# **TORONTO**

Generator Replacement and Fuel System Remediation at 703 Don Mills

703 Don Mills Road, North York, ON, M3C 3N3

**City of Toronto Project No.: TBC** 

# **Technical Specification** Issued for Tender OWNER

**City of Toronto** Attention: Timothy Nguyen 55 John St., Toronto, ON, M5V 3C6

## CONSULTANT



125 Commerce Valley Drive West, Suite 300 Markham, ON, L3T 7W4 Stantec Project No.: 135901001

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### PART 1 - GENERAL

### 1.1 WORK COVERED BY CONTRACT DOCUMENTS

.1 Work of this Contract comprises the replacement of an existing indoor generator in the Penthouse of the building at 703 Don Mills Road in Toronto, as well as modifications to the existing generator and transfer controls as described in Specification 26 32 13 – Modifications to Existing Controls, and upgrades to the existing fuel system to address TSSA variances currently in effect. The totality of this work is identified as the Project.

### 1.2 CONTRACT METHOD

.1 Construct Work under stipulated price contract.

### 1.3 WORK BY OTHERS

- .1 There is no work currently contemplated to be carried out by others on this project.
- .2 If such work becomes necessary, and the Owner retains other contractor(s) to perform it, then co-operate with other Contractors in carrying out their respective works and carry out instructions from Consultant.
- .3 Co-ordinate work with that of other Contractors. If any part of work under this Contract depends for its proper execution or result upon work of another Contractor, report promptly to Consultant, in writing, any defects which may interfere with proper execution of Work.

### 1.4 WORK SEQUENCE

- .1 Construct Work in stages to accommodate Owner's continued use of existing premises during construction.
- .2 Co-ordinate Progress Schedule during construction.
- .3 Maintain fire access/control.

### 1.5 CONTRACTOR USE OF PREMISES

- .1 Unrestricted use of site until Substantial Performance.
- .2 Limit use of premises for Work, access, and storage,]to allow:
  - .1 Owner occupancy.
  - .2 Work by other contractors.
  - .3 Public usage.
- .3 Co-ordinate use of premises under direction of Owner.
- .4 Obtain and pay for use of additional storage or work areas needed for operations under this Contract.
- .5 Remove or alter existing work to prevent injury or damage to portions of existing work which remain.
- .6 Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as directed by Consultant.

At completion of operations condition of existing work: equal to or better than that which existed before new work started.



### 1.6 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING FACILITIES

.1 Execute work with least possible interference or disturbance to occupants, building operations, public and normal use of premises. Arrange with Owner to facilitate execution of work.

### 1.7 EXISTING SERVICES

- .1 Notify, Owner and Consultant of intended interruption of services and obtain required permission.
- .2 Where Work involves intercepting or connecting to existing services, give Owner and Consultant 10 days' notice for necessary interruption of mechanical or electrical service throughout course of work. Minimize duration of interruptions. Carry out work at times as directed by Owner with minimum disturbance to operations.
- .3 Provide alternative routes for personnel traffic.
- .4 Establish location and extent of service lines in area of work before starting Work. Notify Owner and Consultant of findings.
- .5 Submit schedule to and obtain approval from Owner and Consultant for any shut-down or closure of active service or facility including power and communications services. Adhere to approved schedule and provide notice to affected parties.
- .6 Provide temporary services when directed by Owner and/or Consultant to maintain critical building and tenant systems.
- .7 Where unknown services are encountered, immediately advise Owner and Consultant and confirm findings in writing.
- .8 Protect, relocate, or maintain existing active services. When inactive services are encountered, cap off in manner approved by authorities having jurisdiction.
- .9 Record locations of maintained, re-routed, and abandoned service lines.
- .10 Construct barriers in accordance with Section 01 56 00 Temporary Barriers and Enclosures.

### 1.8 DOCUMENTS REQUIRED

- .1 Maintain at job site, one copy each document as follows:
  - .1 Contract Drawings
  - .2 Specifications
  - .3 Addenda
  - .4 Reviewed Shop Drawings
  - .5 List of Outstanding Shop Drawings
  - .6 Change Orders
  - .7 Other Modifications to Contract
  - .8 Field Test Reports
  - .9 Copy of Approved Work Schedule
  - .10 Health and Safety Plan and Other Safety Related Documents
  - .11 Other documents as specified.

### PART 2 - SUMMARY OF WORK

The following is a summary of Scope of Work for this tender:



The project entails replacement of one generator (G1) of the facility's standby power service. The standby power service consists of two stationary Diesel generators, a connection box for a mobile generator, a generator paralleling switchboard (EG-A/EG-B), and two standby power switchboards (EA, EB). Two remote human-machine interface panels (HMIs) are also installed to operate the paralleling and standby switchboards.

Also included in the project scope are the following works:

- 1. a controls upgrade,
- 2. all mechanical and electrical work associated with the new generator,
- 3. miscellaneous general trades work for dismantling and restoration of some ventilation system components (exhaust plenum, dampers, silencer, louvres) as required to facilitate removal of existing equipment and moving new equipment into the building, and
- 4. for current TSSA and CSA B139 compliance, the fuel transfer arrangement for both generator day tanks will be converted from the existing continuous fill and overflow to a pump-on-demand fill operation with atmospheric venting. Other minor works are also needed to address the updated CSA B139 standard.

These upgrades will result in a more robust standby power system. The upgrade will retain existing control features and add new ones, including:

- operation in parallel mode, with two stationary generators
- operation in lead-lag mode with a mobile generator and
- enhanced automation to permit recovery from certain failure scenarios involving generators or breakers in the associated switchboards.

The construction work will occur in two main areas of the building: outdoors, at ground level – for a section of the fuel conveyance system, and indoors, in the Generator Room and Main Electrical Room of the Penthouse (10th floor).

The following outlines the works to be performed in the two areas.

### Ground Level (outdoors)

### Electrical

A mobile generator has been rented independently by the City and is already on site, parked alongside the north wall of the building. It is integrated into the system via the existing connection box. Its purpose is to provide redundancy, as the generator being replaced is currently out of service before it is removed. <u>This</u> <u>Contractor shall assume the current rental contract with Toromont, for the duration of the project and include the cost in the tender price. The intent of this arrangement is to maintain the existing condition without disruption, i.e., without need to disconnect the existing mobile generator and connect a new one.</u>

The new mobile generator shall be operational for the full duration of the project and the Contractor shall maintain it throughout the project life. Maintenance shall include periodic testing, refueling, and any service that may be required while the machine is on site (e.g., replacement of fluids, electrical or mechanical adjustments etc.).

### Mechanical

The underground fuel return lines serving Generator 1 and Generator 2 must be decommissioned from the building transition sump to the underground storage tank. First, the fuel return line serving Generator G1 must



be decommissioned, with the line serving Generator G2 left untouched. Once Generator G1 has been replaced and fully commissioned for service, the fuel return line serving Generator G2 can then be decommissioned. Three (3) separate approaches to decommission each of the two underground fuel return lines are shown on design drawings M-1A, M-1B, and M-1C.

- Base scope (shown on drawing M-1A): each double-wall non-metallic fuel return pipe shall be disconnected from the system and removed without excavation, utilizing the existing underground pipe sleeves to accommodate physical removal.
- Alternate solution A1 (shown on drawing M-1B, Alternate Price A1) currently under review by TSSA. Under this option, each underground return pipe shall be disconnected from its respective system, flushed and cleaned to remove traces of hydrocarbon, and then filled with grout and abandoned in place.
- Alternate solution A2 (shown on drawing M-1C, Alternate Price A2) saw cut the existing
  pavement/asphalt, excavate to expose the piping, remove the return pipe, backfill the trench, and restore
  the site to the original condition. This option is expected to be exercised if the existing conditions prevent
  the removal of each fuel pipe by pulling through the existing pipe sleeve as described in option M-1A, and
  if TSSA does not approve abandoning the piping as described in option M-1B. As one of two routes for
  emergency vehicle access to the building will be occupied by the mobile generator throughout the course
  of the project, excavation work in the parking lot must be coordinated, phased, and controlled by the
  contractor to always maintain emergency vehicle access to the building, including traffic control/protection
  in the work area for both pedestrians and vehicles.

### Penthouse Level (Generator Room and Main Electrical Room)

### **General Trades Work**

This work includes, without being limited to, the following:

- Disconnection of electrical and mechanical services supporting Generator G1. Included are power feeders and control wiring, fuel lines, and combustion exhaust components up to the outlet of the combustion exhaust silencer
- Removal of the exhaust plenum sheet metal wall, motorized exhaust and recirculation dampers, acoustic silencers and louvres on Generator G1 side
- Removal of generator G1 complete with batteries, battery charger, and combustion exhaust silencer
- Slight modification of the concrete pad for Generator G1
- Preparation of an equipment lift plan (for hoisting the removed and new equipment by crane) including the proposed date, time, duration, traffic-control plan, site plan, sequence of work, safety measures, personnel and other relevant details as required by the City, using the services of a crane logistics/equipment moving company
- Final cleanup at project completion.

### Electrical

Electrical work is the dominant component of the project scope and includes, without being limited to, the following:

- Supply and installation of a new generator
- New tap box to interface the existing generator feeder busduct, via cables, with the new generator terminal box



- New control wiring (in raceways) between the new generator and paralleling switchboard EG-A/EG-B.
   Some existing control wiring may be reused if they are long enough to be landed on the new generator.
   For pricing purposes assume that control wiring will be all new.
- Miscellaneous power circuits for battery charger, water jacked heater, oil pan heater
- Upgraded controls for Lead-Lag functionality in Paralleling Switchboard EG-A/EG-B and for tie automation in Standby Switchboards EA and EB.

### NOTES:

- o the Lead-Lag functionality must be implemented as early in the project as possible, as it must work with the mobile generator now on site, and
- o Toromont Power Systems must be retained for the Lead-Lag controls and KRKA Power Systems must be used for the tie automation.

All electrical work resulting in temporary loss of redundancy, switching/transfer operations, or during tests with the building load must be executed in accordance with strict methods of procedure (MOPs). Refer to the specifications for additional details on MOPs.

### Mechanical (Ventilation, Fuel, Exhaust and Monitoring Systems)

Mechanical work on the project is associated with the works required to accommodate the replacement of Generator G1, and the need to bring the existing fuel system up to current code and comply with TSSA requirements. All work relating to the generator system fuel, combustion, or ventilation systems must be performed by a licensed Oil Burner Technician. It generally includes:

- Restoration of the ventilation for Generator G1, including new louvre, acoustic silencer, motorized dampers (with controls), and discharge plenum wall
- Fuel supply and return lines between the existing day tank and the new generator, complete with valves, hoses etc.
- Leak sensor c/w control module and wiring
- New combustion exhaust silencer (muffler) c/w flex coupling, insulation, jacket, and condensate drain, connected to the existing exhaust stack. New structural supports must also be provided
- Controls (wiring, field controller, programming) to integrate the new generator monitored points into the existing Building Automation System.
- Correction of the TSSA variances under which the facility currently operates, to bring the fuel system into code compliance
- Arranging for inspection(s) by TSSA or equivalent authority (OBT1) and obtaining the final report and approval of the remediated fuel system
- Arranging for a noise test and report by a qualified acoustics professional

All mechanical construction work resulting in disruption of fuel flow to the generator(s) or temporary loss of monitored data, or during tests with the building load, must be executed in accordance with strict methods of procedure (MOPs). Refer to the specifications for additional details on MOPs.

### Testing and Commissioning

Both the electrical and mechanical systems must be tested and commissioned to ensure the functionality and performance specified. For this purpose, it is required that support be provided by equipment manufacturers or other specialists (independent testing organization, controls vendors or integrators, as applicable). The





efforts of the various external parties must be coordinated for optimum outcomes, including timing and efficiency.

### Note Regarding Access to the Penthouse (main location of the Work)

Access to the Penthouse is through the Toronto Police 911 Call Centre on the 9th floor. This is a 7/24 hr sensitive environment and extreme caution is required when transiting through it, so as not to attract attention or disrupt its operation.

### Working Hours

General working hours are 7:00 am to 6:00 pm. During this time no restrictions on the Contractor's work are in effect, unless the construction activity

- is deemed noisy or generating vibrations
- interferes with the building operations
- requires intense and continuous traffic of personnel and movement of materials through the common areas, especially the 9<sup>th</sup> floor Call Centre
- impedes access to and circulation around the building (e.g. during hoisting of equipment by crane)

In these situations, work must be performed on the weekends or after hours, and mitigation measures must be used to minimize disruption.

The Contractor is expected to employ tradespeople with adequate qualifications (education, training, experience, and accreditation, where required) for the specific work to be performed.

Also, continuous reporting and coordination with the Owner's representative (Project Manager and/or Consultant) will be required during the project execution, in accordance with the terms of the Contract and per Owner's specific requirements for the building.

Specific working hours and access requirements may be imposed on the Contractor's personnel for the various work areas.

### **END OF SECTION**



### PART 1 GENERAL

### 1.1 SUMMARY

- .1 Section Includes:
  - .1 Aluminum stationary louvres with fixed, drainable blades.

### 1.2 RELATED SECTIONS

- .1 All requirements of Division 01 apply to this section and are to be read in conjunction.
- .2 Division 23 for heating, ventilating, and air conditioning connections.

### 1.3 REFERENCES

- .1 The Aluminum Association Inc. (AAI)
  - .1 AAI DAF-45, Designation System for Aluminum Finishes Latest Edition.
- .2 American Architectural Manufacturers Association (AAMA):
  - .1 AAMA 2604 High Performance Organic Coatings on Architectural Extrusions and Panels.
  - .2 AAMA 2605 High Performance Organic Coatings on Architectural Extrusions and Panels.
- .3 Air Movement and Control Association International (AMCA)
  - .1 AMCA 500-D, Laboratory Methods of Testing Dampers for Rating.
  - .2 AMCA 500-L, Laboratory Methods of Testing Louvers for Rating.
  - .3 AMCA 501, Application Manual for Air Louvers.
  - .4 AMCA 511, Certified Ratings Program for Air Control Devices.
- .4 American National Standards Institute (ANSI)
  - .1 ANSI H35.1/H35.1M-[06], Alloy and Temper Designation Systems for Aluminum.
- .5 American Society for Testing and Materials International (ASTM)
  - .1 ASTM A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
  - .2 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
  - .3 ASTM A1008/A1008M, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened and Bake Hardenable.
  - .4 ASTM B32, Standard Specification for Solder Metal.
  - .5 ASTM B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
  - .6 ASTM B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
  - .7 ASTM B370, Standard Specification for Copper Sheet and Strip for Building Construction.
  - .8 ASTM D523, Standard Test Method for Specular Gloss.



- .9 ASTM D822, Standard Practice for Filtered Open-Flame Carbon-Arc Exposure of Paint and Related Coatings.
- .10 ASTM D4214 Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films.
- .11 ASTM D2244 Standard Test Method for Calculation of Color Differences From Instrumentally Measured Color Coordinates.
- .6 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-1.213, Etch Primer (Pretreatment Coating of Tie Coat) for Steel and Aluminum.
  - .2 CAN2-93.1, Sheet Aluminum Alloy, Prefinished, Residential.

### 1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet including:
    - .1 Product characteristics, physical size, finish, performance criteria and limitations.
    - .2 Preparation instructions and recommendations.
    - .3 Storage and handling requirements and recommendations.
    - .4 Installation methods.
- .3 Shop Drawings:
  - .1 Submit drawings stamped and signed by professional engineer licensed in the Province of Ontario, Canada.
  - .2 Indicate materials, construction, dimensions, accessories, installation details and finishes.
- .4 Quality Assurance Submittals: submit in accordance with Section 01 45 00 Quality Control.
  - .1 Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures.

### 1.5 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with Section 01 06 10 Basic Product Requirements.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
  - .3 Deliver materials to the site in undamaged condition.
  - .4 Protect materials and finishes during handling and installation to prevent damage.
- .2 Storage and Protection:
  - .1 Store products in manufacturer's unopened packaging until ready for installation.
  - .2 Store materials off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .3 Protect louvres from nicks, scratches, and blemishes.
  - .4 Replace defective or damaged materials with new.
- .3 Waste Management and Disposal:

- .1 Separate waste materials for recycling in accordance with Section 01 74 21 Construction/Demolition Waste Management and Disposal.
- .2 Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

### 1.6 **PROJECT CONDITIONS**

.1 Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

### 1.7 WARRANTY

- .1 Manufacturer shall provide standard limited warranty for louvre systems for a period of 1 year from date of installation. When notified in writing from the Owner of a manufacturing defect, manufacturer shall promptly correct deficiencies without cost to the Owner.
- .2 Manufacturer shall provide 20 year limited warranty for fluoropolymer-based finish on extruded aluminum substrates.
- .3 Finish coating shall not peel, blister, chip, crack or check.
- .4 Chalking, fading or erosion of finish when measured by the following tests:
  - .1 Finish coating shall not chalk in excess of 8 numerical ratings when measured in accordance with ASTM D4214.
  - .2 Finish coating shall not change colour or fade in excess of 5 NBS units as determined by ASTM D2244 and ASTM D822.
  - .3 Finish coating shall not erode at a rate in excess of .01 mils/year as determined by Florida test sample.

### PART 2 PRODUCTS

### 2.1 BASIS OF DESIGN

- .1 Manufacturer: Pottorff
- .2 Model: EFD-645
- .3 Free Area: 54.6%
- .4 Frame: 152 mm (6") channel, welded corners, drainable.
- .5 Blades: 45 degrees drainable style. Rear-mounted intermediate reinforcement for blades exceeding 1800mm (72") long.
- .6 Mullions: exposed visible, mullion caps where two section abut each other.
- .7 Material and Finish: Extruded Aluminum, High Performance Fluoropolymer.
- .8 Colour: Match adjacent existing louvre colour.

### 2.2 ACCEPTABLE MANUFACTURERES

- .1 Pottorff
- .2 Construction Specialties, Inc.

- .3 Ruskin Company.
- .4 Greenheck.
- .5 Arrow United.
- .6 Ventex
- .7 Requests for substitutions will be considered in accordance with provisions of Section 01 60 00.

### 2.3 MATERIALS

- .1 Weather resistant louvres, with bird screens made to withstand a wind load of not less than the minimum required by the Ontario Building Code, Part 4 for components and cladding.
- .2 Wall louvers: complete with AMCA certified ratings program seal for air performance and water penetration in accordance with AMCA 500-D, AMCA 500-L, AMCA 511.
- .3 Ratings to indicate water penetration of 0.06 kilograms or less per square meter of free area at free velocity of 244 meters per minute.
- .4 Galvanized steel sheet: commercial quality to ASTM A653/A653M with Z275 zinc coating.
- .5 Steel sheet: commercial quality to ASTM A1008/A1008M with Class I matte finish.
- .6 Aluminum extrusions: to AAI DAF-45, AA6063-T5, ANSI H35.1/H35.1M. ASTM B221 alloy 6063-T5
- .7 Nails and fasteners: same material as fabricated items.
- .8 Gaskets: vinyl.
- .9 Primer: to CAN/CGSB-1.213 aluminum surfaces.
- .10 Screens:
  - .1 Insect screens: 0.3 mm diameter aluminum wire 18 x 14 mesh with 60% free area, secured to aluminum frame.
  - .2 Bird screens: crimped aluminum wire cloth secured to 2 mm thick extruded aluminum frame mitered at corners and secured with corner locks, 13mmsize mesh with minimum 50% free area.
- .11 Extruded aluminum louvres:
  - .1 Fabrication: Visible Mullion Louver Type.
  - .2 Blades: Formed aluminum, Alloy 6063-T6, horizontal, drainable positioned at 35-degree angle, minimum 1.27mm (0.050 inch) thickness.
  - .3 Frame: Fixed, extruded aluminum, Alloy 6063-T6, minimum 3.2mm (0.125 inch) nominal thickness.
  - .4 Install concealed vertical stiffeners spaced to meet required loads.
  - .5 Complete louvre assembly to have minimum 50 % free area.
- .12 Closure angles and closure plates:
  - .1 Fabricate from 2 mm (0.074-inch) galvanized steel.
  - .2 Provide continuous closure angles and closure plates on inside head, jambs and sill of exterior wall louvers.



- .3 Secure angles and plates to louver frames with screws, and to masonry or concrete with fasteners as specified.
- .13 Assembly: Factory-assembled louvre components. Mechanically fastened construction.
- .14 Performance Data:
  - .1 Performance Ratings: AMCA licensed.
    - .1 Based on testing 1219mm by 1219mm (48 inch by 48 inch) size unit in accordance with AMCA 500-L.
  - .2 Free Area: 62 percent, nominal.
  - .3 Maximum Recommended Air Flow through Free Area: See Mechanical Schedules.
  - .4 Air Flow: See Mechanical Schedules.
  - .5 Maximum Pressure Drop (Intake): See Mechanical Schedules.
  - .6 Wind-Driven Rain Performance: Not less than 99 percent effectiveness when subjected to a rainfall rate of 200 mm (8 inches) per hour and a wind speed of 22.4 m/s (50 mph) at a corearea intake velocity of 2.5 m/s (500 fpm).
  - .7 Design Load: Incorporate structural supports required to withstand wind load not less than the minimum required by the Ontario Building Code, Part 4 for components and cladding.
  - .8 Louvers shall be factory-engineered to withstand specified seismic loads where applicable.

### 2.4 ACCESSORIES

- .1 Bird and Insect Screens: Provide manufacturer's standard bird and insect screens to prevent birds and insects from passing through louvre; provide insect screens as typical and bird screens where indicated on drawings.
- .2 Removable / Washable screen: Provide manufacturer's standard removable / washable screen where the site has potential for cottonwood seed contamination. Coordinate with Mechanical Engineer of Record.
- .3 Extended Sills with end dams:
  - .1 Galvanized steel, 20 gauge.
  - .2 Extruded aluminum, Alloy 6063-T5. Minimum nominal thickness 2mm (0.081 inch.)

### 2.5 FINISHES

- .1 Finish exposed surfaces of aluminum components in accordance with AAI DAF-45, ANSI H35.1/H35.1M for Aluminum Finishes.
- .2 Appearance and properties of anodized finishes designated by the Aluminum Association as Architectural Class 1, Architectural Class 2, and Protective and Decorative.
- .3 Powder-Coat Finish: AAMA 2605 except with a minimum dry film thickness of 0.038mm (1.5 mils). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
- .4 Colour and Gloss: Match adjacent existing louvre colour.



### PART 3 EXECUTION

### 3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

### 3.2 EXAMINATION

- .1 Inspect areas to receive louvers. Notify the Consultant of conditions that would adversely affect the installation or subsequent utilization of the louvers. Do not proceed with installation until unsatisfactory conditions are corrected.
- .2 If opening preparation is the responsibility of another installer, notify Consultant of unsatisfactory preparation before proceeding.

### 3.3 PREPARATION

- .1 Clean opening thoroughly prior to installation.
- .2 Prepare surfaces using the methods recommended by the manufacturer to achieve the best result for the substrate under the project conditions.

### 3.4 INSTALLATION

- .1 Install louvers at locations indicated on the drawings and in accordance with manufacturer's instructions.
- .2 Install louvers plumb, level, in plane of wall, and in alignment with adjacent work.
- .3 Install joint sealants as specified in Section 07 90 00.
- .4 Provide all required intermediate supports and fasteners as required by the manufacturer for a complete installation.
- .5 Set adjustable louvre blades for uniform alignment in open and closed positions.
- .6 Adjust louvres so moving parts operate smoothly.
- .7 Attach bird/insect screen to inside face of louvre.
- .8 Repair damage to louvres to match original finish.
- .9 Install wall louvers using stops, flanges, and jamb fasteners as appropriate for wall construction and in accordance with manufacturer's recommendations.

### 3.5 CLEANING

- .1 Proceed in accordance with Section 01 74 00 Cleaning.
- .2 All movable parts, including hardware, shall be cleaned and adjusted to operate as designed without binding or deformation of the members, so as to be centered in the opening of frame, and where applicable, to have all contact surfaces fit tight and even without forcing or warping the components.
- .3 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.
- .4 Touch-up, repair or replace damaged products before Substantial Performance of the Work.



### 3.6 **PROTECTION**

- .1 Where aluminum contacts metal other than zinc, paint dissimilar metal with primer and two coats of aluminum paint.
- .2 Paint metal in contact with mortar, concrete, or other masonry materials with alkali-resistant coatings such as heavy-bodied bituminous paint.
- .3 Paint wood or other absorptive materials that may become repeatedly wet and in contact with metal with two coats of aluminum paint or coat of heavy-bodied bituminous paint.

### 3.7 SCHEDULE

.1 Refer to Structural and Mechanical drawings.

### **END OF SECTION**



### PART 1 – GENERAL REQUIRMENTS

- 1.1 GENERAL CONTRACT DOCUMENTS
  - 1. Comply with General Conditions of Contract, Supplementary Conditions and Division 1 General Requirements.

