

# **ISSUED FOR TENDER**

**Project Reference# J0317**

## **CANADIAN FOOD INSPECTION AGENCY LETHBRIDGE REPLACE EMERGENCY GENERATOR SET**

**Prepared for  
CANADIAN FOOD INSPECTION AGENCY (C.F.I.A)  
PROCUREMENT AND CONTRACTING SERVICE CENTRE  
OTTAWA, ONTARIO**



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**Part 1            General**

**1.1                PRECEDENCE**

- .1        For Federal Government projects, Division 0 Sections take precedence over technical specification sections in other Divisions of this Project Manual.

**1.2                WORK COVERED BY CONTRACT DOCUMENTS**

- .1        Work of this Contract comprises the provision of all construction management, labour and materials, plant, equipment and temporary facilities and all other goods and services require to complete following:

- .1        Remove existing generator assembly including integrated intake/exhaust/cooling systems, diesel day tank and associated pipes, controls as per attached Electrical and Mechanical drawings.
- .2        Install new generator c/w sound attenuated skin-tight enclosure and diesel sub-base tank, and associated new pipes, controls connecting to existing underground diesel tank fuel transfer system as per Electrical and Mechanical drawings and specifications.
- .3        Revise existing normal and emergency standby power distribution systems including: remove, demolish and/or reuse existing feeders, install new feeders and normal/emergency power distribution components as per Electrical drawings and specifications.
- .4        Remove ventilation louvres in existing generator room and replace with in-fill walls as per Building Science drawing.
- .5        Decommission old generator system; commission new generator and associated normal/emergency power distribution, and mechanical systems as per Electrical and Mechanical specifications.
- .6        Demolish existing concrete approach slab in front of existing generator room door exiting to outside; and replace it with new after other site work is done. Install concrete pad for new outdoor generator and enclosure, concrete trench connecting new outdoor generator and existing building, concrete piles to bed rock as per Structural drawing and specifications.
- .7        When plan to conduct any work from demolishing existing generator, new construction to commissioning new generator system which will cause building to lose utility **AND/OR** emergency power, contractors must do such work after hours: after 4:30pm and before 8am on weekdays, starting Friday 4:30pm to the coming Monday 8am on a weekend.

A 300kW 600/347V temporary emergency standby generator c/w built-in fuel tank that will run 24 hours at 75% load and associated temporary cables & fuel must remain on site to provide emergency power as needed **only** when existing emergency power system is not available during construction. Contractors need to coordinate with CFIA and give enough notice (21 days) to conduct such work.

Commissioning work can only be conducted after hours. CFIA Lethbridge facility's after hours include: after 4:30pm and before 8am on weekdays, and full day on the weekends.

- .2 Municipal Address:
  - .1 225090-Township Road 9-1, Lethbridge, Alberta.

### **1.3 WORK SEQUENCE**

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

### **1.4 CONTRACTOR USE OF PREMISES**

- .1 Limit use of premises for Work, for storage, and for access, to allow:
  - .1 Owner occupancy.
  - .2 Public usage.
- .2 Co-ordinate use of premises under direction of Owner Representatives.
- .3 Obtain and pay for use of additional storage or work areas needed for operations under this Contract.
- .4 Remove or alter existing work to prevent injury or damage to portions of existing work which remain.
- .5 Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as directed by Consultant.
- .6 At completion of operations condition of existing work: equal to or better than that which existed before new work started.

### **1.5 OWNER OCCUPANCY**

- .1 Owner will occupy premises during entire construction period for execution of normal operations.
- .2 Co-operate with Owner in scheduling operations to minimize conflict and to facilitate Owner usage.

**1.6 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING**

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

**1.7 EXISTING SERVICES**

- .1 Establish location and extent of service lines in area of work before starting Work. Notify Consultant of findings.
- .2 Submit schedule to and obtain approval from Consultant and CFIA Facility Manager 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.
- .3 Provide temporary emergency power services to maintain critical building and tenant systems if old services are removed and new services are not commissioned.
- .4 Provide adequate bridging over trenches which cross sidewalks or roads to permit normal traffic.
- .5 Where unknown services are encountered, immediately advise Consultant and confirm findings in writing.
- .6 Protect, relocate or maintain existing active services. When inactive services are encountered, cap off in manner approved by authorities having jurisdiction.
- .7 Record locations of maintained, re-routed and abandoned service lines.

**1.8 DOCUMENTS REQUIRED**

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

**Part 2 Products**

**2.1 NOT USED**

- .1 Not used.

**Part 3            Execution**

**3.1                NOT USED**

.1            Not used.

**END OF SECTION**



**Part 1            General**

**1.1                ACCESS AND EGRESS**

- .1        Design, construct and maintain temporary "access to" and "egress from" work areas, including stairs, runways, ramps or ladders and scaffolding independent of finished surfaces and in accordance with relevant municipal, provincial and other regulations.

**1.2                USE OF SITE AND FACILITIES**

- .1        Execute work with least possible interference or disturbance to normal use of premises. Make arrangements with Owner Representative to facilitate work as stated.
- .2        Maintain existing services to building and provide for personnel and vehicle access.
- .3        Where security is reduced by work provide temporary means to maintain security.
- .4        Closures: protect work temporarily until permanent enclosures are completed.

**1.3                ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING**

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

**1.4                EXISTING SERVICES**

- .1        Notify Owner Representative and utility companies of intended interruption of services and obtain required permission.
- .2        Where Work involves breaking into or connecting to existing services, give Owner Representative 3 weeks of notice for necessary interruption of mechanical or electrical service throughout course of work. Keep duration of interruptions minimum; carry out interruptions after normal working hours of occupants, preferably on weekends. Refer to Section 01 11 00 "Summary of Work" for details.
- .3        Provide for personnel and pedestrian and vehicular traffic.

**1.5                SPECIAL REQUIREMENTS**

- .1        Ensure that Contractor personnel employed on site become familiar with and obey regulations including safety, fire, traffic and security regulations.
- .2        Keep within limits of work and avenues of ingress and egress.
- .3        Ingress and egress of Contractor vehicles at site is limited to 1.
- .4        Deliver materials outside of peak traffic hours 18:00 to 19:00 unless otherwise approved by Owner Representative.

**1.6 SECURITY CLEARANCES**

- .1 Personnel employed on this project will be subject to security check. Obtain clearance, as instructed, for each individual who will require entering premises.
- .2 Personnel will be checked daily at start of work shift and provided with pass which must be worn at all times. Pass must be returned at end of work shift and personnel checked out.

**1.7 BUILDING SMOKING ENVIRONMENT**

- .1 Comply with smoking restrictions. Smoking is not allowed.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1        General**

**1.1            INTENT**

- .1        Read this section in conjunction with the conditions governing changes in the work and valuation of changes in the General Conditions of the contract.
- .2        The General Conditions of the contract provide for valuation of changes by three different methods: lump sum, unit price, and cost plus. This section applies to the lump sum method only.

**1.2            DEFINITIONS**

- .1        “Actual cost of material and labour” as used in the valuation of changes article in the General Conditions of the contract means the sum of costs directly related to or necessarily and properly incurred by Contractor, Subcontractors, and Sub-Subcontractors in the performance of a change in the work. Direct costs shall include:
  - .1        materials cost,
  - .2        total labour cost,
  - .3        travel and subsistence cost,
  - .4        temporary work cost,
  - .5        construction equipment cost,
  - .6        And shall exclude overhead cost and profit.
- .2        “Material cost” means cost of all materials, including transportation and storage thereof. All rebates, refunds, returns from sale of surplus materials, and trade discounts other than prompt payment discounts shall be credited to Owner.
- .3        “Total labour cost” means sum of direct labour cost and payroll burden cost.
- .4        “Direct labour cost” means base wage costs of employees, excluding payroll burden cost.
- .5        “Payroll burden cost” means costs statutory charges and fringe benefit costs additional to direct labour cost and includes unemployment insurance, workers’ compensation, vacation pay, statutory holiday pay, health and welfare, pension plan, training fund, and other payroll costs which are hourly wage dependent, and are paid by the employer.
- .6        “Travel and subsistence cost” means travel and subsistence costs incurred by employees when working beyond a reasonable commuting distance from their normal place of residence.
- .7        “Temporary work cost” means cost of temporary structures, facilities, services, controls, and other temporary items used in the performance of a change in the work, including maintenance, dismantling and removal, less any residual value after dismantling and removal.

- .8 “Construction equipment cost” means the cost of rented or owned equipment, including cost of loading, transportation, unloading, erection, maintenance, dismantling, and removal.
- .9 “Overhead cost” means Contractors’, Sub-contractors’, and Sub-Subcontractors’ costs related to:
  - .1 operation and maintenance of head offices, branch offices, and site offices,
  - .2 administration at head offices, branch offices, and site offices,
  - .3 general management, legal, audit, and accounting services,
  - .4 buying organization, corporate tax,
  - .5 financing and other bank charges,
  - .6 bonding and insurance,
  - .7 salaries and other compensation of off-site personnel,
  - .8 salaries and other compensation of on-site superintendents and other supervisory personnel,
  - .9 planning, estimating, and scheduling of work,
  - .10 expendable and non-expendable small tools, including maintenance thereof,
  - .11 recruitment and training of on-site staff, and
  - .12 all other costs not defined as direct costs.
- .10 “Owner”, as it applies to this contract is the Canadian Food Inspection Agency (CFIA).

### **1.3 SCHEDULE OF LABOUR RATES**

- .1 Submit to Owner for approval, within 21 days after date of commencement of contract, a Schedule of Labour Rates.
- .2 Labour rates stated in schedule shall be the hourly labour rates that will be applied when estimating increases and decreases in cost resulting from changes in the work. Assume that work will be performed during regular working hours, not premium time.
- .3 Approved schedule of Labour Rates will be used by Owner solely for evaluating Contractor proposals for changes in the work. Nothing specified herein, nor the submission of a Schedule of Labour Rates by Contractor, shall be construed to mean that the Owner has established, or will establish, minimum wages or benefits applicable to the work, other than those required by law.
- .4 Include all trades that will be employed in the work, including trades employed by Subcontractors and Sub-Subcontractors.
- .5 Provide a breakdown indicating hourly labour rates for direct labour cost, payroll burden cost, and the resulting total labour cost for journeymen, apprentices, foremen, and other applicable classifications within each trade.
- .6 Labour rates stated in schedule shall be consistent with rates that will actually be paid in the normal performance of the work, during regular working hours, and shall not exceed the following:

- .1 Where collective agreements apply:
  - .1 rates for direct labour cost shall not exceed rates established by collective agreements, and
  - .2 rates for payroll burden cost shall not exceed rates established by collective agreements and statutory charges.
- .2 Where collective agreements do not apply:
  - .1 rates for direct labour cost shall not exceed rates prevailing in the locality of the project, and
  - .2 rates for payroll burden cost shall not exceed 25% of rates for direct labour cost.
- .7 Owner's approval of rates provided in the Schedule of Labour Rates will be conditional upon compliance with the foregoing requirements.
- .8 Contractor may request an amendment to an approved rate stated in the Schedule of Labour Rates, if and when required on account of a change in the rate that will actually be paid in the normal performance of the work. If Contractor can prove to Owner's satisfaction that a different rate will actually be paid, Owner may, at his sole discretion, approve such a change in rate.

#### **1.4 CHANGE ORDER PROCEDURES - LUMP SUM METHOD OF VALUATION**

- .1 Owner will issue a Request for Proposal to Contractor.
- .2 Contractor shall submit a Contractor Proposal stipulating:
  - .1 a lump sum increase, decrease, or no change in the Contract Price, and
  - .2 an increase, decrease, or no change in the Contract Time, on account of the proposed change in the work.
- .3 Include in Contractor Proposal a detailed breakdown of lump sum increase or decrease, indicating Contractor's, and where applicable, Subcontractors' and Sub-Subcontractors':
  - .1 itemized direct costs applicable to the proposed change in the work, and
  - .2 applicable amounts for overhead and profit, in accordance with percentages specified in the General Conditions of the contract.

Do not include costs that would otherwise be incurred in the normal performance of the work.
- .4 Include in detailed breakdown of Contractor Proposal a further breakdown of the total labour cost component indicating, for each applicable trade and trade classification, the labour rate(s) and the number of hours from which the total labour cost is derived.
- .5 Include in detailed breakdown of Contractor Proposal only those labour rates included in Schedule of Labour Rates and previously approved by Owner, in writing, unless the extra work cannot be performed during regular working hours and Owner has given approval, in writing, for premium time labour rates.
- .6 Upon Owner's approval and acceptance of Contractor Proposal, a "Change Order" will be issued to Contractor.

**Part 2            Products**

**2.1                NOT USED**

.1            Not Used.

**Part 3            Execution**

**3.1                NOT USED**

.1            Not Used.

**END OF SECTION**

**Part 1            General**

**1.1                APPLICATIONS FOR PROGRESS PAYMENT**

- .1    Make applications for payment on account as provided in Agreement as Work progresses.
- .2    Date applications for payment last day of agreed payment period and ensure amount claimed is for value, proportionate to amount of Contract, of Work performed and Products delivered to Place of Work at that date.
- .3    Submit to Consultant, at least 14 days before first application for payment. Schedule of values for parts of Work, aggregating total amount of Contract Price, to facilitate evaluation of applications for payment.

**1.2                SCHEDULE OF VALUES**

- .1    Provide schedule of values supported by evidence as Consultant may reasonably direct and when accepted by Consultant, be used as basis for applications for payment. Include statement based on schedule of values with each application for payment.
- .2    Support claims for products delivered to Place of Work but not yet incorporated into Work by such evidence as Consultant may reasonably require to establish value and delivery of products.

**1.3                PROGRESS PAYMENT**

- .1    Consultant will issue to Owner, no later than 7 days after receipt of an application for payment, certificate for payment in amount applied for or in such other amount as Consultant determines to be due. If Consultant amends application, Consultant will give notification in writing giving reasons for amendment.

**1.4                PAYMENT OF HOLDBACK UPON SUBSTANTIAL PERFORMANCE OF WORK**

- .1    After issuance of certificate of Substantial Performance of Work:
  - .1    Submit application for payment of holdback amount.
  - .2    Submit sworn statement that accounts for labour, subcontracts, products, construction machinery and equipment, and other indebtedness which may have been incurred in Substantial Performance of Work and for which Owner might in be held responsible have been paid in full, except for amounts properly retained as holdback or as identified amount in dispute.
- .2    After receipt of application for payment and sworn statement, Consultant will issue certificate for payment of holdback amount.
- .3    Amount authorized by certificate for payment of holdback amount is due and payable on day following expiration of holdback period stipulated in lien legislation applicable to Place of Work. Where lien legislation does not exist or apply, holdback amount is due and payable in accordance with other legislation, industry practice, or provisions which may be

agreed to between parties. Owner may retain out of holdback amount sums required by law to satisfy liens against Work or, if permitted by lien legislation applicable to Place of Work, other third party monetary claims against Contractor which are enforceable against Owner.

**1.5 FINAL PAYMENT**

- .1 Submit application for final payment when Work is completed.
- .2 Consultant will, no later than 7 days after receipt of application for final payment, review Work to verify validity of application. Consultant will give notification that application is valid or give reasons why it is not valid, no later than 14 days after reviewing Work.
- .3 Consultant will issue final certificate for payment when application for final payment is found valid.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**



**Part 1            General**

**1.1                PRE-CONSTRUCTION MEETING**

- .1        Within 14 working days after award of Contract, request a tele-conference meeting of parties in contract to discuss and resolve administrative procedures and responsibilities.
- .2        Attendees:
  - .1        Contractor's Representatives: Contractor's senior management, Contractor's project manager, Contractor's site superintendent, representatives of major Subcontractors, and others as necessary.
  - .2        Owner's representatives: As determined by Owner.
  - .3        Engineer representatives.
- .3        Contractor to record minutes of meetings and circulate to attending parties and affected parties not in attendance within 2 days after meeting.
- .4        Agenda to include:
  - .1        Schedule of submission of shop drawings, samples, colour chips. Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
  - .2        Requirements for temporary facilities, site sign, offices, storage sheds, utilities, fences.
  - .3        Delivery schedule of specified equipment.
  - .4        Site security.
  - .5        Proposed changes, change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, administrative requirements.
  - .6        Record drawings in accordance with Section 01 33 00 - Submittal Procedures.
  - .7        Maintenance manuals in accordance with Section 01 78 00 - Closeout Submittals.
  - .8        Take-over procedures, acceptance, warranties in accordance with Section 01 78 00 - Closeout Submittals.
  - .9        Monthly progress claims, administrative procedures, photographs, hold backs.

**1.2                PROJECT SCHEDULE**

- .1        Provide detailed project schedule within 10 working days of Award of Contract date showing activity sequencing, interdependencies and duration estimates. Include listed activities as follows:
  - .1        Shop drawings.
  - .2        Samples.
  - .3        Approvals.
  - .4        Procurement.
  - .5        Construction.
  - .6        Installation.
  - .7        Site works.

- .8 Testing.
- .9 Commissioning and acceptance.
- .2 Allow 3 working days for review by Owner Representative and Consultant of proposed construction Project Schedule.
- .3 Upon receipt of reviewed Project Schedule make necessary revisions and resubmit to Consultant for review within 2 work days.
- .4 Comply with reviewed Project Schedule.
- .5 Proceed with significant changes and deviations from scheduled sequence of activities that cause delay, only after written receipt of approval by Consultant.
- .6 Identify activities that are behind schedule and causing delay. Provide measures to regain slippage.

### **1.3 GENERAL COORDINATION**

- .1 Coordinate all construction activities as required to ensure efficient and orderly installation of each part of the Work.
- .2 Where installation of one part of the work is dependent on installation of other components, either before or after its own installation, schedule and coordinate construction activities in the sequence required to obtain the best results.
- .3 Where availability of space is limited, coordinate installation of different components to assure maximum accessibility for required maintenance, service, and repair.
- .4 Make adequate provisions to accommodate items scheduled for later installation under separate contract or by Owner's own forces.

### **1.4 GENERAL INSTALLATION PROVISIONS**

- .1 Require the installer of each major component to inspect both the substrate and conditions under which work is to be performed. Do not proceed until unsatisfactory conditions have been corrected in an acceptable manner.
- .2 Comply with manufacturer's installation instructions and recommendations, to the extent that those instructions and recommendations are more explicit or stringent than requirements contained in contract documents.
- .3 Inspect materials immediately upon delivery and again prior to installation. Reject damaged and defective items.
- .4 Provide attachment and connection devices and methods necessary for securing work. Secure work true to line and level. Allow for expansion and building movement.
- .5 Provide uniform joint widths in exposed work. Arrange joints in exposed work to obtain the best visual effect. Refer questionable choices to Owner for final decision.

- .6 Install each component during weather conditions and project status that will ensure the best possible results. Isolate each part of the completed construction from incompatible material as necessary to prevent deterioration.
- .7 Coordinate temporary enclosures with required inspections and tests, to minimize the necessity of uncovering completed construction for that purpose.
- .8 Where mounting heights are not indicated, install individual components at standard mounting heights recognized within the industry for the particular application indicated. Refer questionable mounting height decisions to the Owner for final decision.
- .9 Supervise construction activities to ensure that no part of the work, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

## **1.5 PROGRESS MEETINGS**

- .1 During course of Work, schedule Bi-weekly progress meetings.
- .2 Contractor, Departmental Representative and Consultant are to be in attendance. Consultant will attend these progress meetings either in person if consultant planned to conduct site visits after the meeting; otherwise consultant will attend the meetings via tele-conference.
- .3 Notify parties minimum 7 days prior to meetings.
- .4 Contractor to record minutes of meetings and circulate to attending parties and affected parties not in attendance within 2 days after meeting.
- .5 Agenda to include the following:
  - .1 Review, approval of minutes of previous meeting.
  - .2 Review of Work progress since previous meeting.
  - .3 Field observations, problems, conflicts.
  - .4 Problems which impede construction schedule.
  - .5 Review of off-site fabrication delivery schedules.
  - .6 Corrective measures and procedures to regain projected schedule.
  - .7 Revision to construction schedule.
  - .8 Progress schedule, during succeeding work period.
  - .9 Review submittal schedules: expedite as required.
  - .10 Maintenance of quality standards.
  - .11 Review proposed changes for affect on construction schedule and on completion date.
  - .12 Other business.

**1.6 WARRANTY MEETINGS**

- .1 Warranty meetings shall be held between Final Acceptance of the work and Total Completion of the work.
- .2 Purpose: To bring to Contractor's attention contract deficiencies identified during warranty period, determine action required for their correction, and monitor progress of contract deficiency correction.
- .3 Attendees: Same as construction progress meetings.
- .4 Agenda:
  - .1 Review and approval of minutes of previous meeting.
  - .2 Review of progress of contract deficiency correction.
  - .3 Identification of problems impeding contract deficiency correction.
  - .4 Review of outstanding contract deficiencies.
  - .5 Other business.
- .5 Minutes: Same as construction progress meetings.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1            General**

**1.1                ADMINISTRATIVE**

- .1     Submit to Consultant submittals listed for review. Submit promptly and in orderly sequence to not cause delay in Work. Failure to submit in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.
- .2     Do not proceed with Work affected by submittal until review is complete.
- .3     Present shop drawings, product data, samples and mock-ups in only SI metric units.
- .4     This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and co-ordinated with requirements of Work and Contract Documents. Submittals not stamped, signed, dated and identified as to specific project will be returned without being examined and considered rejected.
- .5     Notify Consultant, in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.
- .6     Verify field measurements and affected adjacent Work are coordinated.
- .7     Contractor's responsibility for errors and omissions in submission is not relieved by Consultant's review of submittals.
- .8     Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Consultant review.
- .9     Keep one reviewed copy of each submission on site.

**1.2                SHOP DRAWINGS AND PRODUCT DATA**

- .1     The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.
- .2     Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.
- .3     Allow 7 days for Consultant's review of each submission.
- .4     Adjustments made on shop drawings by Consultant are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Consultant prior to proceeding with Work.

