
  - .3 Directional Arrow of Airflow direction.

Label shall be read as follows, for example 'HRU-1 SUPPLY →'.

- .2 Label shall be 4" high with text that is 3" in height.

## **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 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 CAABC: Canadian 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 10%.
    - .2 Grilles, diffusers and air terminal units (maximum values): -5% to +10%.
    - .3 Exhaust hoods/cabinets: 0 % to + 10 %.
    - .4 Minimum outside air: 0 % to +10 %.
    - .5 Individual room air outlets and inlets, and air flow rates not mentioned above: -5 % to +10 % 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, demonstrating compliance with all ASHRAE 90.1 ductwork sealing requirements.
  - .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 CAABC 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.

### **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 TESTING AND BALANCING FREQUENCY**

- .1 The Mechanical Contractor is responsible for arranging testing and balancing of all systems within a ten (10) business day period prior to the intended date of Project Sign-Off. The TAB Agency shall test, balance and set all systems to achieve the parameters (flow rates, etc.) as set out on the Drawings. In the event that the date of testing and balancing surpasses ten (10) business days prior to the intended date of Project Sign-Off, the Mechanical Contractor is responsible for repeating the testing and balancing exercise at no extra cost to the project. Any TAB Report issued/dated ten (10) business days or more from the date of Sign-Off will have to re-done. No exceptions will be permitted. The Mechanical Contractor is responsible for retaining the TAB Agency as many times as necessary, at no extra cost to the project, to successfully balance all systems as per the Design Criteria.
- .2 The Mechanical Contractor shall include the costs (in the base tender price) for a second complete testing and balancing exercise by the TAB Agency in witness of the Consultant five (5) business days after sending the Original Report to the Engineer. This is intended to demonstrate to the Engineer that all systems are working as intended. All air and water systems shall be demonstrated to the Engineer at the second complete TAB exercise.

### **3.9 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.

### **3.10 CONDUCTING THE TESTING AND BALANCING PROCEDURE**

- .1 Part 1 - The Mechanical Contractor is responsible for conducting testing and balancing of all new mechanical systems and equipment as specified on the Drawings, Specifications and/or other Contract Documents and providing the comprehensive report to the Engineer.
- .2 Part 2 - The Contractor shall include for a repeat of all testing procedures to be conducted in witness of the Consultant on site after the completion of Part 1 (see .1). This is intended to demonstrate the

operating characteristics of all mechanical systems once balancing has been complete and once the Engineer has had a chance to review the comprehensive report. The TAB Agency shall include for additional balancing during this Part as advise by the Engineer on site.

### **3.11 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 GENERAL**

- .1 This section of the specification shall be read in conjunction with and be governed by the requirements of Section 20 05 11 Mechanical General Requirements.

**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 20 05 11 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

.6 Armaflex.

## **2 PRODUCTS**

### **2.1 GENERAL**

.1 K-factors (thermal conductivity) shown are expressed in BTU•in/hr•ft<sup>2</sup>•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.
  - a. Jacketing
    - i. Aluminium Jacket ASTM B209, 3003 alloy, H-14 temper, 0.6 mm (0.023 inch) minimum thickness with locking longitudinal joints. Jackets for elbows, tees and other fittings shall be factory-fabricated to match shape of fitting and of 0.6 mm (0.024) inch minimum thickness aluminum. Fittings shall be of same construction as straight run jackets but need not be of the same alloy. Factory-fabricated stainless-steel bands shall be installed on all circumferential joints. Bands shall be 13 mm (0.5 inch) wide on 450 mm (18 inch) centers. System shall be weatherproof.
  - b. Accessories
    - i. Closure Materials: Butt strips, bands, wires, staples, mastics, adhesives; pressure-sensitive tapes.
    - ii. Support Materials: Hanger straps, hanger rods, saddles, support rings.
    - iii. Contact adhesive: quick-setting, non-flammable fire resistive adhesive to adhere fibrous glass to ducts. Flame spread 15 smoke development 0.

## **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 fibrous glass 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 Externally insulate all supply and return air ductwork served by the new Rooftop Unit.
- .2 Apply insulation after required tests have been completed and approved by Consultant.
  - a. Insulation and surfaces shall be clean and dry when installed and during application of
  - b. any finish.
- .3 Work shall be preformed by insulation journeymen.
- .4 Apply insulation and coverings on hot equipment while surface is between 50 to 60°C.
- .5 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.
- .6 Install insulation with smooth and even surfaces.
- .7 Apply insulation materials accessories and finishes to manufacturer's
  - a. recommendations.
- .8 Apply 1.0mm thick metal corners to all ductwork in mechanical rooms to a height of 7
  - a. ft.
- .9 Use stand-offs for all duct mounted accessories.
- .10 The last 3.0 meters of all exhaust ductwork shall be insulated, whether shown on the Drawings or not.

**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 be governed by the requirements of Section 20 05 11 Mechanical General Requirements.

### **1.2 DESCRIPTION**

1.2.1 Ductwork and accessories for HVAC including the following:

1.2.1.1 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 accessories of 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 ASTM A653 and A924 Standards. Minimal 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.

**2.2.9** Ductwork elbows in the ceiling space from a rooftop/heat recovery unit shall be provided with turning vanes for all airflow directions to minimize noise concerns.

**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)<br>-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)<br>-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)<br>-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)<br>-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.<br>(500 Pa)   | B |  |
| All return ductwork  | Up to 1 " w.g.<br>(250 Pa)  | B |  |
| All exhaust ductwork | Up to -1" w.g.<br>(-250 Pa) | B |  |
| All Other Ductwork   | Up to 0.5" w.g.<br>(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.
- 2.6.5 At the onset of the project, the Sheet Metal Contractor shall submit a sketch demonstrating and confirming the ability to transition the ductwork from the unit to the size shown on the Drawing within the Roof Curb. Advise of any issues prior to fabrication.
- 2.6.6 For all down-discharge rooftop unit, any elbows or transitions within 60' of the unit shall be

equipped with turning vanes.