### 1.2 DOCUMENT ORGANIZATION

- 1. Applicable Divisions for Mechanical Work:
  - 1. Division 20 Common Work for Mechanical
  - 2. Division 23 Heating, Ventilation and Air Conditioning (HVAC)
  - 3. Division 25 Building Automation System
- 2. For clarity, any reference in the Contract Documents to Division 20 includes Divisions 21, 22, 23 and 25.
- 3. The Specifications for these Divisions are arranged in Sections for convenience. It is not intended to recognize, set or define limits to any subcontract or to restrict Contractor in letting subcontracts.
- 4. Contractor is responsible for completion of work whether or not portions are sublet.
- 1.3 DIVISION 20, AS IT APPLIES TO DIVISIONS 21, 22, 23 AND 25
  - 1. Articles that are of a general nature, applicable to each Section of these Divisions.
  - 2. Articles specifying materials, equipment, installation techniques and workmanship that are applicable to more than one Section of these Divisions.
  - 3. Articles that are to be read in context with and form part of relevant Sections of these Divisions.

### 1.4 DEFINITIONS

- 1. The words "indicated", "shown", "noted", "listed" or similar words or phrases used in this Specification, mean that material or item referred to is "indicated", "shown", "listed" or "noted" on Drawings or in Specification.
- 2. The words "approved", "satisfactory", "as directed", "submit", "permitted", "inspected", or similar words or phrases used in this Specification, mean that material or item referred to is to be "approved by", "satisfactory to", "as directed by", "submitted to", "permitted by", "inspected by" the Consultant/Owner.
- 3. Instructions using any form of word "provide" involves Contractor in furnishing labour, materials and services to supply and install referenced item.

### 1.5 LANGUAGE

1. The specification is written as a series of instructions addressed to the Contractor, and by implication to subcontractors and to suppliers. For clarity and brevity, use is made of numbered lists and bulleted lists. Where list follows a semi-colon (;) the punctuation is for clarity, where list follows a colon (:) the punctuation is to be read as a short-hand form of the verb "to be" or "to have" as context requires.



2. It is not intended to debate with the Contractor the reasons for these instructions, and words associated with justification for an instruction or restatement of anticipated performance have been omitted to avoid possible ambiguities.

### 1.6 EXAMINATION

- 1. Examine existing building, local conditions, building site, Specifications, and Drawings and report any condition, defect or interference that would prevent execution of the work.
- 2. No allowance will be made for any expense incurred through failure to make these examinations of the site and the documents prior to Tender or on account of any conditions on site or any growth or item existing there which was visible or known to exist at time of Tender.
- 3. Examine work of other Divisions before commencing this work and report any defect or interference.

### 1.7 DESIGN SERVICES

1. Provide design services for elements of the Work where specified in other sections of Division 20, sealed by a professional engineer licensed in the applicable jurisdiction.

### 1.8 STANDARD OF MATERIAL AND EQUIPMENT

- 1. Materials and equipment:
  - 1. New and of uniform pattern throughout work,
  - 2. Of Canadian, U.S., or North American manufacture where obtainable,
  - 3. Standard products of approved manufacture.
  - 4. Labeled or listed as required by Code and/or Inspection Authorities,
  - 5. Registered in accordance with the requirements of TSSA Boilers and Pressure Vessels Safety Division Guidelines for the Registration of Non-nuclear Fittings in the Province of Ontario.
  - 6. In compliance with Standards and Regulations with respect to
    - 1. chemical and physical properties of materials,
    - 2. design,
    - 3. performance characteristics, and
    - 4. methods of construction and installation.
  - 7. Identical units of equipment to be of same manufacture.
  - 8. Identical component parts of same manufacture in similar units of equipment, but various component parts of each unit need not be from one manufacturer.
- 2. Materials and equipment are described to establish standards of construction and workmanship.
  - 1. Where a manufacturer or manufacturers' products are identified in lists with the phrase "Standard of Acceptance", these are manufacturers and/or products which meet required standards with regard to performance, quality of material and workmanship.
  - 2. Manufacturers and or products used are to be chosen from these lists.



- 3. Select materials and equipment in accordance with manufacturer's recommendations and install in accordance with manufacturer's instructions.
- 4. Materials and equipment not satisfying these selection criteria will be rejected.
- 5. Remove rejected materials from job site and provide properly selected and approved materials.

### 1.9 SUBMITTALS

- 1. SHOP DRAWINGS AND PRODUCT DATA SHEET
  - 1. Submit shop drawings, manufacturers and product data and samples in accordance with Section 01 33 05.
  - 2. Submit shop drawings in the same unit of measure as are used on the drawings. Both metric and imperial measures may be included.
  - 3. Include a shop drawing cover sheet form prepared for this project, for each shop drawing, or, include the same information on the contractors submittal cover sheet. Information required on each submission shall include:

Client/Architect name

Project Name

Stantec project number

Date

Contractor name

Contractor reference No.

Manufacturer name

Product type

Specification section number

Contractor trade: mechanical, electrical, or general trades

If a re-submission, the previous submission Stantec reference number.

- 4. Submit shop drawings in reproducible form;
  - 1. Preferred format: as e-mail attachments in Portable Document Format (PDF)
  - 2. As letter, or 11 x 17, black and white originals of graphic quality suitable for photocopying,
  - 3. for each item of equipment
- 5. Manufacturer's letter sized printed data sheets, as black and white originals of graphic quality suitable for photocopying, are acceptable in place of shop drawings for standard production items.
- 6. Submit with manufacturers data sheets, typed schedules listing manufacturer's and supplier's name and catalogue model number for
  - 1. valves,
  - 2. traps,
  - 3. expansion joints,



- 4. pipe hangers
- 7. Shop drawings and product data to show;
  - 1. dimensioned outlines of equipment
  - 2. dimensioned details showing service connection points.
  - 3. elevations illustrating locations of visible equipment such as gauges, pilot lights, breakers and their trip settings, windows, meters, access doors.
  - 4. description of operation.
  - 5. single line diagrams.
  - 6. mounting and fixing arrangements.
  - 7. operating and maintenance clearances, and
  - 8. access door swing spaces.
- 8. Shop drawings and product data to be accompanied by
  - 1. detailed drawings of bases, supports and anchor bolts,
  - 2. sound power data, where applicable, and
  - 3. performance curves for each piece of equipment marked with point of operation.
- 9. Shop drawing and data sheet submission is taken as certification
  - 1. that units are from Manufacturer's current production and
  - 2. that the units comply with applicable Codes, Standards, and Regulations.
- 10. Do not submit drawings showing internal construction details, component assemblies or interior piping and wiring diagrams. These may be necessary to understand correct functioning of equipment and should be submitted with operating and maintenance data.
- 11. Check and stamp each shop drawing as being correct before submission. Shop drawings without such stamps will be rejected and returned.
- 12. Keep one copy of each reviewed shop drawing and product data sheet on site available for reference purposes.
- 13. Where equipment is delivered without reviewed shop drawing available on site, equipment will be condemned and is to be removed from site and replaced with new equipment after shop drawing has been submitted and reviewed.
- 2. FIELD, FABRICATION, OR INSTALLATION DRAWINGS
  - 1. Contractor field, fabrication, installation, and/or sleeving drawings will not be reviewed as shop drawings. If submitted as a shop drawing, a transmittal only will be returned identifying the submitted drawings have not been reviewed.
  - 2. Maintain a copy on site of such drawings for reference by the Consultant.
  - 3. Provide a copy of such drawings to the Consultant for general information purpose only, upon request.
- 1.10 REFERENCE CODES, STANDARDS, AND REGULATIONS
  - 1. CODES, STANDARDS AND REGULATIONS

- 1. Latest current versions in force at time of Tender.
- 2. Where relevant documents applicable to this work exist, follow these criteria, recommendations, and requirements as minimum standards.
- 3. In the event of conflict between codes, regulations, or standards, or where work shown conflicts with these documents, obtain interpretation before proceeding. Failure to clarify any ambiguity will result in an interpretation requiring application of most demanding requirements.

### 2. CONFINED SPACES

- 1. Unless otherwise prescribed by the Constructor's / Owner's workplace safety program, treat spaces not designed and constructed for continuous human occupancy as "confined spaces", including but not limited to:
  - 1. horizontal and vertical service spaces, shafts, and tunnels,
  - 2. inside of equipment that permits entry of the head and/or whole body, and
  - 3. ceiling spaces that are identified as containing a hazardous substance.
- 3. PERMITS, TESTS AND CERTIFICATES
  - 1. Arrange and pay for permits, tests, and Certificates of Inspection required by Authorities having jurisdiction.
    - 1. Submit variance application to TSSA.
    - 2. Contractor is responsible for all fees with TSSA, including rush applications
  - 2. Submit applications requiring Owner's signature before commencing work.
  - 3. Obtain and submit Inspection Certificates as required for
    - 1. Pressure Vessel Inspection.
    - 2. Fuel safety Inspection.
  - 4. Certificates to be renewed as to remain in force for guarantee period.
  - 5. Co-ordinate and perform testing required by Authorities having jurisdiction in accordance with Clause TESTING in this Section

### 1.11 EQUIPMENT

- 1. MANUFACTURERS NAMEPLATES
  - 1. Provide metal nameplate with raised or recessed lettering, mounted on each piece of equipment.
  - 2. On insulated equipment, mechanically fasten plates on metal stand-off bracket arranged to clear insulation and mount Underwriters Laboratories and/or CSA registration plates on same stand-off brackets.
  - 3. Manufacturer's nameplate to indicate equipment size, capacity, model designation, manufacturer's name, serial number, voltage, cycle, phase and power rating of motors.
- 2. FACTORY APPLIED FINISH PAINTING
  - 1. Apply prime and final paint coats to equipment and materials where specifically detailed in Sections of these Divisions.



- 2. Use heat resistant paint
- 3. Protect factory finished equipment during construction, and clean at completion of work.
- 3. FACTORY APPLIED PRIME PAINTING
  - 1. Have prime paint factory applied to other equipment fabricated from iron or steel including access doors, registers, grilles, diffusers, dampers, metal radiation enclosures and fire hose cabinets.
- 4. FIELD PAINTING
  - 1. After equipment has been installed and piping and insulation is completed, clean rust and oil from exposed iron and steel work provided under this Division, whether it has been factory prime painted.
  - 2. In "un-occupied" areas of the building such as mechanical equipment rooms, boiler rooms, fan rooms, crawl spaces, pipe tunnels and penthouses:
    - 1. paint exposed galvanized metal surfaces with one coat of zinc dust galvanized primer and one coat of 100% Alkyd base enamel in an approved colour.
    - 2. paint exposed iron or steel work with one coat of chrome oxide phenolic base primer and one coat of 100% Alkyd base enamel in an approved colour.
  - 3. In "Unoccupied " areas of the building such as mechanical equipment rooms, boiler rooms, fan rooms, crawl spaces, pipe tunnels and penthouses touch up any damage to prime coat resulting from shipping or installation and leave ready for final painting by Owner's forces.
- 5. PROVISION FOR FUTURE
  - 1. Where space is indicated as reserved for future equipment or for future extension to building, leave such space clear and install piping, raceways and equipment so that connections can be made to future apparatus or building.
  - 2. Identify provisions and service terminations for future on Record Drawings.

### 1.12 OFFICE, STORAGE AND TOOLS

- 1. OFFICE AND STORAGE
  - 1. Provide temporary office, workshop and tools and material storage space.
  - 2. Provide heat, light, telephone and security for these facilities.
- 2. APPLIANCES AND TOOLS
  - 1. Provide tools, equipment, scaffolding, extension cords, lamps and miscellaneous consumable materials, required to carry out work.
- 1.13 CO-ORDINATION
  - 1. GENERAL
    - 1. Consultant drawings are diagrammatic and illustrate the general location of equipment, and intended routing of ductwork, piping, etc, and do not show every structural detail. In congested areas drawings at greater scale may be provided to improve interpretation of the Work. Where equipment or systems are shown as "double line", they are done so either to improve understanding of the Work, or



simply because of the use of a CAD drawing tool, and in either case such drawings are not represented as fabrication or installation drawings.

- 2. Lay out and coordinate Work to avoid conflict with work of other Divisions.
- 3. Make good all damage to Owner's property or to other trade's work caused by inaccurate layout or careless performance of work of this Division.
- 4. When equipment provided under other Sections connects with material or equipment supplied under this Section, confirm capacity and ratings of equipment being provided. Section 20 is intended to define and take all the responsibilities for coordination with all other sections.
- 5. Take information involving accurate measurements from dimensioned Architectural Drawings or at building.
- 6. Install services and equipment which are to be concealed, close to building structure so that furring is kept to minimum dimensions.
- 7. Location of pipes, ductwork, raceways and equipment may be altered without extra cost provided instruction is given or approval is obtained, in advance of installation of items involved. Changes will be authorized by site instructions and are to be shown on Record Drawings.
- 8. Location of floor drains, hub drains, combination drains, plumbing fixtures, convectors, unit heaters, diffuser, registers grilles and other similar items may be altered without extra cost provided instruction is given prior to roughing in. No claim will be paid for extra labour and materials for relocating items up to 3 m (10 ft) from original location nor will credits be anticipated where relocation up to 3 m (10 ft) reduces material and labour.
- 9. Include incidental material and equipment not specifically noted on Drawings or mentioned in Specifications but which is needed to complete the work as an operating installation.

### 2. FIELD, FABRICATION, AND INSTALLATION DRAWINGS

- 1. Prepare field, fabrication, and/or installation drawings to show location of equipment and relative position of services, and to demonstrate coordination with works of other trades. Drawing scale: minimum 1:50 (1/4"=1'-0")
- 2. Use information from manufacturer's shop drawings for each trade and figured dimensions from latest Architectural and Structural Drawings.
- 3. Layout equipment and services to provide access for repair and maintenance.
- 4. Submit drawings to other trades involved in each area and include note in drawing title block as follows:

"This drawing was prepared and circulated for review and mark-up to related subcontractors as noted and initialed in the table below. Corrections and concerns identified through this coordination process have been addressed on this drawing. Areas that incorporate significant changes from layouts shown on Contract Drawings have been circled for Consultants' review"

### 1.14 PROTECTION OF WORK AND PROPERTY

- 1. GENERAL
  - 1. Protect this work and work of other trades from damage.
  - 2. Cover floors with tarpaulins and provide plywood and other temporary protection.



- 3. Assume responsibility for repairing damage to floor and wall surfaces resulting from failure to provide adequate protection.
- 4. Protect equipment, pipe and duct openings from dirt, dust and other foreign materials.

### 1.15 WORK IN EXISTING BUILDING

- 1. GENERAL
  - 1. Work includes changes to existing building and changes at junction of old and new construction.
  - 2. Route pipes, ducts, conduits and other services to avoid interference with existing installation.
  - 3. Relocate existing pipes, ducts, conduits, bus ducts and any other equipment or services required for proper installation of new work.
  - 4. Remove existing plumbing fixtures, lighting fixtures, piping, ductwork, wiring, and equipment to suit new construction. Cut back and cap drain, vent and water outlets, conduits and electrical outlets, not being used.
  - 5. Plumbing fixtures, piping, ductwork, conduit and wiring shown to be removed and not shown relocated, to become property of Contractor and to be taken from site.

### 2. CONTINUITY OF SERVICES

- 1. Connections to existing systems to be made at approved times with minimum length shutdown periods.
  - 1. Obtain written approval of time and length of shut-down periods.
  - 2. Arrange work so that physical access to existing buildings is not unduly interrupted.
  - 3. Make good damage to existing systems resulting from connection process.

### 1.16 MOVING AND SETTING IN PLACE OF OWNER'S EQUIPMENT

- 1. NEW EQUIPMENT
  - 1. Connect mechanical and electrical services to this equipment.
- 2. E.R. OR EX. REL. (EXISTING RELOCATED) OR OTHERWISE SO IDENTIFIED
  - 1. Items so marked on drawings will be
    - 1. moved from their present location and reinstalled by Contractor under Division 1.
  - 2. Disconnect and reconnect mechanical and electrical services to accommodate this equipment relocation.

### 1.17 CLEANING AND FINAL ADJUSTMENTS

- 1. GENERAL
  - 1. Thoroughly clean piping, and vacuum ducts. Clean strainers in piping systems and install clean filters in air handling systems.
  - 2. Remove tools and waste materials on completion of work and leave work in clean and perfect condition.



- 3. Calibrate components and controls and check function and sequencing of systems under operating conditions.
- 4. Supply lubricating oils and packing for proper operation of equipment and systems until work has been accepted.

### 1.18 RECORD DRAWINGS

- 1. SITE RECORDS
  - 1. A set of design drawings in AutoCad 2020 or newer on CD or DVD ROM will be provided by the Consultant. Make sets of white prints for each phase of Work, and as Work progresses and changes occur mark white prints in coloured inks to show revisions. Dimension locations of drains, pipes, ductwork, conduit, and similar buried items within the building, with respect to building column centres. Mark level with respect to an elevation which will be provided.
  - 2. Survey information from excavation and backfill of site services to be held on site, after approval, and to be similarly transferred to white prints.
  - 3. Retain these drawings and make available to Consultant for periodic review.
  - 4. On a weekly basis, scan marked-up drawings to Adobe .pdf format. Where a project has a FTP site, post these files on a weekly basis.
- 2. AS-BUILT DRAWINGS
  - 1. Prior to testing, balancing and adjusting, transfer site record drawing information to AutoCad files, to record final as-built condition. Obtain a current set of CAD files from the Consultant.
    - 1. Drawings are to remain set to and follow Consultants AutoCad Standards. Do not alter drawing scales, X-refs, colours, layers or text styles.
    - 2. The Consultant's CAD files may not reflect all or any construction changes.
  - 2. Where items have been deleted, moved, renumbered or otherwise changed from contract drawings, revise the CAD files to record these changes. "Bubble" these revisions and place these annotations on a separate and easily identified drawing layer.
  - 3. Show on mechanical as-built drawings final location of piping, ductwork, switches, starters, Motor Control Centres, thermostats, and equipment.
  - 4. Show on site services as-built drawings survey information provided by Ontario Land Surveyor (OLS) monitoring services installation.
  - 5. Show on electrical as-built drawings final location of conduit, outlets, panels, branch wiring, system wiring, pull boxes, bus ducts, and equipment.
  - 6. Identify each drawing in lower right-hand corner in letters at least 12 mm (½ in) high as follows "AS BUILT DRAWINGS. This drawing has been revised to show systems as installed" (Signature of Contractor) (Date). The site services drawings are to include (Signature and Stamp of OLS) attached to note.
  - 7. Submit one (1) set of white prints of the draft as-built Cad files for Consultant's review.



- 8. Once "AS BUILT DRAWINGS" white prints are reviewed, transfer Consultant's comments to the CAD files. Return AutoCad drawings modified to "As Built" condition to Consultants on CD or DVD Rom.
- 9. Submit three (3) sets of white prints and three (3) copies of CAD files with Operating and Maintenance Manuals.

### 1.19 OPERATING AND MAINTENANCE INSTRUCTIONS

- 1. START-UP AND TESTING
  - 1. Supply services of skilled mechanic as required, but not for less than 10 days, to start systems in proper sequence, and test and calibrate controls, valves, instrumentation and dampers, and to set-up systems.

### 2. TRAINING

- 1. During this procedure thoroughly explain operation and maintenance of each system, incorporating specialized instruction by manufacturers as described under other Sections in these Divisions.
- 2. Arrange suitable time for instructions with Owner's operating and maintenance personnel.
- 3. Keep record of date and duration of each instruction period together with names of persons attending. Submit signed records at completion of instruction.

### 3. OPERATING AND MAINTENANCE MANUALS

- Provide operation and maintenance data bound in 210 mm x 300 mm x 50mm thick (8½ in x 11 in x 2 in thick) size, vinyl covered, hard back, three-ring covers. Organize material in volumes generally grouped by Trade Section; Site Services, Fuel/Plumbing, Fire Protection, Air Handling, and Controls and Instrumentation, Title sheet in each volume to be labeled "Operating and Maintenance Manual" and to bear Project Name, Project Number, Date, Trade Section, and List of Contents.
- 2. Operating data to include
  - 1. Control schematics for each system.
  - 2. Description of each system and associated control elements.
  - 3. Control operating sequences at various load conditions, reset schedules and anticipated seasonal variances.
  - 4. Operating instructions for each system and each component.
  - 5. Description of actions to be taken in event of equipment failure.
  - 6. Valves schedule and flow diagram.
  - 7. Service piping identification chart.
- 3. Maintenance data to include
  - 1. Manufacturer's literature covering, servicing, maintenance, operating and trouble-shooting instructions for each item of equipment.
  - 2. Manufacturer's parts list.
  - 3. Approved shop drawings.



- 4. Name and address of closest service organization and spare part source.
- 5. Equipment manufacturer's performance sheets.
- 6. Equipment performance verification test results.
- 7. Voltage and ampere rating for each item of electrical equipment.
- 4. Approval procedure
  - 1. Submit two sets of first draft of Operating and Maintenance Manuals for approval.
  - 2. Make corrections and resubmit as directed.
  - 3. Review contents of Operating and Maintenance Manuals with Owner's operating staff or representative to ensure thorough understanding of each item of equipment and its operation.
  - 4. Hand-over two copies of Operating and Maintenance Manuals to Owner's operating staff and obtain written confirmation of delivery.
- 4. SPECIAL TOOLS AND SPARE PARTS
  - 1. Furnish one filter cartridge or set of filter media for each filter or filter bank installed.

### 1.20 TESTING

- 1. GENERAL
  - 1. Methods to comply with following documents
    - 1. The Ontario Building Code
    - 2. Ontario Installation Code for Oil-burning Equipment
    - 3. CSA B139 INSTALLATION CODE FOR OIL-BURNING EQUIPMENT
  - 2. Conduct tests, during progress of Work and at its completion to show equipment and systems meet contract. Submit details of test methods in writing and obtain approval before commencing work.
  - 3. Supply test equipment, apparatus, gauges, meters and data recorders, together with skilled personnel to perform tests and log results.
  - 4. Submit written notice 24 hours in advance of each test series, setting out the time, place and nature of the tests, the Inspection Authority and personnel witnessing tests.
  - 5. Conduct tests before application of external insulation and before any portion of pipes, ducts or equipment is concealed.
  - 6. Do not subject expansion joints, flexible pipe connections, meters, control valves, convertors to test pressures, greater than stated working pressure of equipment. Isolate or remove equipment or devices during tests when prescribed test pressure is greater than working pressure of any piece of equipment or device.
  - 7. Should section of pipe or duct fail under test, replace faulty part with new fittings, pipe or duct, repair and retest. Do not repair screwed joints by caulking nor welded joints by peening. Repeat tests until results are satisfactory.



- 8. Where it is necessary to test portions of duct or piping system before system is complete, overlap successive tests so that no joint or section of duct or pipe is missed in testing.
- 9. Upon completion of work and testing of same, submit logs to demonstrate that tests have been carried out satisfactorily. Repeat any tests if requested.
- 2. TESTING PIPING SYSTEMS
  - 1. Hydraulically test piping systems at 1½ times system design pressure (relief valve setting) or 1000 kPa (150 psi), whichever is greater, for 24 hours. Pressure must remain essentially constant throughout test period without pumping. Make allowance for correction of pressure readings for variations in ambient temperature between start and finish of test. Hammer test welded joints during hydrostatic test.
  - 2. Test fuel oil systems to CSA B139
  - 3. Test drainage, waste and vent piping for tightness and grade as required by the Ontario Building Code, Part 7.
  - 4. Test special service piping as detailed.
- 3. TESTING VENTILATION
  - 1. Test ductwork in accordance with procedures detailed.
  - 2. Test low pressure ductwork with an air pressure of 1 Kpa (4 in wg) for 10 minutes.
  - 3. Test medium pressure ductwork with an air pressure of 2 Kpa (8 in wg) for 10 minutes.
  - 4. Test high pressure ductwork with an air pressure of 3 Kpa (12 in wg) for 10 minutes.
  - 5. Examine construction joints for damage or weakening. Reduce pressure to maximum working pressure or 1 Kpa (4 in wg), whichever is larger, and check joints for audible leaks. Mark each leak and repair after pressure is released. Retest repaired section of duct.

### 1.21 TEMPORARY AND TRIAL USAGE

- 1. GENERAL
  - 1. Temporary and trial usage by Owner of any mechanical or electrical device, machinery, apparatus, equipment or any other work or materials before final completion and written acceptance is not to be construed as evidence of acceptance.
  - 2. Owner has privilege of such temporary and trial usage, as soon as that said work is claimed to be completed and in accordance with Contract Documents, for such reasonable length of time as is sufficient for making complete and thorough tests.
  - 3. No claims for damages will be entertained for injury to or failure of any parts of such work which may be discovered during temporary and trial usage, whether caused by weakness or inaccuracy of structural parts or by defective materials or workmanship of any kind whatsoever.
  - 4. Defects in workmanship and materials identified during temporary and trial usage are to be rectified under guarantee.