- .5 Make changes in shop drawings as Consultant may require, consistent with Contract Documents. When resubmitting, notify Consultant in writing of revisions other than those requested.
- .6 Accompany submissions with transmittal letter, containing:
  - .1 Date.
  - .2 Project title and number.
  - .3 Contractor's name and address.
  - .4 Identification and quantity of each shop drawing, product data and sample.
  - .5 Other pertinent data.
- .7 Submissions include:
  - .1 Date and revision dates.
  - .2 Project title and number.
  - .3 Name and address of:
    - .1 Subcontractor.
    - .2 Supplier Manufacture
  - .4 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.
  - .5 Details of appropriate portions of Work as applicable:
    - .1 Fabrication.
    - .2 Layout, showing dimensions, including identified field dimensions, and clearances.
    - .3 Setting or erection details.
    - .4 Capacities.
    - .5 Performance characteristics.
    - .6 Standards.
    - .7 Operating weight.
    - .8 Wiring diagrams.
    - .9 Single line and schematic diagrams.
    - .10 Relationship to adjacent work.
- .8 After Consultant's review, distribute copies.
- .9 Submit 7 prints or 1 electronic PDF copy of shop drawings and product data sheet for each requirement requested in specification Sections and as requested by Consultant.
- .10 Submit 1 electronic PDF copy of test reports for requirements requested in specification Sections and as requested by Consultant.
  - .1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.
  - .2 Testing must have been within 1 years of date of contract award for project.

- .11 Submit 4 prints or 1 electronic PDF copies of manufacturers instructions for requirements requested in specification Sections and as requested by Consultant.
  - .1 Pre-printed material describing installation of product, system or material, including special notices and Material Safety Data Sheets concerning impedances, hazards and safety precautions.
- .12 Submit 1 electronic PDF copies of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by Consultant. Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.
- .13 Submit 4 prints or 1 electronic PDF copies of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Consultant.
- .14 Delete information not applicable to project.
- .15 Supplement standard information to provide details applicable to project.
- .16 If upon review by Consultant, no errors or omissions are discovered or if only minor corrections are made, copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.

**1.3 CERTIFICATES AND TRANSCRIPTS**

- .1 Immediately after award of Contract, submit Workers' Compensation Board status.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1            General**

**1.1            SECTION INCLUDES**

- .1        Health and safety considerations required to ensure that PWGSC shows due diligence towards health and safety on construction sites, and meets the requirements laid out in PWGSC/RPB Departmental Policy DP 073 - Occupational Health and Safety - Construction.

**1.2            REFERENCES**

- .1        Canada Labour Code, Part 2, Canada Occupational Safety and Health Regulations
- .2        Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1        Material Safety Data Sheets (MSDS).
- .3        Province of Alberta
  - .1        Occupational Health and Safety Act, R.S.A. 2005.

**1.3            SUBMITTALS**

- .1        Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Submit site-specific Health and Safety Plan: Within 21 days after date of Notice to Proceed and prior to commencement of Work. Health and Safety Plan must include:
  - .1        Results of site specific safety hazard assessment.
  - .2        Results of safety and health risk or hazard analysis for site tasks and operation found in work plan.
- .3        Submit 1 copy of Contractor's authorized representative's work site health and safety inspection reports to Consultant and authority having jurisdiction, Bi-weekly.
- .4        Submit copies of reports or directions issued by Federal, Provincial and Territorial health and safety inspectors.
- .5        Submit copies of incident and accident reports.
- .6        Medical Surveillance: where prescribed by legislation, regulation or safety program, submit certification of medical surveillance for site personnel prior to commencement of Work, and submit additional certifications for any new site personnel to Consultant.
- .7        On-site Contingency and Emergency Response Plan: address standard operating procedures to be implemented during emergency situations.

**1.4            FILING OF NOTICE**

- .1        File Notice of Project with Provincial authorities prior to beginning of Work.



**1.5 SAFETY ASSESSMENT**

- .1 Perform site specific safety hazard assessment related to project.

**1.6 REGULATORY REQUIREMENTS**

- .1 Do Work in accordance with Section 01 41 00 - Regulatory Requirements.

**1.7 GENERAL REQUIREMENTS**

- .1 Develop written site-specific Health and Safety Plan based on hazard assessment prior to beginning site Work and continue to implement, maintain, and enforce plan until final demobilization from site. Health and Safety Plan must address project specifications.
- .2 Departmental Representative or Consultant may respond in writing, where deficiencies or concerns are noted and may request re-submission with correction of deficiencies or concerns.

**1.8 RESPONSIBILITY**

- .1 Be responsible for health and safety of persons on site, safety of property on site and for protection of persons adjacent to site and environment to extent that they may be affected by conduct of Work.
- .2 Comply with and enforce compliance by employees with safety requirements of Contract Documents, applicable federal, provincial, territorial and local statutes, regulations, and ordinances, and with site-specific Health and Safety Plan.

**1.9 COMPLIANCE REQUIREMENTS**

- .1 Comply with Occupational Health and Safety Act, General Safety Regulation, Alberta Reg.
- .2 Comply with Canada Labour Code, Canada Occupational Safety and Health Regulations.

**1.10 UNFORSEEN HAZARDS**

- .1 When unforeseen or peculiar safety-related factor, hazard, or condition occur during performance of Work, follow procedures in place for Employee's Right to Refuse Work in accordance with Acts and Regulations of Province having jurisdiction and advise Departmental Representative and Consultant in writing.

**1.11 POSTING OF DOCUMENTS**

- .1 Ensure applicable items, articles, notices and orders are posted in conspicuous location on site in accordance with Acts and Regulations of Province having jurisdiction, and in consultation with Consultant.

**1.12 CORRECTION OF NON-COMPLIANCE**

- .1 Immediately address health and safety non-compliance issues identified by authority having jurisdiction or by Consultant.
- .2 Provide Consultant with written report of action taken to correct non-compliance of health and safety issues identified.
- .3 Consultant may stop Work if non-compliance of health and safety regulations is not corrected.

**1.13 POWDER ACTUATED DEVICES**

- .1 Use powder actuated devices only after receipt of written permission from Departmental Representative.

**1.14 WORK STOPPAGE**

- .1 Give precedence to safety and health of public and site personnel and protection of environment over cost and schedule considerations for Work.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not used.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCES AND CODES**

- .1        Perform Work in accordance with National Building Code of Canada 2010 (NBC) and National Fire Code 2010 (NFC) including amendments up to tender closing date and other codes of provincial or local application provided that in case of conflict or discrepancy, more stringent requirements apply.
  
- .2        Meet or exceed requirements of:
  - .1        Contract documents.
  - .2        Specified standards, codes and referenced documents.

**1.2                BUILDING SMOKING ENVIRONMENT**

- .1        Comply with smoking restrictions and municipal by-laws.

**Part 2            Products**

**2.1                NOT USED**

- .1        Not Used.

**Part 3            Execution**

**3.1                NOT USED**

- .1        Not Used.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCE STANDARDS**

- .1        Within the text of these specifications, reference may be made to the following standards:
  - .1        CEC – Canadian Electrical Code-2012
  - .2        NBC – National Building Code of Canada-2010
  - .3        NFC – National Fire Code of Canada-2010
  - .4        NPC – National Plumbing Code of Canada-2010
  - .5        ANSI – American National Standards Institute.
  - .6        ASTM – American Society for Testing and Materials.
  - .7        CGSB – Canadian General Standards Board.
  - .8        CSA – Canadian Standards Association.
  - .9        CAN – National Standard of Canada (published by CGSB).
  - .10      FM – Factory Mutual Engineering Corporation.
  - .11      ULC – Underwriters Laboratories of Canada.
- .2        The referenced standard and any amendments in force on the day of receipt of bids shall be applicable to the work during the duration of the contract.

**1.2                INSPECTION**

- .1        Allow Consultant access to Work. If part of Work is in preparation at locations other than Place of Work, allow access to such Work whenever it is in progress.
- .2        Give timely notice requesting inspection if Work is designated for special tests, inspections or approvals by Consultant instructions, or law of Place of Work.
- .3        If Contractor covers or permits to be covered Work that has been designated for special tests, inspections or approvals before such is made, uncover such Work, have inspections or tests satisfactorily completed and make good such Work.
- .4        Consultant will order part of Work to be examined if Work is suspected to be not in accordance with Contract Documents. If, upon examination such work is found not in accordance with Contract Documents, correct such Work and pay cost of examination and correction.

**1.3                INDEPENDENT INSPECTION AGENCIES**

- .1        Independent Inspection/Testing Agencies will be engaged by Owner for purpose of inspecting and/or testing portions of Work. Cost of such services will be borne by owner.
- .2        Provide equipment required for executing inspection and testing by appointed agencies.
- .3        Employment of inspection/testing agencies does not relax responsibility to perform Work in accordance with Contract Documents.

- .4 If defects are revealed during inspection and/or testing, appointed agency will request additional inspection and/or testing to ascertain full degree of defect. Correct defect and irregularities as advised by Consultant at no cost to owner. Pay costs for retesting and re-inspection.

#### **1.4 ACCESS TO WORK**

- .1 Allow inspection/testing agencies access to Work, off site manufacturing and fabrication plants.
- .2 Co-operate to provide reasonable facilities for such access.

#### **1.5 PROCEDURES**

- .1 Notify appropriate agency, Owner Representative and Consultant in advance of requirement for tests, in order that attendance arrangements can be made.
- .2 Submit samples and/or materials required for testing, as specifically requested in specifications. Submit with reasonable promptness and in orderly sequence to not cause delays in Work.
- .3 Provide labour and facilities to obtain and handle samples and materials on site. Provide sufficient space to store and cure test samples.

#### **1.6 REJECTED WORK**

- .1 Remove defective Work, whether result of poor workmanship, use of defective products or damage and whether incorporated in Work or not, which has been rejected by Consultant as failing to conform to Contract Documents. Replace or re-execute in accordance with Contract Documents.
- .2 Make good other Contractor's work damaged by such removals or replacements promptly.
- .3 If in opinion of Consultant it is not expedient to correct defective Work or Work not performed in accordance with Contract Documents, Owner will deduct from Contract Price difference in value between Work performed and that called for by Contract Documents, amount of which will be determined by Consultant.

#### **1.7 REPORTS**

- .1 Submit 4 copies of inspection and test reports to Consultant.

#### **1.8 TESTS AND MIX DESIGNS**

- .1 Furnish test results and mix designs as requested.
- .2 Cost of tests and mix designs beyond those called for in Contract Documents or beyond those required by law of Place of Work will be appraised by Owner Representative and may be authorized as recoverable.

**1.9 EQUIPMENT AND SYSTEMS**

- .1 Submit adjustment and balancing reports for mechanical and electrical systems.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1            General**

**1.1                SUBMITTALS**

- .1            Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

**1.2                INSTALLATION AND REMOVAL**

- .1            Provide temporary utilities controls in order to execute work expeditiously.
- .2            Remove from site all such work after use.

**1.3                DEWATERING**

- .1            Provide temporary drainage and pumping facilities to keep excavations and site free from standing water.

**1.4                WATER SUPPLY**

- .1            Owner Representative will provide continuous supply of potable water for construction use.

**1.5                TEMPORARY GENERATOR**

- .1            Provide a 300kW 600/347V temporary emergency standby generator c/w built-in fuel tank that will run 24 hours at 75% load and associated temporary cables & fuel on site to provide emergency power as needed **only** when existing emergency power system is not available during construction. Contractors need to coordinate with CFIA and give enough notice (21 days) to conduct such work.

**1.6                TEMPORARY POWER AND LIGHT**

- .1            Owner Representative will provide electrical power and lighting for construction use at no cost. Connect to existing power supply in accordance with Canadian Electrical Code.

**1.7                TEMPORARY COMMUNICATION FACILITIES**

- .1            Provide and pay for temporary telephone, fax hook up, lines equipment necessary for own use.

**1.8                FIRE PROTECTION**

- .1            Provide and maintain temporary fire protection equipment during performance of Work required by insurance companies having jurisdiction and governing codes, regulations and bylaws.
- .2            Burning rubbish and construction waste materials is not permitted on site.

**Part 2            Products**

**2.1                NOT USED**

.1            Not Used.

**Part 3            Execution**

.1            Not Used

**END OF SECTION**



**Part 1            General**

**1.1                REFERENCES**

- .1 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB 1.189-2000, Exterior Alkyd Primer for Wood.
  - .2 CGSB 1.59-1997, Alkyd Exterior Gloss Enamel. Canadian Standards Association (CSA International)
  - .3 CSA-A23.1/A23.2-2004, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
  - .4 CSA-0121-M1978 (R2003), Douglas Fir Plywood.
  - .5 CAN/CSA-S269.2-M1987 (R2003), Access Scaffolding for Construction Purposes.
  - .6 CAN/CSA-Z321-96(R2001), Signs and Symbols for the Occupational Environment.

**1.2                SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

**1.3                INSTALLATION AND REMOVAL**

- .1 Prepare site plan indicating proposed location and dimensions of area to be fenced and used by Contractor, number of trailers to be used, avenues of ingress/egress to fenced area and details of fence installation.
- .2 Identify areas which have to be gravelled to prevent tracking of mud.
- .3 Indicate use of supplemental or other staging area.
- .4 Provide construction facilities in order to execute work expeditiously.
- .5 Remove from site all such work after use.

**1.4                SCAFFOLDING**

- .1 Provide and maintain scaffolding, ramps, ladders, platforms.

**1.5                HOISTING**

- .1 Provide, operate and maintain hoists cranes required for moving of workers, materials and equipment. Make financial arrangements with Subcontractors for their use of hoists.
- .2 Hoists cranes to be operated by qualified operator.

**1.6 SITE STORAGE/LOADING**

- .1 Confine work and operations of employees by Contract Documents. Do not unreasonably encumber premises with products.
- .2 Do not load or permit to load any part of Work with weight or force that will endanger Work.

**1.7 CONSTRUCTION PARKING**

- .1 Coordinate on-site parking with Owner Representative.
- .2 Provide and maintain adequate access to project site.
- .3 Clean runways and taxi areas where used by Contractor's equipment.

**1.8 SECURITY**

- .1 Provide and pay for responsible security personnel to guard site and contents of site after working hours and during holidays.

**1.9 OFFICES**

- .1 Provide office heated to 22 degrees C, lighted 450 lx and ventilated, of sufficient size to accommodate site meetings and furnished with drawing lay down table.
- .2 Provide marked and fully stocked first-aid case in a readily available location.
- .3 Subcontractors to provide their own offices as necessary. Direct location of these offices.

**1.10 COLD WEATHER CONDITIONS:**

- .1 In advance of expected cold weather and freezing temperatures, take necessary action to protect construction from adverse effects of weather, and to maintain temperatures at specified levels.
- .2 During storage, handling, and installation, maintain materials at specified temperatures. Do not allow materials to freeze or become coated with ice and snow.
- .3 Provide enclosures for each phase of construction so that work may be carried out under temperature controlled conditions.

**1.11 EQUIPMENT, TOOL AND MATERIALS STORAGE**

- .1 Provide and maintain, in clean and orderly condition, lockable weatherproof sheds for storage of tools, equipment and materials.
- .2 Locate materials not required to be stored in weatherproof sheds on site in manner to cause least interference with work activities.

**1.12 SANITARY FACILITIES**

- .1 Provide sanitary facilities for work force in accordance with governing regulations and ordinances.
- .2 Post notices and take precautions as required by local health authorities. Keep area and premises in sanitary condition.

**1.13 VIBRATION AND NOISE CONTROL**

- .1 Operations considered by the Owner to cause excessive vibration or noise include, but are not limited to, the following:
  - .1 Jack hammering
  - .2 Cutting
  - .3 Drilling
- .2 Do the following when work causing vibration or noise may affect user or user operations:
  - .1 Coordinate with Owner and user representative.
  - .2 Schedule and coordinate hours of work with user representative.
  - .3 Stop operations causing excessive vibration or noise when instructed verbally or in writing by Owner. Do not resume such operations until authorized by the Owner.

**1.14 PROTECTION AND MAINTENANCE OF TRAFFIC**

- .1 Provide access and temporary relocated roads as necessary to maintain traffic.
- .2 Maintain and protect traffic on affected roads during construction period except as otherwise specifically directed by Owner Representative.
- .3 Provide measures for protection and diversion of traffic, including provision of watch-persons and flag-persons, erection of barricades, placing of lights around and in front of equipment and work, and erection and maintenance of adequate warning, danger, and direction signs
- .4 Protect travelling public from damage to person and property.
- .5 Contractor's traffic on roads selected for hauling material to and from site to interfere as little as possible with public traffic.
- .6 Verify adequacy of existing roads and allowable load limit on these roads. Contractor: responsible for repair of damage to roads caused by construction operations.
- .7 Construct access and haul roads necessary.
- .8 Haul roads: constructed with suitable grades and widths; sharp curves, blind corners, and dangerous cross traffic shall be avoided.
- .9 Provide necessary lighting, signs, barricades, and distinctive markings for safe movement of traffic.

- .10 Dust control: adequate to ensure safe operation at all times.
- .11 Location, grade, width, and alignment of construction and hauling roads: subject to approval by Consultant.
- .12 Lighting: to assure full and clear visibility for full width of haul road and work areas during night work operations.
- .13 Provide snow removal during period of Work.
- .14 Remove, upon completion of work, haul roads designated by Owner Representative.

**1.15 CLEAN-UP**

- .1 Remove construction debris, waste materials, packaging material from work site daily.
- .2 Clean dirt or mud tracked onto paved or surfaced roadways.
- .3 Store materials resulting from demolition activities that are salvageable.
- .4 Stack stored new or salvaged material not in construction facilities.

**Part 2 Products**

- .1 Not Used.

**Part 3 Execution**

- .1 Not Used.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCES**

- .1        Within text of each specifications section, reference may be made to reference standards.
- .2        Conform to these reference standards, in whole or in part as specifically requested in specifications.
- .3        If there is question as to whether products or systems are in conformance with applicable standards, Consultant reserves right to have such products or systems tested to prove or disprove conformance.
- .4        Cost for such testing will be born by Consultant in event of conformance with Contract Documents or by Contractor in event of non-conformance.

**1.2                QUALITY**

- .1        Products, materials, equipment and articles incorporated in Work shall be new, not damaged or defective, and of best quality for purpose intended. If requested, furnish evidence as to type, source and quality of products provided.
- .2        Procurement policy is to acquire, in cost effective manner, items containing highest percentage of recycled and recovered materials practicable consistent with maintaining satisfactory levels of competition. Make reasonable efforts to use recycled and recovered materials and in otherwise utilizing recycled and recovered materials in execution of work.
- .3        Defective products, whenever identified prior to completion of Work, will be rejected, regardless of previous inspections. Inspection does not relieve responsibility, but is precaution against oversight or error. Remove and replace defective products at own expense and be responsible for delays and expenses caused by rejection. should disputes arise as to quality or fitness of products, decision rests strictly with Consultant based upon requirements of Contract Documents.
- .4        Unless otherwise indicated in specifications, maintain uniformity of manufacture for any particular or like item throughout building.
- .5        Permanent labels, trademarks and nameplates on products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms.

**1.3                AVAILABILITY**

- .1        Immediately upon signing Contract, review product delivery requirements and anticipate foreseeable supply delays for items. If delays in supply of products are foreseeable, notify Consultant of such, in order that substitutions or other remedial action may be authorized in ample time to prevent delay in performance of Work.

- .2 In event of failure to notify Consultant at commencement of Work and should it subsequently appear that Work may be delayed for such reason, Consultant reserves right to substitute more readily available products of similar character, at no increase in Contract Price or Contract Time.

#### **1.4 STORAGE, HANDLING AND PROTECTION**

- .1 Handle and store products in manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions when applicable.
- .2 Store packaged or bundled products in original and undamaged condition with manufacturer's seal and labels intact. Do not remove from packaging or bundling until required in Work.
- .3 Store products subject to damage from weather in weatherproof enclosures.
- .4 Store cementitious products clear of earth or concrete floors, and away from walls.
- .5 Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.
- .6 Store sheet materials, lumber on flat, solid supports and keep clear of ground. Slope to shed moisture.
- .7 Store and mix paints in heated and ventilated room. Remove oily rags and other combustible debris from site daily. Take every precaution necessary to prevent spontaneous combustion.
- .8 Remove and replace damaged products at own expense and to satisfaction of Consultant.
- .9 Touch-up damaged factory finished surfaces to Consultant's satisfaction. Use touch-up materials to match original. Do not paint over name plates.

#### **1.5 TRANSPORTATION**

- .1 Pay costs of transportation of products required in performance of work.

#### **1.6 MANUFACTURER'S INSTRUCTIONS**

- .1 Unless otherwise indicated in specifications, install or erect products in accordance with manufacturer's instructions. Do not rely on labels or enclosures provided with products. Obtain written instructions directly from manufacturers.
- .2 Notify Consultant in writing, of conflicts between specifications and manufacturer's instructions, so that Consultant will establish course of action.
- .3 Improper installation or erection of products, due to failure in complying with these requirements, authorizes Consultant to require removal and re-installation at no increase in Contract Price or Contract Time.

- .4 Ensure Quality of Work is of highest standard, executed by workers experienced and skilled in respective duties for which they are employed. Immediately notify Consultant if required Work is such as to make it impractical to produce required results.
- .5 Do not employ anyone unskilled in their required duties. Consultant reserves right to require dismissal from site, workers deemed incompetent or careless.
- .6 Decisions as to standard or fitness of Quality of Work in cases of dispute rest solely with Consultant, whose decision is final.

#### **1.7 QUALITY OF WORK**

- .1 Ensure Quality of Work is of highest standard, executed by workers experienced and skilled in respective duties for which they are employed. Immediately notify Consultant if required Work is such as to make it impractical to produce required results.
- .2 Do not employ anyone unskilled in their required duties. Consultant reserves the right to require dismissal from site, workers deemed incompetent or careless.
- .3 Decisions as to standard or fitness of quality of Work in cases of dispute rest solely with the Consultant, whose decision is final.

#### **1.8 CO-ORDINATION**

- .1 Ensure co-operation of workers in laying out Work. Maintain efficient and continuous supervision.
- .2 Be responsible for coordination and placement of openings, sleeves and accessories.

#### **1.9 CONCEALMENT**

- .1 In finished areas conceal pipes, ducts and wiring in floors, walls and ceilings, except where indicated otherwise.
- .2 Before installation inform Consultant if there is interference. Install as directed by Consultant.