## **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:

| <b>Duct Size (mm)</b> | <b>Angle Size (mm)</b> | <b>Rod Size (mm)</b> |
|-----------------------|------------------------|----------------------|
| 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 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.

## **2.11 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

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**METALLIC DUCTWORK  
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sealed properly.

**END OF SECTION**

**CONTENT**

| <b><u>SECTION</u></b> | <b><u>TITLE</u></b>               |
|-----------------------|-----------------------------------|
| 16000                 | Electrical Specifications Content |
| 16010                 | Electrical General Requirements   |
| 16050                 | Basic Materials and Methods       |

**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 made 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 On the as-built drawings, the Electrical Contractor is responsible for illustrating the conduit routing, conduit sizes, locations of all fittings, pull boxes and junction boxes. The As-Builts must also note the number of wires in each conduit, the type of wire (T90, RW90, etc.) and the size of all conductors.
- .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 AutoCAD 2017 drawings. Converting the red-line as-builts into CAD format is the responsibility of the Electrical Contractor. CAD files of the Tender Drawings will be provided to the Electrical Contractor.
- .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 Examine Architectural Drawings and specifications and all contract documents before proceeding with the work. Any discrepancies between the drawings and specifications of all disciplines must be referred to the architect before any affected work is commenced.
- .3 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.
- .4 Perform all work in full accordance with the Ontario Building Code, Ontario Electrical Safety Code, City of Toronto 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.
- .5 All cutting, patching, drilling, 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.
- .6 Review the designated substances survey provided by the Owner in detail prior to commencing any work.
- .7 The electrical contractor must review and submit shop drawings for the proposed door hardware in conjunction with the general contractor to the architect and electrical consultant prior to ordering. Order only upon receipt of approval. Order, supply and install as per all comments.
- .8 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.
- .9 Provide all wiring, raceways, electrical boxes, and such components as required for a complete and operational installation.
- .10 All conduit shall be rigid steel or EMT with compression type couplings (cast fittings/set screws not acceptable) to be zinc die-cast. Conduit connectors shall be provided with factory-installed insulated throats. 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.

- .11 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.
- .12 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.
- .13 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.
- .14 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.
- .15 Demolition: remove all exposed conduits, branch wiring, outlets, etc. from surfaces being demolished.
- .16 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.
- .17 All work shall be done with minimum possible interruption to the existing building systems and in the time schedule permitted by the Owner. Consult with the project supervisor prior to pricing. Complete the project within the allocated schedule.
- .18 Paint all exposed conduit and backboxes, inside and outside of the building, to match the surrounding colour. Minimize exterior conduit run where feasible.
- .19 All surface backboxes/outlet boxes installed indoors shall be Wiremold or approved equal with matching raceway. All backboxes/outlet boxes installed inside and outside shall be of die-cast aluminum or zinc finish. No sheet metal backboxes/outlet boxes will be acceptable.
- .20 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 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) ESA Inspection & 'Final' Certificates.
  - (c) Fire Alarm Verification Report.
  - (d) Operations & Maintenance Manuals for all new Devices/Equipment.
  - (e) All reviewed Shop Drawings.
  - (f) Red-Line As-Builts (completed by the Electrical Contractor).
  - (g) CAD As-Builts (completed by the Electrical Contractor).

### **1.26 IFC DRAWINGS**

- .1 The Contractor will be responsible for working off of the Tender Drawings/Specification issued along with any addenda issued during Tender. The Consultant will not be obligated to provide the Contractor an IFC Set of Electrical Drawings at the time of construction.

**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. Couplings shall be compression type (cast fittings/set screws not acceptable) with 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.

## **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 All branch wiring shall be RW90. T90 will not be accepted.
- .3 Cables shall have gland watertight connectors.

## **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.5252ITR, 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 Fan Switches - 1100 mm (to the center of the switch)  
Receptacles - 400 mm above finished floor  
Wall-Mounted Key Switch - 1100 mm (to the center of the switch)  
Television Outlets - 400 mm  
Telephone Outlets - 400 mm  
Manual Fire Alarm Pull Stations - 1100 mm to the middle of the Pull Station.  
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.

### **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°C unless "minus 40" type is used. Wiring to heating equipment shall be rated 90°C minimum, the ampacity of which shall be limited to 75°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 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 outlet boxes shall not be used.
- .4 Panel 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 boxes with suitable stainless steel faceplates.

- .8 Paint the full length of conduits (whether exposed or above the existing ceilings) as per the following colour scheme.
- |                     |        |
|---------------------|--------|
| - Lighting          | Yellow |
| - Lighting Controls | Orange |
| - Power             | Green  |
| - Fire Alarms       | Red    |
| - Data              | Cream  |
| - Intercom & Sound  | Purple |

All conduits shall be painted with minimum three (3) coats of paint along the full circumference of the conduit for a clean and consistent finish. Conduits shall be painted prior to installation.

- .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 & BONDING – GENERAL**

- .1 Ground all electrical systems in accordance with provisions of the Ontario Electrical Safety Code.
- .2 Provide bonding of all electrical devices, wiring, raceways and equipment in accordance with provisions of the Ontario Electrical Safety Code.
- .3 Provide a grounding electrode in accordance with Section 10 of the Canadian Electrical Code.
- .4 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.

- .5 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 (firestop) 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**