### 1.22 CONSULTANT REVIEWS

- 1. GENERAL
  - 1. Consultant's attendance at site including but not limited to site meetings, demonstrations, site reviews and any resulting reports are for the sole benefit of the Owner and the local authority having jurisdiction.
- 2. SITE REVIEWS
  - 1. General reviews and progress reviews do not record deficiencies during the Work until such time as a portion or all of the work is declared complete. In some instances, before the work is completed, deficiencies may be recorded where the item is indicative of issues such as poor workmanship, incorrect materials or installation methods, or may be difficult to correct at a later date. Any such reported items, or lack thereof, shall not be relied on in any way as part of the Contractors quality assurance program nor relieve the Contractor in the performance of the Work.
  - 2. Deficiency reviews conducted by the Consultant are performed on a sampling basis, and any deficiency item is to be interpreted as being indicative of similar locations elsewhere in the Work, unless otherwise shown.
- 3. MILESTONE REVIEWS
  - 1. Specific milestone reviews are conducted at key stages by the Consultant, including:
    - 1. Before backfilling of buried piping
    - 2. Before closing of shafts
    - 3. Equipment demonstration
    - 4. Substantial Performance deficiency review
    - 5. Total Performance deficiency review.
  - 2. Coordinate with the Consultant the type and quantity of milestone reviews required and incorporate these requirements in the construction schedule.
  - 3. Notify the Consultant in writing five (5) calendar days in advance of work to be concealed to arrange a site review prior to the Work being concealed. Any noted deficiencies are to be corrected and reviewed again by the Consultant before being concealed. Failure to provide notification can result in the Work being exposed for review at the Contractor's cost.

### 4. WARRANTY

- 1. At completion, submit written warranty undertaking to remedy defects in work for a period of one year from date of substantial completion. This warranty is not to supplant other warrantees of longer period called for on certain equipment or materials.
- 2. Warranty to encompass replacement of defective parts, materials or equipment, and to include incidental fluids, gaskets, lubricants, supplies, and labour for removal and reinstallation work.
- 3. Submit similar guarantee for one year from date of acceptance for any part of work accepted by Owner, before completion of whole work.



### 5. FINAL REVIEW

- 1. At project completion submit written request for final review of mechanical and electrical systems.
- 2. Refer to section 20 08 19 Project Close-Out.

### 1.23 QUALIFICATIONS AND AUTHORITIES

- 1. SCOPE
  - 1. Qualification requirements for tradesmen in the province of Ontario.
  - 2. Registration and inspection of systems.
- 2. QUALIFICATIONS
  - 1. TRADES QUALIFICATION AND APPRENTICESHIP ACT

Tradesmen to hold certification of applicable trades:

Construction Millwright, O.Reg. 1048

Electrician, O.Reg. 1051

Plumber, O.Reg. 1073

Refrigeration and air-conditioning mechanic, O.Reg. 75/05

Sheet metal worker, O.Reg. 1077

Sprinkler and fire protection installer, O.Reg. 1078

Steamfitter, O.Reg. 1079

Oil burner technician (OBT)

Petroleum Mechanic (PM)

### 2. TECHNICAL STANDARDS AND SAFETY AUTHORITY ACT 2000

- 1. Manufacturers and installers of regulated pressure piping parts and systems shall hold certificates of authorization under Boilers and Pressure Vessels O.Reg. 220/01, for pressure piping systems, CSA B51 Boiler, Pressure Vessel and Pressure Piping Code
- 2. Installers to hold certificates of authorization made under Fuel Industry Certificates O.Reg. 215/01 for Fuel Oil, O.Reg. 213/01

### 3. AUTHORITIES, REGISTRATION AND INSPECTION

1. ONTARIO BUILDING CODE

Submit and pay for building permit, and arrange for inspections, for plumbing and HVAC. Application for Building Permit including plumbing and HVAC has been made by the Owner. Arrange and coordinate for required municipal inspections as required under the Ontario Building Code.

- 4. TECHNICAL STANDARDS AND SAFETY AUTHORITY
  - 1. Arrange, provide documentation, and pay for registration, field inspection and variance approvals (where variance approval is required) of the fuel oil and fuel safety system.



### PART 2 – PRODUCTS

2.1 N/A

### PART 3 – EXECUTION

3.1 N/A

**END OF SECTION** 



### PART 1 – GENERAL

- 1.1 SCOPE
  - 1. Excavation and backfilling for work of Division 20, outside of building, including shoring design and supply.
  - 2. All excavation to be performed using hydrovac services
  - 3. All excavation and backfilling work shall be executed under a work plan and approved method of procedure, to be coordinated with and approved by building operations and the owner's consultant

### 1.2 POSITION AND EXTENT OF EXISTING SERVICES

- 1. Existing buried services and other services shown have been taken from available information.
- 2. Check field conditions and report any discrepancies before commencing work.
- 3. Contractor shall perform full underground locates for full extent of proposed excavation areas prior to commencing work
- 4. Engage services of water supply, drainage, electric supply, telephone and gas authorities to assist in locating services on and around site.

### 1.3 APPLICABLE CODES AND STANDARDS

- 1. ASTM D698, Test method for Laboratory compaction characteristic of soil using standard effort.
- 2. Ontario Occupational Health and Safety Act and Regulations for Construction Projects with respect to trench excavation.
- 3. Ontario Provincial Standard Specification 514 Construction Specification for Trenching, Backfilling, and Compacting
- 4. Ontario Provincial Standard Specification 1010 Material Specification for Aggregates Base, Subbase, Select Subgrade, and Backfill Material
- 5. Ontario Water Resources Act, and Regulations.
- 6. Uniform Traffic Control Devices for Canada (UTCD)
- 7. Manual of Uniform Traffic Control Devices for Streets and Highways (MUTCD), US FHWA, Part IV

### 1.4 SUBMITTALS

1. Co

### **PART 2 – PRODUCTS**

- 2.1 BACKFILL MATERIALS
  - 1. As defined in OPSS 1010:
    - 1. Granular 'A'
    - 2. Granular 'B' and
  - 2. Select subgrade material;



- 1. lean coarse granular material containing stones not more than 25 mm (1 in) in size and free from organics, silt, rubble, and clay lumps,
- 2. approved native soil.

### PART 3 – EXECUTION

### 3.1 EXCAVATION

- 1. Saw cut asphalt, pavements, curbs and sidewalks before proceeding with excavation. Layout cuts for approval before commencing work.
- 2. Prepare excavation for underground services of depth and dimensions so that no portion of any pipe bears directly against any rock or other hard surface.
- 3. Cut and trim banks of excavations and shore to prevent caving in. Limit width of excavation from invert up to "crown" of pipe to not more than twice outside diameter of pipe for pipe sizes up to 300 mm (12 in). For larger sizes limit width of excavation to outside diameter of pipe plus 300 mm (12 in).
- 4. Break up and remove rocks and boulders from excavation. Use drilling and wedging to remove rock encountered in trench. Blasting will not be allowed unless approved and authorized in writing.
- 5. Store materials excavated during progress of work to produce minimum of damage or disfigurement of existing ground.
- 6. Keep sides and bottoms of excavations from freezing and protect work from damage due to weather conditions. Excavate in limited lengths to enable protective measures to function efficiently during pipe backfilling.
- 7. Backfill trenches or provide sheeting, sheet piling or bracing to support trench walls and fence perimeter of work area or cover trench opening with steel plates when work area is not supervised.

### 3.2 PIPE LAYING AND SUPPORT

- 1. Bedding class for buried piping to be as defined in OPSS 514.
- 2. Grade bottom of excavations for pipes to achieve specified slope.
- 3. Inside building;
  - 1. Form bottom of trench in earth so that pipe is supported on solid bed of undisturbed earth free from debris or stones exceeding 25 mm (1 in) in diameter. Shape earth to fit lower one-third segment of pipes and hubs, care being taken to ensure even bearing along barrels.
  - Support piping installed in unstable or filled ground on reinforced 15 Mpa (2500 lb) concrete pad or piers. Shape concrete support to provide bearing for at least lower one-third of circumference of pipe.
  - 3. Support piping installed under framed slabs over unstable or filled ground with mastic-coated clevis hangers and hanger rods or formed hangers tied to slab rebar, arranged as for suspended drainage piping. Support piping temporarily on earth within excavation without backfill and cover trench with plywood. Secure hanger rods to slab reinforcing steel. Use bronze hanger rods in corrosive fill.
- 4. Outside building:
  - 1. Form bottom of trench in earth so that pipe is supported on Class "B" bedding.
  - 2. Support piping installed in unstable or filled ground on Class "A" 15 Mpa (2500 lb) concrete bedding.



- 3. Grade bottom of excavations for pipes to achieve specified slope.
- 4. Place pipe and fittings in trench with invert conforming to elevations, slopes and alignment.
- 5. On grades exceeding 10 percent, pipe to be laid uphill with compacted fill "collars" at each joint.
- 6. Support piping, conduits and duct banks passing through backfill at building foundation walls and at manholes and catch basins on 150 mm (6 in) thick reinforced concrete pads. Dowel concrete pads into side of manholes and catch basins and extend sufficiently to obtain minimum bearing of 600 mm (2 ft) on undisturbed ground.
- 7. Where excavation has been carried to greater depth than required, replace with Granular 'A' material compacted in 150 mm (6 in) lifts to achieve 95% modified Proctor compaction or 10 Mpa (1500 lb) concrete.
- 8. Do not lay pipe in standing or running water. Prevent surface run-off from entering trench.
- 9. When ground water is present in work area, dewater by bailing or pumping to maintain stability of trench and backfilled areas, and control water level below pipe bedding. Maintain control of water in trench before, during and after pipe installation, and until sufficient backfill has been placed to prevent floatation of pipe.
- 10. When pipe laying is interrupted, secure piping against movement and seal open ends to prevent entrance of water, mud, debris or foreign material
- 5. Wall Penetrations:
  - 1. Over-excavate trench for one and half pipe diameters below invert for distance of 600 mm (2 ft) from face of wall.
  - 2. Pipe to be fitted through steel sleeve that is sized to suit link-seal unit..
  - 3. Fit link seal between sleeve and pipe and tighten.
  - 4. Backfill over excavated area up to invert of pipe with compacted pea gravel, crushed stone, or crushed gravel with grain size of less than 25 mm (1 in).
  - 5. Backfill remainder of trench in accordance with procedures described below.[][
- 6. Road or rail crossing
  - 1. Compact trench bed along route of road or rail crossing and at each end.
  - 2. Install corrugated casing of sufficient length to extend 600 mm (2 ft) beyond road compaction wedge on each side of roadbed.
    - 1. Standard of Acceptance
      - .1 Armco
  - 3. Install centralizing fins or padding on pipe every 3 m (10 ft) and at each end of casing.
  - 4. Slide pipe inside corrugated casing with fins in place.
  - 5. Install and tighten link seals at each end of casing.
  - 6. Backfill casing in accordance with procedure for trenches under building floors, roads, curbs, walks, and paved areas described below.]



### 3.3 IDENTIFICATION INSTALLATOIN

- 1. Install continuous metallic underground warning tape identification during backfilling of excavations for fuel oil piping. Locate tape 6 inches to 8 inches below finished grade, directly over piping. Tapes shall be polyethylene plastic tape with metallic core, 6" wide by 4 mils thick. Include solid yellow background with continuously printed caption in black letters.
  - 1. Caption for storage tanks: "CAUTION BURIED FUEL OIL STORAGE TANK BELOW."
  - 2. Caption for piping: "CAUTION BURIED FUEL OIL PIPING BELOW."

### 3.4 BACKFILLING

- 1. Do not commence backfilling over services until testing is complete and approval has been obtained.
- 2. Do not use frozen material for backfilling nor place any backfilling on or against frozen earth.
- 3. Under roads, curbs, walks, and paved areas;
  - 1. Backfill entire trench with Granular 'A' material compacted in 150 mm (6 in) lifts to achieve 95% modified Proctor compaction
- 4. Spaces around manholes, sumps, and catch basins;
  - 1. Backfill with Granular 'A' material brought up to height of at least 600 mm (2 ft) above top of pipes.
  - 2. Fill remainder of trench with Select subgrade material laid down, compacted, watered and consolidated in one foot layers. Consolidate material carefully so that walls are not damaged and support for piping entering or leaving concrete structure is undisturbed.
- 5. Backfill excavation in close proximity to and below any footing level with 10 Mpa (1500 lb) concrete to level of top of highest adjacent footing.
- 6. Withdraw shoring before backfilling and fill voids left on removal of supports with Granular A.
- 7. Minimize localized loadings and differential settlement wherever pipe crosses other utilities or subsurface structures.
- 8. Provide cushion of Granular 'A' bedding between pipe and any subsurface structure.

### 3.5 RESTORATION OF WORK AREA

- 1. Make up settlement of backfill in roads and walks, as it occurs, and minimize inconvenience to traffic in and around work.
- 2. After period adequate to reveal settlement has passed, fill depressions to restore correct grade.
- 3. Remove and dispose of excess excavated material, and leave site clear and unencumbered.
- 4. Make good damage to roads, curbs, lawns, walks, and paved areas caused by excavation, backfill, settlement and subsequent restoration.
- 5. Support, backfill and restore surface finishes for existing underground piping, conduit or other services uncovered during excavation.



### 3.6 TRAFFIC CONTROL

- 1. General
  - 1. Comply with requirements of Owner's standards and facility traffic control guidelines for use of roadways upon or over which it is necessary to carry out work or haul materials or equipment.
  - 2. When working on traveled way:
    - 1. Place equipment in position to present minimum of interference and hazard to traveling public.
    - 2. Keep equipment units as close together as working conditions permit and preferably on same side of traveled way.
    - 3. Do not leave equipment on traveled way overnight.
  - 3. Do not close any lanes of road without approval of Owner and Consultant, as documented in an approved workplan and method of procedure
  - 4. Before re routing traffic, erect suitable signs and devices
  - 5. Keep traveled way graded, free of pot holes and of sufficient width for required number of lanes of traffic.
- 2. Informational Signs and Warning Devices
  - 1. Provide and maintain signs and other devices required to indicate construction activities or other temporary and unusual conditions resulting from project work which requires road user response.
  - 2. Supply and erect signs, delineators, barricades and miscellaneous warning devices as required in in Owner's standards
  - 3. Place signs and other devices in locations recommended.
  - 4. Meet with facility operations prior to commencement of work to prepare list of signs and other devices required for project. If situation on site changes, revise list to approval of facility operations.
  - 5. Continually maintain traffic control devices in use by:
    - 1. Checking signs regularly for legibility, damage, suitability and location. Clean, repair or replace to ensure clarity and reflectance.
    - 2. Removing or covering signs which do not apply to conditions existing from day to day.
- 3. Control of Public Traffic
  - 1. Provide flag persons, trained in accordance with, and properly equipped as specified in UTCD manual and Ontario Provincial Standards for Roadways and Public Works, in following situations;
    - 1. Where temporary protection is required while other traffic control devices are being erected or taken down.
    - 2. For emergency protection when other traffic control devices are not readily available.
    - 3. In situations where complete protection for workmen, working equipment and public traffic is not available.

### END OF SECTION



### PART 1 – GENERAL

- 1.1 SCOPE
  - 1. Provide commissioning of mechanical systems provided under Division 20.
  - 2. Mechanical system installation, start up, testing, balancing, preparation of O&M manuals and operator training are the responsibility of the Division 20 Contractors, with the coordination of the commissioning process the responsibility of the General Contractor/ Construction Manager.

### 1.2 REFERENCE STANDARDS

1. Comply with the latest edition of ASHRAE Guideline 1 1996 The HVAC Commissioning Process, as amended herein.

### 1.3 COMMISSIONING PROCESS

- 1. The Commissioning process develops, coordinates, and documents the following:
  - 1. Equipment start up
  - 2. Control system calibration
  - 3. Testing and balancing
  - 4. Verification and Performance Testing
  - 5. Operation documentation
  - 6. Operator training
- 2. The Commissioning Program is divided into the following parts:
  - 1. Part 1: Pre-Start and Start-Up testing
  - 2. Part 2: Installation Verification testing
  - 3. Part 3: Performance Validation testing
  - 4. Part 4: Systems Operating Manuals
  - 5. Part 5: Operator Training

### 1.4 WORK INCLUDED

- 1. Commissioning work of Division 20 includes, but is not limited to:
  - 1. Testing and start up of equipment.
  - 2. Testing, adjusting and balancing of air systems.
  - 3. Cooperation with the Commissioning Authority in developing and implementation of the commissioning plan.
  - 4. Providing qualified personnel for participation in implementing commissioning test procedures, including seasonal testing required after the initial testing.
  - 5. Providing equipment, materials, and labour as necessary to correct construction and/or equipment deficiencies found during the commissioning process.
  - 6. Providing operation and maintenance manuals, and as built drawings to the Commissioning Authority for verification.


- 7. Providing training and demonstrations for the systems specified in this Division.
- 2. Conduct complete and thorough evaluation and documentation of the operation and performance of all components, systems, and sub systems, including the following equipment and systems:
  - 1. Air handling systems
  - 2. Building Automation Systems
  - 3. Fuel systems
  - 4. Generator Systems
- 3. Commission services to equipment, but not the equipment itself, where the supply of the equipment does not form part of the mechanical Work.
- 4. Provide the following commissioning documentation:
  - 1. recording completed Pre start and Start up procedures test results,
  - 2. recording completed Installation Verification and Performance Validation test results,
  - 3. As-built records.
  - 4. Operation and maintenance manuals
- 5. The final commissioning report will be prepared by the Commissioning Authority.

## 1.5 EXCLUDED WORK

1. Unless otherwise specified, equipment which is not supplied by the mechanical contractor or their sub-trades, where the value for the supply of equipment is not included as part of the Work, such as equipment marked Not in Contract (NIC) or Not in Mechanical Contract (NIMC).

## 1.6 DEFINITIONS

- 1. Major deficiency an item which if not corrected renders the equipment or system unsuitable or unsafe for use by the Owner. Major deficiencies must be corrected as a condition for achieving Substantial Performance.
- 2. Minor deficiency an item which does not impact on the operation of the equipment or system and will allow the Owner to use the system safely. Minor deficiencies may be corrected before or after Substantial Performance, but will not prevent certification of Substantial Performance of the Work.

## 1.7 COMMISSIONING SCHEDULE

- 1. Provide a detailed commissioning schedule for consolidation into the main construction schedule.
- 2. Include:
  - 1. equipment and systems start-up predecessors
  - 2. time periods for pre-start and start up testing, verification and validation testing for each equipment and system.



#### 1.8 DOCUMENTATION DELIVERABLES

- 1. Identify documents including test documents, binder covers, etc. using equipment ID numbers provided on equipment schedules.
- 2. Scan original signed test reports, including verification and performance test reports, manufacturers service reports, etc. in PDF format. For original document chapters, provide Adobe chapter referencing.
- 3. Submit three (3) copies of each completed and accepted Verification and Functional Performance Test reports, both preliminary and final issues.
- 4. Collate final, accepted and signed test results in separate binders as follows:
  - 1. Fuel Systems
  - 2. Ventilation and Exhaust Systems
  - 3. Building Automation Systems
- 5. Provide three (3) CD R or DVD R copies of commissioning documentation.

## 1.9 SUBSTANTIAL PERFORMANCE

- 1. Substantial Performance
- 2. Application for Substantial Performance of the Work is precedent on the Work being ready for Owner's use which includes completion of the following commissioning elements:
  - 1. Start-Up and testing, including TAB reports,
  - 2. Commissioning Verification testing including submission of completed records,
  - 3. Commissioning Performance Validation testing including submission of completed records, except for alternate season tests,
  - 4. Commissioning Controls Validation testing,
  - 5. Training of Owner's operations personnel,
  - 6. As-built documentation issued for Consultant's review,
  - 7. Operations and Maintenance manuals which have been reviewed by the Consultant and accepted by the Owner.

## 1.10 TEST EQUIPMENT

- 1. Furnish tools and equipment required during the commissioning process.
- 2. Utilities (water, gas, fuel oil, electrical power) are provided by the Owner
- 3. Provide any proprietary test equipment and software required by equipment manufacturer for programming and / or start up, whether specified or not.
- 4. Manufacturer provides test equipment, demonstrate its use, and assists in the commissioning process as needed.
- 5. Turn-over proprietary test equipment to the Owner upon completion of the commissioning process, where such requirement is specified in the relevant equipment specification sections.



## PART 2 – ORGANIZATION

#### 2.1 GENERAL

- 1. Complete all phases of work so that the systems can be started, tested, balanced, and owner's acceptance procedures be undertaken in a timely manner such that only one acceptance test is conducted at any one time.
- 2. Participate and assist in the development of the Commissioning Plan and schedule by the General Contractor, by providing necessary information pertaining to the equipment and installation. Provide commissioning schedule information to be incorporated into the overall Construction Plan schedule.
- 3. Acceptance procedures may begin prior to completion of a system and/or sub system. Start of acceptance procedures before system completion does not relieve the Contractor from completing those systems in accordance with the commissioning and construction schedule.

#### 2.2 PARTICIPANTS

- 1. Commissioning Team consists of multiple parties with separate responsibilities.
- 2. Owner:
  - 1. establishes acceptance criteria,
  - 2. provides operations staff to receive training, and to witness any or all tests at their discretion,
  - 3. final acceptance of commissioning results.
- 3. Design Consultant / Commissioning Authority:
  - 1. responsible for the construction review activities in accordance with local building code requirements,
  - 2. develops commissioning plan and procedures,
  - 3. coordinates Owner's commissioning team members who witnesses tests,
  - 4. selectively witnesses commissioning tests on an audit basis to confirm compliance by the Contractor to the Commissioning Plan,
  - 5. reviews commissioning test results and makes recommendations to the Owner for acceptance.
- 4. General Contractor / Construction Manager:
  - 1. coordinates and manages commissioning activities,
  - 2. develops and integrates commissioning activities into the construction schedule,
  - 3. ensures commissioning procedures are completed and documented, and commissioning records including any required attachments are submitted.
- 5. Mechanical trades Contractors:
  - 1. Provide the services of qualified technician(s) who are familiar with the construction and operation of the system, to start up and debug equipment and systems within the Division 20 scope of Work. Include for labour, materials, and subsistence costs for these same technicians to assist the Commissioning Authority in completing the commissioning program.



- 2. Provide access to the contract plans, shop drawings, and equipment cut sheets of all installed equipment.
- 3. Ensure the qualified technician(s) are available and present during commissioning testing to complete the tests, make adjustments and to assist in problem resolutions.
- 4. Should any equipment or system experience performance problems and/or reconstruction or replacement of comments is required, include for additional technician time for subsequent retesting of systems until required system performance is achieved.
- 5. The Commissioning Authority reserves the right to approve proposed technicians with regard to the technical skill level required for each type of equipment and/or system, and a willingness by the individual(s) to work within the Commissioning Group.
- 6. Controls Contractor, in addition to the requirements described above:
  - 1. Provide test reports using own documentation formats, for wiring tests, loop testing, loop tuning, and sequence functional tests.
  - 2. Provide details of the control system, schematics, and a narrative description of control sequences of operation.
- 7. Electrical Contractor:
  - 1. provide a foreman electrician familiar with the electrical interlocks, interfaces with emergency power supply, and interfaces with alarm and life safety systems. Provide access to the contract plans, and all as built schematics of sub systems, interfaces and interlocks.
- 8. Equipment suppliers:
  - 1. provide the services of manufacturers' service personnel to provide assistance with pre start and initial start up of the equipment, as required.

# PART 3 – EXECUTION

- 3.1 COMMISSIONING MEETINGS
  - 1. Conduct, chair, and record commissioning meetings.
  - 2. Pre construction:
    - 1. participate in a pre construction meeting of commissioning team members, to familiarize parties with the commissioning process, and to ensure that the responsibilities of each party are clearly understood.
  - 3. Construction and Post Construction:
    - 1. participate in commissioning meetings as scheduled by the General Contractor.
    - 2. participate in trade commissioning meetings as required, in addition to the regular commissioning team meetings,
    - 3. identify to the commissioning group problems relating to the commissioning schedule, identification of start up issues, etc, and participate in the resolution of these problems.