#### **1.10 REMEDIAL WORK**

- .1 Perform remedial work required to repair or replace parts or portions of Work identified as defective or unacceptable. Co-ordinate adjacent affected Work as required.
- .2 Perform remedial work by specialists familiar with materials affected. Perform in a manner to neither damage nor put at risk any portion of Work.

#### **1.11 LOCATION OF FIXTURES**

- .1 Consider location of fixtures, outlets, and mechanical and electrical items indicated as approximate.
- .2 Inform Consultant of conflicting installation. Install as directed.

**1.12 FASTENINGS**

- .1 Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials, unless indicated otherwise.
- .2 Prevent electrolytic action between dissimilar metals and materials.
- .3 Use non-corrosive hot dip galvanized steel fasteners and anchors for securing exterior work, unless stainless steel or other material is specifically requested in affected specification Section.
- .4 Space anchors within individual load limit or shear capacity and ensure they provide positive permanent anchorage. Wood, or any other organic material plugs are not acceptable.
- .5 Keep exposed fastenings to a minimum, space evenly and install neatly.
- .6 Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.

**1.13 FASTENINGS - EQUIPMENT**

- .1 Use fastenings of standard commercial sizes and patterns with material and finish suitable for service.
- .2 Use heavy hexagon heads, semi-finished unless otherwise specified. Use No. 304 stainless steel for exterior areas.
- .3 Bolts may not project more than one diameter beyond nuts.
- .4 Use plain type washers on equipment, sheet metal and soft gasket lock type washers where vibrations occur. Use resilient washers with stainless steel.

**1.14 PROTECTION OF WORK IN PROGRESS**

- .1 Prevent overloading of parts of building. Do not cut, drill or sleeve load bearing structural member, unless specifically indicated, without written approval of Consultant.

**1.15 EXISTING UTILITIES**

- .1 When breaking into or connecting to existing services or utilities, execute Work at times directed by local governing authorities, with minimum of disturbance to Work, and/or building occupants.
- .2 Protect, relocate or maintain existing active services. When services are encountered, cap off in manner approved by authority having jurisdiction. Stake and record location of capped service.



**Part 2            Products**

**2.1                NOT USED**

.1            Not Used.

**Part 3            Execution**

**3.1                NOT USED**

.1            Not Used.

**END OF SECTION**

**Part 1            General**

- .1        Owner's identification of existing survey control points and property limits.

**1.2                SURVEY REFERENCE POINTS**

- .1        Existing base horizontal and vertical control points are designated on drawings.
- .2        Locate, confirm and protect control points prior to starting site work. Preserve permanent reference points during construction.
- .3        Make no changes or relocations without prior written notice to Owner.
- .4        Report to Owner Representative when reference point is lost or destroyed, or requires relocation because of necessary changes in grades or locations.
- .5        Require surveyor to replace control points in accordance with original survey control.

**1.3                SURVEY REQUIREMENTS**

- .1        Establish lines and levels, locate and lay out, by instrumentation.
- .2        Stake for grading, fill and topsoil placement and landscaping features.
- .3        Stake slopes.
- .4        Establish pipe invert elevations.
- .5        Establish piles locations.
- .6        Establish lines and levels for mechanical and electrical work.

**1.4                EXISTING SERVICES**

- .1        Before commencing work, establish location and extent of service lines in area of Work and notify Owner Representative of findings.
- .2        Remove abandoned service lines within 2 m of structures. Cap or otherwise seal lines at cut-off points as directed by Owner Representative.

**1.5                LOCATION OF EQUIPMENT AND FIXTURES**

- .1        Location of equipment and outlets indicated or specified are to be considered as approximate.
- .2        Locate equipments and distribution systems to provide minimum interference and maximum usable space and in accordance with manufacturer's recommendations for safety, access and maintenance.

- .3 Inform Owner Representative of impending installation and obtain approval for actual location.

**1.6 RECORDS**

- .1 Maintain a complete, accurate log of control and survey work as it progresses.
- .2 On completion of foundations and major site improvements, prepare a certified survey showing dimensions, locations, angles and elevations of Work.
- .3 Record locations of maintained, re-routed and abandoned service lines.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1            General**

**1.1                SUBMITTALS**

- .1        Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Submit written request in advance of cutting or alteration which affects:
  - .1        Structural integrity of elements of project.
  - .2        Integrity of weather-exposed or moisture-resistant elements.
  - .3        Efficiency, maintenance, or safety of operational elements.
  - .4        Visual qualities of sight-exposed elements.
  - .5        Work of Owner or separate contractor.
- .3        Include in request:
  - .1        Identification of project.
  - .2        Location and description of affected Work.
  - .3        Statement on necessity for cutting or alteration.
  - .4        Description of proposed Work, and products to be used.
  - .5        Alternatives to cutting and patching.
  - .6        Effect on Work of Owner or separate contractor.
  - .7        Written permission of affected separate contractor.
  - .8        Date and time work will be executed.

**1.2                MATERIALS**

- .1        Required for original installation.
- .2        Change in Materials: Submit request for substitution in accordance with Section 01 33 00 - Submittal Procedures.

**1.3                PREPARATION**

- .1        Inspect existing conditions, including elements subject to damage or movement during cutting and patching.
- .2        After uncovering, inspect conditions affecting performance of Work.
- .3        Beginning of cutting or patching means acceptance of existing conditions.
- .4        Provide supports to assure structural integrity of surroundings; provide devices and methods to protect other portions of project from damage.
- .5        Provide protection from elements for areas which are to be exposed by uncovering work; maintain excavations free of water.

**1.4 EXECUTION**

- .1 Execute cutting, fitting, and patching including excavation and fill, o complete Work.
- .2 Fit several parts together, to integrate with other Work.
- .3 Uncover Work to install ill-timed Work.
- .4 Remove and replace defective and non-conforming Work.
- .5 Provide openings in non-structural elements of Work for penetrations of mechanical and electrical Work.
- .6 Execute Work by methods to avoid damage to other Work, and which will provide proper surfaces to receive patching and finishing.
- .7 Employ original installer to perform cutting and patching for weather-exposed and moisture-resistant elements, and sight-exposed surfaces.
- .8 Cut rigid materials using masonry saw or core drill. Pneumatic or impact tools not allowed on masonry work without prior approval.
- .9 Restore work with new products in accordance with requirements of Contract Documents.
- .10 Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- .11 At penetration of fire rated wall, ceiling, or floor construction, completely seal voids with fire stopping material, full thickness of the construction element.
- .12 Refinish surfaces to match adjacent finishes: Refinish continuous surfaces to nearest intersection. Refinish assemblies by refinishing entire unit.
- .13 Conceal pipes, ducts and wiring in floor, wall and ceiling construction of finished areas except where indicated otherwise.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1            General**

**1.1                PROJECT CLEANLINESS**

- .1        Construction work is executed in a normally occupied facility. Maintain Work in tidy condition, free from accumulation of waste products and debris, including that caused by Owner or other Contractors.
- .2        Remove waste materials from site at daily regularly scheduled times or dispose of as directed by Consultant. Do not burn waste materials on site.
- .3        Clear snow and ice from access to building, bank/pile snow in designated areas only make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .4        Provide on-site containers for collection of waste materials and debris.
- .5        Provide and use marked separate bins for recycling. Refer to Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .6        Clean interior areas prior to start of finishing work, and maintain areas free of dust and other contaminants during finishing operations.
- .7        Dispose of waste materials and debris off site.
- .8        Store volatile waste in covered metal containers, and remove from premises at end of each working day.
- .9        Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.
- .10       Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.
- .11       Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

**1.2                FINAL CLEANING**

- .1        When Work is substantially performed remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.
- .2        Remove waste products and debris other than that caused by others, and leave Work clean and suitable for occupancy.
- .3        Prior to final review remove surplus products, tools, construction machinery and equipment.
- .4        Remove waste products and debris including that caused by Owner or other Contractors.

- .5 Remove waste materials from site at regularly scheduled times or dispose of as directed by Consultant. Do not burn waste materials on site.
- .6 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .7 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, and mechanical and electrical fixtures. Replace broken, scratched or disfigured glass.
- .8 Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture fitments, walls and floors. Clean lighting reflectors, lenses, and other lighting surfaces in affected areas.
- .9 Vacuum clean and dust building interiors, behind grilles, louvres and screens.
- .10 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.
- .11 Broom clean and wash exterior walks, steps and surfaces; rake clean other surfaces of grounds.
- .12 Remove dirt and other disfiguration from exterior surfaces.
- .13 Clean and sweep roofs, gutters, areaways, and sunken wells.
- .14 Sweep and wash clean paved areas, clean equipments and fixtures to sanitary condition; clean or replace filters of mechanical equipment.
- .15 Remove debris and surplus materials from crawl areas and other accessible concealed spaces. Remove snow and ice from access to building.

### **1.3 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management And Disposal.

### **Part 2 Products**

#### **2.1 NOT USED**

- .1 Not Used.

### **Part 3 Execution**

#### **3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1            General**

**1.1                DEFINITIONS**

- .1        Recyclable: Ability of product or material to be recovered at end of its life cycle and re-manufactured into new product for reuse by others.
- .2        Recycle: Process by which waste and recyclable materials are transformed or collected for purpose of being transferred into new products.
- .3        Recycling: Process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for purpose of using in altered form. Recycling does not include burning, incinerating, or thermally destroying waste.
- .4        Reuse: Repeated use of product in same form but not necessarily for same purpose. Reuse includes:
  - .1        Salvaging reusable materials from re-modelling projects, before demolition stage, for resale, reuse on current project or for storage for use on future projects.
  - .2        Returning reusable items including pallets or unused products to vendors.
- .5        Salvage: Removal of structural and non-structural materials from deconstruction/disassembly projects for purpose of reuse or recycling.
- .6        Separate Condition: Refers to waste sorted into individual types.
- .7        Source Separation: Acts of keeping different types of waste materials separate beginning from first time they became waste.

**1.2                STORAGE, HANDLING AND PROTECTION**

- .1        Store, materials to be reused, recycled and salvaged in locations as directed by owner.
- .2        Unless specified otherwise, materials for removal do not become Contractor's property.
- .3        Protect, stockpile, store and catalogue salvaged items.
- .4        Separate non-salvageable materials from salvaged items. Transport and deliver non-salvageable items to licensed disposal facility.
- .5        Protect structural components not removed for demolition from movement or damage.
- .6        Support affected structures. If safety of building is endangered, cease operations and immediately notify Consultant.
- .7        Protect surface drainage, mechanical and electrical from damage and blockage.
- .8        Separate and store materials produced during dismantling of structures in designated areas.



- .9 Prevent contamination of materials to be salvaged and recycled and handle materials in accordance with requirements for acceptance by designated facilities.
  - .1 On-site source separation is recommended.
  - .2 Remove co-mingled materials to off-site processing facility for separation.
  - .3 Provide waybills for separated materials.

### **1.3 DISPOSAL OF WASTES**

- .1 Do not bury rubbish or waste materials.
- .2 Do not dispose of waste, volatile materials, mineral spirits, oil and paint thinner into waterways, storm, or sanitary sewers.
- .3 Keep records of construction waste including:
  - .1 Number and size of bins.
  - .2 Waste type of each bin.
  - .3 Total tonnage generated.
  - .4 Tonnage reused or recycled.
  - .5 Reused or recycled waste destination.
- .4 Remove materials from deconstruction as deconstruction/disassembly Work progresses.
- .5 Prepare project summary to verify destination and quantities on a material-by-material basis as identified in pre-demolition material audit.

### **1.4 USE OF SITE AND FACILITIES**

- .1 Execute work with least possible interference or disturbance to normal use of premises.
- .2 Maintain security measures established by existing facility, provide additional temporary security measures approved by owner.

### **1.5 SCHEDULING**

- .1 Coordinate Work with other activities at site to ensure timely and orderly progress of Work.

## **Part 2 Products**

### **2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 APPLICATION**

- .1 Handle waste materials not reused, salvaged, or recycled in accordance with appropriate regulations and codes.

**3.2 CLEANING**

- .1 Remove tools and waste materials on completion of Work, and leave work area in clean and orderly condition.
- .2 Clean-up work area as work progresses.
- .3 Source separate materials to be reused/recycled into specified sort areas.

**3.3 DIVERSION OF MATERIALS**

- .1 From following list, separate materials from general waste stream and stockpile in separate piles or containers, as reviewed by owner, and consistent with applicable fire regulations.
  - .1 Mark containers or stockpile areas.
  - .2 Provide instruction on disposal practices.
- .2 On-site sale of salvaged, recovered, reusable, recyclable materials is not permitted.
- .3 Demolition Waste

Material Type	Recommended Diversion %
Acoustical Insulation	100
Electrical Equipment	100
Mechanical Equipment	100
Metals	100
Rubble	100
Wood (uncontaminated)	100

- .4 Construction Waste

Material Type	Recommended Diversion %
Cardboard	100
Plastic Packaging	100
Rubble	100
Steel	100
Wood (uncontaminated)	100

**END OF SECTION**

**Part 1           General**

**1.1               INSPECTION AND DECLARATION**

- .1       Notify Consultant in writing of satisfactory completion of Contractor's Inspection and that corrections have been made.
- .2       Request Consultant's Inspection.
- .2       Consultant's Inspection: Consultant and Contractor will perform inspection of Work to identify obvious defects or deficiencies. Contractor to correct Work accordingly.
- .3       Completion: submit written certificate that following have been performed:
  - .1       Work has been completed and inspected for compliance with Contract Documents.
  - .2       Defects have been corrected and deficiencies have been completed.
  - .3       Equipment and systems have been tested, adjusted and balanced and are fully operational.
  - .4       Operations of systems have been demonstrated to Owner's personnel.
  - .5       Work is complete and ready for final inspection.
- .4       Final Inspection: when items noted above are completed, request final inspection of Work by Consultant, and Contractor. If Work is deemed incomplete by Consultant, complete outstanding items and request re-inspection.

**1.2               CLEANING**

- .1       In accordance with Section 01 74 11 - Cleaning.
- .2       Remove waste and surplus materials, rubbish and construction facilities from the site in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**1.3               WARRANTY INSPECTION**

- .1       Seven (7) months after the date of Interim Certificate of Completion the Owner Representative, Contractor and Generator & Enclosure Manufacture Representative shall together inspect the generator system including sub-base fuel tank, sound attenuated enclosure and entire project related work to determine any deficiencies of material or workmanship that have occurred become apparent since completion of the project. The consultant shall notify the contractor to rectify any deficiencies noted within three (3) months prior to end of the one (1) year warranty period.
- .2       14 days before the date of one-year warranty period the Owner Representative and Contractor shall together conduct a final inspection of the Generator operation and remedial works to ensure that the deficiencies noted at the 7-month inspection, and reported in the following 3-months, have been satisfactorily corrected by contractor.

**Part 2            Products**

**2.1                NOT USED**

.1            Not Used.

**Part 3            Execution**

**3.1                NOT USED**

.1            Not Used.

**END OF SECTION**

**Part 1            General**

**1.1                SUBMITTALS**

- .1        Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Prepare instructions and data using personnel experienced in maintenance and operation of described products.
- .3        Copy will be returned after final inspection, Consultant's comments.
- .4        Revise content of documents as required prior to final submittal.
- .5        **Two (2) weeks** prior to Substantial Performance of the Work, submit to the Consultant, four final copies of operating and maintenance manuals in English.
- .6        Ensure spare parts, maintenance materials and special tools provided are new, undamaged or defective, and of same quality and manufacture as products provided in Work.
- .7        Furnish evidence, if requested, for type, source and quality of products provided.
- .8        Defective products will be rejected, regardless of previous inspections. Replace products at own expense.
- .9        Pay costs of transportation.

**1.2                FORMAT**

- .1        Organize data as instructional manual.
- .2        Binders: vinyl, hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets.
- .3        When multiple binders are used correlate data into related consistent groupings. Identify contents of each binder on spine.
- .4        Cover: identify each binder with type or printed title 'Project Record Documents'; list title of project and identify subject matter of contents.
- .5        Arrange content by systems, under Section numbers and sequence of Table of Contents.
- .6        Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.
- .7        Text: manufacturer's printed data, or typewritten data.
- .8        Drawings: provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

### **1.3 CONTENTS - EACH VOLUME**

- .1 Table of Contents: provide title of project; Date of submission; names.
  - .1 Addresses, and telephone numbers of Consultant and Contractor with name of responsible parties.
  - .2 Schedule of products and systems, indexed to content of volume.
- .2 For each product or system:
  - .1 List names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.
- .3 Product Data: mark each sheet to identify specific products and component parts, and data applicable to installation; delete inapplicable information.
- .4 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.
- .5 Typewritten Text: as required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section 01 45 00 - Quality Control.
- .6 Training: refer to Section 01 79 00 - Demonstration and Training.

### **1.4 AS-BUILTS AND SAMPLES**

- .1 Maintain in addition to requirements in General Conditions, one record copy of:
  - .1 Contract Drawings.
  - .2 Specifications.
  - .3 Addenda.
  - .4 Change Orders and other modifications to Contract.
  - .5 Reviewed shop drawings, product data, and samples.
  - .6 Generator manufacturer test records. Field test records.
  - .7 Inspection certificates.
  - .8 Manufacturer's certificates.
- .2 Store record documents and samples in field office apart from documents used for construction. Provide files, racks, and secure storage.
- .3 Label record documents and file in accordance with Section number listings in List of Contents of this Project Manual. Label each document "PROJECT RECORD" in neat, large, printed letters.
- .4 Maintain record documents in clean, dry and legible condition. Do not use record documents for construction purposes.
- .5 Keep record documents and samples available for inspection by Consultant.

## **1.5 RECORDING ACTUAL SITE CONDITIONS**

- .1 Record information on set of red line opaque drawings, provided by Consultant.
- .2 Provide felt tip marking pens, maintaining separate colours for each major system, for recording information.
- .3 Record information concurrently with construction progress. Do not conceal Work until required information is recorded.
- .4 Contract Drawings and shop drawings: mark each item to record actual construction, including:
  - .1 Measured depths of elements of foundation in relation to finish first floor datum.
  - .2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
  - .3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.
  - .4 Field changes of dimension and detail.
  - .5 Changes made by change orders.
  - .6 Details not on original Contract Drawings.
  - .7 References to related shop drawings and modifications.
- .5 Specifications: mark each item to record actual construction, including:
  - .1 Manufacturer, trade name, and catalogue number of each product actually installed, particularly optional items and substitute items.
  - .2 Changes made by Addenda and change orders.
- .6 Other Documents: maintain manufacturer's certifications, inspection certifications, field test records, required by individual specifications sections.

## **1.6 EQUIPMENT AND SYSTEMS**

- .1 Each Item of Equipment and Each System: include description of unit or system, and component parts. Give function, normal operation characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
- .2 Include installed colour coded wiring diagrams.
- .3 Operating Procedures: as per Sequence of Operation stated in construction documents. Include regulation, control, stopping, shut-down, and emergency instructions. Include any special operating instructions.
- .4 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and CSA-C282 "Emergency Electrical Power Supply for Buildings" maintenance instructions.
- .5 Provide servicing schedule.

- .6 Include manufacturer's printed operation and maintenance instructions.
- .7 Include sequence of operation.
- .8 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- .9 Provide installed control diagrams by controls manufacturer.
- .10 Provide Contractor's coordination drawings, with installed colour coded piping diagrams.
- .11 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- .12 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- .13 Include test and balancing reports as specified in Section 01 45 00 - Quality Control and 01 91 13 - General Commissioning (Cx) Requirements.
- .14 Additional requirements: as specified in individual specification sections.

#### **1.7 MATERIALS AND FINISHES**

- .1 Building Products, Applied Materials, and Finishes: include product data, with catalogue number, size, composition, and colour and texture designations.
- .2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .3 Moisture-Protection and Weather-Exposed Products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .4 Additional Requirements: as specified in individual specifications sections.

#### **1.8 SPARE PARTS**

- .1 Provide spare parts, in quantities specified in individual specification sections.
- .2 Provide items of same manufacture and quality as items in Work.
- .3 Deliver to site, place and store.
- .4 Obtain receipt for delivered products and submit prior to final payment.

#### **1.9 MAINTENANCE MATERIALS**

- .1 Provide maintenance and extra materials, in quantities specified in individual specification sections.



- .2 Provide items of same manufacture and quality as items in Work.
- .3 Deliver to site; place and store.
- .4 Obtain receipt for delivered products and submit prior to final payment.

#### **1.10 SPECIAL TOOLS**

- .1 Provide special tools, in quantities specified in individual specification section.
- .2 Provide items with tags identifying their associated function and equipment.
- .3 Deliver to site; place and store. Receive and catalogue items. Submit inventory listing to Consultant. Include approved listings in Maintenance Manual.

#### **1.11 STORAGE, HANDLING AND PROTECTION**

- .1 Store spare parts, maintenance materials, and special tools in manner to prevent damage or deterioration.
- .2 Store in original and undamaged condition with manufacturer's seal and labels intact.
- .3 Store components subject to damage from weather in weatherproof enclosures.
- .4 Store paints and freezable materials in a heated and ventilated room.
- .5 Remove and replace damaged products at own expense and to satisfaction of Consultant.