## 3.2 COMMISSIONING PROCEDURES

- 1. The Owner's Design Consultant / Commissioning Authority provides the commissioning procedures (checklists, etc.) for use by the contractor.
- 2. Each commissioning procedure tests the equipment and systems, and consists of the following elements:
  - 1. Document sign-off
  - 2. Pre-start and Initial test
  - 3. Installation Verification Equipment
  - 4. Installation Verification Systems
  - 5. Performance Validation
  - 6. Controls Validation
  - 7. Appendices.
- 3. Document Sign Off:
  - 1. each completed procedure is signed off by the following parties:
    - 1. Contractor, for testing,
    - 2. Commissioning Consultant, for review and witnessing,
    - 3. Owner, for test acceptance.
- 4. Pre Start and Initial Test:
  - 1. Checklists included: confirmation of authorities inspections, pre start safety checks (where applicable), system cleaning and pressure testing, and confirmation of availability of supporting systems.
- 5. Installation Verification Equipment
  - 1. Checklists to verify the installation of equipment, including: design specification requirements, drawing requirements, manufacturer installation requirements, and other experience related items.
  - 2. Use of pre printed manufacturer installation and start up checklists are permitted and encouraged; however, the commissioning procedure checklists may contain supplemental items.
- 6. Installation Verification Systems:
  - 1. Checklists to verify the installation of the system associated with the equipment.
- 7. Performance Validation:
  - 1. Specific test procedures and record documentation requirements for performance measurements of the various systems.
- 8. Controls Validation:
  - 1. Step by step testing methodologies to prove the functional operation of control systems, for normal and abnormal operating conditions, and alarm conditions.
- 9. Appendices:
  - 1. Collate test reports from authorities having jurisdiction, manufacturer start-up and test reports, balancing reports, etc.



#### 3.3 COMMISSIONING TEST METHODOLOGY

- 1. Step 1: complete the pre-start, start-up and testing, and adjusting and balancing tests. On completion of this phase, complete the related documentation and submit to the Commissioning Authority and Consultant.
- 2. Steps 2 and 3: on completion of Step 1, conduct the Verification and Validation testing of the operating systems. Identify deficiencies and correct. After the deficiencies have been corrected, notify the Commissioning Authority and agree on dates to demonstrate the commissioned systems.
- 3. Step 4: where the Commissioning Authority identifies systems which require witness demonstration, repeat Steps 2 and 3. These demonstrations may be coordinated with training demonstrations of Owner's operations staff.
- 4. On completion of systems which do not require witness demonstration, finalize the report and submit to the Commissioning Authority and the Consultant for review.
- 5. On completion of systems which have been witness demonstrated, the Commissioning Authority is to sign-off the completed document, before they are issued for review.

#### 3.4 COMMISSIONING IMPLEMENTATION

- 1. Conduct operating tests and checks to verify that all components, equipment, systems, and interfaces between systems, operate in accordance with contract documents.
- 2. Demonstrate and verify operating modes, interlocks, specified control sequences, specific responses to abnormal or emergency conditions, and verification of the proper response of the Building Automation System.
- 3. Validate the results of the TAB report.
- 4. Roles and Responsibilities:

Test sheets provided by:	Commissioning Authority		
Testing Conducted by:	Div 20 Contractors		
Testing recorded by:	Div 20 Contractors		
Tests witnessed by:	Design Consultant		
	Commissioning Authority (selected tests)		
Reports reviewed by:	General Contractor		
	Commissioning Authority		
	Design Consultant		
	Owner		
Reports Accepted by:	Owner		

#### 3.5 OPERATING CHECKS

- 1. The Commissioning Authority witnesses selected equipment and system tests on an audit basis.
- 2. Set the system equipment into operating mode to be tested including but not limited to:
- 3. Inspect and verify the position of each device and interlock identified on the checklist.
- 4. Repeat the above tests for each operating cycle that applies to the system being tested.
- 5. Check the operating condition of the following elements during all modes of operation of the system:
- 6. For failed test items, provide appropriate comments to the checklist data sheet and classify whether it is a "Major" or "Minor" deficiency.



- 1. The Design Consultant / Commissioning Authority retains the right to make the final decision regarding classifications of deficiencies.
- 7. Verify the operational control of the systems through the Building Management System as follows:
  - 1. TAB airflow rates and calibrate terminal boxes in all modes of operation
  - 2. Equipment operation in both heating and cooling modes.
  - 3. Minimum outdoor air intake positions, air side economizer cycles, and multi set outdoor air damper positions as required for each operating sequence and mode.
  - 4. Building pressurization and other specialty programs
- 8. Verify the proper responses of instrumentation and control devices (actuators) as follows:
  - 1. For each controller or sensor, record the indicated monitoring and control system reading, and the test instrument reading.
  - 2. If the initial test indicates that the test reading is outside of the control range of the installed device, check the calibration of the installed device and adjust as required. Re-test the deficient device and record the results on the checklist data sheets.
- 9. The Commissioning Authority witnesses the field verification of the final TAB report as follows:
  - 1. Select, at random, 10% of the report data for verification.
  - 2. The TAB contractor will be provided advance notice of the date of retesting, but not the equipment to be tested.
  - 3. The TAB contractor uses the same equipment and instruments used for collecting the original data.
- 10. Test failure is defined as:
  - 1. For all readings other than sound, a deviation of more than 10 percent from the TAB report results.
  - 2. For sound pressure readings, a deviation of 2 dB at any bandwidth, not including differences in background noise readings.
  - 3. A failure rate greater than 10% of the selected items (1% of all TAB test results) will result in rejection of the final TAB report.
- 11. Acceptance
  - 1. The final reports will be reviewed by the Commissioning Authority and the Consultant, to determine if verification is complete and the operating systems are functioning in accordance with the contract documents.
  - 2. The Commissioning Authority, in conjunction with the Consultant, reviews and makes final classification of all noted deficiencies. Correct deficiencies classified as "Major" before acceptance of the Verification stage.
  - 3. The Owner will make the final acceptance of test results.

## 3.6 PERFORMANCE VALIDATION TESTING

1. Conduct performance tests and checks to validate that the ventilation system components are providing the required airflow at the design supply air temperature and required static pressure.



#### 3.7 PROBLEM RESOLUTION

- 1. In the event that additional work is required to either correct systems, misapplied equipment, and/or deficient performance under varying load conditions, assist the Owner and Commissioning Authority in developing an acceptable resolution to the problem, including the resources of equipment suppliers.
- 2. The Owner has final approval over any additional work required to achieve the required level of performance.
- 3. Complete corrective work in a timely fashion to permit the completion of the commissioning process.

#### 3.8 ACCEPTANCE

- 1. Any identified deficiencies will be reviewed by the Consultant in conjunction with the General Contractor/Construction Manager to determine if correction of the deficiency is the result of a defect in the equipment or installation.
- 2. If it is determined the performance deficiency is the result of a defect in the equipment or its installation, rectify the deficiency and repeat the performance test until the required performance levels are achieved.
- 3. If it is determined the equipment or system has been constructed in accordance with the contract documents, the Owner will decide whether to accept the performance as is, or, direct the installation contractor to make changes to the system as required to obtain performance levels which meet the design intent, and retest the system.

#### 3.9 ADDITIONAL COMMISSIONING

1. Additional commissioning activities may be required after completion of system performance testing. Include in the tender cost a reasonable reserve to complete this work, including assistance from manufacturers' service technicians.

#### 3.10 SYSTEMS OPERATING MANUALS

- 1. Provide Operating and Maintenance Manuals in accordance with the requirements of section 20 01 01.
- 2. The Systems Operating Manuals (SOM) are in addition to the Operating and Maintenance Manuals (OMM) required under Section 20 01 01.

## 3.11 TRAINING

- 1. Equipment Training: Provide equipment training in accordance with Section 20 01 01. The manufacturer's representative training will emphasize operating instructions and preventative maintenance.
- 2. Systems Training:
  - 1. In addition to the equipment training described above, provide additional training to describe the operational requirements and design intent of each system.
  - 2. Include classroom instruction, delivered by competent instructors. Place emphasis on overall systems diagrams and descriptions, and design criteria and conditions.
  - 3. If required, obtain and pay for the services of the Design Consultant to provide the instructor services and to provide lecture material for inclusion in the training manual.



- 4. Training topics to include:
  - 1. Types of installed systems
  - 2. Design intent and design criteria
  - 3. Design constraints
  - 4. Different operating modes at rest, running, normal, emergency conditions
  - 5. System operation
  - 6. Automatic controls
  - 7. Service, maintenance, diagnostics and repairs
  - 8. Use of reports and logs
  - 9. Troubleshooting
- 5. Structure each session to start with the classroom instruction for the overall system, followed by hands on instruction for each equipment, with the services of the manufacturers' representative as required. Demonstrate the start up and shut down of each system.
- 6. Organize and schedule each training session to deliver the required instruction in an efficient and effective manner on a schedule agreed upon with the Owner. Allow for two (2) training sessions for each topic, separated by approximately one week each, to allow for shift coverage.
- 7. Structure each training session based on type of maintenance personnel attending the training session, i.e., Plumbers, fitters, general maintenance, controls technicians, etc. Develop the proposed training plan and obtain approval from the Owner before commencing the training.
- 8. Complete the training as close to Substantial Performance as possible, so that the Owner's operations staff are prepared to operate the system after Substantial Performance is certified.
- 3. Training Manuals
  - 1. Provide training material hand outs for each session.
  - 2. Collect training material and bind into separate binders.

# END OF SECTION



## PART 1 – GENERAL

- 1.1 SCOPE
  - 1. Provide fuel oil systems.
- 1.2 SHOP DRAWINGS
  - 1. Submit manufacturer's data sheets for valves, special piping, and oil pumps with model numbers, performance and design data, outline dimensions and power requirements.

## 1.3 APPLICABLE CODES AND STANDARDS

- 1. Legislation:
  - 1. Technical Standards and Safety Act, 2000, S.O. 2000, c. 16
  - 2. O.Reg. 223/01 Codes and Standards Adopted by Reference
  - 3. O. Reg. 216/01 Certification of Petroleum Mechanics
  - 4. O. Reg. 215/01 Fuel Industry Certificates
  - 5. O. Reg. 213/01 Fuel Oil
  - 6. O. Reg. 213/07 Fire Code
  - 7. O. Reg. 163/24 Building Code
- 2. Installation standards:
  - 1. CSA B139 Installation code for oil-burning equipment
  - 2. CSA C282 Emergency Electrical power supply for buildings
  - 3. NFPA 30 Flammable and Combustible Liquids Code
  - 4. NFPA 31 Standard for Installation of Oil Burning Equipment
  - 5. NFPA 37 Stationary Combustion Engines and Gas Turbines
- 3. Product standards:
  - 1. CAN/ULC-S602, Aboveground Steel Tanks for Fuel Oil and Lubricating Oil.
  - 2. ULC-S601, Aboveground Horizontal Shop Fabricated Steel Tanks.
  - 3. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc-Coated, Welded and Seamless.
  - 4. ASME B16.3 Malleable Iron Threaded Fittings
  - 5. ASME B16.9 Factory Made Wrought Steel Buttwelding Fittings
  - 6. ASME B16.11 Forged Fittings, Socket-Welding and Threaded
  - 7. ASME B16.5 Pipe Flanges and Flanged Fittings
  - 8. ASTM A216: Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service



## 1.4 QUALITY AND EQUIVALENCE

.1 Valve Selection are in general identified by model designations taken from Manufacturers catalogues to indicate physical properties and qualities standards not otherwise described

## 1.5 DIESEL AND FUEL OIL SYSTEMS

- 1. Piping design code: ASME B31.1 Power Piping.
- 2. System includes:
  - 1. Storage tanks,
  - 2. Pumps,
  - 3. Controls
- 3. System design criteria:
  - 1. Design pressure: 99 psig
  - 2. Design temperature range: -30°C (22°F) to 38°C (100°F)

## 1.1 SELECTION CRITERIA – VALVES

- 1. Valves to be line size, selected as follows
  - 1. for shut-off or isolating service, valves to be
    - 1. Ball
- 2. Drain valves to be selected as follows
  - 1. On mains NPS 2 and under: line size brass threaded ball valve of appropriate pressure rating with hose thread, cap and chain
  - 2. On mains NPS 5 and over: NPS 1 brass threaded ball valve of appropriate pressure rating with hose thread, cap and chain.

# PART 2 – PRODUCTS

- 2.1 ABOVE GROUND STEEL PIPE FOR OIL SUCTION, DISCHARGE, OVERFLOW, RETURN AND VENT
  - 1. Pipe:
    - 1. NPS 2 and under: ASTM A106 Gr B, schedule 40 Seamless
    - 2. NPS 2-1/2 to 10: ASTM A53 Gr B, schedule 40 Electric Resistance Weld (ERW)
    - 3. NPS 12 and over: ASTM A53 Gr B, 0.375 in wall, ERW.
  - 2. Fittings:
    - 1. NPS 2 and under:
      - 1. steel socket welding type to ASME B 16.11, 2070 kPa (300 #) forged, wall thickness to match pipe,
      - 2. 1030 kPa (150 #) black malleable iron, bronze face, ground joint unions. Standard of Acceptance: Fittings Limited 165
    - 2. NPS 2  $\frac{1}{2}$  and over:



- 1. welding fittings, wall thickness to match pipe,
- 2. butt weld type to ASME 16.9 or socket weld type to ASME 16.11.,
- 3. long radius elbows,
- 4. tee fittings:
  - .1 prefabricated weld type where branch connections are same size as main,
  - .2 welded tee fittings or welded outlet fittings where branch connections are smaller than main and where main is NPS 2  $\frac{1}{2}$  and over.
- 3. Flanges:
  - 1. NPS  $\frac{1}{2}$  and over:
    - 1. forged steel, 1035 kPa (150 #) to ASME B16.5, weld neck with wall thickness to match pipe, or slip on type.
    - gaskets to ASME B16.21, ASME B16.20 or ASME A21.11 of heavy-duty graphite impregnated compressed sheet 1.6 mm (1/16 in) thick. Standard of Acceptance: Chesterton 195
  - 2. NPS  $\frac{1}{2}$  and over, high pressure oil lines:
    - 1. Forged steel, 2070 kPa (300#) to ASME B16.5, weld neck with wall thickness to match pipe.
    - 2. Gaskets to ASME B16.5 ring style spiral wound type with carbon steel outer ring and stainless-steel inner ring for raised face flanges. Standard of Acceptance: Flexitallic.
  - 3. Studs, bolts and nuts: "high strength" type to ASME B18.2.1 with ASME 18.2.2 or ASTM A307 with ASTM A563 or ASTM A194.

## 2.2 ANTI-SYPHON OIL VALVE

- .2 Provide anti-siphon valves at storage tanks with built-in pressure relief
- .3 Type:
  - 1. pipe line size, spring loaded, two position angle valve with zinc plated cast iron body, machined seats and Buna-N seals.
  - 2. selected for the hydrostatic head measured from top of tank to fuel pump inlet.
  - 3. fitted with integral pressure relief trim.
  - 4. Standard of Acceptance
    - .1 OPW 199ASV
- 2.3 VALVES
  - 1. Valves NPS 2 and under, threaded or flanged
    - 1. Full-bore ball valve for flammable liquid service, lead-free brass body and ball with PTFE seats. All materials to be compatible with fuel oil.
    - 2. Confirming to ULC/ORD-C842



- 3. Standard of Acceptance:
  - 1. Jomar
- 2.4 FIRE SAFE EMERGENCY SHUT-OFF VALVES ABOVEGROUND
  - 1. Firesafe ball valve NPS 2 and under, flanged;
    - 1. firesafe ball valve for flammable liquid service, carbon steel body with 316 stainless steel trim, PTFE seats, flanged ends,
    - 2. Spring loaded, held-open actuator, with fusible set to release at 70 C (160 F).
    - 3. FM approved firesafe valve.
    - 4. Standard of Acceptance:
      - 1. Morrison Brothers

## 2.5 LEAKAGE DETECTION SYSTEM - TANKS

- 1. Type:
  - 1. Vacuum monitoring
  - 2. reset switch and isolated relay for remote alarm.
- 2. Leak detection sensors:
  - 1. designed for NPS1 or NPS 2 access pipe or end cap opening,
  - 2. attached 4.5 m (16 ft) cable,
  - 3. detects presence of liquid in annular space surrounding sensor.
- Control cable: twisted pair of 20 AWG woven conductors with 300 V insulation and PVC jacket. Standard of Acceptance: Davis Controls - DMS series Leak Detector with SVP2 or DLP sensor

## 2.6 LEAK DETECTION SYSTEM - FLOORS AND PIPING

- 1. Type: CSA approved, continuous hydrocarbon detection cable, with oil / water discrimination
- 2. Leak detection sensor cable:
  - 1. radiation cross-linked, conductive-polymer cable jacket with fluoropolymer braid
  - 2. two sensing wires, alarm signal wire, and continuity wire,
  - 3. factory or field installed connector kits. Standard of Acceptance: Tyco Thermal Controls TT5000
- 3. Control unit:
  - 1. single channel alarm module,
  - 2. continuity fault test and indication,
  - 3. audible and visual alarm, with audible silence switch,
  - 4. remote alarm contacts, 3A at 120 VAC.
  - 5. NEMA 1 metal enclosure,
  - 6. 120 VAC, 60 Hz. Standard of Acceptance: Tyco Thermal Controls Tracetek TTA



## PART 3 – EXECUTION

## 3.1 PIPING INSTALLATION - ABOVE GROUND

- 1. Above ground piping and piping inside of building:
  - 1. NPS 2 and smaller: socket weld fittings.
  - 2. NPS 2-1/2 and larger: welded, with butt weld fittings.
  - 3. Piping connections to oil pump set, tanks, and other equipment: flanged.
- 2. Slope in direction of tanks
- 3. Locate fittings and joints in accessible chambers.
- 4. Ream steel pipe after cutting to length, clean off scale and dirt inside and outside of pipe.
- 5. Cap ends during construction to prevent entry of foreign matter.
- 6. Use eccentric reducers at pipe size change installed FOT to provide positive drainage.
- 7. Make flanged connections to equipment.
- 8. Apply two coats of bituminous paint to buried steel or steel in contact with concrete.

## 3.2 HANGER INSTALLATION

1. Install hangers for steel pipe with spacing and hanger rod diameter in accordance with the table below.

#### Table: Hanger Spacing for Steel Piping

Pipe Size NPS	Rod Diameter	Maximum Spacing	
1/2	10 mm (3/8 in)	1.8 m (6 ft)	
3/4 to 1	10 mm (3/8 in)	2.4 m (8 ft)	
1¼ to 2½	13 mm (½ in)	3.0 m (10 ft)	
3 to 4	16 mm (5/8 in)	4.6 m (15 ft)	
6 to 8	22 mm (3/4 in)	6.0 m (20 ft)	
Larger than 8	22 mm (7/8 in)	7.6 m (25 ft)	

- 2. Support vertical riser piping:
  - 1. NPS 1 and smaller: every other floor level.
  - 2. NPS 1-1/4 and larger at every floor level.

## 3.1 VALVE INSTALLATION

- 1. Install shut off valves at:
  - 1. branch take-offs,
  - 2. to isolate piping to each piece of equipment, and
  - 3. in locations shown.
- 2. Install valves in upright position with stem above horizontal
- 3. Remove internal parts of valves before soldering, welding or brazing pipe to valve body.



## 3.2 LEAK DETECTION SYSTEM - TANKS

- 1. Install vacuum-type leak detection system to monitor interstitial space on tanks with integral containment tanks.
- 2. Install with tee fitting with vacuum gauge
- 3.3 LEAK DETECTION SYSTEM FLOORS AND PIPING
  - 1. Install leak detection cable at floor level around perimeters of rooms as shown.
    - 1. terminate cable at each side of door,
    - 2. for multiple doors, loop cabling up and over doors to maintain single channel.
  - 2. Install alarm panel adjacent to door of room served, outside the room. Provide 120 VAC wiring and 15 A breaker from nearest power distribution panel.

## 3.4 ALARM MONITORING

- 1. Wire monitoring and alarm outputs from control panels to Building Automation System:
  - 1. Transfer pumps each pump set:
    - 1. pump No. 1 failure, discrete
    - 2. pump No. 2 failure, discrete
    - 3. summary alarm, discrete
  - 2. Day tank control panels each tank:high day tank alarm, discrete
  - 3. Main tank inventory control panels each tank:
    - 1. oil low tank level alarm, discrete
    - 2. oil high tank level alarm, discrete
    - 3. water high tank level alarm, discrete
    - 4. interstitial space oil alarm (contained tanks)
    - 5. tank oil inventory level, 4- 20 mA
  - 4. Automatic oil filter unit:
    - 1. Summary alarm, discrete.
    - 2. high water level alarm, discrete.

## 3.5 TESTING

- 1. Air test primary pipe after assembly at 415 kPa (60 psi).
- 2. Conduct initial pneumatic air test on steel piping at 110% of design pressure. Fill system with No.1 or No.2 fuel oil and conduct service pressure test at design pressure for 2 hours. Test passes if there is no pressure drop over the test duration. Conduct visual check for leaks,
- 3. Provide all fuel required for testing
- 3.6 FLUSHING AND CLEANING
  - 1. Flush out oil piping after pressure test with No. 1 or No. 2 fuel oil for minimum of 2 hours. Clean strainers.



- 2. Dispose of flushing oil as contaminated waste.
- 3. Obtain and provide owner with disposal certificates for all waste generated as a result of piping flushing.

## 3.7 STARTUP

- 1. Retain fuel pump transfer control manufacturer to perform startup and testing of fuel pump transfer system. Provide written report.
- 2. Contractor shall provide all fuel for the purposes of testing

## 3.8 INSPECTION

- 1. Provide to Owner a copy of the fuel distributor's inspection report.
- 2. Submit copy of TSSA final inspection report
- 3.9 FINAL FUEL FILL
  - 1. Contractor shall provide final fuel fill of all tanks to 90% level after the completion of work

# END OF SECTION

## PART 1 – GENERAL

- 1.1 SCOPE
  - 1. Provide diesel exhaust system with drip legs, guides, anchors, and expansion joints, and install muffler/silencer, cross-over pipe, and engine flexible metal connectors, supplied with engine.
  - 2. New diesel exhaust to be Factory made chimney manufactured by Cheminée Lining E. Inc., Terrebonne, QC to match existing installation
- 1.2 APPLICABLE STANDARDS
  - 1. CSA B139 Installation Code for Oil Burning Equipment
- 1.3 SHOP DRAWINGS AND PRODUCT DATA
  - 1. Provide engineered drawings, stamped by an engineer licensed in the Province of Ontario, showing diesel exhaust system layout including anchors, supports, combustion muffler, expansion joints, connections to generators and connections to existing exhaust systems. Exhaust sections and supports shall be exhaust system manufacturer's standard products, and indicate expected loading conditions.
    - 1. Prepare drawings using contractor selected generators and mufflers
    - 2. Coordinate layout with existing services and new work

## PART 2 – PRODUCTS

- 2.1 STEEL PIPE FOR DIESEL EXHAUST
  - 1. ASTM A53-84a Grade B
    - 1. Schedule 40, seamless for sizes up to NPS 2,
    - 2. Schedule 40, ERW for sizes NPS 2 <sup>1</sup>/<sub>2</sub> and up to NPS 12,
    - 3. 0.375 wall thickness ERW or spiral weld for sizes NPS 14 and above.

# 2.2 PIPE JOINTS

- 1. NPS 3 and over:
  - 1. welding fittings
    - 1. Wall thickness to match pipe
    - 2. Butt weld type to ANSI 16.9 or socket weld type to ANSI 16.11.
    - 3. Long radius type elbows
  - 2. flanges
    - 1. cast iron Class 150 to ANSI B16.1.
    - 2. forged steel, 1035 kPa (0 #) to ANSI B16.5, weld neck with wall thickness to match pipe, or slip on type.
    - 3. studs, bolts and nuts to ANSI B18.2.1, ANSI 18.2.2 and ASTM A194, "high strength" type.



- 4. gaskets to ANSI B16.5 ring style spiral wound type with carbon steel outer ring and stainless-steel inner ring for raised face flanges.
  - .1 Standard of Acceptance: Flexitallic.
- 2. NPS  $2\frac{1}{2}$  and smaller:
  - 1. threaded malleable iron fittings: Class 150 to ANSI B16.3,
  - 2. forged steel socket welding type: Class 3000 to ANSI B 16.11, wall thickness to match pipe,
  - 3. unions: Class 150, black malleable iron, bronze face, ground joint unions.
    - 1. Standard of Acceptance: Fittings Limited 165.