#### **1.12 WARRANTIES AND BONDS**

- .1 Develop warranty management plan to contain information relevant to Warranties.
- .2 Submit warranty management plan, 30 days before planned pre-warranty conference, to Consultant approval.
- .3 Warranty management plan to include required actions and documents to assure that Owner receives warranties to which it is entitled.
- .4 Provide plan in narrative form and contain sufficient detail to make it suitable for use by future maintenance and repair personnel.
- .5 Submit, warranty information made available during construction phase, to Consultant for approval prior to each monthly pay estimate.
- .6 Assemble approved information in binder and submit upon acceptance of work. Organize binder as follows:
  - .1 Separate each warranty or bond with index tab sheets keyed to Table of Contents listing.
  - .2 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

- .3 Obtain warranties and bonds, executed in duplicate by subcontractors, suppliers, and manufacturers, within ten days after completion of applicable item of work.
- .4 Verify that documents are in proper form, contain full information, and are notarized.
- .5 Co-execute submittals when required.
- .6 Retain warranties and bonds until time specified for submittal.
- .7 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial Performance is determined.
- .8 Conduct joint 6 month and 9 month warranty inspection, measured from time of acceptance, by Owner Representative and Contractor.
- .9 Include information contained in warranty management plan as follows:
  - .1 Roles and responsibilities of personnel associated with warranty process, including points of contact and telephone numbers within the organizations of Contractors, subcontractors, manufacturers or suppliers involved.
  - .2 Listing and status of delivery of Certificates of Warranty for extended warranty items, to include Generator c/w sub-base tank & sound attenuated enclosure, new Transfer Switch, and commissioned systems.
  - .3 Provide list for each warranted equipment, item, and feature of construction or system indicating:
    - .1 Name of item.
    - .2 Model and serial numbers.
    - .3 Location where installed.
    - .4 Name and phone numbers of manufacturers or suppliers.
    - .5 Names, addresses and telephone numbers of sources of spare parts.
    - .6 Warranties and terms of warranty: include one-year overall warranty of construction. Indicate items that have extended warranties and show separate warranty expiration dates.
    - .7 Cross-reference to warranty certificates as applicable.
    - .8 Starting point and duration of warranty period.
    - .9 Summary of maintenance procedures required to continue warranty in force.
    - .10 Cross-Reference to specific pertinent Operation and Maintenance manuals.
    - .11 Organization, names and phone numbers of persons to call for warranty service.
    - .12 Typical response time and repair time expected for various warranted equipment.
  - .4 Contractor's plans for attendance at 6 and 9 month post-construction warranty inspections.
  - .5 Procedure and status of tagging of equipment covered by extended warranties.
  - .6 Post copies of instructions near selected pieces of equipment where operation is critical for warranty and/or safety reasons.

- .10 Respond in a timely manner to oral or written notification of required construction warranty repair work.
- .11 Written verification will follow oral instructions. Failure to respond will be cause for the Consultant to proceed with action against Contractor.

**1.13 PRE-WARRANTY CONFERENCE**

- .1 Meet with Owner and Consultant, to develop understanding of requirements of this section. Schedule meeting prior to contract completion, and at time designated by Consultant.
- .2 Consultant will establish communication procedures for:
  - .1 Notification of construction warranty defects.
  - .2 Determine priorities for type of defect.
  - .3 Determine reasonable time for response.
- .3 Provide name, telephone number and address of licensed and bonded company that is authorized to initiate and pursue construction warranty work action.
- .4 Ensure contact is located within local service area of warranted construction, is continuously available, and is responsive to inquiries for warranty work action.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1            General**

**1.1                DESCRIPTION**

- .1        Demonstrate operation and maintenance of equipment and systems to Owner's personnel two weeks prior to date of substantial performance.
- .2        Owner will provide list of personnel to receive instructions, and will co-ordinate their attendance at agreed-upon times.

**1.2                QUALITY CONTROL**

- .1        When specified in individual Sections require manufacturer to provide authorized representative to demonstrate operation of equipment and systems, instruct Owner's personnel, and provide written report that demonstration and instructions have been completed.

**1.3                SUBMITTALS**

- .1        Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Submit schedule of time and date for demonstration of each item of equipment and each system three (3) weeks prior to designated dates, for Consultant's approval. Submit reports within one week after completion of demonstration, that demonstration and instructions have been satisfactorily completed.
- .3        Give time and date of each demonstration, with list of persons present.

**1.4                CONDITIONS FOR DEMONSTRATIONS**

- .1        Equipment has been inspected and put into operation in accordance with related Sections.
- .2        Testing and adjusting has been performed in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements and equipment and systems are fully operational.
- .3        Provide copies of completed operation and maintenance manuals for use in demonstrations and instructions.

**1.5                PREPARATION**

- .1        Verify that conditions for demonstration and instructions comply with requirements.
- .2        Verify that designated personnel are present.

**1.6                DEMONSTRATION AND INSTRUCTIONS**

- .1        Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, and maintenance of each item of equipment at agreed upon times, at the equipment location.

- .2 Instruct personnel in phases of operation and maintenance using operation and maintenance manuals as basis of instruction.
- .3 Review contents of manual in detail to explain aspects of operation and maintenance.
- .4 Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instructions.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

## **Part 1           General**

### **1.1               SUMMARY**

- .1   Section Includes:
  - .1       General requirements relating to commissioning of project's components and systems, specifying general requirements to PV of components, equipment, sub-systems, systems, and integrated systems.
- .2   Acronyms:
  - .1       AFD - Alternate Forms of Delivery, service provider.
  - .2       BMM - Building Management Manual.
  - .3       Cx - Commissioning.
  - .4       EMCS - Energy Monitoring and Control Systems.
  - .5       O&M - Operation and Maintenance.
  - .6       PI - Product Information.
  - .7       PV - Performance Verification.
  - .8       TAB - Testing, Adjusting and Balancing.

### **1.2               GENERAL**

- .1   Cx is a planned program of tests, procedures and checks carried out systematically on systems and integrated systems of the finished Project. Cx is performed after systems and integrated systems are completely installed, functional and Contractor's Performance Verification responsibilities have been completed and approved. Objectives:
  - .1       Verify installed equipment, systems and integrated systems operate in accordance with contract documents and design criteria and intent.
  - .2       Ensure appropriate documentation is compiled into the BMM.
  - .3       Effectively train O&M staff.
- .2   Contractor assists in Cx process, operating equipment and systems, troubleshooting and making adjustments as required.
  - .1       Systems to be operated at full capacity under various modes to determine if they function correctly and consistently at peak efficiency. Systems to be interactively with each other as intended in accordance with Contract Documents and design criteria.
  - .2       During these checks, adjustments to be made to enhance performance to meet environmental or user requirements.
- .3   Design Criteria: as per client's requirements or determined by designer. To meet Project functional and operational requirements.

### **1.3               COMMISSIONING OVERVIEW**

- .1   Cx to be a line item of Contractor's cost breakdown.

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- .2 Cx activities supplement field quality and testing procedures described in relevant technical sections.
- .3 Cx is conducted in concert with activities performed during stage of project delivery. Cx identifies issues in Planning and Design stages which are addressed during Construction and Cx stages to ensure the built is constructed and proven to operate satisfactorily under weather, environmental and occupancy conditions to meet functional and operational requirements. Cx activities include transfer of critical knowledge to facility operational personnel.
- .4 Consultant will issue substantial performance acceptance certificate when:
  - .1 Completed Cx documentation has been received, reviewed for suitability and approved by Consultant.
  - .2 Equipment, components and systems have been commissioned.
  - .3 O&M training has been completed.

#### **1.4 NON-CONFORMANCE TO PERFORMANCE VERIFICATION REQUIREMENTS**

- .1 Should equipment, system components, and associated controls be incorrectly installed or malfunction during Cx, correct deficiencies, re-verify equipment and components within the un-functional system, including related systems as deemed required by Consultant, to ensure effective performance.
- .2 Costs for corrective work, additional tests, inspections, to determine acceptability and proper performance of such items to be borne by Contractor. Above costs to be in form of progress payment reductions or hold-back assessments.

#### **1.5 PRE-CX REVIEW**

- .1 Before Construction:
  - .1 Review contract documents, confirm by writing to Consultant.
    - .1 Adequacy of provisions for Cx.
    - .2 Aspects of design and installation pertinent to success of Cx.
- .2 During Construction:
  - .1 Co-ordinate provision, location and installation of provisions for Cx.
- .3 Before start of Cx:
  - .1 Have completed Cx Plan up-to-date.
  - .2 Ensure installation of related components, equipment, sub-systems, systems is complete.
  - .3 Fully understand Cx requirements and procedures.
  - .4 Understand completely design criteria and intent and special features.
  - .5 Submit complete start-up documentation to Consultant.
  - .6 Have Cx schedules up-to-date.

- .7 Ensure systems have been cleaned thoroughly.
- .8 Complete TAB procedures on systems, submit TAB reports to Consultant for review and approval.
- .9 Ensure "As-Built" system schematics are available.
- .4 Inform Consultant in writing of discrepancies and deficiencies on finished works.

## **1.6 CONFLICTS**

- .1 Report conflicts between requirements of this section and other sections to Consultant before start-up and obtain clarification.
- .2 Failure to report conflict and obtain clarification will result in application of most stringent requirement.

## **1.7 SUBMITTALS**

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Submit no later than 8 weeks after award of Contract:
    - .1 Name of Contractor's Cx agent.
    - .2 Preliminary Cx schedule.
  - .2 Request in writing to Consultant for changes to submittals and obtain written approval at least 8 weeks prior to start of Cx.
  - .3 Submit proposed Cx procedures to Consultant where not specified and obtain written approval at least 8 weeks prior to start of Cx.
  - .4 Provide additional documentation relating to Cx process required by Consultant.

## **1.8 COMMISSIONING DOCUMENTATION**

- .1 Refer to related division 23 and 26 sections.
- .2 Consultant to review and approve Cx documentation.
- .3 Provide completed and approved Cx documentation to Consultant.

## **1.9 COMMISSIONING SCHEDULE**

- .1 Provide detailed Cx schedule as part of construction schedule.
- .2 Provide adequate time for Cx activities prescribed in technical sections and commissioning sections including:
  - .1 Approval of Cx reports.
  - .2 Verification of reported results.
  - .3 Repairs, retesting, re-commissioning, re-verification.
  - .4 Training.



### **1.10 COMMISSIONING MEETINGS**

- .1 At 80% construction completion stage, consultant to call a separate Cx scope meeting to review progress, discuss schedule of equipment start-up activities and prepare for Cx. Issues at meeting to include:
  - .1 Review duties and responsibilities of Contractor and subcontractors, addressing delays and potential problems.
  - .2 Determine the degree of involvement of trades and manufacturer's representatives in the commissioning process.
- .2 Meeting will be chaired by Consultant, who will record and distribute minutes. Meeting will be via tele-conference.
- .3 Ensure subcontractors and relevant manufacturer representatives are present at 80% and subsequent Cx meetings and as required.

### **1.11 STARTING AND TESTING**

- .1 Contractor assumes liabilities and costs for inspections. Including disassembly and re-assembly after approval, starting, testing and adjusting, including supply of testing equipment.

### **1.12 WITNESSING OF STARTING AND TESTING**

- .1 Provide 14 days notice prior to commencement.
- .2 Owner to witness of start-up and testing.
- .3 Contractor's Cx Agent to be present at tests performed and documented by sub-trades, suppliers and equipment manufacturers.

### **1.13 MANUFACTURER'S INVOLVEMENT**

- .1 Factory testing: manufacturer to:
  - .1 Coordinate time and location of testing.
  - .2 Provide testing documentation for approval by Consultant.
  - .3 Arrange for Consultant to witness tests.
  - .4 Obtain written approval of test results and documentation from Consultant before delivery to site.
- .2 Obtain manufacturers installation, start-up and operations instructions prior to start-up of components, equipment and systems and review with Consultant
  - .1 Compare completed installation with manufacturer's published data, record discrepancies, and review with manufacturer.
  - .2 Modify procedures detrimental to equipment performance and review same with manufacturer before start-up.
- .3 Integrity of warranties:

- .1 Use manufacturer's trained start-up personnel where specified elsewhere in other divisions or required to maintain integrity of warranty.
- .2 Verify with manufacturer that testing as specified will not void warranties.
- .4 Qualifications of manufacturer's personnel:
  - .1 Experienced in design, installation and operation of equipment and systems.
  - .2 Ability to interpret test results accurately.
  - .3 To report results in clear, concise, logical manner.

#### **1.14 PROCEDURES**

- .1 Verify that equipment and systems are complete, clean, and operating in normal and safe manner prior to conducting start-up, testing and Cx.
- .2 Conduct start-up and testing in following distinct phases:
  - .1 Included in delivery and installation:
    - .1 Verification of conformity to specification, approved shop drawings and completion of PI report forms.
    - .2 Visual inspection of quality of installation.
  - .2 Start-up: follow accepted start-up procedures.
  - .3 Operational testing: document equipment performance.
  - .4 System PV: include repetition of tests after correcting deficiencies.
  - .5 Post-substantial performance verification: to include fine-tuning.
- .3 Correct deficiencies and obtain approval from Consultant after distinct phases have been completed and before commencing next phase.
- .4 Document requires tests on approved PV forms.
- .5 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency selected by owner. If results reveal that equipment start-up was not in accordance with requirements, and resulted in damage to equipment, implement following:
  - .1 Minor equipment/systems: implement corrective measures approved by Consultant.
  - .2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved by Consultant.
  - .3 If evaluation report concludes that major damage has occurred, Consultant shall reject equipment.
    - .1 Rejected equipment to be removed from site and replace with new.
    - .2 Subject new equipment/systems to specified start-up procedures.

#### **1.15 START-UP DOCUMENTATION**

- .1 Assemble start-up documentation and submit to Consultant for approval before commencement of commissioning.

- .2 Start-up documentation to include:
  - .1 Factory and on-site test certificates for specified equipment.
  - .2 Pre-start-up inspection reports.
  - .3 Signed installation/start-up check lists.
  - .4 Start-up reports,
  - .5 Step-by-step description of complete start-up procedures, to permit Consultant to repeat start-up at any time.

#### **1.16 OPERATION AND MAINTENANCE OF EQUIPMENT AND SYSTEMS**

- .1 After start-up, operate and maintain equipment and systems as directed by equipment/system manufacturer.
- .2 With assistance of manufacturer develop written maintenance program and submit Consultant for approval before implementation.
- .3 Operate and maintain systems for length of time required for commissioning to be completed.
- .4 After completion of commissioning, operate and maintain systems until issuance of certificate of interim acceptance.

#### **1.17 TEST RESULTS**

- .1 If start-up, testing and/or PV produce unacceptable results, repair, replace or repeat specified starting and/or PV procedures until acceptable results are achieved.
- .2 Provide manpower and materials, assume costs for re-commissioning.

#### **1.18 START OF COMMISSIONING**

- .1 Notify Consultant at least 14 days prior to start of Cx.
- .2 Start Cx after elements of building affecting start-up and performance verification of systems have been completed.

#### **1.19 INSTRUMENTS / EQUIPMENT**

- .1 Submit to Consultant for review and approval:
  - .1 Complete list of instruments proposed to be used.
  - .2 Listed data including, serial number, current calibration certificate, calibration date, calibration expiry date and calibration accuracy.
- .2 Provide the following equipment as required:
  - .1 2-way radios.
  - .2 Ladders.
  - .3 Equipment as required to complete work.

## **1.20 COMMISSIONING PERFORMANCE VERIFICATION**

- .1 Carry out Cx:
  - .1 Under actual operating conditions, over entire operating range, in all modes.
  - .2 On independent systems and interacting systems.
- .2 Cx procedures to be repeatable and reported results are to be verifiable.
- .3 Follow equipment manufacturer's operating instructions.
- .4 EMCS trending to be available as supporting documentation for performance verification.

## **1.21 WITNESSING COMMISSIONING**

- .1 Owner Representative to witness activities and verify results.

## **1.22 AUTHORITIES HAVING JURISDICTION**

- .1 Where specified start-up, testing or commissioning procedures duplicate verification requirements of authority having jurisdiction, arrange for authority to witness procedures so as to avoid duplication of tests and to facilitate expedient acceptance of facility.
- .2 Obtain certificates of approval, acceptance and compliance with rules and regulation of authority having jurisdiction.
- .3 Provide copies to Consultant within 5 days of test and with Cx report.

## **1.23 SUNDRY CHECKS AND ADJUSTMENTS**

- .1 Make adjustments and changes which become apparent as Cx proceeds.
- .2 Perform static and operational checks as applicable and as required.

## **1.24 DEFICIENCIES, FAULTS, DEFECTS**

- .1 Correct deficiencies found during start-up and Cx to satisfaction of Consultant.
- .2 Report problems, faults or defects affecting Cx to Consultant in writing. Stop Cx until problems are rectified. Proceed with written approval from Consultant.

## **1.25 COMPLETION OF COMMISSIONING**

- .1 Upon completion of Cx leave systems in normal operating mode.
- .2 Except for warranty and seasonal verification activities specified in Cx specifications, complete Cx prior to issuance of Interim Certificate of Completion.
- .3 Cx to be considered complete when contract Cx deliverables have been submitted and accepted by Consultant.

**1.26 ACTIVITIES UPON COMPLETION OF COMMISSIONING**

- .1 When changes are made to baseline components or system settings established during Cx process, provide updated Cx form for affected item.

**1.27 TRAINING**

- .1 In accordance with Section 01 91 41 - Commissioning (Cx) - Training.

**1.28 MAINTENANCE MATERIALS, SPARE PARTS, SPECIAL TOOLS**

- .1 Supply, deliver, and document maintenance materials, spare parts, and special tools as specified in contract.

**1.29 INSTALLED INSTRUMENTATION**

- .1 Use instruments installed under Contract for TAB and PV if:
  - .1 Accuracy complies with these specifications.
  - .2 Calibration certificates have been deposited Consultant.
- .2 Calibrated EMCS sensors may be used to obtain performance data provided that sensor calibration has been completed and accepted.

**1.30 PERFORMANCE VERIFICATION TOLERANCES**

- .1 Application tolerances:
  - .1 Specified range of acceptable deviations of measured values from specified values or specified design criteria. Except for special areas, to be within +/- 5% of specified values.
- .2 Instrument accuracy tolerances:
  - .1 To be of higher order of magnitude than equipment or system being tested.
- .3 Measurement tolerances during verification:
  - .1 Unless otherwise specified actual values to be within +/- 2 % of recorded values.

**1.31 OWNER'S PERFORMANCE TESTING**

- .1 Performance testing of equipment or system by Consultant will not relieve Contractor from compliance with specified start-up and testing procedures.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3            Execution**

**3.1                NOT USED**

.1            Not Used.

**END OF SECTION**

**Part 1            General**

**1.1                SUMMARY**

.1            Section Includes:

- .1            This Section specifies roles and responsibilities of Commissioning Training.

**1.2                TRAINEES**

.1            Trainees: personnel selected for operating and maintaining this facility. Includes Facility Manager, building operators, maintenance staff, security staff, and technical specialists as required.

.2            Trainees will be available for training during later stages of construction for purposes of familiarization with systems.

**1.3                INSTRUCTORS**

.1            Consultant will provide:

- .1            Descriptions of systems.
- .2            Instruction on design philosophy, design criteria, and design intent.

.2            Contractor and certified factory-trained manufacturers' personnel: to provide instruction on the following:

- .1            Start-Up, operation, shut-down of equipment, components and systems.
- .2            Control features, reasons for, results of, implications on associated systems of, adjustment of set points of control and safety devices.
- .3            Instructions on servicing, maintenance and adjustment of systems, equipment and components.

**1.4                TRAINING OBJECTIVES**

.1            Training to be detailed and duration to ensure:

- .1            Safe, reliable, cost-effective, energy-efficient operation of systems in normal and emergency modes under all conditions.
- .2            Effective on-going inspection, measurements of system performance.
- .3            Proper preventive maintenance, diagnosis and trouble-shooting.
- .4            Ability to update documentation.
- .5            Ability to operate equipment and systems under emergency conditions until appropriate qualified assistance arrives.

**1.5                TRAINING MATERIALS**

.1            Instructors to be responsible for content and quality.

.2            Training materials to include:

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- .1 "As-Built" Contract Documents.
- .2 Operating Manual.
- .3 Maintenance Manual.
- .4 Management Manual.
- .5 TAB and PV Reports.
- .3 Consultant and CFIA Project Manager, Commissioning Manager and Facility Manager will review training manuals.
- .4 Training materials to be in a format that permits future training procedures to same degree of detail.
- .5 Supplement training materials:
  - .1 Transparencies for overhead projectors.
  - .2 Multimedia presentations.
  - .3 Manufacturer's training videos.
  - .4 Equipment models.

## **1.6 SCHEDULING**

- .1 Deliver training during regular working hours, training sessions to be 3 hours in length.
- .2 Training to be completed prior to acceptance of facility.

## **1.7 RESPONSIBILITIES**

- .1 Be responsible for:
  - .1 Implementation of training activities,
  - .2 Coordination among instructors,
  - .3 Quality of training, training materials,
- .2 Consultant will evaluate training and materials.
- .3 Upon completion of training, provide written report, signed by Instructors, witnessed by Facility manager.

## **1.8 TRAINING CONTENT**

- .1 Training to include demonstrations by Instructors using the installed equipment and systems.
- .2 Content includes:
  - .1 Review of facility and occupancy profile.
  - .2 Functional requirements.
  - .3 System philosophy, limitations of systems and emergency procedures.
  - .4 Review of system layout, equipment, components and controls.



- .5 Equipment and system start-up, operation, monitoring, servicing, maintenance and shut-down procedures.
  - .6 System operating sequences, including step-by-step directions for starting up, shut-down, operation of valves, dampers, switches, adjustment of control settings and emergency procedures.
  - .7 Maintenance and servicing.
  - .8 Trouble-shooting diagnosis.
  - .9 Inter-Action among systems during integrated operation.
  - .10 Review of O&M documentation.
- .3 Provide specialized training as specified in relevant Technical Sections of the construction specifications.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

## **1. GENERAL**

### **1.1 GENERAL CONDITIONS**

- .1 The Contractor shall read and be governed by the General Conditions, General Instructions, Instructions to Bidders, Addenda, Form of Tender and Agreement of the complete specifications for this project.
- .2 The complete work under this trade shall be governed by the dictates of good practice in all details of materials and methods, even if not minutely specified. The work shall be properly coordinated with the requirements of other units of work specified in other sections.

### **1.2 STANDARDS**

- .1 American Society for Testing and Materials: ASTM (where noted).

### **1.3 SITE CONDITIONS**

- .1 Visit the site and note all characteristics and irregularities affecting the work of this section.
- .2 To proceed with the work will mean acceptance of the conditions, and failure to comply with the above will in no sense form the basis for any claims.

### **1.4 UTILITY LINES**

- .1 Contact all required utility companies prior to commencing work, and become informed of exact location of utilities. Protect utilities during construction, and assume liability for damage to utilities.

### **1.5 PERMITS**

- .1 Obtain and pay for any necessary permits required to complete the work.

### **1.6 COMPACTION DENSITIES**

- .1 Compaction densities are percentages of Standard Proctor maximum dry density, at optimum moisture content obtainable from ASTM D698.

### **1.7 INSPECTION AND TESTING**

- .1 Testing of materials and compaction will be carried out by testing laboratory in accordance with Section 01400.
- .2 Owner will pay costs for inspection and testing.
- .3 Sieve Analysis: Proposed fill materials may be tested to confirm suitability for intended use, and conformity with specifications.
- .4 Frequency of Tests:

- .1 Excavated Surfaces: When undisturbed excavated surface is being prepared, a series of three (3) tests of surface for each 500 m<sup>2</sup> area will be made.
- .2 Fills Under Slabs-On-Grade: Three (3) tests for every two lifts of compacted fill for each 500 m<sup>2</sup> area will be made.
- .3 Backfill Against Walls: One (1) test of each different material for approximately each 50 m of wall being backfilled at depth increments of 600 mm will be made.
- .5 Backfilling and compaction densities not conforming to the specifications and drawings, as represented by test results, shall be rejected at any time defects are found during the progress of the work. Defective materials shall be removed, replaced, and the fill retested at the Contractor's expense.

## **1.8 PROTECTION**

- .1 Protect bottoms of excavations from softening. Should softening occur, remove softened soil, and replace with Type 1 fill compacted to 97% ASTM D698 maximum dry density.
- .2 Protect bottoms of excavations from freezing.
- .3 Construct banks in accordance with local bylaws, and local soil conditions. Protect excavations by shoring, bracing or by other methods, as required to prevent cave-ins or loose dirt from falling into excavation.
- .4 Provide adequate protection around bench markers, lay-out markers, survey markers, and geodetic documents.
- .5 Provide protection to ensure no damage to existing facilities and equipment situated on site.
- .6 Do not stockpile excavated material to interfere with site operations or drainage.
- .7 Maintain adequate barriers and construction signs to prevent injury to the public.

## **1.9 MATERIALS**

- .1 All materials to be subject to Engineer's approval.
- .2 Grading of granular materials to show no marked fluctuations between opposite ends of extreme limits.

- .3 Type 1 Fill: Clean crushed gravel composed of sound, hard particles free from frozen material, flaky particles, soft shale, organic matter, or foreign matter, to meet the following requirements:

Sieve Size (mm)	Percent Passing (by weight)
20.0	100
16.0	84 - 94
10	63 - 86
5.0	40 - 67
1.250	20 - 43
0.63	14 - 34
0.315	9 - 26
0.16	5 - 18
0.08	2 - 10

- .4 Type 2 Fill: Pit run gravel composed of sound, hard particles free from frozen material, flaky particles, soft shale, organic matter, or foreign matter, to meet the following requirements:

Sieve Size (mm)	Percent Passing (by weight)
80.0	100
50.0	55 - 100
25.0	38 - 100
16.0	32 - 85
5.0	20 - 65
0.315	6 - 30
0.080	2 - 10

- .5 Type 3 Fill: Clean, natural river or bank sand, free from frozen material, silt, clay, loam, friable or soluble materials, and vegetable matter, to meet the following requirements:

Sieve Size (mm)	Percent Passing (by weight)
10.0	100
5.0	95 - 100
2.5	80 - 100
1.25	50 - 90
0.630	25 - 65
0.315	10 - 35
0.160	2 - 10

- .6 Type 3 Fill: Clean, washed, coarse sand free from frozen material, clay, shale, and organic matter.
- .7 Type 4 Fill: Excavated earth free from frozen material, roots, rocks larger than 75 mm in size, and building debris and organic material. Fill under landscaped areas to be free from alkali, salt, petroleum products, and other materials detrimental to plant growth. Use subsoil excavated from site only if approved by Engineer.
- .8 Type 5 Fill: Imported earth free from frozen material, roots, rocks larger than 75 mm in size, approved by the Engineer.

## **1.10 STOCKPILING**

- .1 Stockpile fill materials in areas designated by Engineer. Stockpile granular materials in manner to prevent segregation.
- .2 Protect fill materials from contamination.

## **2. EXECUTION**

### **2.1 EXCAVATING**

- .1 Strip all topsoil from the confines of the building.
- .2 Stockpile and remove all topsoil which is unsuitable for re-grading.
- .3 Excavate to elevations and dimensions indicated for installation, construction, and inspection of work specified.
- .4 Excavate to well defined lines to minimize quantity of fill material required.
- .5 Earth bottoms of excavations to be dry, undisturbed soil, level, free from loose or organic matter.
- .6 Excavation must not interfere with normal 45° splay of bearing from bottom of any footing.
- .7 When complete, the Engineer shall inspect excavations to verify soil bearing capacity, depths, and dimensions.
- .8 Correct unauthorized excavation or over-excavation at no extra cost as follows:
  - .1 Fill under floor slabs and wall footings with Type 1 fill compacted to 100% density min thickness 150mm.
  - .2 Fill under other areas with Type 1 fill compacted to 98% density.
- .9 Excavate trenches to lines and grade shown, to a minimum of 150 mm below underside of pipe. Provide recesses for bell and spigot pipe to ensure bearing will occur along barrel of pipe.

- .10 Cut trenches 300 mm wider than maximum pipe diameter. Trim and shape trench bottoms, and leave free of irregularities, lumps, or projects to give uniform and even bearing for length of pipe.

## **2.2 BACKFILLING**

- .1 Do not commence backfilling until areas of work to be backfilled have been inspected by the Engineer.
- .2 Areas to be backfilled shall be free from debris, snow, ice water or frozen ground. Backfill material shall not be frozen or contain ice, snow or debris.
- .3 Place and compact fill materials in continuous horizontal layers, not exceeding 200 mm loose depth or 150 mm compacted depth.
- .4 Where temporary unbalanced earth pressures are liable to develop on walls or other structures, use extreme caution during backfill operations. Maximum unbalanced earth elevations against foundations to be 300 mm, unless noted otherwise. Shore as required. Shoring to be the responsibility of the Contractor.
- .5 Provide bracing inside sumps or similar structures when backfilling against walls. Do not backfill until walls have cured a minimum of 7 days, or until in situ concrete has a minimum strength of 70% of  $f_c$ .
- .6 If, during progress of work, tests indicate fills do not meet specified requirements, remove defective fills, replace, and retest at no extra cost.

## **2.3 FILL TYPES AND COMPACTION**

- .1 Exterior Side of Grade Beams or Foundations Walls: Use Type 2 fill or approved Type 4 fill (if approved) or Type 5 fill (if approved) to subgrade level. Compact to 98% density.
- .2 Interior Side of Grade Beams or Foundation Walls: Use Type 2 fill or Type 4 fill (if approved) or Type 5 fill (if approved) against foundations. Compact to 97% density.
- .3 Under Grade Supported Slabs:
  - .1 Prior to placing fill, scarify and re-compact top 200 mm of existing subgrade to 100% density. Remove “soft” material, and fill with Type 1 fill or other fill materials (if approved), compacted to 100% density.
  - .2 Use Type 2 fill or Type 4 fill (if approved) sub-base to base course levels. Compact to 100% density.
  - .3 Use 150 mm base course of Type 1 fill compacted to 100% density, with a 13 mm layer of Type 3 fill to underside of vapour barrier.
- .4 Underground Services:

- .1 Pipe Bedding and Immediate Protection Cover: Bed pipe on a 150 mm layer of Type 3 fill. Place immediate cover of Type 3 fill for the full trench width, in layers not exceeding 150 mm to a point at least 80 mm above the crown of the pipe. Compact cover to 98% density.
- .2 Conduit and Cable Duct Bedding and Immediate Protection Cover: Install underground ducts or conduit on undisturbed soil or on Type 3 fill compacted to 98% density. Open trench completely before ducts or conduits are laid, and ensure that no obstructions will necessitate a change in the grade of the ducts. Slope ducts away from building at 1 to 400. Cap both ends of ducts or conduit. Provide 75 mm of Type 3 fill compacted to 95% density on top and side of duct or conduit.
- .3 Fill Above Protective Cover: In areas within buildings, and where paving and walks occur, fill remainder of trench with Type 2 fill. In other areas, fill to subgrade level using Type 2 fill or Type 4 fill (if approved).
- .4 Compaction: Compact bedding and immediate protective cover to 95% density. In areas within buildings, compact remainder of fill to 98% density. Where paving and walks occur, compact remainder of fill to 98% density. In other areas, compact remainder of fill to 85% density.
- .5 Notify Engineer one day prior to backfilling of trenches for electrical services.

#### **2.4 SURPLUS MATERIAL**

- .1 Remove from the site and dispose of surplus or unsuitable material not required for backfill or grading.

#### **2.5 DEWATERING**

- .1 Keep excavations dry at all stages of construction.
- .2 Control the grading adjacent to the excavation to prevent water running into excavated areas. If trenches are used, ensure that trench excavation does not interfere with or weaken footing bearing surfaces.
- .3 Provide suitable equipment including pumps, piping, temporary drains, trenches, and sumps to keep excavations free from water until concrete is placed, cured, and structural adequacy is assured.

**END OF SECTION**

## **1. GENERAL**

### **1.1 RELATED SECTIONS**

- .1 Section 03 20 00 – Concrete Reinforcing
- .2 Section 03 30 00 – Cast-in-Place Concrete
- .3 Section 01 33 00 – Submittal Procedures

### **1.2 GENERAL CONDITIONS**

- .1 The Contractor shall read and be governed by the General Conditions, General Instructions, Instructions to Bidders, Addenda, Form of Tender and Agreement of the complete specifications for this project.
- .2 The complete work under this trade shall be governed by the dictates of good practice in all details of materials and methods, even if not minutely specified. The work shall be properly coordinated with the requirements of other units of work specified in other sections.

### **1.3 STANDARDS**

- .1 Perform cast-in-place concrete work in accordance with the following standards, except where specified otherwise. All standards to be latest issue at time of tender.
  - .1 Concrete Materials and Methods of Concrete Construction: CSA A23.1-most current version.
  - .2 Methods of Test for Concrete: CSA A23.2-most current version.
  - .3 Design of Concrete Structures for Buildings: CSA A23.3-most current version.
  - .4 CAN/CSA-O86-most current version, “Engineering Design in Wood (Limit States Design)”.
  - .5 CAN/CSA-O86S1-most current version, Supplement No. 1 to CAN/CSA-O86-01, “Engineering Design in Wood”.
  - .6 CSA-O121-most current version, “Douglas Fir Plywood”.
  - .7 CSA-O151-most current version, “Canadian Softwood Plywood”.
  - .8 CSA-O153-most current version, “Poplar Plywood”.
  - .9 CSA-O325-most current version, “Construction Sheathing”.
  - .10 CSA-O437-most current version, “Standards on OSB and Waferboard”.
  - .11 CSA-S269.1-most current version, “Falsework for Construction Purposes”.
  - .12 CAN/CSA-S269.3-most current version, “Concrete Formwork, National Standard of Canada”.
  - .13 CAN/ULC-S701-most current version, “Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering”.
  - .14 Erection, Maintenance and Removal of Formwork: Conform to applicable safety regulations.



#### 1.4 INSPECTION AND TESTING

- .1 Testing of concrete work will be carried out by a designated testing laboratory in accordance with Section 01 45 00 – Quality Control.
- .2 Provide casual labour to the testing firm's field personnel for the purpose of obtaining and handling sample materials.
- .3 Advise testing firm in advance of concrete placement.
- .4 Provide and maintain facilities at the site for storage of concrete test cylinders for the first 24 hours.
- .5 Provide copies of mill test reports of cement and reinforcing steel as required.
- .6 Secure sufficient 3 and 7 day cylinders for testing by concrete supplier to ensure concrete quality control.
- .7 Provide at least one ASTM cube test on grout used under base plates and machinery.
- .8 Testing firm will take three test cylinders from each 50 m<sup>3</sup> of concrete, or fraction thereof, of each type of concrete placed in any one day.
- .9 Testing firm will moist cure and test one cylinder in 7 days, and will moist cure and test the remaining two cylinders in 28 days.
- .10 Testing firm will take one additional test cylinder when the temperature is likely to fall below 0°C within 48 hours after placing, and no provisions have been made to heat the concrete to greater than 10°C. Test cylinder to be cured on jobsite under same conditions as concrete it represents, and tested in 7 days.
- .11 Testing firm will make at least one slump test, and one entrained air test for each set of test cylinders taken.
- .12 Results of field tests will be reported immediately to the Contractor by the field representative of the testing firm. These results do not imply approval or disapproval of the work, but are for the Contractor's information. The acceptability of the work will be determined by the Engineer.
- .13 Results of concrete tests will be forwarded to the Owner and to the Contractor. Included with the results will be the following information: Name of Project, Date of Sampling, Name of Supplier, Delivery Truck Number, Identification of Sampling and Testing Technician, and Exact Location in the Structure of the Concrete Sampled.
- .14 Testing firm personnel are not authorized to revoke, relax, enlarge, or release any requirements of the specifications, nor to approve or disapprove any portion of the work.
- .15 Obtain Engineer's review before placing concrete. Provide 24 hours written notice prior to placing of concrete.

## **1.5 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Review of the shop drawings is intended to assist the Contractor and does not relieve the Contractor of responsibility for the completeness and accuracy of the work and its conformance with the contract drawings and specifications.
- .3 Fabrication that commences prior to shop drawing review is at the risk of the Contractor.

## **1.6 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver all materials to the site in bundles easily identified and properly marked.
- .2 Store and handle all material on site in a manner to prevent damage and contamination.
- .3 Store and manage hazardous materials in accordance with Section 01 35 20- Sustainable Requirements: Construction.
- .4 Waste Management and Disposal
  - .1 Separate waste materials for reuse and recycling in accordance with Section 01 35 41–Construction/Demolition Waste Management and Disposal.
  - .2 Place materials defined as hazardous or toxic in designated containers.
  - .3 Divert wood materials from landfill to an approved recycling, reuse, composting facility.
  - .4 Divert plastic materials from landfill to an approved recycling, reuse, composting facility.
  - .5 Divert unused from release materials from landfill to an official, approved hazardous material collections site.

## **1.7 ACCEPTABILITY**

- .1 Failure to comply with the requirements which control strength will result in the structure being considered potentially deficient.
- .2 A structure will be considered potentially deficient when:
  - .1 Concrete strength not as specified.
  - .2 Reinforcing steel size, quantity, position, quality, or arrangement not as specified or detailed.
  - .3 Improper curing.
  - .4 Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.
  - .5 Mechanical injury from fire, construction overload, or premature removal of forms.
  - .6 Poor workmanship.
  - .7 Failure to notify the Consultant to inspect formwork and reinforcement before placing concrete.

- .8 Concrete which differs from the required dimensions.
- .3 Strength Evaluation Tests and Analysis
  - .1 The Engineer may order an independent testing firm to obtain cores, x-rays, or similar non-destructive tests.
  - .2 The Engineer may order a load test and/or analysis as defined by CSA-A23.3, if the non-destructive tests are impractical or inconclusive.
  - .3 Reinforce by additional construction or replace as directed by the Engineer at own expense, concrete judged inadequate by structural analysis or by results of load tests.
  - .4 Pay the cost of testing and/or analysis which is required to demonstrate the adequacy of the structure which does not meet the requirements for strength, or which has been placed before formwork and reinforcing have been inspected and approved by the Engineer.
  - .5 The Engineer may order additional testing at any time, even though the required tests indicate that the strength requirements have been met. In this instance, the Owner will pay for those tests that meet the specified requirements, and the Contractor shall pay for those that do not.

## **2. PRODUCTS**

### **2.1 MATERIALS**

- .1 Materials and resources in accordance with Section 01 35 20 - Sustainable Requirements: Construction.
- .2 Formwork Materials:
  - .1 For concrete without special architectural features, use wood and wood product formwork materials to CAN/CSA-O86, subject to consultant's review.
  - .2 Rigid insulation board: to CAN/ULC-S701.
- .3 Void Form: Biodegradable cardboard form capable of supporting wet concrete. Polystyrene is not acceptable as a void form.
- .4 Form Ties:
  - .1 For concrete not designated 'Architectural', use removable or snap-off metal ties, fixed or adjustable length, free of devices leaving holes larger than 25 mm diameter in concrete surface.
  - .2 For Architectural concrete, use snap ties complete with plastic cones and light grey concrete plugs.
- .5 Form liner:
  - .1 Plywood: Douglas Fir to CSA O121, concrete form grade, with one face overlaid with resin impregnated surface and treated with form release agent.

- .6 Form release agent: non-toxic, biodegradable, low VOC.
- .7 Form stripping agent: colourless mineral oil, non-toxic, biodegradable, low VOC, free of kerosene, with viscosity between 15 to 24 mm<sup>2</sup>/s at 40 degrees C, flashpoint minimum 150 degrees C, open cup.
- .8 Falsework materials: to CSA-S269.1.
- .9 Sealant: to Section 07 90 00 - Joint Sealing.

### **3. EXECUTION**

#### **3.1 FABRICATION AND ERECTION**

- .1 Verify lines, levels, column and wall centres, and arrangement of parts of the structures before proceeding with formwork, and ensure that dimensions agree with drawings.
- .2 Hand trim sides and bottoms and remove loose earth from earth forms before placing concrete.
- .3 Obtain approval for use of earth forms framing openings not indicated on drawings. When using earth forms, hand-trim sides and bottoms and remove loose dirt prior to placing concrete. Increase concrete cover as required.
- .4 The design of all falsework for the temporary support of components is the responsibility of the Contractor, and shall be performed by a qualified Professional Engineer registered in the [Province of Alberta][Northwest Territories].
- .5 Fabricate and erect falsework in accordance with CSA S269.1.
- .6 Camber beams: 6 mm per 3 m of span, unless shown otherwise.
- .7 Camber slabs, purlins: 0.1% of span for all spans over 3m, unless otherwise noted.
- .8 Review method of providing camber with engineer prior to proceeding. Maintain beam depth and slab thickness from cambered surface.
- .9 Apply form release agent on formwork in accordance with the manufacturer's recommendations. Apply prior to placing reinforcing steel, anchoring devices and embedded parts.
- .10 Do not apply form release agent where concrete surfaces are to receive special finishes or applied coverings which are affected by agent. Soak inside surfaces of untreated forms with clean water and keep moist prior to placing concrete.
- .11 Do not re-use formwork with surface defects that will impair the appearance of finished concrete. Do not patch formwork. Meet the requirements of Part 2 of this section when re-using formwork.

- .12 Use 20 mm chamfer strips on external corners of beams, joists, columns, curbs, equipment bases, and other exposed corners.
- .13 Refer to architectural drawings for concrete members requiring architectural exposed finishes.
- .14 Do not place shores and mud sills on frozen ground.
- .15 Provide site drainage to prevent washout of soil supporting mud sills and shores.
- .16 Fabricate and erect formwork in accordance with CAN/CSA-S269.3 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CSA-A23.1/A23.2.
- .17 Construct formwork to maintain concrete tolerances in accordance with CSA-A23.1, clause 10 unless closer tolerances are required for special conditions such as elevators.
- .18 Align form joints and make watertight. Keep form joints to minimum. Obtain approval for location of form joints in exposed work.
- .19 Locate horizontal form joints for exposed columns 2400 mm above finished floor elevation.
- .20 Line forms for following surfaces:
  - .1 Outer face of outside and beams.
  - .2 Secure lining taut to formwork to prevent folds.
  - .3 Pull down lining over edges of formwork panels.
  - .4 Ensure lining is new and not reused material.
  - .5 Ensure lining is dry and free of oil when concrete is poured.
  - .6 Application of form release agents on formwork surface is prohibited where drainage lining is used.
  - .7 If concrete surfaces require cleaning after form removal, use only pressurized water stream so as not to alter concrete's smooth finish.
  - .8 Cost of textile lining is included in price of concrete for corresponding portion of Work.
- .21 Form construction joints in accordance with CSA-A23.1 at locations indicated on the drawings or with the written approval of the Engineer as follows:
  - .1 At centre of span of suspended slabs, beams and joists.
  - .2 In walls directly over centroid of pile or pile cap if applicable.
  - .3 In grade beams at midspan.
  - .4 In walls and columns immediately above and below floor construction joints.
- .22 Construction joints at centre of span of suspended slabs, beams and joists to be adequately doweled and keyed. Maximum concrete placement length for structural slabs to be 35 m unless otherwise detailed. Refer to drawings for construction joint details.

- .23 Construction joints in walls and grade beams maximum 12 m or as detailed.
- .24 Construction joints in slabs on grade maximum 24 m or as detailed.
- .25 Proposed construction joint locations and details to be approved by the Engineer.
- .26 Roughen surface of construction joints to sound concrete, dampen surface and apply an epoxy bonding agent prior to placing fresh concrete.
- .27 Provide continuous waterstop at all construction joints in water retaining structures and structures with high ground water level to 1000 mm above the water level and not less than the locations noted on the drawings.

### **3.2 FORMING OF ARCHITECTURAL AND EXPOSED CONCRETE**

- .1 The intent of this section is to ensure the formwork is of a high quality to result in exposed concrete surfaces free of unsightly cold joints, blemishes, bugholes, honeycombing and cracking. Acceptable symmetrical joint patterns are mandatory.
- .2 Formwork to be in accordance with CSA-A23.1.
- .3 Allow Engineer to inspect and approve each section of formwork prior to placing reinforcement.
- .4 Control joint and placement break spacings outlined on structural drawings are maximum allowable. More frequent spacings will likely be required to conform to architectural requirements. Joint pattern not necessarily based on using standard or maximum permissible spacing of ties.
- .5 All horizontal and vertical joints are to result in a satisfactory symmetrical pattern approved in advance of forming by the Engineer.
- .6 Horizontal joints are to extend on all sides of a given space or spaces at the same elevation unless otherwise detailed.
- .7 Allow for horizontal joints at the top of all openings, and extend as required unless otherwise detailed.
- .8 Allow for vertical joints each side of all openings, and extend to the underside of slabs or deck unless otherwise detailed.
- .9 Horizontal reglets to be placed on both sides of all placement breaks in walls, railings, beams and/or slabs.
- .10 All V-joints or reglets in walls and railings to also extend over top of the wall or railing.
- .11 Caulk or otherwise seal all form joints including corners to prevent bleeding of fines.