## 2.3 JOINTING MATERIALS

1. Jointing compound for threaded pipe: pulverized lead paste.

## 2.4 EXHAUST EXPANSION JOINTS

- 1. Construction:
  - 1. corrugated multi-ply bellows element, type 321 stainless steel
  - 2. threaded or weld end connections up to NPS 2<sup>1</sup>/<sub>2</sub>
  - 3. flanged connections NPS 3 and above.
  - 4. shipped with retention straps holding the joint in a pre-stretched length.
- 2. Operating conditions:
  - 1. pressure: 100 kPa (15 psi)
  - 2. temperature: 650°C (1200°F)
  - 3. 3000 cycles for any one movement to EMJA standard.
- 3. Designed to absorb:
  - 1. 75 mm (3 in) axial movement,
  - 2. 13 mm (1/2 in) lateral movement,
  - 3. 10<sup>0</sup> angular movement.
  - 4. Standard of Acceptance
    - .1 DME Series 650
    - .2 Flexonics
    - .3 United Flexible
    - .4 Hyspan
    - .5 Flextech
    - .6 Pathway
    - .7 Thorburn

# 2.5 PREFABRICATED DIESEL EXHAUST STACK

1. Construction:



- 1. catalogued, factory manufactured product recommended for the application
- 2. ULC listed for 760°C (1400°F) flue temperature
- 3. double wall construction with 50mm (2 in.) of mineral wool insulation between liner and shell, or to match existing
  - 1. inner liner: 304 stainless steel 1 mm (0.035 in),
  - 2. shell: aluminized steel 0.6 mm (0.024 in).
- 4. supplied with lined bellows expansion joints
- 5. assembled with vee band and sealant for liner flanges and draw band for shell flanges.
- 6. Standard of Acceptance
  - .1 Chiminée Lining PPL2F

# PART 3 – EXECUTION

## 3.1 EXHAUST SYSTEM INSTALLAION – WELDED PIPING

- 1. Weld exhaust system throughout, with butt weld fittings NPS 3 and above and socket weld fittings NPS 2<sup>1</sup>/<sub>2</sub> and smaller.
- 2. Connections at equipment:
  - 1. NPS 2<sup>1</sup>/<sub>2</sub> and smaller: threaded unions,
  - 2. NPS 3 and larger: welded with flanges.
- 3. Ream pipe after cutting to length, clean off scale and dirt on inside and outside of pipe.
- 4. Use only long radius elbows for turns. Do not use Tee's.
- 5. Make-up joints in screwed pipe with joint compound.

## 3.2 EXHAUST SYSTEM INSTALLATION - MANUFACTURED SYSTEM

- 1. Seal exhaust system throughout.
- 2. Support prefabricated stack, flash and counter-flash at roof penetrations.
- 3. Erect stacks true and plumb to within 1 in 1200.
- 4. Seal inner joints in double wall pressure stacks with bead of high temperature sealant, fill channel of vee band with high temperature sealant and install and tension vee-band, install insulation filler strips in air space between inner and outer walls, and secure outer shell with draw band. Caulk upper edge of drawbands exposed to the weather with silicone sealant.
- 5. Cap ends during construction to prevent entry of foreign matter.
- 6. Use eccentric reducers at pipe size change installed FOT to provide positive drainage.
- 7. On horizontal runs, maintain pitch of 1:50 (in per foot) down in direction of flow.

# 3.3 FLEXIBLE METAL CONNECTORS AND MUFFLER SILENCERS SUPPLIED WITH ENGINE/GENERATOR

1. Locate muffler/silencer with respect to exhaust discharge, connection on engine, and support from building structure on spring hangers.



2. Install piping and flexible connectors between muffler/silencer and discharge side of exhaust manifold, and between discharge connections of muffler/silencer and exhaust piping.

## 3.4 EXHAUST SYSTEM EXPANSION COMPENSATION

- 1. Locate first anchor at engine connection to the muffler. Provide additional anchors and guides as shown.
- 2. Install expansion joints, guides, and anchors as shown, with;
  - 1. pipe guides at each expansion joint,
  - 2. two guides on each side of and adjacent to joint, consisting of pipe roll guides or fabricated structural steel sliding units, clamped to building structure,
  - 3. guides may be omitted between joint and anchor where an anchor is located within 1 m (3 ft) of expansion joint,
  - 4. anchors consisting of structural steel angles, channels, or plates fastened to structure.

## 3.5 DRIP LEGS

- 1. Provide drip legs;
  - 1. same size as exhaust up to NPS 6 and NPS 6 for larger sizes,
  - 2. at foot of each vertical leg, and in horizontal run before each elbow, with Schedule 80 long nipple, cap and threaded NPS 1 ½ drain connection, valved and piped to nearest open drain.

# END OF SECTION



## PART 1 – GENERAL

- 1.1 SCOPE
  - 1. Provide motorized dampers as shown.
- 1.2 RELATED SECTIONS
  - 1. Dampers complying with Section 25 35 01: B.A.S. Instrumentation and Actuators
- 1.3 SHOP DRAWINGS AND PRODUCT DATA
  - 1. Submit manufacturer's catalogue literature with:
    - 1. performance charts, pressure drop vs approach velocity for range of blade angles from 0 to  $90^{\circ}$
    - 2. torque requirements.
    - 3. construction details.

# PART 2 – PRODUCTS

- 2.1 MULTI-LEAF DAMPERS
  - 1. Parallel blade type:
    - 1. for two-position, OPEN/CLOSED service
    - 2. for modulating fresh and return service in air discharge plenum.
  - 2. Opposed blade type for other modulating service.
  - 3. Performance:
    - 1. leakage in closed position: maximum 2% of rated air flow at 500Pa (2 in wg) differential across assembly,
    - 2. pressure drop in open position: maximum 50 Pa (0.2 in wg) differential at 5 m/s (1000 fpm).
  - 4. Construction:
    - 1. blades, non-insulated: extruded aluminum interlocking blades,
    - 2. frame, non-insulated: extruded aluminum,
    - 3. blades, insulated: extruded aluminum interlocking double thickness insulated blades,
    - 4. frame, insulated: extruded aluminum, thermally broken,
    - 5. seals: extruded vinyl seals, and spring stainless steel side seals,
    - 6. maximum blade width: 125 mm (5 in),
    - 7. maximum blade length: 1200 mm (4 ft).
    - 8. self-lubricated bronze bearings.
    - 9. blade linkage with steel tie rods, brass pivots and steel brackets.



- 5. Actuator: 24 Volt electric actuator with spring return, stroking damper from closed to open with 4 -20 mA signal.
- 6. Standard of Acceptance: Belimo electric actuators

## PART 3 – EXECUTION

- 3.1 INSTALLATION
  - 1. Secure dampers within ductwork and at air exhaust outlets, and as shown.
  - 2. Caulk around frames and between multiple damper modules with UL listed silicone-free sealant.

## **END OF SECTION**



## PART 1 – GENERAL

- 1.1 SCOPE
  - 1. Provide sound attenuation as shown in accordance with ASTM E477, ASTM E90 and ASTM C423, selected to maintain noise levels in areas of building as follows:
  - 2. Provide shop drawing or product data sheet for each piece of attenuation equipment.
  - Provide performance rating data on silencers and acoustic plenums, certified by Professional Engineer and supported by test results in accordance with referenced standards as follows
    - 1. Silencer: Insertion loss, pressure drop.
    - 2. Acoustic plenums: Transmission loss and acoustical absorption.

# 1.2 APPLICABLE CODES AND STANDARDS

- 1. ASTM E477 Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Material and Prefabricated Silencers
- 2. ASTM E90 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
- 3. ASTM C423 Standard Test method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
- 4. ASTM C 739 Standard Specification for Cellulosic Fiber Loose-fill Thermal Insulation
- 5. ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process
- 6. Sheet Metal and Air Conditioning Contractors National Association (SMACNA) material and fabrication specifications.

## PART 2 – PRODUCTS

- 2.1 ACOUSTIC PLENUMS AND PANELS
  - 1. Manufacturers, Standard of Acceptance
    - 1. Vibro-Acoustics
    - 2. Vibron
    - 3. Korfund
    - 4. IAC
  - 2. Panels:
    - 1. tongue and groove connection type, with individual panels removal for equipment access,
    - 2. outer sheet of 1.3 mm (18 ga) thick galvanized steel to ASTM A653, with coating designation Z90,
    - 3. inner sheet of 0.8 mm (22 ga) thick galvanized steel to same specification with 2 mm (3/32 in) diameter perforations on 5 mm (3/16 in) staggered centres,



- 4. edge frame made up with 1.3 mm (18 ga) galvanized steel channels,
- 5. horizontal stiffeners of 0.8 mm (22 ga) minimum galvanized steel on 800 mm (32 in) centres.
- 3. Access panels:
  - 1. sized for equipment removal,
  - 2. two handles per panel and machine screws around perimeter at 100 mm (4 in) maximum centres,
  - 3. perimeter neoprene sponge gasket.
  - 4. constructed as specified above for standard panel.
- 4. Access doors:
  - 1. minimum 510 mm x 1375 mm (20 in x 54 in) opening,
  - 2. constructed as specified for standard panel except with interior sheet unperforated.
  - 3. perimeter neoprene sponge gasket,][
  - 4. zinc plated hardware; two butt type nylon bushed hinges and two cam type latches with inside and outside handles,
  - 5. opening against direction of air flow.
- 5. Inspection windows:
  - 1. minimum 310 mm x 310 mm (12 in x 12 in) opening,
  - 2. double glazed with 6 mm ( $\frac{1}{4}$  in) wire reinforced glass mounted in neoprene 'U' channels.
- 6. Plenum assembly:
  - 1. stiffened to limit deflection to 1/200th of span when subjected to pressure differential equal to fan shut off static pressure.
  - 2. fabricated with base sections and flashing of 1.3 mm (18 ga) minimum galvanized steel.
  - 3. externally sealed at panel and flashing joints with 5 mm (3/16 in) diameter bead of elastomeric sealant.
  - 4. sealed between floor channel and floor connection with 3 mm x 13 mm ( $\Box$  in x  $\frac{1}{2}$  in) monolastic tape.
- 7. Openings in panel assembly:
  - 1. factory cut and framed where greatest dimension exceeds 310 mm (12 in),
  - 2. located and cut on site where greatest dimension is less than 310 mm (12 in),
  - 3. cut 50 mm (2 in) larger than pipe or conduit and sleeved with 0.8 mm (22 ga) minimum galvanized steel, with
  - 4. space between pipe or conduit and sleeve or frame to be filled with acoustic media, covered and sealed.
- 8. Plenum performance:
  - 1. Assembly RSI to be not less than  $1.2 \text{ (m}^{2.0}\text{C})/\text{W}$  at  $10^{\circ}$  C.



2. Certified acoustical transmission loss to ASTM E90 and acoustical absorption to ASTM C423 to be in accordance with following table.

	Octave bands (Hz)						
	125	250	500	1k	2k	4k	
Transmission loss, db	21	28	39	50	53	56	
Absorption coefficient	0.7	0.9	0.99	0.99	0.9	0.9	

# 2.2 SILENCERS

1. Factory manufactured of galvanized or prime painted steel, meeting SMACNA material standards.

# 2. Material:

- 1. acoustic quality, 100% natural cotton fibre treated with EPA registered, flash dried non toxic borate solution.][glass fibre, free of shot and odour].
- 2. bacteria and fungus resistant.
- 3. free of corrosion causing or accelerating agents.
- 4. minimum density of 72 kg/m3 (4.5 lb/ft3) when packed under 10% compression.
- 5. in accordance with Code fire requirements for duct lining.
- 3. Construction:
  - 1. 0.8 mm (22 ga) minimum outer shell with airtight mastic filled seams for rectangular low velocity applications up to 10 m/s (2000 fpm),
  - 1.6 mm (16 ga) welded outer shell for rectangular high velocity application over 10 m/s (2000 fpm) and for circular units 600 mm (24 in) diameter and larger,
  - 3. 1.2 mm (18 ga) welded outer shell for circular units of less than 600 mm (24 in) diameter,
  - 4. 50 mm (2 in) slip connections, and lifting lugs.
- 4. Fittings:
  - 1. inner casing minimum 0.8 mm (22 ga) perforated metal, enclosing acoustic media, and
  - 2. media erosion protection of mold resistant cloth between media and perforated metal, where airflow gap velocity exceeds 22.5 m/s (4500 fpm).
- 5. Standard of Acceptance
  - .1 Vibro-Acoustics
  - .2 Vibron
  - .3 Korfund
  - .4 IAC

## 2.3 CROSS-TALK SILENCERS

- 1. Factory manufactured of galvanized or prime painted steel, meeting SMACNA material standards.
- 2. Construction:





- 1. 0.8 mm (22 ga) outer casing,
- 2. 0.6 mm (24 ga) perforated inner galvanized metal facings,
- 3. 75 mm (3 in) slip connections, and
- 4. acoustic media.
- 3. Standard of Acceptance
  - .1 Vibro-Acoustics
  - .2 Vibron
  - .3 Korfund
  - .4 IAC[][
- 2.4 FLOATING FLOORS
  - 1. Isolators:
    - 1. select type and spacing to provide constant deflection and natural frequency of 15 Hz over floating floor section.
    - 2. two layers of density 24 kg/m3 (1.5 lb/ft3) glass fibre 38 mm ( $1\frac{1}{2}$  in) thick to be bonded to entire area of plywood.
  - 2. Standard of Acceptance
    - .1 Vibro-Acoustics
    - .2 Vibron
    - .3 Korfund]

# PART 3 – EXECUTION

- 3.1 INSTALLATION
  - 1. Install sound attenuation equipment in accordance with manufacturer's instructions
- 3.2 MANUFACTURER'S INSPECTION
  - 1. On completion of installation and start-up of equipment
    - 1. arrange for manufacturer/supplier of Sound Attenuation equipment to visit site, check performance of noise attenuation systems, inspect installation and submit written recommendations.
    - 2. make corrections to installation in accordance with manufacturer/suppliers recommendations.
    - 3. provide notice 24 hours in advance of this site visit.

# END OF SECTION



## PART 1 - GENERAL

#### 1.1 SCOPE

- 1. The work described in this specification covers the replacement of one existing generator at the City's 703 Don Mills Road facility. The work entails supply and installation of equipment and materials, testing and commissioning, and other services as described in the various sections of the electrical specifications and as shown on the drawings.
- 2. The scope of the electrical work includes, without being limited to the following:
  - 1. Disconnection and removal of existing Generator G-1 (Mitsubishi).
  - 2. Supply and installation of a new 1250 kW, 600 V Diesel generator, complete with exhaust silencer and battery chargers
  - 3. Supply and installation of new cable tap box and power cables for the connection of the new generator to the existing bus duct
  - 4. Supply and installation of new control cables between the generator and existing Switchboard EG-A/EG-B
  - 5. Supply and installation of miscellaneous electrical materials including power conductors, conduits, junction and pull boxes, conduit fittings, supports, and the like
  - 6. Modifications to existing generator and transfer controls to implement the modes of operation described in Section 26 32 13
  - 7. Testing and commissioning of all equipment and systems supplied and installed, including provision of load bank and temporary load bank cables.
  - 8. Some work on 'premium time' (i.e. during night and/or weekends) as directed by the Owner and as required by the critical nature of the operations at the facility.
  - 9. Preparation of MOP documents (Method of Procedure) for the critical activities,
  - 10. Provision of fire alarm bypass and fire watch during critical activities, and
  - 11. All other work required to deliver a complete and functional system, whether detailed on the drawings or described in the specifications.

## 1.2 DEFINITIONS

- 1. Wherever the words "equal", "approved", or "approved equal" are used, they shall be understood to mean, "equal", "approved", or "approved equal".
- 2. "Concealed" is defined as "out of sight" in "normal" viewing conditions, and includes buried in concrete, above acoustic tile or gypsum board ceilings, within masonry or gypsum board constructed walls, within cable trays, or below raised access floors.
- 3. Whenever the words "install", "provide", or "supply and install", are used, they shall be understood to mean "provide and install, inclusive of all labour, materials, installation, testing, and connections" for the item to which they refer.

## 1.3 CODES AND STANDARDS

1. All work shall meet or exceed the latest applicable Codes and Standards. Do complete installation in accordance with the Ontario Electrical Safety Code – 2021 and applicable Bulletins (the Code) except where specified otherwise.



- 2. Abbreviations for electrical terms: to CSA Z85.
- 3. Unless noted otherwise, reference to a code or standard shall mean the most recent version of that code or standard.

## 1.4 PERMITS, FEES, AND INSPECTION

1. The Contractor shall obtain all necessary permits, pay the fees, and make the work available for inspection as necessary to comply with the regulatory requirements of the authorities having jurisdiction.

## 1.5 DRAWINGS AND SPECIFICATIONS

- 1. Drawings and Specifications are intended to cover the scope of work described herein. It is not the intent to show or describe every detail, and it shall be agreed that the Contractor will provide all work and material required to satisfy the intent of the Drawings and Specifications.
- 2. Drawings and Specifications are not guaranteed to be free of discrepancies and the Owner and/or Consultant will not be responsible for the absence of any detail the Contractor may require, or for any special work, equipment, material or labour which may be found necessary as the work progresses.
- 3. It shall be specifically understood that the omission of any Drawing, Detail or Schedule, or reference thereto, or any item from any Drawing, Detail or Schedule, or from the Specification, which is required to make the work complete and operational, shall not relieve the Contractor from the obligation of providing the required items and associated labour.
- 4. Any discrepancies shall be submitted to the Consultant for his instructions.

## 1.6 VOLTAGE RATINGS

1. Operating voltages to: CAN3-C235.

## 1.7 CONSULTANT'S INSTRUCTIONS

1. During construction, the Consultant will issue such instructions in writing as may be necessary for verification and correction of the work. These instructions shall be binding as part of the Contract Documents.

## 1.8 ADDITIONAL WORK AND CHANGES

1. No additional money over and above the Contract Price will be paid for extra work unless a written order, signed by the Owner's representatives for such work is given.

# PART 2 - PRODUCTS

## 2.1 MATERIALS AND EQUIPMENT

1. Except for the existing equipment shown on the drawings and referred to in other sections of these specifications, all other equipment and material shall be new and suitable for the use intended.



- 2. Equipment and material shall be certified by CSA, or such other agency as may be recognized by the Electrical Safety Authority. Where there is no alternative to supplying equipment which is not thus certified, obtain special approval from Electrical Safety Authority, and notify the Consultant of any extra costs.
- 3. Where materials or other products are specified by a manufacturer's brand name, type or catalogue number, such designation is to establish the standards of desired quality, style or dimensions, and shall be the basis of the Bid. Furnish materials so specified under this Contract unless changed by mutual agreement.
- 4. Where the use of equivalent, alternate or substitute equipment alters the design or space requirements indicated on the plans, the Contractor shall include all items of cost for the revised design and construction, including the cost of all the other trades involved.
- 5. Acceptance of the proposed equivalents, alternates or substitutions shall be subject to review by the Consultant and, if requested, the Contractor shall submit for inspection, samples of both the specified and the proposed alternate items.
- 6. In all cases where the use of equivalents, alternates or substitutions is permitted, the Contractor shall bear any extra costs incurred by the Consultant in evaluating the quality of materials and the equipment to be installed.

# 2.2 EQUIVALENTS AND ALTERNATES

- 1. Should the Contractor propose to furnish materials other than those specified, he shall apply in writing to the Consultant for approval of equivalents, by submitting complete descriptive and technical data on the item or items he proposes to furnish. Approval for changes will be considered only upon the individual requests of the Contractor. No blanket approval for equipment will be given to suppliers or distributors.
- 2. For the materials to be supplied by the Contractor, alternates may be offered in lieu of 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.
- 3. Replace unspecified materials and/or rejected equivalents and alternates built into the work with specified or accepted materials, at no additional cost.
- 4. In case of differences in price, the Owner shall receive all benefit of the difference in cost involved in any substitution, and the Contract shall be altered by change order to credit the Owner with any savings so obtained.
- 5. Materials and equipment substituted or offered as alternatives shall have spare parts and servicing available and shall fit into the space allocation shown on the drawings.
- 6. If any material being considered for substitution involves additional design, architectural or engineering fees or other costs in checking whether or not the substitute material or equipment is suitable for the project, such fees or costs shall be paid for by the Contractor.



## 2.3 SHOP DRAWINGS

- 1. Submit shop drawings in accordance with relevant Section.
- 2. Provide a schedule for shop drawing submission and a schedule for the delivery of materials to the site. At this stage, identify any item whose delivery time could negatively impact the project completion date. Failure to do so will require the Contractor to provide temporary replacement materials until the specified item(s) is (are) available.
- 3. Specifications and Drawings are intended to cover all electrical systems. It is not the intent to describe or show every detail, and it shall be agreed that the Contractor will provide all work and materials according to the requirements and intent of the Drawings and Specifications.
- 4. Where applicable, Shop Drawings must indicate details of construction, dimensions, scale, capacities, weights and electrical performance characteristics of proposed materials, as well as project name and specification reference Section number.
- 5. Shop drawings shall be provided in electronic format (pdf), with space on the front sheet for the Contractor's and Consultant's "Review" stamps.
- 6. Work affected by submittals shall not proceed until review is complete.
- 7. Review submittals prior to submission to Consultant. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and coordinated with requirements of the work and Contract Documents.
- 8. Changes made to Shop Drawings by the Consultant will not affect the Contract Price.
  - 1. Shop drawings will be reviewed by the Consultant and returned to the Manufacturer marked "REVIEWED", "REVIEWED AS NOTED" or "REVISE AND RESUBMIT". Shop drawings noted "REVISE AND RESUBMIT" shall be corrected and re-submitted.
  - 2. No equipment shall be delivered to the job site unless the Manufacturer has received a "REVIEWED" or "REVIEWED AS NOTED" copy of the pertinent shop drawing.
  - 3. The Manufacturer's Schedule shall allow five (5) business days for review or return for correction of shop drawings submitted to Consultant, with the time period starting at the time of receipt of the Drawings by the Consultant.

## PART 3 - EXECUTION

## 3.1 SPECIAL CONDITIONS

- 1. The Contractor shall be aware that the work under this scope is subject to limitations imposed by the critical nature of the live operations in the facility. Limitations include:
  - .1 Performance of work according to stringent Method of Procedure (MOP) documents. Contractor shall provide the Owner with a schedule of MOP documents for review and approval.
  - .2 Work subject to MOPs generally includes activities that result in loss of redundancy of power supply to the critical load, operation on generator power from the site and/or mobile generator, work on upgrading the generator or transfer controls, disconnection of existing equipment for the purpose of reconnection to a new supply, and



- .3 Other activities that may affect power to the base building systems, not only those of the 3<sup>rd</sup> floor Data Hall to be identified by the Owner and the Consultant.
- 2. The MOP document for each critical activity shall include:
  - .1 Objective/purpose of the activity (Example: disconnection, tie-in, load transfer, controls upgrade, installation, testing etc.)
  - .2 Systems affected (tenant's critical systems, base building systems, as applicable)
  - .3 Sequence of steps / tasks to be performed, with identification of location, equipment, and component on which the work will be done
  - .4 Responsibility for performing the tasks (Contractor, Vendor, Building Operations etc.)
  - .5 Estimated duration of the tasks, start and end times
  - .6 Contingency / back-out plan for unforeseen situations
  - .7 Safety precautions to be taken during the performance of specific tasks
  - .8 Initial checks of systems' condition at beginning of MOP activity, and post-completion checks to ensure restoration to normal of affected systems at end of activity.
- 3. The schedule of MOP activities shall list all MOP documents to be provided for the Work, and the activities to which they relate. The Contractor shall provide to the Owner and the Consultant all MOP documents for review and approval prior to proceeding with the Work. MOP documents shall be written for the specific electrical system(s) affected by the Work. Include:
  - .1 Restriction of work to times and durations prescribed by the Owner. Unless otherwise approved by the Owner, all work affecting the operation of the existing systems including testing and commissioning required to be carried out with the existing systems must be performed during time windows prescribed by the Owner.
  - .2 Controlled access and security requirements.
  - .3 Any other operations that may become necessary for the completion of the work.
- 4. The required MOPs shall be prepared and submitted for review by the Owner at least 15 days in advance of the contemplated work.

## 3.2 INSTALLATION - GENERAL

- 1. Lay out of the work of this contract. Take special precautions and note drawing scales. Generally, floor plans are drawn at metric scale. Make field verifications of dimensions on plans since actual locations, distances, and level will be governed by actual field conditions.
- 2. Wherever differences occur between plans and riser diagrams or schematics, and between specifications and drawings, most stringent conditions shall govern. Bring discrepancies between plans, or between plans and actual field conditions, or between plans and specifications promptly to the attention of the Consultant for clarification.
- 3. As the work progresses and before installing apparatus, equipment, fixtures and devices which may interfere with the interior treatment and use of the building, obtain approval from the Consultant of detailed drawings or sketches for the exact location of all electrical raceways, panels, trays/ladders, equipment, fixtures and wiring devices. Failure to do so will make the Contractor responsible for rectification at his own cost.
- 4. Before commencing to work, check and verify with the Consultant all elevations, levels, dimensions etc. to ensure proper and correct installation of the work.