- .12 Provide V-joints and reglets to forms at all vertical and horizontal placement breaks and as noted or detailed. Caulk V-joint and reglet formwork to prevent bleeding of fines from concrete.
- .13 Replace damaged forms and forms with poor surfaces with new material as directed by the Engineer.
- .14 Chamfer all exposed edges and corners.
- .15 Fill all exterior V-joints and reglets in walls below grade or where waterproofing is specified with an approved cementitious waterproofing or other approved waterproofing material.
- .16 Line forms for following surfaces:
  - .1 Outer face of outside and beams.
  - .2 Soffit of girders and underside of bridge decks if exposed.
  - .3 Exposed faces of abutments, wingwalls, piers and pylons: do not stagger joints of form lining material and align joints to obtain uniform pattern. Secure lining taut to formwork to prevent folds.
  - .4 Pull down lining over edges of formwork panels.
  - .5 Ensure lining is new and not reused material.
  - .6 Ensure lining is dry and free of oil when concrete is poured.
  - .7 Application of form release agents on formwork surface is prohibited where drainage lining is used.
  - .8 If concrete surfaces require cleaning after form removal, use only pressurized water stream so as not to alter concrete's smooth finish.
  - .9 Cost of textile lining is included in price of concrete for corresponding portion of Work.
- .17 Do not place shores and mud sills on frozen ground.
- .18 Provide site drainage to prevent washout of soil supporting mud sills and shores.
- .19 Fabricate and erect formwork in accordance with CAN/CSA-S269.3 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CSA-A23.1/A23.2.
- .20 When slip forming and flying forms are used, submit details as indicated in Part 1 – SUBMITTALS.

### **3.3 CLEANING FORMS**

- .1 Clean formwork in accordance with CSA-A23.1/A23.2, before placing concrete.

- .2 Clean forms as erection proceeds to remove foreign matter. Remove cuttings, shavings and debris from within forms. Flush completely with water or compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports. Do not use water to clean forms where hydrophyllic type water stops are specified.
- .3 During cold weather, remove ice and snow from within forms. Do not use de-icing salts. Do not use water to clean out completed forms unless formwork and concrete construction proceed within a heated enclosure. Use compressed air or other means to remove foreign matter.
- .4 Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain. Close temporary ports or openings with tight-fitting panels, flush with inside of forms, neatly fitted so that joints will not be apparent in exposed concrete surfaces.

### **3.4 INSERTS/EMBEDDED PARTS/OPENINGS**

- .1 Provide formed openings/chases or slots where required for pipes, conduits, sleeves and other work to be embedded in and passing through concrete members.
- .2 Refer to architectural, mechanical and electrical drawings for sleeves and openings required through structural components. These are not to reduce the structural capacity. Locations and sizes not shown on the structural drawings are to be approved in writing by the Engineer.
- .3 Maximum size of electrical conduit in structural slabs is 1/5 of solid portion of the slab thickness, and where more than two are adjacent to each other, they are to be spaced 100 mm apart. Conduit is to be placed in the middle third of the slab unless otherwise specified or approved in writing by the Engineer.
- .4 Provide recesses in top of foundation walls at all doors and openings to allow slab to bear on walls.
- .5 Accurately locate and set in place all items that are to be cast directly in concrete.
- .6 Coordinate work of other sections and cooperate with the trade involved in forming and/or setting openings, slots, recesses, chases, sleeves, bolts, anchors and other inserts. Do not perform work unless specifically indicated on drawings or approved prior to installation.
- .7 Do not place anchor bolts, sleeves and inserts into freshly placed concrete. Tie firmly into place prior to placing concrete.
- .8 Ensure that anchors and inserts will not protrude beyond surfaces designated to receive applied finishes, including paint.



- .9 Install all concrete accessories in accordance with drawings and manufacturer's recommendations, straight, level and plumb. Ensure adequate support to prevent movement during concrete placement.
- .10 Obtain Engineer's permission before forming openings, not indicated on the drawings, in concrete beams or columns.
- .11 Install waterstops continuous without displacing reinforcement. Do not nail through waterstops. Heat seal all joints watertight.
- .12 Wire all waterstop to reinforcing to prevent folding during concrete placement.

### **3.5 REMOVAL AND RESHORING**

- .1 Comply with CSA-S269.1 for dismantling all falsework.
- .2 Leave formwork in place for following minimum periods of time after placing concrete.
  - .1 3 days for walls and sides of beams.
  - .2 3 days for columns.
  - .3 14 days for beam soffits, slabs, decks and other structural member, or 2 days when replaced immediately with adequate shoring to standard specified for falsework.
  - .4 2 days for footings and abutments.
- .3 Remove formwork when concrete has reached 75% of its design strength or minimum period noted above, whichever comes later, and replace immediately with adequate reshoring.
- .4 Provide necessary reshoring of members where early removal of forms may be required or where members may be subjected to additional loads during construction as required.
- .5 Space reshoring in each principal direction at not more than 3000mm apart.
- .6 Re-use formwork and falsework subjected to requirements of CSA-A23.1/A23.2.
- .7 Arrange forms to allow removal without removal of principal shores where these are required to remain in place.
- .8 Remove formwork progressively and in accordance with code requirements so that no shock loads or unbalanced loads are imposed on structure.
- .9 Loosen forms carefully. Do not damage concrete by wedging pry bars, hammers or tools against concrete surfaces.

### **3.6 VOID FORM**

- .1 Ensure void form is in place and not damaged prior to placing concrete (top protection may be required – by contractor).

- .2 Install void space protection prior to backfilling walls and grade beams (required for biodegradable void form only).
- .3 Install void form top protection for structural slabs on grade.

**END OF SECTION**

## **1. GENERAL**

### **1.1 RELATED SECTIONS**

- .1 Section 03 10 00 – Concrete Forming and Accessories
- .2 Section 03 30 00 – Cast-in-Place Concrete
- .3 Section 01 33 00 – Submittal Procedures

### **1.2 GENERAL CONDITIONS**

- .1 The Contractor shall read and be governed by the General Conditions, General Instructions, Instructions to Bidders, Addenda, Form of Tender and Agreement of the complete specifications for this project.
- .2 The complete work under this trade shall be governed by the dictates of good practice in all details of materials and methods, even if not minutely specified. The work shall be properly coordinated with the requirements of other units of work specified in other sections.

### **1.3 STANDARDS**

- .1 Perform cast-in-place concrete work in accordance with the following standards, except where specified otherwise. All standards to be latest issue at time of tender.
  - .1 Concrete Materials and Methods of Concrete Construction: CSA A23.1-most current version.
  - .2 Methods of Test for Concrete: CSA A23.2-most current version.
  - .3 Design of Concrete Structures for Buildings: CSA A23.3-most current version.
  - .4 American Society for Testing and Materials: ASTM – where noted
  - .5 Erection, Maintenance and Removal of Formwork: Conform to applicable safety regulations.
  - .6 American Concrete Institute Detailing Manual: ACI SP-66-most current version.
  - .7 Reinforcing Steel Institute of Canada (RSIC) Reinforcing Steel Manual of Standard Practice: RSIC-most current version.
  - .8 Concrete Reinforcing Steel Institute (CRSI) where noted.
  - .9 General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel: CSA-G40.20/G40.21-most current version.
  - .10 Hot Dip Galvanizing of Irregularly Shaped Articles, A National Standard of Canada: CAN/CSA-G164-most current version.
  - .11 Welding of Reinforcing Bars in Reinforced Concrete Construction: CSA W186-most current version.

#### **1.4 SHOP DRAWINGS**

- .1 Submit shop drawings, including placing drawings for reinforcing steel and welded steel wire fabric in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Support and placing details of reinforcing to ACI SP-66 and RSIC Manual of Standard Practice.
- .3 Submit shop drawings including placing of reinforcement and indicate:
  - .1 Bar bending details.
  - .2 Lists.
  - .3 Quantities of reinforcement.
  - .4 Sizes, spacings, locations of reinforcement and mechanical splices if approved Engineer, with identifying code marks to permit correct placement without reference to structural drawings.
  - .5 Indicate sizes, spacings and locations of chairs, spacers and hangers.
- .4 Detail lap lengths and bar development lengths to CSA –A23.3, unless otherwise indicated.
- .5 Use large scale details for areas of congested reinforcement.
- .6 Review of the shop drawings by the Engineer is intended to assist the Contractor and does not relieve the Contractor of responsibility for the completeness and accuracy of the work and its conformance with the contract drawings and specifications.
- .7 Fabrication that commences prior to shop drawing review by the Engineer is at the risk of the Contractor.
- .8 When Chromate solution is used as replacement for galvanizing non-prestressed reinforcement, provide product description for review by Engineer prior to use.

#### **1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Store manage hazardous materials in accordance with Section 01 35 20 – Sustainable Requirements: Construction.
- .2 Deliver all materials to the site in bundles easily identified and properly marked.
- .3 Store and handle all material on site in a manner to prevent damage and contamination.
- .4 Do not straighten or re-bend any reinforcement.
- .5 Do not use any reinforcement that has been kinked or bent on site.
- .6 Waste Management and Disposal:
  - .1 Separate waste materials for –reuse and recycling in accordance with Section 01 35 41 – Construction/Demolition Waste Management and Disposal.
  - .2 Place materials defined as hazardous or toxic in designated containers.

## 1.6 ACCEPTABILITY

- .1 Failure to comply with the requirements which control strength will result in the structure being considered potentially deficient.
- .2 A structure will be considered potentially deficient when:
  - .1 Concrete strength not as specified.
  - .2 Reinforcing steel size, quantity, position, quality, or arrangement not as specified or detailed.
  - .3 Improper curing.
  - .4 Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.
  - .5 Mechanical injury from fire, construction overload, or premature removal of forms.
  - .6 Poor workmanship.
  - .7 Failure to notify the Consultant to inspect formwork and reinforcement before placing concrete.
  - .8 Concrete which differs from the required dimensions.
- .3 Strength Evaluation Tests and Analysis
  - .1 The Engineer may order an independent testing firm to obtain cores, x-rays, or similar non-destructive tests.
  - .2 The Engineer may order a load test and/or analysis as defined by CSA CAN3-A23.3-94, if the non-destructive tests are impractical or inconclusive.
  - .3 Reinforce by additional construction or replace as directed by the Engineer at own expense, concrete judged inadequate by structural analysis or by results of load tests.
  - .4 Pay the cost of testing and/or analysis which is required to demonstrate the adequacy of the structure which does not meet the requirements for strength, or which has been placed before formwork and reinforcing have been inspected and approved by the Engineer.
  - .5 The Engineer may order additional testing at any time, even though the required tests indicate that the strength requirements have been met. In this instance, the Owner will pay for those tests that meet the specified requirements, and the Contractor shall pay for those that do not.

## 2. PRODUCTS

### 2.1 REINFORCING MATERIALS

- .1 Materials and resources in accordance with Section 01 35 20 - Sustainable Requirements: Construction.
- .2 Reinforcing steel for straight reinforcing bars only: To CAN/CSA-G30.18.
- .3 Reinforcing steel for welded and bent reinforcing bars: To CAN/CSA-G30.18, 400W MPa yield grade special low alloy deformed billet steel. The equivalent carbon content is not to exceed 0.5.

- .4 Reinforcing steel: weldable low alloy steel deformed bars to CAN/CSA-G30.18.
- .5 Cold-drawn annealed steel wire ties: to ASTM A497/A497M.
- .6 Chairs, bolsters, bar supports, spacers to meet requirements of CSA-A23.1/A23.2: Adequate for strength and support of reinforcing. Where concrete is exposed to view, exposed to elements or where rust is possible; use plastic or non-corrosive material, or precast concrete made from concrete of equal strength and durability of concrete to be placed. Chairs used are not to result in voids or unacceptable appearance in exposed concrete surfaces.
- .7 Slab on grade chairs and bar supports: Precast concrete, plastic chairs, or subject to approval concrete masonry block or brick of correct height. Metal pipe, stone or wood are not acceptable. Chairs shall be compatible with void form where applicable.
- .8 Welded steel wire fabric: to ASTM A185/A185M.
- .9 Welded deformed steel wire fabric: to ASTM A497/A497M.
- .10 Patching material for epoxy coated reinforcement: Use approved compatible epoxy coating material applied in strict accordance with the manufacturer's instructions.
- .11 Galvanizing of non-prestressed reinforcement: to CAN/CSA-G164, minimum zinc coating 610 g/m<sup>2</sup>.
  - .1 Protect galvanized reinforcing steel with chromate treatment to prevent reaction with Portland cement paste.
  - .2 If chromate treatment is carried out immediately after galvanizing, soak steel in aqueous solution containing minimum 0.2% by weight sodium dichromate or 0.2% chromic acid.
    - .1 Temperature of solution equal to or greater than 32 degrees and galvanized steels immersed for minimum 20 seconds.
  - .3 If galvanized steels are at ambient temperature, add sulphuric acid as bonding agent at concentration of 0.5% to 1%.
    - .1 In this case, no restriction applies to temperature of solution.
  - .4 Chromate solution sold for this purpose may replace solution described above, provided it is of equivalent effectiveness.
    - .1 Provide product description as described in PART 1 – SUBMITTALS
- .12 Mechanical splices: subject to approval of Engineer.
- .13 Plain round bars: to CSA-G40.20/G40.21.

## 2.2 FABRICATION

- .1 Fabricate reinforcing steel in accordance with CSA-A23.1/A23.2 and Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Canada.
- .2 Verify dimensions of existing work prior to commencing fabrication.
- .3 Verify all drawing dimensions and conditions prior to commencing fabrication.
- .4 Bend all reinforcement cold unless otherwise approved by the Engineer.
- .5 Obtain Engineer's Consultant's approval for locations of reinforcement splices other than those shown on placing drawings.

- .6 Upon approval of Engineer, weld reinforcement in accordance with CSA W186.
- .7 Dowel columns and walls into foundations using same reinforcing as in column and wall, unless noted otherwise on the drawings.
- .8 Provide horizontal “L” shaped corner bars of same cross-section and spacing as horizontal bars around wall and grade beam corners.
- .9 Provide all additional support bars as required to support all main reinforcement indicated.
- .10 Provide 10M stirrup support bars in hooks or corners of beam stirrups, unless noted otherwise on drawings.
- .11 Provide 10M “U” spacers at 3 m on centre horizontally and 1.5 m on centre vertically to hold wall reinforcing mats in position.
- .12 Locate reinforcing splices not indicated on drawings at points of minimum stress. Location of splices is to be approved by the Engineer.
- .13 Provide four extra 15M diagonal corner bars around holes larger than 100 mm in floor slabs and walls. Corner bars shall be 1.5 times length of shortest side of hole or minimum 750 mm long.
- .14 Provide one 15M bar each face for holes larger than 1000 mm in walls.
- .15 Cover electrical conduit, ductwork or piping buried in slabs with 600 mm wide strip of 100 x 100 x P18 x P18 welded wire fabric. If principle slab reinforcement is placed above conduit, then place 600 mm strip under conduit. Position of reinforcing steel takes precedence over conduit, ductwork or piping.
- .16 Use splices only where shown on the drawings, or as approved by the Engineer. For splices not shown on the drawings, use Class “C” splices for reinforcement bars. All horizontal bars in walls shall be considered as top reinforcement.
- .17 Lap adjacent sheets of welded steel wire fabric to provide an overlap of at least one cross wire spacing plus 50 mm.
- .18 Ship bundles of bar reinforcement, clearly identified in accordance with bar bending details and lists.

### **3. EXECUTION**

#### **3.1 PREPARATION**

- .1 Galvanizing to include chromate treatment.
  - .1 Duration of treatment to be 1 hour per 25 mm of bar diameter.
- .2 Conduct bending tests to verify galvanized bar fragility in accordance with ASTM A143/A143M.

#### **3.2 FIELD BENDING**

- .1 Do not field bend or field weld reinforcement except where indicated or authorized by Engineer.

- .2 When field bending is authorized, bend without heat, applying slow and steady pressure.
- .3 Replace bars, which develop cracks or splits.

### **3.3 PLACING REINFORCING STEEL**

- .1 Place reinforcing steel as indicated on placing drawings and in accordance with CSA-A23.1/A23.2.
- .2 Use plain round bars as slip dowels in concrete.
  - .1 Paint portion of dowel intended to move within hardened concrete with one coat of asphalt paint.
  - .2 When paint is dry, apply thick even film of mineral lubricating grease.
- .3 Prior to placing concrete, obtain Engineer's approval of reinforcing material and placement.
- .4 Ensure cover to reinforcement is maintained during concrete pour.
- .5 Place reinforcement within a tolerance of 6 mm for slab steel, and 12 mm for other steel. Bends and end of bars shall be within 50 mm of specified location.
- .6 Provide minimum concrete cover to reinforcing steel in accordance with CSA A23.1, except where indicated otherwise on the drawings.
- .7 Reinforce around openings as noted on structural drawings.
- .8 Reinforcement is to be placed on purpose made supports. A reinforcement technician is to be on site during the placement of concrete floor slabs, and is to re-chair and/or adjust supports for reinforcement as required during the placement of concrete.
- .9 After initial fabrication, reinforcing steel shall not be re-bent or straightened unless so indicated on drawings.
- .10 Welding of reinforcement is not permitted.
- .11 Stagger splices in adjacent bars by at least 1500 mm, except where approved otherwise.
- .12 All dowel reinforcement is to be tied in place prior to placing of concrete. Inserting dowels after concrete is placed is not acceptable.
- .13 Obtain written approval from the Engineer prior to cutting of reinforcing to accommodate openings, or embedded items or to accommodate precast concrete, structural steel or timber connections. Allow for additional splice material which may be required to reinforce these cut bars as directed by the Engineer.
- .14 Where a structural concrete member is required to have a fire-resistance rating as identified on the drawings or in the specifications, provide minimum concrete cover to reinforcing steel in accordance with the Supplement to the National Building Code, "Fire Performance Ratings".
- .15 Ensure reinforcing is clean, free of loose scale, dirt, oil, rust and other foreign coatings.

**END OF SECTION**



## **1. GENERAL**

### **1.1 WORK INSTALLED BUT SUPPLIED UNDER OTHER SECTIONS**

- .1 Install following materials specified to be supplied under other Sections of these project specifications:
  - .1 Fabricated components, anchor bolts, bearing plates, sleeves and other inserts to be built into concrete.

### **1.2 QUALITY ASSURANCE**

- .1 Cast-in-place concrete to conform to CSA-A23.1
- .2 Testing shall conform to CSA-A23.2
- .3 These standards shall be available in Contractor's site office for use of Contractor and Engineer.

### **1.3 REFERENCE DOCUMENTS**

- .1 Perform cast-in-place concrete work in accordance with the following standards except where specified otherwise.
- .2 ASTM C109/C109M-most current version, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars Using 2-in. of 50-mm Cube Specimens.
- .3 ASTM C295- most current version, Standard Guide for Petrographic Examination of Aggregates for Concrete.
- .4 ASTM C309-most current version, Standard Specification for Liquid Membrane – Forming Compounds for Curing Concrete.
- .5 ASTM C330-most current version, Standard Specification for Lightweight Aggregates for Structural Concrete.
- .6 CAN/CGSB-51.34-M most current version, Vapour Barrier, Polyethylene Sheet for Use in Building Construction.
- .7 CAN/CSA-A3000- most current version, Cementitious Materials Compendium (Consists of A5-98, A8-98, A23.5-98, A362-98, A363-98, A456.1-98, A456.2-98, A456.3-98).
- .8 CAN/CSA-A23.1- most current version, Concrete Materials and Methods of Concrete Construction.
- .9 CAN/CSA-A23.2- most current version, Methods of Test for Concrete.
- .10 CAN/CSA-A23.1- most current version, Design of Concrete Structures.

- .11 CAN/CSA G30.5- most current version, Welded Steel Wire Fabric for Concrete Reinforcement.
- .12 CAN/CSA G30.14-M most current version, Deformed Steel Wire for Concrete Reinforcement.
- .13 CAN/CSA G30.15-M most current version, Welded Deformed Steel Wire Fabric for Concrete Reinforcement.
- .15 CAN/CSA-S269.3, Concrete Formwork.
- .16 CAN/CSA W186-M most current version, Welding of Reinforcing Bars in Concrete Construction.
- .17 American Concrete Institute (ACI) Detailing Manual - SP-66, ACI 315, most current versions.
- .18 Concrete Reinforcing Steel Institute (CRSI) – Reinforcing Steel Manual of Standard Practice.

#### **1.4 INSPECTION AND TESTING**

- .1 Concrete work may be tested to CAN/CSA A23.2 or as specified herein by a testing firm retained by the Owner.
- .2 Submit the following:
  - .1 Proposed concrete mix design.
  - .2 Results of petrographic examination of aggregates conforming to ASTM C295 representative of aggregates to be supplied for project, when requested by Engineer.
  - .3 Samples of fine and coarse aggregate, when requested by Engineer.
- .3 Provide casual labour for the purpose of obtaining and handling sample materials.
- .4 Advise testing firm in advance of concrete placement.
- .5 Provide and maintain facilities at the site for storage of concrete test cylinders for the first 24 hours.
- .6 Provide copies of mill test reports of cement and reinforcing steel as required.
- .7 Secure sufficient cylinders for testing to ensure concrete quality control.
- .8 Provide at least one ASTM cube test on grout used under base plates and machinery.
- .9 Conduct core tests when required.

- .10 Obtain Consultant's approval of reinforcing before placement of concrete commences. Refer to Section 3 for notification requirements.
- .11 Concrete shall not be placed until the shaft has been inspected and approved by the Engineer.
- .12 The contractor shall have available suitable light for the inspection of each bore throughout its entire length.
- .13 All improperly set sleeving and shaft shall be corrected to the satisfaction of the Engineer.
- .14 The testing firm may perform the following tests:
  - .1 Take three test cylinders from each 60 m<sup>3</sup> of concrete, or fraction thereof, of each type of concrete placed in any one day.
  - .2 Take samples of concrete mix close to the point of final deposit in the form. Contractor is required to provide suitable access to the Work for obtaining samples.
  - .3 Moist cure and test one cylinder in 7 days and moist cure and test the remaining two cylinders in 28 days.
  - .4 Take one additional test cylinder when the temperature is likely to fall below 0°C within 48 hours after placing and no provisions have been made to heat the concrete to greater than 10°C. Cure the additional test cylinder on the job-site under same conditions as concrete it represents and test in 7 days.
  - .5 Make at least one slump test and one entrained air test for each set of test cylinders taken.
  - .6 Monitor Temperature of concrete.
  - .7 Results of field tests will be reported immediately to the Contractor by the field representative of the testing firm. These results do not imply approval or disapproval of the work, but are for the Contractor's information. The Engineer will determine acceptability of the work.
  - .8 Results of concrete tests will be forwarded to the Engineer and to the Contractor. Included with the results will be the following information: Name of Project, Date of Sampling, Name of Supplier, Delivery Truck Number, Identification of Sampling and Testing Technician and exact location in the structure of the concrete sampled.
  - .9 Testing firm personnel are not authorized to revoke, relax, enlarge or release any requirements of the specification, nor to accept or reject any portion of the work.

## **1.5 SHOP DRAWINGS**

- .1 Submit Shop Drawings, including placing drawings for reinforcing steel and welded steel wire fabric in accordance with Division 1.
- .2 Identify support and placing details of reinforcing conforming to ACI 315 and CRSI.

## **1.6 ACCEPTABILITY**

- .1 Failure to comply with the requirements which control strength and durability will result in the structure being considered potentially deficient.
- .2 A structure will be considered potentially deficient when:
  - .1 Concrete is not as specified in Concrete Mix Schedule in this Section.
  - .2 Reinforcing steel size, quantity, position, quality or arrangement are not as specified or detailed.
  - .3 Improper curing methods or materials are used.
  - .4 Inadequate protection of concrete is provided from extremes of temperature during early stages of hardening and strength development.
  - .5 Mechanical injury occurs from fire, construction overload or premature removal of forms.
  - .6 Poor workmanship is evident.
  - .7 Placed concrete differs from the required dimensions.
  - .8 The Engineer has not reviewed formwork and reinforcement before concrete placement.
- .3 Strength evaluation tests and analysis.
  - .1 The Engineer may order an independent testing firm to obtain cores, x-rays, or similar non-destructive tests.
  - .2 The Engineer may order a load test and/or analysis as defined by CSA-A23.3 Section 20, if the non-destructive tests are impractical or inconclusive.
  - .3 The Contractor shall reinforce by additional construction or replace, as directed by the Engineer at own expense, concrete judged inadequate by structural analysis or by results of load tests.
  - .4 The Contractor shall pay the cost of testing and/or analysis which is required to demonstrate the adequacy of the structure, which does not meet the requirements for strength, or which has been placed before formwork and reinforcing have been inspected and approved by the Engineer.

- .5 The Engineer may order additional testing at any time even though the required tests indicate that the strength requirements have been met. In this instance the Engineer will pay for those tests that meet the specified requirements and the Contractor shall pay for those that do not.
- .4 Concrete not conforming to the lines, detail, strength and grade specified herein or as shown on drawings shall be modified or replaced at the Contractor's expense, to the satisfaction of the Engineer.

## **2. PRODUCTS**

### **2.1 CONCRETE MATERIALS**

- .1 Portland Cement: to CAN/CSA-A3000.
- .2 Aggregates: to CSA-A23.1 and as follows:
  - .1 Ironstone content of aggregates in exposed interior or exterior concrete subject to intermittent or continuous wetting not to exceed the following, when tested to ASTM C295:
    - .1 Coarse Aggregate: maximum 1% by mass.
    - .2 Fine Aggregate Retained on 2.5 mm Sieve: maximum 1.5% by mass.
- .3 Water: potable, to CSA-A23.1.
- .4 Lightweight Aggregates For Structural Lightweight Concrete: to ASTM C330.
- .5 Air Entraining Admixtures: to CSA-A23.1
- .6 Chemical Admixtures: to CSA-A23.1 and as approved by the Engineer. Calcium chloride will not be permitted.
- .7 Supplementary Cementing Materials: to CAN/CSA-A3000.

### **2.2 CONCRETE ACCESSORIES**

- .1 Liquid Membrane Forming Curing Compound: to CSA-A23.1.
- .2 Grout: Non-shrink premixed types with a minimum of 30 MPa compressive strength at 24 hours.
- .3 Concrete Topping: Not applicable.

- .4 Bonding Agent: High polymer resin emulsion mixed with cement mortar or grout to form a water resistant adhesive bond.
- .5 Control Joint Sealant: JT filler
- .6 Waterstops: Not applicable.
- .7 Dampproof Membrane: 150 micrometre polyethylene film to CAN/CGSB-51.34.

### **2.3 REINFORCING MATERIALS**

- .1 Reinforcing Steel: to CSA G30.18 400W MPa yield grade deformed billet steel bars except for beam stirrups and column ties use only 400W MPa yield grade or 400 MPa yield grade to CSA G30.18.
- .2 Reinforcing Steel: to CSA G30.18, 400W MPa yield grade special low alloy deformed billet steel for welding and/or bending.
- .3 Welded Steel Wire Fabric: to CSA G30.5.
- .4 Chairs, Bolsters, Bar Supports, Spacers: to CSA A23.1, adequate for strength and support of reinforcing. Non-corrosive and non-staining where specified.

### **2.4 FORMWORK MATERIALS**

- .1 Formwork: design to CSA A23.1, CSA S269.1, ACI 347, and all applicable construction safety regulations for the place of work. Formwork to be free of bends, dents and residual concrete, well matched, tight fitting and adequately stiffened to support concrete weight without deflection detrimental to appearance of finished concrete surfaces.
- .2 Form Ties:
  - .1 Concrete without special architectural features: use removable or snap-off metal ties, fixed or adjustable length, free of devices leaving holes larger than 25 mm diameter in concrete surface. Non-corrosive and non-staining at surfaces where concrete will be exposed.
- .3 Form Oil: non-staining and non-volatile type.
- .4 Void Forms: low density bead board; structurally sufficient to support weight of wet concrete mix until initial set; thickness noted on Drawings.
- .5 Falsework materials: to CSA-S269.1.
- .6 Steel sleeving shall be used to temporarily line the shaft to prevent bulging or caving of the walls prior to concrete placement. Sleeving shall be designed and constructed to resist all forces which may tend to distort it.

### **2.5 MIX**

- .1 Supply concrete mix proportioned to produce concrete specified in Concrete Mix Schedule.
- .2 For requirements not specified in Schedule, conform to CSA A23.1.
- .3 Use of admixtures, other than air-entraining admixtures, are not permitted without prior approval of the Engineer.

## **2.6 FABRICATION OF CONCRETE REINFORCEMENT**

- .1 Fabricate reinforcing steel in accordance with CSA A23.1, ACI 315 and the (CRSI) Reinforcing Steel Manual of Standard Practice.
- .2 Obtain Engineer's approval for locations of reinforcing splices other than those shown on placing drawings.
- .3 Upon approval of Engineer, weld reinforcing steel in accordance with CSA W186.
- .4 For Hooks, Bends, Laps and Similar Details conform to ACI Detailing Manual SP-66.
- .5 Dowel columns and walls into foundations using same reinforcing as in column and wall unless noted otherwise in the Contract Documents.
- .6 Provide horizontal "L" shaped corner bars of same cross section and spacing as horizontal bars or welded wire fabric around wall and grade beam corners.
- .7 Provide 10M stirrup support bars in hooks or corners of beam stirrups unless noted otherwise in the Contract Documents.
- .5 Provide 4 extra 15M diagonal corner bars around holes larger than 100 mm in floor slabs and walls. Provide corner bars 1.5 times the length of shortest side of hole or minimum 750 mm long.
- .9 Provide one 15M bar each face for holes larger than 1000 mm in walls.
- .10 Cover electrical conduit, ductwork or piping buried in slabs with 600 mm wide strip of 102 x 102 x MW13.3 x MW13.3 welded wire fabric. When principal slab reinforcement is placed above conduit then place 600 mm strip under conduit. Position of reinforcing steel takes precedence over conduit, ductwork or piping.

## **3. EXECUTION**

### **3.1 PREPARATION**

- .1 Obtain Engineer's approval before placing concrete. Provide Engineer and testing agency 2 working days notice prior to placing concrete.
- .2 Coordinate placement of waterstops, inserts and joint devices with erection of concrete formwork and formwork accessories.

- .3 Pumping of concrete is permitted only after approval of equipment, mix, and additives.
- .4 Ensure reinforcement and inserts are not disturbed during concrete placement.
- .5 Prior to placing concrete obtain Engineer's review of method for protection of concrete during placing and curing [in adverse weather] and in conformance with CSA-A23.1.
- .6 If the Engineer finds any portion of the preparation is not in conformance with the Contract Documents and/or good workmanship, the Contractor shall rectify the deficiency and no concreting shall be done until the deficiency is rectified.

### **3.2 FORMWORK**

- .1 Fabricate and erect formwork in accordance with CAN/CSA-S269.3 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CAN/CSA-A23.1.
- .2 Apply form release agent in accordance with manufacturer's recommendations, prior to placing reinforcing steel, anchoring devices and embedded parts.
- .3 Do not apply form release agent where concrete surfaces are to receive special finishes or applied coverings which are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces moist prior to placing concrete.
- .4 Fabricate and erect falsework in accordance with CSA-S269.1.
- .5 Do not place shores and mud sills (if required) on frozen ground.
- .6 Provide site drainage to prevent washout of soil supporting shores and mudsills.
- .7 Align form joints and make watertight. Keep form joints to a minimum.
- .8 Use 20 mm chamfer strips on external corners and 20 mm fillets at interior corners of concrete members, unless specified otherwise.
- .9 Form chases, slots, openings, drips, recesses, expansion and control joints as indicated.
- .10 Build in anchors, sleeves, and other inserts required to accommodate work specified in other sections. Ensure that anchors and inserts will not protrude beyond surfaces designated to receive applied finishes, including paint.
- .11 Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings in bottom of forms to allow flushing water to drain.
- .12 Steel sleeving shall be withdrawn as the concrete is placed in the shaft. Sleeving shall extend at least 1.0 metres below the top of the freshly deposited concrete at all times.



- .13 Close temporary ports or openings with tight fitting panels, flush with inside face of forms, neatly fitted so no leakage occurs and to provide uniform surface on exposed concrete.

### **3.3 INSERTS, EMBEDDED ITEMS, AND OPENINGS**

- .1 Provide formed openings where required for pipes, conduits, sleeves or other work to be embedded in and passing through concrete members. Obtain Engineer's approval before framing openings not shown on drawings.
- .2 No sleeves, ducts, pipes or other openings shall pass through joists, beams, column capitals or columns, except where indicated on Structural Drawings or approved by the Engineer.
- .3 Do not cut, bend, eliminate or displace reinforcement to accommodate sleeves, ducts, pipes and embedded items. If these cannot be located as specified, obtain approval of modifications from the Engineer before placing of concrete.
- .4 Check locations and sizes of sleeves and openings shown on drawings. Accurately locate and set in place items which are to be cast directly into concrete. Coordinate installation of concrete accessories.
- .5 Set special inserts for strength testing as indicated and as required by non-destructive method of testing concrete.
- .6 Conduit and pipe embedded in concrete shall:
  - .1 Not displace more than 4% of the cross sectional area of a column, including the area of concrete displaced by the bending of the conduit, or the exit path of the conduit out of the column.
  - .2 Not exceed one-third of the solid portion of the slab thickness.
  - .3 Not be spaced closer than three diameters on centre.
  - .4 Have a minimum concrete cover of 25 mm.

### **3.4 ANCHOR BOLTS AND BASE PLATES**

- .1 Set anchor bolts to templates under supervision of appropriate trade prior to placing concrete. "Wet placement" of anchor bolts is not acceptable.
- .2 Grout under base plates and machinery using procedures in accordance with manufacturer's recommendations which result in 100% contact over grouted area.

### **3.5 WATERSTOPS**

- .1 Not applicable.

### **3.6 FORM REMOVAL**

- .1 Contractor to provide proposed form removal schedule.
- .2 Leave formwork in place for following minimum periods of time after placing concrete [or as otherwise directed by the Engineer for specific locations].
  - .1 Seven days for walls, sides of beams, and columns, **or** three days if a strength test indicates that 60% of the 28 day compressive design strength is achieved.
  - .2 Fourteen days for beam soffits, slabs, decks and other structural members, or seven days when replaced immediately with adequate shoring to standard specified for falsework **and** a seven day strength test indicates that 70% of the 28 day compressive design strength is achieved.
  - .3 Two days for footings and abutments.
  - .4 Where forms are providing curing protection, they shall be left in place a minimum of seven days.
- .3 Remove falsework progressively, in accordance with CSA 269.1 and ensure that no shock loads or unbalanced loads are imposed on the structure.
- .4 Loosen forms carefully. Do not wedge pry bars, hammers or tools against finish concrete surfaces scheduled for exposure to view.
- .5 Do not place load upon or against new concrete until authorized by the Engineer.
- .6 Submit backfilling schedule to the Engineer. Backfilling against the structure should not start until the following time and must be authorized by the Engineer.

Foundation walls retaining  
earth on one side

The greater of 7 days or when  
70% of 28-day design strength is reached

Cantilever Walls

The greater of 28 days or when  
28-day design strength is reached

Foundation walls retaining  
earth on both sides

The greater of 3 days or when  
60% of 28-day design strength is reached

### 3.7 RESHORING

- .1 Prepare a schedule of reshoring and submit to Engineer for review.
- .2 Reshore structural members where required due to design requirements or construction conditions. Remove load supporting forms only when concrete has attained 80 percent of required 28-day strength and reshore.

- .3 Install reshoring as required to permit progressive construction. Provide reshoring under the previously constructed concrete floors for two levels below the floor being constructed.
- .4 If a concrete floor is supporting shoring for the floor above, forms for the bottom floor shall be left in place not less than 28 days.

### 3.8 PLACING REINFORCING STEEL

- .1 Place reinforcing steel as indicated on reviewed shop drawings and in accordance with CSA A23.1.
- .2 Prior to placing concrete, obtain Engineers approval of reinforcing and placement.
- .3 Ensure cover to reinforcement is maintained during concrete pour.
- .4 Do not field bend or field weld reinforcement, except where indicated in the Contract Documents or as authorized by the Engineer.
- .5 Remove all loose scale, loose rust and other deleterious matter from surfaces of reinforcing.
- .6 Place reinforcement within a tolerance of + or - 6 mm for slab steel and to within + or - 12 mm for other steel. Locate bends and end of bars within 50 mm of specified location.
- .7 Place reinforcing steel to provide concrete cover to the most stringent requirements of either the minimum requirements of CSA A23.1, as indicated elsewhere in the Contract Documents, or as follows:

Item	Cover (mm)
Beam Stirrups	40
Supported Slabs and Joists	20
Column Ties	40
Interior Walls not exposed to weather or backfill	25
Walls Exposed to weather or backfill	50
Footings and concrete formed against earth	75
Slabs on Fill	50

- .8 Where a structural concrete member is required to have a fire resistance rating, provide minimum concrete cover to reinforcing steel in accordance with Appendix B of the Alberta Building Code, except where indicated otherwise in the Contract Documents.
- .9 Provide 10M "U" spacers at 3 m on centre horizontally and 1.5 m on centre vertically to hold wall reinforcing mats in position.
- .10 Provide non-corrosive and non-staining reinforcing steel supports at surfaces where concrete will be exposed.
- .11 Support welded wire mesh and reinforcing steel in slabs on grade, using concrete bricks or high chairs located at maximum 1 m on centre each way.

- .12 Placing reinforcing on or in layers of fresh concrete as the work progresses is not permitted.

### **3.9 PLACING CONCRETE**

- .1 Perform concrete work in accordance with CAN/CSA-A23.1.
- .2 Place concrete as a continuous operation stopping only at construction joints indicated on the drawings or as follows:
  - .1 At center of span of suspended slabs, beams and joists;
  - .2 In walls and columns immediately above or below floor construction;
  - .3 At center of steel beam that supports concrete slab.
- .3 Construction joints at center of span of suspended slabs beams and joists shall be adequately doweled and keyed.
- .4 Place floor slabs on grade as one continuous pour between construction joints indicated on drawings. Control joints for each pour shall be formed by sawing a continuous 25 mm deep slot at 6 m centers each way unless otherwise indicated on drawings. Sawing shall be done as soon as the concrete has sufficiently hardened to prevent raveling of the edges but in no case later than 24 hours after the concrete slab has been placed.
- .5 Isolate slabs on grade from vertical concrete using pre-moulded joint fillers extending from bottom of slab to within 12 mm of slab surface unless otherwise indicated.
- .6 Use winter concreting methods in accordance with CAN/CSA A23.1 when the mean daily temperature falls below 5°C.
- .7 Use procedures noted in CAN/CSA-A23.1 to remove excess bleed water. Ensure surfaces are not damaged.
- .8 Vibrate concrete using the appropriate size equipment as placing proceeds in strict accordance with Clause 19.5 of CSA-A23.1. Check frequency and amplitude of vibrations prior to use. Provide additional standby vibrators in the event of equipment failure. The concrete shall be vibrated throughout the entire length of the pile.
- .9 Do not place concrete if carbon monoxide producing equipment has been in operation in the building during the 12 hours preceding the pour. This equipment shall not be used during placing, or for 24 hours after placing. During placing and curing concrete, surfaces shall be protected by formwork or by an impermeable membrane from direct exposure to carbon monoxide, combustion gases or drying from heaters.
- .10 Honeycomb or embedded debris in concrete is not acceptable. Honeycombed areas discovered after the removal of the forms shall not be repaired until inspected by the Engineer. Where honeycombing has occurred, the corrective method of treatment shall be carried out as directed by the Engineer.

- .11 Remove and replace concrete deemed to be defective by the Engineer.
- .12 Revise, re-seat and correct improperly positioned reinforcing, immediately before placing concrete.
- .13 Maintain accurate records of poured concrete items to indicate date, location of pour, quality of concrete, ambient air temperature and test samples taken.
- .14 Clean previously placed concrete with steel brush. Use acid if necessary and permitted by bonding agent manufacturer. Mix and brush on bonding agent in accordance with manufacturer's instructions.
- .15 Concrete shall not have a free fall of more than 2.0 meters and shall be placed so that the aggregates do not separate or segregate.
- .16 Concrete shall be placed to the elevations as shown on the Drawings. Laitance on the top of the pile shall be removed before placing the concrete pad.
- .17 The shaft shall be free of water prior to placing concrete. Concrete shall not be placed in or through water unless authorized by the Engineer.
- .18

### **3.10 FINISHING FORMED SURFACES**

- .1 Rough Form Finish Concrete Surfaces not Exposed to View: in accordance with CSA A23.1. Place concrete against forms reasonably true and plane. Cut off form ties a minimum of 10 mm below concrete surface. Patch tie holes and defects. Remove fins exceeding 5 mm.
- .2 Smooth Form Finish Concrete Surfaces Exposed to View: in accordance with CSA A23.1. Place concrete against plywood, steel or tempered hardboard. Patch tie holes and defects. Remove fins.
- .3 On all surfaces, cavities produced by form ties, air bubbles, all other holes, broken edges or corners and all other defects shall be repaired. The resulting surfaces shall be true and uniform.
- .4 There are to be no visible joints as part of the final wall finish for interior exposed concrete walls.

### **3.11 FINISHING FLATWORK**

- .1 Surfaces to be level to within 6mm in 3.0M with a maximum total variance of +/- 12mm.
- .2 Interior floor slabs to be left exposed or to receive carpet, sheet vinyl or other covering requiring a smooth surface: initial finishing operations followed by mechanical floating and steel trowelling as specified in CSA A23.1, to produce hard, smooth, dense trowelled surface free from blemishes. Finish tolerance classification: flat.
- .3 Equipment pads: smooth trowelled surface.

### **3.12 TREATMENT OF SLAB OR FLOOR SURFACES**

- .1 Not applicable

### **3.13 CURING AND PROTECTION**

- .1 Initial Curing: Keep concrete surface continuously moist until concrete temperature has dropped several degrees.
- .2 Final Curing: Immediately following initial curing and before the concrete has dried cure for an additional seven days. During that time, ensure that the temperature of the air in contact with the concrete is above 10°C.
- .3 Acceptable Curing Methods:
  - .1 Ponding or continuous sprinkling.
  - .2 Absorptive mat or fabric kept continuously wet.
  - .3 Damp sand, earth, or similar moist material.
  - .4 Continuous steam vapour mist bath not exceeding 66°C.
  - .5 Curing compound, except where chemical hardener is to be used.
  - .6 Waterproof paper or plastic film
  - .7 Forms in contact with the concrete surface and left in place for 7 days.
- .4 Do not use curing compounds on concrete surfaces to receive topping or other type of bonded finish unless approved by the Engineer.
- .5 Protect freshly placed and consolidated concrete against damage or defacement from adverse weather conditions.
- .6 Exposed Concrete Walking Surfaces Not to Receive an Integral Hardener: Coat with curing compound of type that provides permanent seal.
- .7 Provide appropriate cold weather protection as specified in CSA A23.1.

### **3.14 COLD AND HOT WEATHER CONCRETING**

- .1 Conform to the requirements of CSA A23.1.
- .2 Protect slabs being finished during drying conditions above 25° C, and/or during high winds with moisture retention film.

### **3.15 DAMPPROOF MEMBRANE**

- .1 Place dampproof membrane on prepared sub-grade under slabs on grade. Lap each sheet minimum 150 mm. Seal laps and penetrations using materials recommended by membrane manufacturer.

### **3.16 GROUT**

- .1 Mix grout to flowable consistency and apply in accordance with manufacturer's instructions.

### **3.17 EQUIPMENT PADS**

- .1 Provide concrete pads for equipment where indicated on drawings. Adjust dimensions of pads to reviewed shop drawings.
- .2 Insert bolts and sleeves and pack with non-shrink grout, in accordance with setting details and templates.
- .3 Steel trowel surfaces smooth. Chamfer exposed edges.