- 5. Protect finished and unfinished work and equipment and building elements from damage due to the carrying out of the work of this trade.
- 6. In addition to the work specifically mentioned in the specifications and shown on the drawings, provide all other items that are required by the authorities having jurisdiction over the work.
- 7. Contain all work being performed within the physical area of work which is underway during any period. Keep the amount of disruption in the existing facility to a minimum.
- 8. Advise the Owner and Consultant in advance of any work that may interfere with or cause disruption to existing operations. Should the work within a particular area cause any electrical apparatus in another area to cease to function properly, identify and remedy the problem within the shortest possible time.

# 3.3 RESPONSIBILITY FOR SUPPLIED EQUIPMENT

- 1. All materials under this contract shall be supplied by the Contractor.
- 2. The Contractor shall be responsible for removing the old generator from the building, including hoisting of the old and new machine and building components (louvres, dampers, exhaust silencer etc.).
- 3. For all supplied equipment, the Contractor's responsibilities include the following:
  - 1. Preparing and submitting shop drawings for whips and receptacles and coordinating with the construction drawings,
  - 2. Coordinating deliveries with the various suppliers,
  - 3. Offloading and moving materials to the installation location; inspection after offloading and reporting to Owner/Consultant of any defects or damage,
  - 4. Supplying and installing power feeders and control cables complete with raceways as per manufacturer's recommendations,
  - 5. Testing and commissioning of the new and upgraded equipment in its installed condition, as per Manufacturer's recommendations.
  - 6. Arrange for generator manufacturer and controls vendor's competent technical representative (or accredited service contractor) to approve installation and participate in the testing and commissioning.

# 3.4 SCHEDULING OF WORK

- 1. For all work to be performed under this contract, adhere to construction schedule detailed in other parts of the contract.
- 2. Ensure that all material and services are ordered in time to meet the schedule. Provide to the Consultant/Owner a schedule of deliveries and include the following milestones: shop drawings submittal, shipment, and acceptance testing.
- 3. 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 construction schedule.
- 4. Generally, the following work can be performed during regular business hours:



- 1. Disconnection of services from the generator to be removed
- 2. Installation of miscellaneous conduits and wiring within Penthouse Generator and Electrical rooms
- 3. Modifications to Switchboards EG-A/EG-B, EA, EB
- 5. Work to be performed outside business hours (on 'premium' time, during the night or on weekends) includes:
  - 1. Hoisting of removed generator and new generator
  - 2. Any activity generating excessive dust or noise advise Owner in advance to determine acceptable time and protection measures, if required.
  - 3. Repeated testing that requires load transfers and assistance from outside vendors (Toromont for Generator G-2, Eaton for UPS systems etc.)
- 6. Co-ordinate all required shutdowns of existing services with the operating staff to maintain any disruption to a minimum. Provide ample notice to Owner before proceeding with work on any existing service or equipment.

#### 3.5 INSTALLATION OF RACEWAYS

- 1. Install all conduits to conserve headroom and interfere as little as possible with the free use of the space through which they pass.
- 2. Do not remove or damage any structural fireproofing. Leave space to permit the fireproofing to be inspected and/or repaired.

#### 3.6 CUTTING AND PATCHING

- 1. Employ the trade responsible for a particular item of work to do all cutting, patching, and repairing of surfaces affected by that work.
- 2. Do not cut supporting members of any floor, wall, or the building structure. If this is necessary, cut only at locations and in such manner as required by the work, without affecting structural integrity, and as approved by the Consultant/Owner.
- 3. Repair all openings and surfaces made in the process of installing the new work with the type of material removed, by tradesmen expert in the type of repair required.
- 4. Provide fire barriers around all components in openings which penetrate fire separations. The fire barrier medium provided shall make the fire separation equal to or better than the one which was cut away. All materials shall be CSA approved, and UL listed.
- 5. All floor saw-cutting and drilling required for electrical services shall be performed within hours approved by the Owner. Prior written notice of minimum 48 hours must be given to the Owner and Consultant.

## 3.7 PAINTING AND FINISHING

1. All hangers, channels, conduits, etc. shall be delivered to the site galvanized after fabrication and all metal cut and finishes damaged on the job shall be painted to match.



- 1. All equipment and materials shall be stored in a dry, clean location, covered if necessary to preserve factory finish.
- 2. Where equipment and material are designated unfinished, all exposed metal work, with the exception of chromed locks and hardware, shall be left with a suitable prime coat finish.
- 3. Painting of equipment and material requiring a finished coat or touch up after installation shall be carried out wherever required. This does not apply to the making good of damaged factory finishes which shall be done by the Electrical Contractor.

## 3.8 WIRING IDENTIFICATION

- 1. Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- 1. Maintain phase sequence and colour coding throughout.
- 2. Colour code: in accordance with the Code.
- 3. Use colour coded wires in communication cables, matched throughout system.

## 3.9 CONDUIT AND CABLE IDENTIFICATION

- 1. Colour code conduits and boxes.
- 2. Code with plastic tape or paint at points where conduit enters or exits wall, ceiling, or floor, and at 10m intervals.
- 3. Label all conduits using "P-Touch" or paint at every entry or exit of wall, ceiling and at 10m intervals.

## 3.10 WIRING TERMINATIONS

- 1. Lugs, terminals, screws used for termination of wiring shall be suitable for copper conductors, according to the material of the wiring being terminated.
- 2. Electrical Contractor shall provide cable lugs, terminals, screws, etc. required for wiring terminations.

## 3.11 MANUFACTURER'S AND APPROVAL LABELS

1. Provide visible and legible labels after equipment is installed.

## 3.12 WARNING SIGNS

1. Provide warning signs to meet requirements of Electrical Inspection Authority and any Authority having jurisdiction.



#### 3.13 AS-BUILT ELECTRICAL DRAWINGS

- 1. Prepare marked-up drawings based on the Single Line Diagram and Layout provided by Consultant.
- 2. Indicate changes made during construction.
- Display Single Line Diagram in frame of size no smaller than 600 mm x 900 mm, protected by glass cover. Locate in Main Electrical Room in the Penthouse and in the Data Hall on the 3<sup>rd</sup> floor.

#### 3.14 TESTING AND COMMISSIONING

- 1. Provide testing and commissioning of all equipment and systems installed.
- 2. Refer to the individual material specification for details on testing and commissioning.
- 3. Arrange and pay for services of manufacturers' factory service technicians and controls vendor's technicians to supervise start-up of installation, check, adjust, balance and calibrate components, wherever required.
- 4. Resolve all commissioning issues discovered at each stage before proceeding to the next level of commissioning.

#### 3.15 OPERATOR TRAINING

- 1. Instruct Owner and operating personnel in the operation, care, and maintenance of equipment.
- 2. Provide an outline of the training material to the Owner and Consultant for review prior to delivering the training.
- 3. Prepare training material with a level of detail adequate for the equipment and controls installed. Material to be made available to the attendees in printed format for the training sessions and in digital format (CD or other convenient storage media) for future reference.
- 4. Conduct "classroom" training followed by "hands-on" training. Demonstrate the operation of the equipment and its features. Enlist the assistance of manufacturers' representatives where appropriate.
- 5. Provide these services for such period, and for as many visits, as necessary to ensure that operating personnel are conversant with all aspects of equipment operation and care. Obtain written acceptance of operating personnel's understanding of the systems.

## 3.20 CLEANING

1. During the performance of the work and on completion, remove from the site and premises all debris, rubbish and waste materials caused by the performance of the work for this contract. Remove all tools and surplus materials after acceptance of the work, to the Owner and/or Consultant's satisfaction.



**END OF SECTION** 


### PART 1 - GENERAL

#### 1.1 **REFERENCES**

- 1. CSA C22.2 No.0.3, Test Methods for Electrical Wires and Cables.
- 2. CSA C22.2 No. 38, Thermoset-Insulated Wires and Cables (Tri-National Standard, with UL-44 and ANCE NMX-J-451).
- 3. ICEA S-95-658 (NEMA WC70) Power Cables Rated 2kV or Less for the Distribution of Electrical Energy

## PART 2 - PRODUCTS ICEA

### 2.1 BUILDING WIRES

- 1. Cable: to CSA C22.2 No. 38.
- 2. Conductors: stranded for #8 AWG and larger. Minimum size: #12 AWG.
- 3. Copper conductors (347/600V): size as indicated, with 1000V insulation of chemically cross-linked thermosetting polyethylene material rated RW90.

## 2.2 DLO CABLES

- 1. For installation between the generator terminal box and new cable tap box
- 2. Conductor number and size as indicated on the drawings
- Conductors: fully annealed flexible strand Class I tinned copper, ASTM B-172, ASTM B-174, ASTM B-33
- 4. Insulation: Ethylene-Propylene Rubber (EPR), per UL, CSA, ICEA, AAR RP-588, 90°C
- 5. Tape separator between conductor and insulation
- 6. Jacket: Black heavy duty thermoset CPE per ICEA S-95-658 NEMA WC-70, AAR RP-586. Ozone, sunlight, oil, grease, weather, chemical, and abrasion resistant

## PART 3 - EXECUTION

## 3.1 INSTALLATION OF BUILDING WIRES

- 1. Install wiring in raceways in accordance with the relevant Sections of this Division.
- 2. Do not exceed maximum pulling tension as specified by cable/wire manufacturer.
- 3. Connect cables as indicated.



# 3.2 INSTALLATION OF DLO CABLES

- 1. Install exposed between the alternator terminal box and new cable tap box.
- 2. Fasten cables to vertical metal rack or short section of cable tray for support.
- 3. Bend and terminate according to manufacturer's recommendation.
- 4. Leave slack to account for vibration during generator operation.
- 5. Identify cables of each cable with coloured tape, at both ends (alternator and cable tap box.

### 3.3 FIELD QUALITY CONTROL

- 1. Perform tests using qualified personnel and the necessary instruments and equipment.
- 2. Check each cable for continuity, short circuits, and grounds.
- After installing cable but before terminating, perform insulation resistance test with megger on each phase conductor. Ensure insulation resistance to ground of circuits is not less than 100 megohms.
- 4. Check insulation resistance after each termination to ensure that cable system is ready for acceptance testing.
- 5. Provide Consultant with list of test results showing location at which each test was made, circuit tested and result of each test.
- 6. Remove and replace entire length of cable if cable fails to meet any of test criteria.

## END OF SECTION

### PART 1 - GENERAL

### 1.1 SCOPE

1. This section covers the requirements for system and equipment grounding.

#### 1.2 REFERENCES

1. CSA C22.3 No.2, General Grounding Requirements and Grounding Requirements for Electrical Supply Stations.

#### PART 2 - PRODUCTS

### 2.1 MATERIALS

- 1. Conductors: stranded, insulated, soft annealed copper wire, size as indicated on drawings
- 2. Accessories: non-corroding, necessary for complete grounding system, type, size, and material as indicated, including:
  - 1. Grounding and bonding bushings
  - 2. Protective type clamps
  - 3. Bolted type conductor connectors
  - 4. Bonding jumpers, straps

## PART 3 - EXECUTION

#### 3.1 INSTALLATION - GENERAL

- 1. Install continuous grounding system including, conductors, connectors, and accessories in accordance with CSA C22.3 No.2.
- 2. Install connectors in accordance with manufacturer's instructions.
- 3. Protect grounding conductors from mechanical injury.
- 4. Use mechanical connectors for grounding connections to equipment provided with lugs.

## 3.2 FIELD QUALITY CONTROL

- 1. Perform tests in accordance with Section 26 05 00 Electrical General Requirements.
- 2. Perform earth loop test and resistance tests using method appropriate to site conditions and to approval of Consultant and Electrical Safety Authority.
- 3. Perform test before energizing electrical system.

## END OF SECTION



### PART 1 - GENERAL

### 1.1 SCOPE

1. This section covers the requirements for support systems used with the electrical feeders and boxes on the project.

## PART 2 - PRODUCTS

## 2.1 FASTENINGS AND SUPPORT CHANNELS

- 1. Support channels shall be U shape, size 40 x 40 mm, 2.5 mm thick, mounted as required to support the various loads.
- 2. Finish of fastenings, fittings and supports shall be hot dip galvanized or stainless steel; electro-plating is not acceptable as it promotes formation of zinc whiskers unacceptable in environments with high airflow velocity and sensitive electronic equipment.

### PART 3 - EXECUTION

### 3.1 INSTALLATION

- 1. Secure conduits and boxes to solid masonry surfaces with lead anchors.
- 2. Secure conduits and boxes to poured concrete with expandable inserts.
- 3. Secure conduits and boxes to hollow walls with toggle bolts.
- 4. Support conduit using clips, spring loaded bolts, or cable clamps designed as accessories to basic channel members.
- 5. Fasten exposed conduit to building construction or support system using straps. Use onehole steel straps to secure surface conduits and cables 50 mm and smaller and two-hole steel straps for conduits and cables larger than 50 mm.
- 6. Use beam clamps to secure conduit to exposed steel work.
- 7. Suspended support systems: support individual conduit runs and boxes with 6 mm diameter threaded rods and spring clips; support 2 or more conduits on channels supported by 6 mm diameter threaded rod hangers where direct fastening to building construction is impractical.
- 8. For surface mounting of two or more conduits use channels at 1.2 m spacing.
- 9. Provide metal brackets, frames, hangers, clamps and related types of support structures as required to support conduit runs and boxes.
- 10. Ensure adequate support for raceways dropped vertically to equipment where there is no wall support.



- 11. Do not use supports or equipment installed for other trades for conduit support.
- 12. Install fastenings and supports as required for conduits and boxes, and in accordance with manufacturer's installation recommendations.

**END OF SECTION** 



#### PART 1 - GENERAL

#### 1.1 SCOPE

- 1. This section describes miscellaneous equipment and materials to be used in the electrical installation.
- 2. The drawings do not necessarily show junction and pull boxes.

### PART 2 - PRODUCTS

#### 2.1 JUNCTION, PULL AND TAP BOXES

- 1. Welded steel construction with screw-on flat covers for surface mounting.
- 2. Where wiring from 2 or more sources are contained in or running through pull or junction box, the box shall be labelled with appropriate warning as well as voltage and sources.

### PART 3 - EXECUTION

### 3.1 JUNCTION, PULL, AND TAP BOX INSTALLATION

- 1. Install boxes in accessible locations.
- 2. Install pull boxes so as not to exceed two 90° bends, between boxes.

#### 3.2 IDENTIFICATION

1. Provide equipment identification in accordance with Section 26 05 00.

## END OF SECTION

### PART 1 - GENERAL

### 1.1 **REFERENCES**

- 1. Canadian Standards Association (CSA)
  - 1. CAN/CSA C22.2 No.18, Outlet Boxes, Conduit Boxes, and Fittings.
  - 2. CSA C22.2 No.83, Electrical Metallic Tubing.

### 1.2 RELATED WORK

1. Comply with the relevant Sections of this and other Divisions of this Specification.

### 1.3 APPLICATION

- 1. EMT conduit may be used in all indoor locations, except as excluded herein and provided that it is not susceptible to mechanical injury.
- 2. Flexible metallic conduit shall be used for the last 1.0 m in connections to vibrating equipment including, but not limited to transformers.
- 3. Notwithstanding anything in this Article, a specific direction on the Drawings to use a particular type of conduit shall override this Article.

## PART 2 - PRODUCTS

#### 2.1 CONDUIT FASTENINGS

- 1. One-hole steel straps to secure surface conduits 50 mm and smaller. Two-hole steel straps for conduits larger than 50 mm. "Caddy" clips shall not be used.
- 2. Beam clamps to secure conduits to exposed steel work.
- 3. Channel type supports for two or more conduits at 1.2 m oc.
- 4. Threaded rods, 6 mm diameter, to support suspended channels.

#### 2.2 CONDUIT FITTINGS

- 1. Fittings: manufactured for use with conduit specified. Coating: same as conduit.
- 2. Factory "ells" where 90° bends are required for 25 mm and larger conduits.
- 3. Compression watertight connectors and couplings for EMT exposed to moisture.
- 4. Set-screw fittings for EMT conduit where acceptable.



### 2.3 FISH CORD

1. Install Polypropylene cord in each conduit.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- 1. Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- 2. Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- 3. Mechanically bend steel conduit over 20 mm diameter.
- 4. Install fish cord in empty conduits.
- 5. Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- 6. Dry conduits out before installing wire.
- 7. Remove burrs at conduit ends prior to installing wire.

#### 3.2 SURFACE CONDUITS

- 1. Run conduits parallel or perpendicular to building lines.
- 2. Group conduits wherever possible on channels.
- 3. Do not pass conduits through structural members.
- 4. Do not locate conduits less than 75 mm parallel to hot water lines with minimum of 25 mm at crossovers.

## END OF SECTION

#### PART 1 – GENERAL

## 1.1 SCOPE OF WORK

- 1. This specification covers the supply, installation, testing and commissioning of one (1) Diesel generator for a critical facility application. The generator is indoor type, labelled G-1 as noted in the attached Single Line Diagram and layout drawings.
- 2. In connection with this equipment the scope of work shall also include the cost of the following services:
  - 1. Factory Acceptance Testing (FAT) of the generator prior to shipping to the installation site. The testing will be witnessed by the Owner and/or Owner's representative (Consultant).
  - 2. Shipping of the generator to the installation site, unloading, and moving into the building by hoisting it to the Penthouse level (10<sup>th</sup> floor).
  - 3. Installation, Site Acceptance Testing (SAT) and commissioning.
  - 4. Preparation and submission of documentation
  - 5. Site support by the manufacturer, including as many visits as required during installation, SAT and commissioning, to ensure soundness of the installation and adequate performance during testing and commissioning.
  - 6. Training of facility's operating personnel upon acceptance of the work

## 1.2 **REFERENCE STANDARDS**

- 1. Canadian Standards Association: C282-05, CSA Z299, CSA 22.2 94, CSA B-139
- 2. Technical Standards and Safety Association (TSSA)
- 3. Underwriters' Laboratories of Canada, Inc. (ULC)
- 4. American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)

B16.5 -. Steel Pipe Flanges and Flanged Fittings C50,- Rotating Machines

- 5. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE): ASHRAE Handbook, HVAC Applications Volume, Chapter 47, "Sound and Vibration Control)
- 6. American Society for Testing and Materials (ASTM):

D975 - Standard Specification for Diesel Fuel Oils D2622 - Standard Test Method for Sulphur in Petroleum Products

- 7. ISO 8528 Reciprocating internal combustion engine-driven alternating current generating sets
- 8. ISO 3046 Reciprocating Internal Combustion Engines



- 9. National Electrical Manufacturers Association (NEMA)
  - MG1 Motors and Generators
  - MG2 Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators
- 10. National Fire Protection Association (NFPA)
  - 37 Stationary Combustion Engines and Gas Turbines
  - 70 National Electrical Code
  - 101 Standard for Safety to Life from Fire in Buildings and Structures
  - 110 Emergency and Standby Power Systems
- 11. Underwriters Laboratories, Inc. (UL)
  - 142 Above-ground Tanks for Flammable and Combustible Liquids
  - 489 Low Voltage Circuit Breakers
  - 1066 Power Circuit Breakers
  - 2200 Stationary Engine Generator Assemblies (600V generators or less)
- 12. Occupational Health and Safety Administration (OHSA): 29 CFR 1910, Occupational Safety and Health Standards

### 1.3 WARRANTY

- 1. Warranty Period: two (2) years, commencing upon acceptance of the equipment by the City.
- 2. Warranty shall account for continuous operation of the system for an extended outage duration.
- 3. Warranty shall include two (2) preventative maintenance (PM) visits per year; each visit shall include up to four (4) hours of site support following the completion of the PM tasks. **Provide separate cost of yearly PM service following the expiration of warranty.**
- 4. Manufacturer shall agree to repair or replace all generator components that fail in materials or workmanship within the specified warranty period. Warranty shall include all labour, material, and related expenses to restore equipment and / or components from failures.
- 5. Correction of defects in materials and workmanship shall be completed within ten (10) days from receiving written notification of equipment failure to meet the guaranteed performance. In the meantime, the City of Toronto reserves the right to use the equipment as required for operation until service is performed.
- 6. The warranty specified in this Article shall not deprive the City of rights under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the manufacturer under the requirements of the Contract Documents.

## 1.4 SUBMITTALS

- 1. Provide the following product information:
  - 1. Capacity calculations to verify that the power ratings of submitted engine-generator set are adequate for the specified load profile.



- 2. General arrangement drawings showing the overall dimensions, clearances, and operating weights.
- 3. Product Data:
  - 1. Continuous full load output of set at 0.8 PF lagging
  - 2. Engine: make and model, DIN rating, performance curve
  - 3. Engine heaters: make and electrical characteristics
  - 4. Cooling air requirements (cfm) and radiator sizing calculations
  - 5. Governor: make and type
  - 6. Exhaust muffler (silencer): make, type and acoustic performance curve
  - 7. Flow diagrams for Diesel fuel, cooling air and lubricating oil
  - 8. Fuel consumption data at 50%, 75% and 100% load
  - 9. Acoustical performance of the open engine
  - 10. Emissions content of the engine.
  - 11. Alternator: make, model, reactance data and Thermal Damage Curve
  - 12. Voltage Regulator: make, model and type
  - 13. Battery: make, type, capacity and other relevant characteristics
  - 14. Battery Charger: make, model and relevant characteristics
  - 15. Control Panel: make and type of meters and controls
  - 16. Circuit breakers, relays
  - 17. Communications interface type and capabilities
- 2. Shop Drawings
  - 1. Prepare shop as early as possible after award of contract. It is extremely important that generator manufacturing and delivery processes be expediated in the context of the current long lead times in the supply chain. The Consultant will support this effort by providing a quick turnaround on the shop drawing review.
  - 2. Submit shop drawings, including:
    - 1. Bill of Material
    - 2. Dimensioned outlines of generator sets showing plan, side, front, rear and side views, and anchoring provisions
    - 3. AC single line and three-line schematic diagrams with all components cross referenced.
    - 4. Equipment interconnection drawings showing terminal points and external device function.
    - 5. Schedule of breakers, with all relevant ratings



- 6. Calculation of battery size and battery charger, in accordance with ANSI/IEEE-1115.
- 7. Quality control procedures, including:
  - 1. Factory witness test and field-test procedures
  - 2. Sample factory witness test report
  - 3. A summary of the customer training to be furnished. Training shall be conducted by a factory service technician at the Project Site.
- 8. Certifications: submit paragraph-by-paragraph specification compliance statement, describing the differences between the specified and proposed equipment. Submit proof of compliance with indicated qualification requirements.
- 3. Provide Operation and Maintenance Manual in printed and soft format. Include the following:
  - 1. Shop drawings, including any field modifications or changes to reflect actual, "as installed" conditions.
  - 2. Technical data:

1. Illustrated parts lists with catalogue numbers

- 2. Schematic diagram of electrical controls
- 3. Flow diagrams for: fuel system, lubricating oil, cooling system
- 4. Fault locating guide
- 5. Precise details for adjustment and setting of time delay relays or sensing controls, which require on site adjustment.
- 3. Complete point-to-point wiring diagrams in AutoCAD showing connections between components installed inside the generator control panel, and between the generator(s) and external equipment/switchgear or other equipment (e.g. fuel tanks, ventilation controls, monitoring system etc.)
- 4. Operation instructions for each individual component
- 5. Recommended maintenance and repair/troubleshooting instructions and schedules
- 6. Recommended spare parts list, showing all consumables anticipated to be required during routine maintenance and testing
- 7. Certified factory and field test reports
- 8. Warranty
- 9. Addresses and phone numbers of suppliers and/or their authorized representatives.
- 4. The soft format documents shall be AutoCAD and PDF files.
- 5. PDF files shall be created in Adobe Acrobat and shall be formatted with bookmarks and table of contents.
- 6. Printed (hard copy) documents shall be assembled in a manual complete with a CD/DVD or flash drive, inserted in a plastic sleeve attached to the manual binder.



# 1.5 SOURCE QUALITY CONTROL

- 1. Provide Factory Acceptance Testing (FAT) of the equipment at the manufacturer's facility in presence of the City of Toronto and/or the City's representatives.
- 2. The Bid Price shall include travel expenses (transportation, accommodation and meals) for up to two participants for the duration of the factory tests.
- 3. Provide notice of factory test date at least fifteen (15) days prior to the test date.
- 4. Prior to the FAT, provide manufacturer's pre-acceptance test reports indicating that the assembled equipment is ready for factory acceptance tests. Provide such reports five (5) days in advance of the FAT.
- 5. The Vendor's local Service Supervisor for the contract shall attend the factory acceptance test. This individual shall have a technical background and shall be the primary contact for all future system startup and maintenance.
- 6. Provide suitable test area with adjustable loading facilities. Assemble and setup each unit for tests to be witnessed. Prior to commencing the tests, ensure that
  - 1. the engine has run sufficiently prior to load test
  - 2. the system has been de-bugged
  - 3. monitors/recorders are connected, and
  - 4. all test forms are filled with the information pertaining to the system tested.
- 7. Visual inspection: a complete mechanical and electrical examination will be conducted to determine compliance with specification and drawings with respect to materials, workmanship, dimensions, and marking.
- 8. Non-operational tests and checks: perform following checks before starting the unit:
  - 1. Shaft alignment, end float, angular and parallel
  - 2. Cold resistance of generator windings
  - 3. Electrical wiring and equipment grounds
  - 4. All lubricating points
  - 5. Personnel safety guards
  - 6. Air filters
  - 7. Lubricating oil type and level
  - 8. Type of fuel
  - 9. Vibration isolator adjustment
  - 10. Temperature and pressure sensors
  - 11. Engine exhausts system
  - 12. Tools
  - 13. Spares.



- 9. Provide fuel for factory tests.
- 10. Operational test and check: on completion of the above. Provide multi-channel recorder and record the following:
  - 1. Time for unit to cold-start and reach stable voltage and frequency
  - 2. Time from initiation of start to full load application, with voltage and frequency settled
  - 3. Voltage and frequency transient and steady state limits for full load to no load, 3/4 load to no load, 1/2 load to no load, 1/4 load to no load and vice versa. Measure machine vibration levels under the same load conditions.
  - 4. Record battery voltage drop during cranking.
- 11. Protection and control demonstration. Following completion of the previous step, demonstrate the following:
  - 1. In manual and automatic mode:
    - a. Over-temperature protection
    - b. Low oil pressure protection
    - c. Over-speed protection
  - 2. In automatic mode only:
    - a. Cranking cut-out
    - b. Over-crank protection (3 attempts)
    - c. Under and over frequency
    - d. Under and over voltage
  - 3. All control functions.
- 12. Load tests: load test the unit for 8 h at full rated load in ambient room temperature of minimum 25°C. Record the following data at the start of load test and every 15 minutes thereafter:
  - 1. Frequency
  - 2. Voltage
  - 3. Current
  - 4. Kilowatts
  - 5. Generator frame temperature
  - 6. Engine temperature
  - 7. Oil temperature and pressure
  - 8. Manifold pressure
  - 9. Ambient room temperature
  - 10. Generator cooling air outlet temperature.
- 13. Miscellaneous: provide accurate means for determining fuel and lubricating oil consumption.



- 14. Provide strip chart recorder (or digital data logger) for monitoring frequency, voltage and load. The recorder shall have been calibrated by the recorder manufacturer (or designated representative) within three months of the factory testing.
- 15. Voltage and frequency regulation tests: on completion of load tests record resistance of the hot generator windings. Subject the unit to voltage and frequency regulation tests while the unit is hot. Perform tests and record voltage and frequency applying load starting at no load, to 25%, 50%, 75% and 100% load, and vice versa.
- 16. Control panel functions and performance: check sequence of operation under service conditions.
- 17. Hi-pot tests: perform over potential tests on primary and secondary wiring in accordance with appropriate EEMAC Standard.
- 18. Additional tests: perform any tests consistent with the contract, which the City representative may require to satisfy themselves of the performance of the units.

# 1.6 MAINTENANCE MATERIALS

- 3. Provide a complete set of specialized tools required for the proper care, adjustment and maintenance of equipment supplied.
- 4. Include in Bid the following replacement parts:
  - 1. air filters, 2 each
  - 2. oil filters, 2 each
  - 3. fuel filters, 2 each
  - 4. spare pilot lamps,
  - 5. spare fuses for control panel, 2 of each size
  - 6. spare jacket water heater element
  - 7. antifreeze inhibitor; inhibitor test kit
  - 8. oil sampling kit
- 5. Provide a list of recommended spare parts complete with unit cost and lead time, indicating what parts are to be kept on site for repair and/or replacement during the first 600 hours of operation.

## 1.7 SHIPPING

- 1. Ship all equipment and material by direct dedicated carrier, without enroute transfers.
- 2. Adequately package/crate, brace and secure equipment to prevent physical and environmental damage during transit and handling. Provide shipping damage indicators to allow easy identification of spots damaged during transportation.
- 3. All material not mounted or installed on the major equipment during shipping shall be properly crated and shipped with the associated equipment.



- 4. Coordinate shipping of all equipment and material with the City to ensure receiving arrangements are in place.
- 5. Arrange shipping components to permit transportation and moving into building at destination without need to remove or modify building elements.
- 6. The equipment shall be equipped for handling by crane, forklift, pallet jack and rollers.
- 7. All equipment arriving at site must match the equipment that was factory tested. If the serial number of any equipment shipped differs from the equipment that was witness tested, it will be rejected and sent back to the manufacturer at no cost to the City. The manufacturer shall be responsible for all costs resulting from this, including new manufacturing, testing, shipping, etc.
- 8. At time of receipt of equipment, the supplier's technical representative shall be present to inspect the equipment prior to unloading and report any damage to the City. The technical representative shall also witness the unloading and hoisting and advise on the appropriate method for handling the equipment in order to avoid damage during the unloading, hoisting moving and pre-assembly. In the event the equipment has been found to be damaged before unloading, it shall be returned immediately to the factory for repairs and/or replacement.
- 9. In the event of damage occurring at any time during unloading and until the equipment is accepted by the City, the Contractor shall be responsible for repairs and/or replacement to the satisfaction of the City.

## 1.8 SITE ACCEPTANCE TESTING

- 1. Provide the first fuel fill of the main storage tank before commencing the site tests.
- 2. Perform visual checks on generator sets and ancillary equipment prior to starting and testing.
  - 1. Ensure that all shipping members have been removed.
  - 2. Check for damage, including dents, scratches, frame misalignment and damage to panel devices.
  - 3. Ensure that assembly is free of foreign materials, tools, loose materials and dirt.
  - 4. Check electrical connections and grounding.
- 2. Functional Tests:
  - 1. Attach a phase rotation meter to generator output and observe proper phase sequences.
  - 2. Check for proper phasing and identification.
  - 3. Check components for proper alignment and operation.
  - 4. Check and test selector switches and pushbuttons and meters for proper operation.
  - 5. Check and test indicating lights and alarms for proper operation and colour.
- 3. Perform manufacturer's on-site field test procedures:
  - 1. Demonstrate that all functions and interlocks have been implemented.
  - 2. Test the installed engine-generator set for an 8-hour period using a resistive load bank. Supply load bank and load bank cables to facilitate governor adjustments, generator



synchronization, engine generator start-up under loaded conditions, and to conduct the load tests described above. Instrument readings on engine generator sets and generator paralleling switchgear shall be recorded every 15 minutes.

- 3. Field tests shall include, but not be limited to, automatic engine starting and control, standby system transfers, metering, annunciations and control panel operations.
- 4. Perform installation acceptance tests required by NFPA 110, including cold start and load acceptance tests.
- 5. Test 100 percent single-step load application and acceptance within 5 seconds. Additional step loading test shall also be performed at 25 percent, 50 percent, and 75 percent.
- 6. After completing all adjustments and field tests in accordance with the approved field test procedures, conduct an acceptance and integration test for each piece of equipment, and an additional final system integration test, to demonstrate compliance with the requirements of this Specification.
- 7. If any of the site acceptance tests are not successful, make any necessary corrections and re-test the corrected equipment at no cost to the Owner.
- 4. Replace engine oil and filters before turning generators over to the Owner.
- 5. Top up fuel tank at the completion of site tests.

# PART 2 - PRODUCTS

# 2.1 MANUFACTURERS

- 1. The listing of the specific manufacturers below does not imply acceptance of products that do not meet the specified ratings, features or functions required for this project. Manufacturers listed below are not exempted from meeting these specifications in their entirety.
- 2. The complete system(s) shall be engineered, fabricated, tested, delivered, and warranted by a single source. The approved vendors (no equal, unless approved by the City) are:
  - 1. Caterpillar, c/o Toromont
  - 2. Cummins, c/o Cummins Power Systems
  - 3. IGSA, c/o Total Power Limited
  - 4. Kohler, c/o Pritchard Power Systems
  - 5. Blue Star, c/o MegaWatt Power Solutions
- 3. Unique, non-standard capacity ratings will not be accepted. Only certified performance data, published and listed as the manufacturer's standard offering will be considered.

# 2.2 VENDOR QUALIFICATIONS

- 1. Vendor shall be an authorized factory distributor of the equipment manufacturer.
- 2. Vendor shall maintain complete parts and service availability with factory-certified technicians available 24 hours per day, 7 days a week with a four (4) hour response time.



## 2.3 CONDITIONS AND RATINGS

- 1. Diesel generator set required to maintain the specified power output required to sustain a load profile in a mission-critical application.
- 2. Sizing of generator based on the published maximum allowable power (kW) loading over a 24-hour period.
- 3. Generator rated to deliver a maximum of 1250 kW at the output of the alternator, at 0.8 power factor.
- 4. Diesel generator set capable of accepting full rated load within 10 seconds of receiving a start signal.
- 5. System Configuration: 600 V, three phase, three wire, solidly grounded. Installation in the following environmental conditions:
  - 1. Altitude: 650 ft (200 m) above sea level:
  - 2. Ambient temperature: 40<sup>o</sup> C.
  - 3. Relative humidity: 85 %.
- 6. Installation type: Indoor, on a skid

## 2.4 SEISMIC REQUIREMENTS

1. Generator set designed and constructed to meet the seismic design criteria per the 2012 Ontario Building Code (O.Reg. 332/12, as amended), Division B, Article 4.1.8.18.

## 2.5 SYSTEM DESCRIPTION

- 1. Refer to the Single Line Diagram drawing attached to this Specification.
- 2. Designed and configured for automatic, unattended operation, in conjunction with an existing external switchgear and a second generator (stationary or mobile).
- 3. Coordination with the supplier / manufacturer of the switchgear and controls (Toromont and KRKA Power) is required for this purpose.
- 4. Modes of operation:
  - 1. The system is configured for N+1 redundancy and this generator is connected to its own bus. It will operate in one of the following modes:
    - 1. in parallel with another (existing) generator, also connected to its own bus, or
    - 2. Independently (standalone, carrying the full load of the essential buses) or in Lead-Lag mode with a mobile generator (each generator supporting its own bus).
  - 2. The generator capacity is adequate to carry the full load when operating alone.
  - 3. Transfers between the utility and generator sources open transition type, performed via pairs of beakers in separate switchgear.
- 5. Generator set shall include:
  - 1. Diesel engine, complete with governor, cooling, lubrication, fuel, and exhaust system



- 2. Engine starting systems
- 3. Alternator
- 4. Engine and alternator control panel
- 5. Remote annunciator one for each generator, suitable for wall mounting. Supplier to review the existing switchgear to ensure no gap or duplication in the remote annunciation capabilities.

# 2.6 DIESEL ENGINE

- 1. Diesel engine: to ISO 3046-1, standard product of current manufacture, with performance per the requirements of subsection 2.3.
- 2. Four-stroke, four-cycle design, turbo-charged and intercooled, synchronous speed 1800 rpm.
- 3. Capacity: Power output sufficient to deliver the specified electrical output of alternator at rated speed, after de-rating and adjustment for system losses in auxiliary equipment necessary for engine operation, calculated under the site conditions outlined in Section 2.3.
- 4. Engine capable of producing the specified performance criteria indicated when operating on No. 2 diesel fuel meeting ASTM D 975 and D2622.
- 5. Combustion system designed to limit emissions for minimum EPA Tier 2 certification.
- 6. Turbochargers: driven by the exhaust gases, directly connected to an impeller supplying air to the engine intake manifold.
- 7. Capability to operate lightly loaded without adverse effects.
- 8. Guards to protect personnel from hot and moving parts. Locate guards so that normal daily maintenance inspections can be undertaken without their removal.

## 2.7 STARTING SYSTEM

- 1. 24 V DC starting system consisting of batteries, battery stands and cables, starter motors, and battery chargers.
- 2. Starting engine at minimum ambient temperature of 0<sup>o</sup> C should not affect/degrade life of cranking motor. If this requirement cannot be met, an additional starting motor shall be provided.
- 3. Starting batteries (two sets) shall be lead acid, heavy-duty for engine starting applications, capable of 180 seconds of cycle cranking at 0°, including four (4) crank cycles of 45 seconds each. Terminals and all exposed electrical connections shall be protected from accidental short circuit. Provide best battery selector for each generator.
- 4. Battery sizing shall consider specific application conditions, including engine oil viscosity, ambient starting temperature, control voltage, overcharging and vibration. Submit sizing calculations in accordance to ANSI/IEEE 1115.
- 5. Battery warranty shall be the responsibility of the engine generator manufacturer.



- 6. Cranking motor: positively engaged to flywheel ring. Cranking limiter to provide 3 cranking periods of 10-second duration, each separated by 10-second rest.
- 7. Battery stand: seismic rated battery racks fabricated from angle irons, with tie-down straps, and coated with acid resistant paint, for installation separate from generator frame.
- 8. Battery Cables: DLO type (locomotive style), multi strand copper conductor with the required cables clamps and lugs.
- 9. Battery charger (two for each generator):
  - 1. UL listed/CSA certified
  - 2. wall-mount type in NEMA 1 enclosure
  - 3. compatible with batteries provided
  - 4. solid state (silicon diode full-wave rectifier), with overload protection and voltage surge suppressors
  - 5. 120 or 208 V AC input, single phase, 24 V output, capacity to recharge its set of batteries within six (6) hours, but not less than 10 A DC output current.
  - 6. automatic two-stage operation, from trickle charge at standby to boost charge after use, with DC regulation of 1% for ±10% input variation. Automatic boost for 6 h every 30 days
  - 7. selector switch for manual mode float or boost/high-rate charge
  - 8. local DC ammeter and voltmeter, AC and DC circuit breakers
  - 9. alarm relays with Form C contacts for remote annunciation of faults (at generator annunciator panel); including:
    - 1. Loss of AC power
    - 2. Low battery voltage
    - 3. Ground fault
    - 4. Trouble signal
    - 5. LED lights on front panel for low DC volts, rectifier failure, loss of AC power, and high DC volts.

# 2.8 GOVERNOR

- 1. Governor and accessories to be selected by engine manufacturer to meet stated performance criteria and to maintain emissions performance.
- 2. Electronic type, with electric actuator, in compliance with ISO 3046/4.
- 3. Direct acting type, externally adjustable from isochronous to 5%, with ramping function to control engine speed and limit exhaust smoke on unit start. Speed shall be sensed by a magnetic pickup off the engine flywheel ring gear.
- 4. Speed, stability and gain adjustments to be possible without the use of special devices/tools, including computer/software.
- 5. Performance:



- 1. Minimum range of speed changer (percent of rated speed): -15% to + 5%.
- 2. Frequency regulation (percent of steady-state cycles): ± 0.25%.
- 3. Transient response to "sudden addition or removal of 25% percent load"
  - 1. speed deviation: ± 3.0%

2.time to return to steady-state frequency: 3 seconds.

## 2.9 COOLING SYSTEM

- 1. System: designed to maintain manufacturer's recommended engine temperature at full load operation in 40°C ambient, measured at the generator air inlet (not at the fan discharge). Prealarm temperature set at 50°C (122 F)
- 2. Heat transfer medium: 50/50 propylene glycol/water mixture. Units shall be delivered with an initial supply of propylene glycol in the amount of 50 percent of the total cooling capacity of the system.
- 3. Extended life propylene glycol shall be used, to provide a five-year service interval.
- 4. V-design engines shall be provided with:
  - 1. piping header to wye the two engine water outlets into a single flanged outlet.
  - 2. coolant outlet connection.
  - 3. flanged engine coolant return connection.
- 5. Rotating parts and parts subject to heating at temperatures over 70°C shall be guarded against accidental contact per OSHA requirements.
- 6. Water (coolant) Pump: Self-lubricated, engine-driven, gear type
- 7. Heavy-duty industrial radiator, having the following characteristics:
  - 1. vertical type with horizontal air discharge, mounted on generator set base
  - 2. provided with a duct adapter flange for connecting to the discharge duct through the building wall, through a discharge (acoustic) silencer
  - 3. bolted steel frame, duct flange, plenum chamber, lifting lugs, core guard, OSHA fan guard and fan drive supported by channels integral to frame.
  - 4. split, vertical core with continuous aluminium plate fins, solder bonded to flat brass tubes and separate jacket water and intercooler water sections.
  - 5. oversize top tank for water inspection, single-pass model, for low-pressure drop
  - 6. sight glass, vent and drain connections, and 15 psi filler cap.
  - 7. low-level coolant alarm switch, with spare contacts for remote alarm indication
- 8. Radiator fan:
  - 1. forced draft, fixed centre, air foil type with adjustable steel blades, engine-driven by minimum two belts.



- 2. capable of operating against a maximum external air pressure drop through the radiator of 0.5" water column
- 7. Provide hoses and readily accessible drain valves to allow convenient and full draining of coolant fluid. Hoses shall be stainless steel, with appropriate hydraulic-style, screw-on fittings (SAE100R5) or fittings approved for use with stainless steel hose.
- 8. Install jacket water heaters, circulating type, properly sized to maintain jacket water temperature and provide reliable engine starting in the specified ambient conditions.
- 9. One heater shall be installed on each side of the 'V' engine.
- 10. Heaters shall be
  - 1. thermostatically controlled and supplied by separate power circuits (120 V or 240/208V), to allow the engine to start and assume full load in max. 10 seconds.
  - 2. isolated using stainless steel, full port ball valves.
  - 3. electrically protected with suitable devices mounted in control cubicle.

## 2.10 LUBRICATION SYSTEM

- 1. Full-pressure type, complete with duplex filters and oil cooler.
- 2. Oil pump: engine-driven gear type, complete with strainer and pressure regulator, to supply filtered lubricating oil under pressure to main bearings, crank pin bearings, piston pins, timing gears, camshaft bearings, valve rocker mechanism, governor and turbochargers.
- 3. Filters: full flow, engine mounted, spin-on canister elements, full flow type, removable without disconnecting piping, and installed in accessible location; filter assembly to include a spring-loaded automatic by-pass valve.
- 4. Lube Oil Cooler: engine mounted, full flow, equipped with bypass valve and having sufficient capacity to maintain oil temperature within engine manufacturer's tolerances while operating at rated load under conditions specified.
- 5. Oil sump with oil drainpipe, gate valve and pipe cap, located to permit complete drainage in a convenient manner.
- 6. Crankcase vent breather filter with fumes recovery system to filter out the oil mist from the blowby, unless a closed crankcase design is provided.
- 7. Thermostatically controlled lube oil heaters supplied separately from the jacket water heaters
- 8. Metallic hoses of steel reinforced rubber type with crimped or swaged end fittings.

## 2.11 FUEL SYSTEM

- 1. Fuel: Type A fuel oil to CAN/CGSB-3.6.
- 2. Fuel system: solid injection, positive displacement, with
  - 1. Fuel transfer pump: self-lubricated, positive displacement, gear-driven, with hand primer





- 2. Fuel filters: 30-micron filter, redundant, triplex hot swap assembly with water separator, installed upstream of fuel pump and injectors. Fuel filters to allow individual filter replacement while engine running at rated speed under full load generator manufacturer to confirm fuel flow requirements in GPH with only two bowls in service. Engine mounted fuel filter to be manufacturer's standard to maintain equipment warranty and maximize uptime.
- 3. Air intake filters: dry type, replaceable, with alarm for low flow indication
- 4. Filter elements directly replaceable with elements of Canadian manufacture.
- 3. Return fuel oil cooler / heat exchanger: mechanical, mounted on engine side of radiator radiator airflow cools the fuel circulating through cooler; capacity to reject 100% of the heat absorbed by the excess fuel being returned to the oil tank at full load and 40° C ambient. Flexible fuel oil-connectors(s) shall be braided stainless steel type UL approved. Provide a valve bypass around the cooler.
- 4. Fuel oil shall be piped from the fuel oil filters to the intake of the engine fuel oil pump and then to the engine.
- 5. Excess fuel oil shall be piped through the fuel oil cooler and returned to the fuel oil tank.
- 6. Fuel Injectors: unit fuel injector mounted in each cylinder head, complete with external feeder lines. Injection timing and duration electronically controlled with injection pressure accomplished by a piston pump driven by the engine camshaft.
- 7. Fuel rack solenoid energized when engine running.
- 8. Flexible fuel connectors: non-metallic fuel hoses with braided steel reinforcement and crimped or swaged end fittings, ULC approved.

## 2.12 EXHAUST AND EMISSIONS CONTROL SYSTEM

- 1. Generator designed to limit emissions to level acceptable for minimum Tier 2 certification.
- 2. Combustion Exhaust Silencer to mitigate noise:
  - 1. Hospital grade acoustical performance
    - 1. Noise level shall not exceed 68 dBA at 10 ft from discharge point (installed outdoors)
    - 2. Exhaust silencer shall be selected by the generator set Vendor to limit back pressure on the engine to values acceptable to engine manufacturer
    - 3. Silencer to include a condensate drain outlet, with plug.
  - 2. Silencer inlet and outlet of size determined by the manufacturer to satisfy the specified sound performance criteria provide calculations.
  - 3. Coupling between the silencer inlet outlet and engine exhaust outlet shall be through a standard class 125# ANSI flange.
  - 4. Silencer shall be tested by the manufacturer at a minimum pressure of 3 lb/sqin for a minimum duration of 4 hours, with no leaks. Provide certified test report for review by Consultant.



- 3. Engine exhaust manifold outlets to be coupled to the exhaust silencer by means of adequately sized flexible stainless-steel connectors with flanged couplings.
- 4. Piping, insulation and supports for the exhaust system components of the indoor generators will be supplied and installed by others.

# 2.13 ALTERNATOR

- 1. Synchronous type to ANSI/NEMA MG1.
- 2. Rating: 3 phase, 600 V, 4 wire, 1250 kW, 60 Hz, at 0.8 PF
- 3. Solidly grounded
- 4. Output at  $40^{\circ}$  C ambient: 100% full load.
- 5. Mechanical features:
  - 1. Drip proof construction, air cooled by a direct drive centrifugal blower fan directly connected to the engine with flexible drive disc and equipped with anti-condensation heater
  - 2. Ventilation: self-ventilated, with one-piece internal fan for high-volume, low-noise air delivery.
  - 3. Rotor: one-piece, dynamically balanced, permanently aligned to engine by flexible disc coupling.
  - 4. Bearings: pre-lubricated, shielded, insulated cartridge type with provisions for adding and changing grease through grease pipes extended to the generator exterior. Minimum L-10 bearing life shall be 40,000 hours.
- 6. Electrical characteristics:
  - 1. Revolving field, brushless, four poles.
  - 2. Stator: copper winding, form wound, insulated, and vacuum pressure-impregnated and baked; 2/3 Pitch to eliminate the third harmonic and to have maximum calculated sub-transient reactance (Xd") of 13.5% to minimize voltage distortion caused by non-linear load currents.
  - 3. Main Rotor: four-pole, amortisseur windings with field pole coil supports forming a singlepiece rotor core.
  - 4. Rotating Permanent Magnet Generator (PMG) Exciter: brushless construction with fullwave, three-phase rotating rectifier assembly with hermetically sealed, metallic-type silicon diodes. Mounted outboard of the generator bearing to allow removal of any part of the exciter without disassembly of the generator; checking the rotating diodes shall be possible without breaking any solder connection. Multi-plate selenium surge protector connected across the rotating diode network to protect it against transient conditions. PMG excitation current derived excitation from pilot exciter mounted on the rotor shaft.
  - 5. Insulation System and Temperature Rise: NEMA Class "H" materials, synthetic and nonhygroscopic. Stator winding impregnated and baked, with a final coating of epoxy for extra moisture and abrasion resistance. Rotor winding insulation of thermosetting epoxy impregnation, plus a final coating epoxy for moisture and abrasion resistance.



Temperature rise of both rotor and stator (as measured by the resistance method), not to exceed 800 C for continuous rated over a 400 C ambient temperature in accordance with NEMA MG1-22.40 for a Class "H" insulation system.

- 6. Temperature Detection: minimum two resistance temperature detectors (100 Ohm platinum RTDs) per phase embedded in each stator winding; each bearing provided with RTDs. All temperature detection devices to be wired to compatible transducers in the Control Panel for alarms.
- 7. Internally mounted anti-condensation strip heater(s), minimum 300 Watts at 120 VAC, with thermostatic control to maintain alternator space at approximately 10 degrees F above ambient.
- 8. Alternator: capable of sustaining 300% rated current for period not less than 10 seconds, to permit selective tripping of downstream protective devices on short circuit.
- 7. Alternator Terminal Box:
  - 1. NEMA 1 construction with hinged cover secured with bolts, suitably sized for load feeder connection, and to allow connection through the top, bottom or either side of the box.
  - 2. Size to accommodate terminations of cables of sizes and number commensurate with generator capacity. Terminal box to accommodate a ground bus for connection of the neutral points of the generator windings and the differential current transformers.
  - 3. Current sensors for use with external protection relay (if employed in the protection solution), wired to terminal block on the alternator connection box
  - 4. Potential transformers for voltmeter, frequency and run-time meters.
  - 5. Barrier to separate terminals for the instrument transformers from the main power lugs.
- 8. Voltage Regulator:
  - 1. Solid-state (SCR) type, microprocessor-controlled digital voltage regulator with phasecontrolled sensing circuit and accessories, including software interface for settings and communications
  - 2. Mounted on generator set, complete with current and potential transformers for 3-phase sensing
  - 3. Control and Protection Features and Capabilities:
    - 1. Communication interface module
    - 2. Stability network
    - 3. Accessory input
    - 4. Manual excitation control
    - 5. Remote voltage adjusting capability
    - 6. Stability (minimum 20 selectable stability ranges)
    - 7. Voltage matching
    - 8. Paralleling capability
    - 9. Soft start
    - 10. Thermal protection



- 11. VAR/power factor regulation
- 12. Over-excitation / Under-excitation
- 13. Overvoltage
- 14. Over-frequency / Under-frequency
- 4. Performance:
  - Voltage Regulation: ± 0.25% of mean voltage between no-load steady state and full load steady state
  - 2. Regulator stability (drift): less than 0.5% of maximum voltage, at any constant load from no-load to full load, over 72 F (23<sup>o</sup> C) ambient temperature change.
  - 3. Transient Response: in accordance with ISO 8528-1 to meet G3 Class performance as measured on an Astro-Med recorder.
  - 4. Harmonic Distortion: maximum 5% total RMS measured line to line at full-rated load
  - 5. Balanced Telephone Interference Factor (TIF): maximum 50
- 9. Termination block in the Engine Control panel for connection of the raise-lower external inputs from the generator switchgear, if provided.
- 10. Auxiliaries: Mounted and terminated in generator junction box for interfacing with generator switchgear. CTs terminated on shorting terminal blocks by ring type insulated gripping terminals.

## 2.14 ENGINE AND ALTERNATOR CONTROL PANEL

- 1. Set mounted control panel to provide local operating, monitoring, control, paralleling and protection functions for the generator set.
- 2. Digital type (micro-processor based), totally enclosed, in hinged enclosure, prototype tested to verify the durability of all components in the system under the vibration conditions encountered.
- 3. 24 V control power from the battery system
- 4. Control circuits using heavy-duty electromagnetic relays and time delay relays suitable for industrial applications.
- 5. Real time digital communications to all engine and regulator controls via SAE J1939.
- 6. Features and functions as follows:
  - 1. Alternator integral protection against electrical faults (overcurrent, overload, ground fault)
  - 2. Local-Remote-Lockout control switch.

Local - engine can be operated from the Run-Stop switch.

Remote - generator can be run from a remote closed contact in the generator switchgear so that the engine runs as long as the remote contact remains closed.

Lockout - engine is locked out and cannot start or run either locally or from a remote signal



- 3. Reset Switch for fault clearing, to allow restarting the generator after it has shut down due to a fault condition. Reset switch to also extinguish alarm lights. Engine cannot start or run if any of the shutdown signals are present and until the reset switch is operated.
- 4. Emergency Stop with extended guard by local button to stop engine and provision for remote emergency stop.
- 5. Push-to-test button for all indicating lights
- 6. Horn to sound if an alarm is activated. Horn silence push-button to also be provided.
- 7. Power monitoring by analogue or digital Instruments to manufacturer's standard, minimum 2% accuracy, for voltage, current, frequency, kW, kVAR, engine RPM, complete with phase selector switches, if applicable.
- 7. Engine Status Monitoring, by means of analogue gauges or digital display, per manufacturer's standard equipment, for the following parameters:
  - 1. Engine oil pressure
  - 2. Engine coolant temperature
  - 3. Coolant level
  - 4. Hours of operation
  - 5. Battery voltage (DC volts)
- 8. Indicator lights for alarm with 1 set manually reset NO/NC contacts wired to terminal block for remote annunciation on:
  - 1. Low fuel level
  - 2. Low and high battery voltage
  - 3. Ventilation failure
  - 4. Low coolant temperature
  - 5. Low coolant level
  - 6. Control switch not in automatic position
  - 7. Overcurrent
  - 8. Overload (kW)
  - 9. Lamp test button
- 9. Solid state controller for automatic shutdown and alarms with 1 set manually reset NO/NC contacts wired to terminal block for remote annunciation on:
  - 1. Engine over-crank
  - 2. Engine over-speed
  - 3. Engine under-speed
  - 4. Engine high temperature
  - 5. Engine low lube oil pressure
  - 6. Short circuit

- 7. AC over-voltage
- 8. AC under-voltage
- 9. Excitation fault
- 10. Communication ports: MODBUS and LAN (Ethernet). Coordinate with the paralleling switchgear and main switchgear suppliers to ensure compatibility of communications protocol across all switchgear line-ups.
- 11. Multiple sets of dry contacts for interfacing with external systems, including:
  - 1. Main switchgear, for generator Start-Stop signals
  - 2. Ventilation System
  - 3. Fire alarm System
  - 4. Building Automation System, for generator status
- 12. Automatic voltage regulation (AVR) system, matched to and prototype tested with the governing system provided. AVR shall be microprocessor based, with fully programmable operating and protection characteristics, and the following characteristics:
  - 1. Output voltage regulation of +/- 0.25% for any constant load between no load and full load
  - 2. VAR/pf control feature
  - 3. Adjustable dual slope characteristic to optimize voltage and frequency response for site conditions.
  - 4. Torque-matching characteristic to reduce output voltage in proportion to frequency below a threshold of 58-59 Hz.
  - 5. Control shall also include a voltage adjusting rheostat, locking-screwdriver type, to adjust voltage up to  $\pm$  5% from rated value, mounted on inside of control panel.
- 13. Tested and certified to the following environmental conditions:
  - 1. -40°C to +70°C, 0-95% humidity non-condensing, 30°C to 60°C
  - 2. 5% salt spray, 48 hours, +38°C, 36.8 V system voltage
  - 3. Sinusoidal vibration 4.3Gs RMS, 24-1000Hz
  - 4. Electromagnetic Capability: 89/336/EEC, 91/368/EEC, 93/44/EEC, 93/68/EEC, BS EN 50081-2, 50082-2)
  - 5. Shock: withstand: 15Gs

# 2.15 BASE

- 1. Engine-generator set and auxiliaries to be mounted on a structural steel base (skid).
- 2. Base to have the necessary cross-members, braces, lifting lugs, and side-mounting; designed with rigidity sufficient to resist all starting and operating forces.
- 3. Provide hoisting diagram, showing lift points, weights and centre of gravity.



- 4. Base to have two (2) NEMA standard 2-hole copper-faced or stainless-steel ground pads on opposite corners of the base
- 5. Seismic-restrained vibration isolators with the following characteristics:
  - 1. 1<sup>1</sup>/<sub>2</sub> inch minimum static (not 'rated') deflection, and 1 inch clearance between the structural base and the support structure when operating.
  - 2. Vibration isolators selected for lowest disturbing frequency and uniform static deflections according to distribution of weight and seismic design criteria per the 2012 Ontario Building Code (O.Reg. 332/12, as amended), Division B, Article 4.1.8.18.
- 6. Supply for each generator an oil drip pan made of 16-gauge galvanized steel sheet. The pan shall be leak-proof and shall be sized to collect any leaks from the radiator end to the engine flywheel end. The pan shall be easily accessible from the alternator end of the generator

# PART 3 - PRODUCTS

## 3.1 INSTALLATION

- 1. Locate generator where shown on drawings and bolt to floor.
- 2. Fit and adjust isolators in accordance with the manufacturer's installation and adjustment instruction bulletin contained in the unit manual. If isolator housing feet are equipped with 6 mm rubber sound pads there is no requirement for bolting housings to the foundation.
- 3. Install battery and battery chargers in the Generator Room, near the generator they serve.
- 4. Install power and control wiring between generator and external distribution and transfer switchgear
- 5. Follow manufacturer's recommendation with respect to all work.
- 6. Engine-generator shaft alignment is adjusted at the factory. Check the alignment on site to ensure that no change has occurred due to shipment and handling

# 3.2 SITE ACCEPTANCE TESTING

- 1. Perform visual checks on generator set prior to starting and testing.
  - 1. Ensure that all shipping members have been removed.
  - 2. Check for damage, including dents, scratches, frame misalignment and damage to panels.
  - 3. Ensure that assembly is free of foreign materials, tools, loose materials and dirt.
  - 4. Check electrical connections and grounding.
- 2. Arrange to fill up main fuel storage tank. Owner will pay the cost of the first fill.
- 3. Functional Tests:
  - 1. Attach a phase rotation meter to generator output and observe proper phase sequences.



- 2. Check for proper phasing and identification.
- 3. Check components for proper alignment and operation.
- 4. Check and test selector switches, pushbuttons and meters for proper operation.
- 5. Check and test indicating lights and alarms for proper operation and colour.
- 4. Perform manufacturer's on-site field test procedures:
  - 1. Demonstrate to the Owner and Consultant that all functions have been implemented.
  - Test installed engine-generator set for an 8-hour period using resistive load bank. Provide load bank and cables to conduct the load tests. Instrument readings on engine generator set and generator paralleling switchgear shall be recorded every 15 minutes.
  - 3. Field tests shall include, but not be limited to, automatic engine starting and control, standby system transfers, paralleling with the existing stationary generator, metering, annunciations and control panel operations.
  - 4. Perform installation acceptance tests required by NFPA 110, including cold start and load acceptance tests.
  - 5. Test 100 percent single-step load application and acceptance within 10 seconds. Additional step loading test shall also be performed at 25 percent, 50 percent, and 75 percent.
  - 6. After completing all adjustments and field tests in accordance with the approved field test procedures, conduct an acceptance and integration test for the generators and transfer switchgear, and an additional final system integration test for the benefit of the Owner and Consultant, to demonstrate compliance with the requirements of this Specification.
  - 7. If any of the field acceptance tests are not successful, the Contractor, in collaboration with equipment manufacturers shall make any necessary corrections and re-test the corrected equipment at no cost to the Owner.
  - 8. Top up fuel tank at the completion of tests, before turning the generator over to the Owner.

# 3.3 TRAINING

- 1. Provide two (2) training sessions (both in 'classroom' setting and hands-on) of minimum four (4) hours each, at the installation site.
- 2. Prepare training outline and materials to be used during the presentations. Issue training materials in advance of the sessions for review by the team for adequacy.
- 3. Allow the Owner to videotape the training classes for training future employees, if desired.

# END OF SECTION



#### PART 1 – GENERAL

### 1.1 SCOPE OF WORK

- 1. This specification covers the modifications to the existing controls in Switchboards EG-A, EG-B and EA, EB as required to enable operation of the generators in synchronized (parallel) and Lead-Lag (independent) modes, and to recover the system from certain failures of generators and/or associated breakers.
- 2. The work entails
  - 1. In Generator Switchboard EG-A/EG-B: installation of hard-wired interlocks if not already installed between pairs of breakers of the stationary and temporary generator for buses A and B
  - 2. Controls (logic and hard-wired, as necessary) to enable independent (non-parallel) operation of one stationary generator and one mobile generator

NOTE: This work must be performed by Toromont Power Systems, as it is the vendor of the original equipment controls

- 3. Work under 1. and 2. above must be completed as early as possible in the project, as a mobile generator is already connected to the system and must operate in automatic mode with existing stationary Generator G2.
- 4. In Standby Switchboards EA, EB: upgrading of PLC logic to control the operation of one tie breaker (EA-1d) upon loss of emergency supply to the switchboard

NOTE: This work must be performed by KRKA Power Inc., as it is the vendor of the original equipment controls

- 5. Updating of the graphics of the two HMIs, if required
- 3. In connection with the modifications to this equipment the scope of work shall also include the cost of the following services:
  - Factory Acceptance Testing (FAT) of the upgraded PLC logic for Switchboards EG-A/EG-B and EA, EB. The testing shall take place at the controls manufacturer shops (Toromont and KRKA Power) and will be witnessed by the Owner and/or Owner's representative (Consultant).
  - 2. Installation, Site Acceptance Testing (SAT) and commissioning of the updated PLC programs, and of any required new hardware and wiring.
  - 3. Preparation and submission of documentation.
  - 4. As many visits as required by the controls Vendors during installation, SAT, and commissioning, to ensure soundness of the installation and adequate performance during testing and commissioning in all modes of operation, including failure scenarios.
  - 5. Training of facility's operating personnel upon acceptance of the work.

#### 1.2 WARRANTY

1. Standard Warranty Period: two (2) years, commencing upon acceptance of the upgraded controls by the City.



- 2. Optional Extended Warranty: for 5 years and to 10 years, separately priced (refer to Price Form)
- 3. Warranty shall account for correct operation of the system under the expected normal and failure scenarios.
- 4. Manufacturer shall agree to update, repair or replace all components, including PLC logic, that fail in materials, workmanship or performance within the specified warranty period. Warranty shall include all labour, material, and related expenses to restore equipment and / or components from failures.
- 5. Correction of defects in materials and workmanship shall be completed within ten (10) days from receiving written notification of equipment failure to meet the guaranteed performance. In the meantime, the City reserves the right to use the equipment as required for operation until service is performed.
- 6. The warranty specified in this Article shall not deprive the City of rights under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the manufacturer under the requirements of the Contract Documents.

# 1.3 SUBMITTALS

- 1. For each of the two upgrades submit shop drawings, including:
  - 1. Sequence of Operation in narrative format
  - 2. Control wiring diagrams, with all components cross referenced.
  - 3. Equipment interconnection drawings showing terminal points and external device function. Include interconnections between generators and switchboards, and switchboards and miscellaneous new field devices, if applicable.
  - 2. Quality control procedures, including:
    - 1. Factory witness test and field-test procedures
    - 2. Sample factory witness test report
    - 3. A summary of the customer training to be furnished. Training shall be conducted by a factory service technician at the Project Site.
  - 3. Provide Operation and Maintenance Manual for the upgraded controls of each switchboard in printed and soft format. Include the following:
    - 1. Shop drawings, including any field modifications or changes to reflect actual, "as installed" conditions.
    - 2. Complete point-to-point wiring diagrams in AutoCAD showing connections between components installed inside the generator control panel, and between the generator control panels and external equipment/switchgear or other equipment (e.g. fuel tanks, ventilation controls, monitoring system etc.)
    - 3. Factory and field test reports
    - 4. Warranty
    - 5. Address and phone numbers of supplier and/or their authorized representatives.



- 4. The soft format documents shall be AutoCAD and PDF files.
- 5. PDF files shall be created in Adobe Acrobat and shall be formatted with bookmarks and table of contents.
- 6. Printed (hard copy) documents shall be assembled in a manual complete with a CD/DVD or flash drive, inserted in a plastic sleeve attached to the manual binder.

# PART 2 - PRODUCTS

## 2.1 CONTROLS VENDORS

1. Retain Toromont Power Systems and KRKA Power Inc. to undertake the modifications to the controls of switchboards EG-A/ EG-B and EA, EB. These are the vendors of the original controls and switchboards and their remote HMIs.

# 2.2 EXISTING GENERATOR SWITCHBOARD EG-A/EG-B

- 1. The switchboard has the following major components:
  - 1. Two incoming feeders from stationary generators GEN-1 and GEN-2, via electrically operated breakers EA-3d and EB-4d. Breakers are normally open (when the stationary generators are at rest).
  - 2. Two incoming feeders from the mobile generator connection box MCB, via electrically operated breakers EA-1b and EB-2b. Breakers are normally open (when the mobile generator is at rest).
  - 3. Two tie breakers between buses A and B, via electrically operated breakers EA-1d and EB-2d. Breakers are normally closed, to provide a common reference for generator synchronization.
  - 4. Two outgoing feeder breakers to Switchboards EA and EB, via breakers EA-3b and EB-4b. Breakers are normally closed, and their operation is not automated.
  - 5. Switchboard EG-A/EG-B has controls for including, but not limited to, the following:
    - 1. generator start/stop (both stationary and mobile generator)
    - 2. generator synchronization (voltage and frequency lower/raise)
    - 3. synch breaker operation (open/close)
    - 4. load sharing between generators
    - 5. power monitoring and alarm annunciation
    - 6. operator control (selector switches, open/close pushbuttons etc.)
  - 6. The current synchronization, load sharing and paralleling controls can operate with a combination of the two stationary generators or one of the stationary generators with the mobile generator. Synchronization with the mobile generator is no longer required and must be disabled.
  - 2. The normal conditions and sequence of operation are as follows:
    - 1. Each bus section is supplied from its respective generator via the synch breaker



- 2. Upon receiving a "loss of utility supply" signal from Switchboards EA or EB
  - 1. Both generators start
  - 2. The first generator reaching nominal voltage and frequency closes its synch breaker to its bus
  - 3. The second generator synchs to the common bus and closes its synch breaker.
  - 4. If, during operation, one generator fails or a synch breaker opens, the other generator assumes the total load and continues to run. The supply to the standby switchboards EA, EB is not affected.
  - 5. If, during operation, one feeder breaker opens (EA-3b or EB-4b), the supply to the respective switchboard (EA or EB) is discontinued and the switchboard remains de-energized until its utility supply is restored. This scenario (also identified in 2.3 below) is being addressed through this controls upgrade.
- 3. The above sequence is also executed if one stationary generator is out of service and is replaced with a mobile generator. The mobile generator synch breaker (EA-1b or EB-2b) takes the place of the out-of-service generator's synch breaker, which shall be racked out and locked by the facility personnel. This mode of operation will be disabled through this controls upgrade.

## 2.3 EXISTING STANDBY SWITCHBOARDS EA, EB

- 1. One incoming utility feeder, from Normal Switchboards B and C, via electrically operated breakers EA-7c and EB-8c. Breakers are normally closed.
  - 2. One incoming generator feeder, from Switchboard EG-A/EG-B, via electrically operated breakers EA-7d and EB-8d. Breakers are normally open.
  - 3. Two electrically operated tie breakers, EA-1d and EB-2d, linking the buses of the two switchboards. Breaker EA-1d is normally open, and breaker EB-2d is normally closed.
  - 4. Redundant controls for open transition transfers between the utility and generator sources. The normal conditions and sequence of operation are as follows:
    - 1. Each switchboard is supplied from its respective utility source (Switchboards B, C) via the incoming utility breaker
    - 2. Upon loss of one utility supply (the other utility supply remains energized)
      - 1. the utility breaker EA-7c or EB-8c of the switchboard that lost its supply opens
      - 2. tie breaker EA-1d closes and restores power to the de-energized switchboard from the healthy switchboard.
    - 3. Upon loss of both utility supplies
      - 1. both generators start and energize the line side of the generator breakers EA-7d and EB-8d of Switchboards EA and EB
      - 2. utility breakers EA-7c and EB-8c of Switchboards EA and EB open
      - 3. generator breakers EA-7d and EB-8d of Switchboards EA and EB close and restore power to the switchboards via the independent emergency feeders. Tie breaker EA-1d remains open.
      - 4. If, during operation on generators one supply path becomes de-energized i.e.



- i. one generator fails/shuts down
- ii. its synch breaker in Switchboard EG-A/EG-B opens, or

iii. a feeder breaker EA-3b or EB-4b opens),

then the switchboard supplied from the failed generator bus becomes deenergized. Tie breaker EA-1d does not close in this scenario. This condition must be addressed through the controls upgrade.

## 2.4 CONTROLS UPGRADE

- 1. Modify the controls, including PLC logic, wiring, remove some devices, and install additional devices (relays, terminal blocks, selector switches etc.), if required, to implement the new modes of operation described below.
  - 2. For Switchboard EG-A/EG-B:
    - 1. Retain the synchronization functionality for the stationary generators
    - 2. Disable the synchronization functionality for the mobile generator
    - 3. Verify presence of hard-wired interlocks in the coil closing circuits of pairs of breakers EA-1b and EA-3d, and EB-2b and EB-4d. If existing, leave as is, If not, install interlocks to prevent breakers of the same pair being closed at the same time.
    - 4. Update HMI graphics following controls upgrade, if required.
    - 5. At the completion of controls upgrade, the normal condition and sequence of operation of Switchboard EG-A/EG-B shall be as follows:
      - 1. If two stationary generators are in service parallel operation:
        - 1. Generator Start signal from Switchboards EA, EB same as existing
        - 2. Tie breakers EA-1d, EB-2d normally closed
        - 3. Feeder breakers EA-3b, EB-4b: normally closed, non-auto operation
        - 4. If one bus becomes de-energized (through generator failure or generator synch breaker failure to close), then
          - 1. faulty generator shall shut down and be locked out
          - 2. generator breaker shall be locked out
          - 3. healthy generator assumes the full load

Both feeders to Switchboards EA and EB will be energized from one (healthy) generator through its closed breaker and the tie breakers.

- 2. If one stationary generator and a mobile generator are in service independent ('lead-lag') operation:
  - 1. Generator Start signal from Switchboards EA, EB same as existing
  - 2. Tie breakers EA-1d, EB-2d open
  - 3. Feeder breakers EA-3b, EB-4b: normally closed, non-auto operation



- 4. If one bus becomes de-energized (through generator failure or generator breaker tripping), then
  - 1. faulty generator shall shut down and be locked out
  - 2. generator breaker shall be locked out
  - 3. tie breakers EA-1d, EB-2d close
  - 4. healthy generator assumes the full load

For the 'lead-lag' mode of operation (i.e. when a mobile generator is connected), the operator shall make the selection manually so that the initial condition of the two tie breakers becomes Open.

- 3. For Switchboards EA, EB
  - 1. At the completion of controls upgrade, the normal condition and sequence of operation of Switchboard EA, EB shall be as follows:
    - 1. Utility feeder breakers EA-7c and EB-8c normally closed unchanged
    - 2. Generator feeder breakers EA-7D and EB-8d normally open unchanged
    - 3. Tie breakers: EA-1d normally open; Eb-2d normally closed
    - 4. Generator Start and transfer initiation signal unchanged
    - 5. Upon loss of one utility supply: existing response shall not change
    - 6. Upon loss of both utility supplies:
      - 1. Generator start sequence shall be initiated in Switchboard EG-A/EG-B - unchanged
      - 2. Both buses shall be isolated from their utility supplies unchanged
      - 3. Generator breakers EA-7d and EB-8d shall close unchanged
      - If any of the utility or generator breakers fail (i.e., fail to open or fail to close) – unchanged. Controls Vendor to spell out the response (i.e., alarm, lockout etc.)
    - If, during operation on generator supply one bus becomes de-energized (through failure at Switchboard EG-A/EG-B or through generator breaker failing to close in EA or EB), then
      - 1. generator breaker on the faulty bus shall be opened and locked out
      - 2. tie breaker EA-1d shall close
      - 3. Alarm shall be generated.
  - 2. Update HMI graphics following controls upgrade, if required.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

1. Review documentation of the existing system, including operation narrative and wiring diagrams.


- 2. Inspect existing switchboards in the field to confirm agreement between the record drawings and 'as-built' condition. Use the services of the building electrician to open live equipment for inspection, if necessary.
- 3. Perform partial isolations of the switchboards, if necessary to permit working on the controls upgrade. Use approved MOPs for this purpose.
- 4. Perform all programming work for the PLC logic offsite. Upload the new program(s) to the PLCs only after successful completion of FAT at controls Vendor's shop.
- 5. Following removal of components (if applicable), and modifications to the wiring, leave system in neat and safe condition. Remove all disconnected wires and components. Identify all new wiring.

## 3.2 SITE ACCEPTANCE TESTING

- 1. Prepare test scripts for all normal operation and failure scenarios. Submit to Consultant for review and acceptance.
- 2. Perform testing of the upgraded controls in conjunction with the stationary generators and mobile generator. Include the following:
  - 1. Generator start and assumption of load
  - 2. Simulation of generator failure
  - 3. Simulation of breaker failure fail to open and fail to close.
  - 4. Simulation of alarms for generators, control system, and breaker operation. Confirm annunciation of simulated alarms on Switchboard EG-A/EG-B and on the remote HMIs.
  - 5. Demonstrate to the Owner and Consultant that all functions have been implemented.
- 3. Allow for as many visits as necessary, but not less than 24 hours for each switchboard, to ensure successful testing and commissioning of the new controls with the generators and related support systems.

## 3.3 TRAINING AND DOCUMENTATION

- 1. Provide two (2) training sessions (both in 'classroom' setting and hands-on) of minimum four (4) hours each, at the installation site.
- 2. Prepare training outline and materials to be used during the presentations. Issue training materials in advance of the sessions for review by the team for adequacy.
- 3. Update wiring diagrams and operation narrative to reflect the modified sequence of operation.
- 4. Assemble and submit complete documentation of the upgraded controls for incorporation into the Operation and Maintenance Manual. The documentation shall be in printed and electronic format.

## END OF SECTION