**3.18 CONCRETE MIX SCHEDULE**

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Component	Type	Min. Comp. Strength	Max. Water/	Air Content	Slump	Nominal Max. Size
		@ 56 Days (MPa)	Cement Ratio	Range (%)	Range* (mm)	Aggregate Size (mm)
Structural Concrete Foundations and Foundation Walls	HS	32	0.45	4-7	50-80	20-14

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\*Subject to Engineer's prior written approval, maximum slump may be increased beyond specified range by the use of chemical admixtures, except for zero slump mixes.

\*\*Fly-ash to a maximum of 25% of cementitious content by weight may be substituted for cement content, subject to Engineer's approval. **Fly ash is not permitted in exterior walkways, driveways or sidewalks.**

**END OF SECTION**



**1. GENERAL**

**1.1 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 03 30 00 - Cast-in-Place Concrete.

**1.2 GENERAL CONDITIONS**

- .1 The Contractor shall read and be governed by the General Conditions, General Instructions, Instructions to Bidders, Addenda, Form of Tender and Agreement of the complete specifications for this project.
- .2 The complete work under this trade shall be governed by the dictates of good practice in all details of materials and methods, even if not minutely specified. The work shall be properly coordinated with the requirements of other units of work specified in other sections.

**1.3 INTENT**

- .1 Detail, fabricate, supply, and erect miscellaneous items shown on the drawings, and/or specified herein.
- .2 Provide supports, brackets, anchor bolts, washers, nuts, and incidental metal work indicated, or required but not specifically shown but necessary for the completion of the work.

**1.4 STANDARDS**

- .1 Perform metal fabrications work in accordance with the following standards, except where specified otherwise.
  - .1 Limit States Design of Steel Structures: CAN/CSA-S16-most current version.
  - .2 North American Specifications for the Design of Cold-Formed Steel Structural Members: CSA-S136-most current version.
  - .3 Certification of Companies for Fusion Welding of Steel: CSA W47.1-most current version.
  - .4 Certified Electrodes and Welding Procedures: CSA W48-most current version.

- .5 Welded Steel Construction (Metal Arc Welding): CSA W59-most current version.
- .6 Qualification Code for Welding Inspection Organizations: CSA W178.1 most current version.
- .7 Structural Quality Steel: CSA G40.21-most current version.
- .8 Canadian Institute of Steel Construction (CISC): Code of Standard Practice for Buildings.
- .9 American Society for Testing and Materials: ASTM.
- .10 Primer, Structural Steel, Oil Alkyd Type: CGSB.

## **1.5 QUALIFICATIONS**

- .1 All work is to be performed by a firm certified by the Canadian Welding Bureau to the requirements of CSA W47.1.
- .2 Submit documentation and proof of Canadian Welding Bureau certification to Engineer 4 weeks prior to commencing fabrication.
- .3 Submit mill test certificates for structural steel.

## **1.6 INSPECTION AND TESTING**

- .1 Inspection and testing of welding is to be carried out by a certified welding inspection organization appointed by the Engineer, and paid for by the Owner.
- .2 Inspection of welding shall be undertaken only by an organization certified by the Canadian Welding Bureau to the requirements of CSA W178.1 for buildings and bridges by visual, radiographic, ultrasonic, magnetic particle, liquid penetrant, mechanical, or metallographic test methods.
- .3 Notify the Engineer at commencement of shop work so that testing or inspection will be properly scheduled.
- .4 When defects are revealed, the Engineer may request additional inspection to ascertain full degree of defect, at no cost to the Owner.
- .5 Correct defects and irregularities as advised by the Engineer, and subject to further inspection under similar conditions as earlier inspections, at no cost to Owner.

## **1.7 SHOP DRAWINGS**

- .1 Submit shop drawings and erection drawings in accordance with Section 01 33 00 - Submittal Procedures prior to fabrication.
- .2 Clearly indicate materials, core thicknesses, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details, and accessories.
- .3 Shop drawings for work designed by fabricator shall bear the stamp and signature of a qualified Professional Engineer registered in the Province of Alberta.

## **1.8 PRODUCT DELIVERY AND STORAGE**

- .1 Schedule delivery of components to site to coincide with installation of this work.
- .2 Store components to prevent damage and distortion.
- .3 Protect finishes from scratches and soiling.

## **2. PRODUCTS**

### **2.1 MATERIALS**

- .1 Structural Steel: To CAN/CSA-G40.20/G40.21, with the following minimum yield strengths:
  - .1 Structural Shapes Grade 300W
  - .2 Hollow Structural Sections (HSS) Grade 350W, Class "C"
  - .3 Miscellaneous Plates, Bars and Rods Grade 300W
- .2 Bolts, Nuts, and Washers: To ASTM A325M or A490M.
- .3 Anchor Bolts: To CSA G40.21, Grade 300.
- .4 Steel Pipe: To ASTM A53-07.
- .5 Welding Materials: To CSA W48 and CSA W59.
- .6 Shop Paint: To CAN/CGSB-1.40.
- .7 Chromium Plating: Chrome and nickel plating to ASTM B456-[03], satin finish.
- .8 Galvanized Primer: Zinc rich ready mix, to CGSB 1-GP-181M.
- .9 Galvanizing: To CAN/CSA-G164, hot dip galvanizing, minimum coating of 610 g/m<sup>2</sup>.

### **2.2 FABRICATION**

- .1 Fabricate in accordance with CSA S16, CSA S136, and approved shop drawings.
- .2 Examine drawings and specifications, and furnish all miscellaneous metalwork items required for proper execution of project.
- .3 Where work of other sections is to be attached to work of this section, prepare work by drilling and tapping holes as required to facilitate installation of such work.
- .4 Work of this section, supplied for installation under other sections, shall be prepared as required ready for installation.
- .5 Shop fabricate components where possible.
- .6 Fabricate components square, straight, true, free from warpage and other defects. Accurately cut, machine, file and fit joints, corners, copes, and mitres.
- .7 Exposed joints and connections shall be tight, flush, and smooth, unless otherwise indicated.
- .8 Weld connections where possible, otherwise bolt connections. Countersink exposed fastenings, and cut off bolts flush with nuts. Exposed connections to be same material, colour, and finish as base material on which they occur.
- .9 Accurately form connections with exposed faces flush, and mitres and joints tight.
- .10 Use self-tapping shake-proof countersunk flat headed screws on items required to be assembled by screws or as indicated.
- .11 Fabricate items from steel, unless indicated otherwise.

## **2.3 SURFACE PREPARATION**

- .1 Thoroughly clean and suitably pre-treat steel prior to finishing.
- .2 Remove loose mill scale, rust, oil, grease, dirt, and other foreign matter using one or more of the following methods.
  - .1 Solvent cleaning.
  - .2 Wire brushing.
  - .3 Power wire brushing.
  - .4 Sandblasting.
- .3 Grind smooth sharp projections.

## **2.4 FINISHES**

- .1 Unless otherwise indicated, shop apply primer paint finish to unscheduled components, except those items which are chrome plated, stainless steel, aluminum, or to be encased in concrete.
- .2 Prime Paint
  - .1 Apply one coat of prime paint to components prior to assembly.
  - .2 Apply primer to properly prepared surfaces at temperature above 7°C.
  - .3 Leave surfaces to be welded unpainted.
  - .4 Give two coats of prime paint of different colours to parts inaccessible after final assembly.
- .3 Galvanized
  - .1 Hot dip galvanize components to CSA G164.
  - .2 Where size permits, galvanize components after assembly.
  - .3 Galvanized items are not to be painted.
- .4 Zinc Rich Paint:
  - .1 Clean metal in accordance with surface preparation requirements of CGSB1-GP-181M.
  - .2 Apply one coat of zinc rich paint to all surfaces exposed after assembly to minimum dry film thickness of 60 micrometres. Apply coating immediately after cleaning.
- .5 Isolation Coating:
  - .1 Apply an isolation coating to contact surfaces of following components in contact with cementitious materials and dissimilar metals except stainless steel:
    - .1 exterior components;
    - .2 interior components exposed to high humidity conditions.

## **3. EXECUTION**

### **3.1 INSTALLATION**

- .1 Install components square, straight, and true to line.
- .2 Install in accordance with the design drawings, approved shop drawings, and the manufacturer's printed instructions.
- .3 Securely anchor components in place. Unless otherwise indicated, anchor components as follows:
  - .1 To concrete and solid masonry with expansion shields and bolts.
  - .2 To hollow construction with toggle bolts.
  - .3 To thin metal with screws or bolts.
  - .4 To thick metal with bolts or by welding.
  - .5 To wood with bolts for heavy and medium duty fastenings; with screws for light duty fastenings.
- .4 After installation, site clean and refinish damaged finishes, welds, bolt heads, and nuts. Refinish with primer or zinc rich paint to match original finish.
- .5 Provide suitable and acceptable means of anchorage, such as dowels, anchor clips, bar anchors, expansion bolts and shields, and toggles.
- .6 Hand over to appropriate trades together with setting templates, items to be cast into concrete.
- .7 Make provision for erection stresses and temporary bracing to keep work in alignment until completion of erection.
- .8 Replace members damaged in course of erection.

### **3.2 SCHEDULE OF METAL FABRICATIONS - FINISHES**

- .1 The following generally describes the scope of this section, however, for the full extent of requirements, refer to the drawings. Galvanize all steel items except as noted on the drawings, or in the following list:
  - .1 All anchors, plates, bolts, nuts, screws, shims, washers and brackets, etc., as required for securement or support of metal fabrications - galvanize.

### **3.3 ACCESSORIES**

- .1 All items are to be complete with all required anchorage and accessories necessary for installation.

Canadian Food Inspection Agency Lethbridge  
Replace Emergency Generator Set  
Lethbridge, Alberta  
Project No: J0317

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METAL FABRICATIONS  
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**END OF SECTION**

**Part 1            General**

**1.1                SUBMITTALS**

- .1        Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Shop drawings; submit drawings stamped and signed by professional engineer registered or licensed in Province of Alberta, Canada.
- .3        Shop drawings to show:
  - .1        Mounting arrangements.
  - .2        Operating and maintenance clearances.
- .4        Shop drawings and product data accompanied by:
  - .1        Detailed drawings of bases, supports, and anchor bolts.
  - .2        Acoustical sound power data, where applicable.
  - .3        Points of operation on performance curves.
  - .4        Manufacturer to certify current model production.
  - .5        Certification of compliance to applicable codes.
- .5        In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.
- .6        Closeout Submittals:
  - .1        Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
  - .2        Operation and maintenance manual approved by, and final copies deposited with, Engineer before final inspection.
  - .3        Operation data to include:
    - .1        Control schematics for systems including environmental controls.
    - .2        Description of systems and their controls.
    - .3        Description of operation of systems at various loads together with reset schedules and seasonal variances.
    - .4        Operation instruction for systems and component.
    - .5        Description of actions to be taken in event of equipment failure.
    - .6        Valves schedule and flow diagram.
    - .7        Colour coding chart.
  - .4        Maintenance data to include:
    - .1        Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
    - .2        Data to include schedules of tasks, frequency, tools required and task time.
  - .5        Performance data to include:



- .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
- .2 Equipment performance verification test results.
- .3 Special performance data as specified.
- .6 Approvals:
  - .1 Submit electronic copies of draft Operation and Maintenance Manual to Engineer for approval. Submission of individual data will not be accepted unless directed by Engineer.
  - .2 Make changes as required and re-submit as directed by Engineer.
- .7 Site records:
  - .1 Contractor to mark changes on red-line drawings as work progresses and as changes occur.
  - .2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed, and submit these as final as-built drawings upon completion of work.
  - .3 Make available for reference purposes and inspection.
- .8 As-built drawings:
  - .1 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
  - .2 Submit to Engineer for approval and make corrections as directed.
  - .3 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.

**Part 2 Products**

**2.1 MATERIALS**

- .1 Not Used.

**Part 3 Execution**

**3.1 PAINTING REPAIRS AND RESTORATION**

- .1 Complete priming and painting of all new mechanical piping.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged.

**3.2 CLEANING**

- .1 Clean interior and exterior of all systems.

**3.3 PROTECTION**

- .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

**END OF SECTION**

**GENERATOR SUB-BASE FUEL TANK FLOAT CONTROLS COMMISSIONING FORM Form M-1**

Unit ID.:	_____	Equipment Tag:	_____
Manufacturer:	_____	Location:	_____
Model No.:	_____	System:	_____
Serial No.:	_____		

INDICATE ACCEPTANCE  
 WITH A ( ✓ ) MARK

<u>INSTALLATION REVIEW</u>	<u>CONTRACTOR</u>	<u>CxA</u>	<u>COMMENTS</u>
Equipment Conforms to Shop Drawings	( )	( )	
Nameplate Complete	( )	( )	
Wiring Identification Complete	( )	( )	
Check Power Supply	( )	( )	
Mounting	( )	( )	

<u>OPERATIONAL REVIEW</u>	<u>CONTRACTOR</u>	<u>CxA</u>	<u>COMMENTS</u>
BMS display shows status of LL, L, H & HH	( )	( )	
Fuel tank LL indicates alarm	( )	( )	
Fuel tank L turns on pump P-52	( )	( )	
Fuel tank H turns off pump P-52	( )	( )	
Fuel tank HH shuts off pump P-52	( )	( )	
Fuel tank HH turns activates alarm through BMS	( )	( )	
Fuel tank LL activates alarm through BMS	( )	( )	

**REMARKS** .....

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POSITION/ TITLE	SIGNATURE	DATE
Building Owner/Representative		
Building Operations and Maintenance Staff		
Cx Authority		
Design Consultants		
Contractors/Subcontractor		
Manufacture / Independent Testing Specialists		

**FUEL DETECTION CABLE COMMISSIONING FORM**

**Form M-2**

Unit ID.: \_\_\_\_\_  
 Manufacturer: \_\_\_\_\_  
 Model No.: \_\_\_\_\_  
 Serial No.: \_\_\_\_\_

Equipment Tag: \_\_\_\_\_  
 Location: \_\_\_\_\_  
 System: \_\_\_\_\_

INDICATE ACCEPTANCE  
 WITH A ( ✓ ) MARK

**INSTALLATION REVIEW**

<b>CONTRACTOR</b>	<b>CxA</b>
( )	( )
( )	( )
( )	( )
( )	( )
( )	( )

**COMMENTS**

Equipment Conforms to Shop Drawings  
 Nameplate Complete  
 Wiring Identification Complete  
 Check Power Supply  
 Mounting

**OPERATIONAL REVIEW**

<b>CONTRACTOR</b>	<b>CxA</b>
( )	( )
( )	( )
( )	( )

**COMMENTS**

Fuel contact activates alarm  
 Local alarm on control module is activated  
 Controller alarm activates DDC callout alarm

**REMARKS** .....

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POSITION/ TITLE	SIGNATURE	DATE
Building Owner/Representative		
Building Operations and Maintenance Staff		
Cx Authority		
Design Consultants		
Contractors/Subcontractor		
Manufacture / Independent Testing Specialists		

**GENERATOR DIGITAL CONTROL CONNECTION COMMISSIONING FORM**

**Form M-3**

Unit ID.: \_\_\_\_\_  
 Manufacturer: \_\_\_\_\_

Location: \_\_\_\_\_  
 Model No.: \_\_\_\_\_

INDICATE ACCEPTANCE  
 WITH A ( ✓ ) MARK  
**CONTRACTOR    CxA**

**OPERATIONAL REVIEW**

**COMMENTS**

Control Connection to DDC system:

Graphical Interface Updated	( )	( )
Generator status readouts to DDC	( )	( )
Generator alarms readout to DDC	( )	( )
Activation of DDC callout alarms	( )	( )

**REMARKS** .....

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POSITION/ TITLE	SIGNATURE	DATE
Building Owner/Representative		
Building Operations and Maintenance Staff		
Cx Authority		
Design Consultants		
Contractors/Subcontractor		
Manufacture / Independent Testing Specialists		

**End of Section**

**Part 1            General**

**1.1                REFERENCES**

- .1    ASTM International Inc.
  - .1    ASTM D2235-04, Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
  - .2    ASTM D2564-04e1, Standard Specification for Solvent Cements for Poly(Vinyl-Chloride) (PVC) Plastic Piping Systems.
- .2    Canadian Standards Association (CSA International)
  - .1    CAN/CSA-Series B1800-06, Thermoplastic Nonpressure Pipe Compendium - B1800 Series.
- .3    Green Seal Environmental Standards (GSES)
  - .1    Standard GS-36-00, Commercial Adhesives.
- .4    Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1    Material Safety Data Sheets (MSDS).
- .5    South Coast Air Quality Management District (SCAQMD), California State
  - .1    SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

**1.2                ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Product Data:
  - .1    Provide manufacturer's printed product literature and datasheets for piping and adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.

**1.3                DELIVERY, STORAGE AND HANDLING**

- .1    Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2    Store at temperatures and conditions recommended by manufacturer.

**Part 2            Products**

**2.1                MATERIAL**

- .1    Use DWV for drainage piping.

**2.2 PIPING AND FITTINGS**

.1 For buried or above ground DWV piping, to:

.1 CAN/CSA B1800.

**2.3 JOINTS**

.1 Solvent weld for PVC: to ASTM D2564.

.2 Solvent weld for ABS: to ASTM D2235.

**Part 3 Execution**

**3.1 APPLICATION**

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

**3.2 INSTALLATION**

.1 In accordance with Section 23 05 05 - Installation of Pipework.

.2 Install in accordance with National Plumbing Code and local authority having jurisdiction.

**3.3 TESTING**

.1 Pressure test buried systems before backfilling.

.2 Hydraulically test to verify grades and freedom from obstructions.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCES**

- .1 American Society for Testing and Materials International (ASTM).
  - .1 ASTM A126-95(2001), Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
  - .2 ASTM B62-02, Specification for Composition Bronze or Ounce Metal Castings.
- .2 Plumbing and Drainage Institute (PDI).
  - .1 PDI-G101-96, Testing and Rating Procedure for Grease Interceptors with Appendix of Sizing and Installation Data.

**1.2                SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet for fixtures and equipment.
  - .2 Indicate dimensions, construction details and materials for specified items.
- .2 Shop Drawings:
  - .1 Submit shop drawings to indicate materials, finishes, dimensions construction and assembly details and accessories.
- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Instructions: submit manufacturer's installation instructions.
- .5 Manufacturers' Field Reports: manufacturers' field reports specified.
- .6 Closeout submittals: submit maintenance and engineering data for incorporation into manual, include:
  - .1 Description of plumbing specialties and accessories, giving manufacturer's name, type, model, year and capacity.
  - .2 Details of operation, servicing and maintenance.

**Part 2            Products**

**2.1                OIL INTERCEPTOR DRAIN PIPE**

- .1 SPI Petro-Pipe model PIT-410-M2 with pre-filter (PFC-44-M2) and pre-filter basket (PFB-8810).
- .2 Installation requirements: To be installed on a 25° slope.



- .3 Supply one complete system replacement: One each of the pre-filter basket (PFB-88100), the pre-filter (PFC-44-M2), and the Petro-Pipe (PIT-410-M2).

### **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 data sheet.

#### **3.2 INSTALLATION**

- .1 Install in accordance with National Plumbing Code of Canada, local authority having jurisdiction, and manufacturer's installation instructions.

#### **3.3 OIL INTERCEPTOR DRAIN PIPE**

- .1 Install assembly with sufficient space, as indicated, for ease of maintenance. See manufacturer's instructions.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCES**

- .1        Canadian General Standards Board (CGSB)
  - .1        CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .2        Canadian Standards Association (CSA International)
  - .1        CSA B139-09, Installation Code for Oil Burning Equipment.

**Part 2            Products**

**2.1                MATERIAL**

- .1        Not Used.

**Part 3            Execution**

**3.1                CONNECTIONS TO EQUIPMENT**

- .1        In accordance with manufacturer's instructions unless otherwise indicated.
- .2        Use valves and either unions or flanges for isolation and ease of maintenance and assembly.

**3.2                CLEARANCES**

- .1        Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer, National Fire Code of Canada, and CSA B139.
- .2        Provide space for disassembly, removal of equipment and components as recommended by manufacturer or as indicated (whichever is greater) without interrupting operation of other system, equipment, or components.

**3.3                DRAINS**

- .1        Install piping with grade in direction of flow except as indicated.
- .2        Install drain valve at low points in piping systems, at equipment and at section isolating valves.
- .3        Drain valves: NPS 3/4 ball valves unless indicated otherwise, with hose end male thread, cap and chain.

**3.4                DIELECTRIC COUPLINGS**

- .1        General: compatible with system, to suit pressure rating of system.
- .2        Locations: where dissimilar metals are joined.
- .3        NPS 2 and under: isolating unions or bronze valves.

- .4 Over NPS 2: isolating flanges.

### **3.5 PIPEWORK INSTALLATION**

- .1 Protect openings against entry of foreign material.
- .2 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .3 Assemble piping using fittings manufactured to ANSI standards.
- .4 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .5 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- .6 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .7 Ream pipes, remove scale and other foreign material before assembly.
- .8 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .9 Provide for thermal expansion as indicated.
- .10 Valves:
  - .1 Install in accessible locations.
  - .2 Remove interior parts before soldering.
  - .3 Install with stems above horizontal position unless indicated.
  - .4 Install valves to be accessible for maintenance without removing adjacent piping.
  - .5 Install ball valves in bypass around control valves.
  - .6 Use ball valves at branch take-offs for isolating purposes except where specified.
- .11 Check Valves:
  - .1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and as indicated.
  - .2 Install swing check valves in horizontal lines on discharge of pumps as indicated.

### **3.6 SLEEVES**

- .1 General: Install where pipes pass through masonry, concrete structures, fire rated assemblies, and as indicated.
- .2 Material: Schedule 40 black steel pipe.
- .3 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
- .4 Installation:
  - .1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.
  - .2 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.

- .5 Sealing:
  - .1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.

### **3.7 FLUSHING OUT OF PIPING SYSTEMS**

- .1 Before start-up, clean interior of piping systems.
- .2 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

### **3.8 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK**

- .1 Advise Engineer 48 hours minimum prior to performance of pressure tests.
- .2 Pipework: After installation, hydrostatically test piping at 350 kPa in accordance with requirements of CSA B139.
- .3 Maintain specified test pressure without loss for 10 hours minimum.
- .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .5 Pay costs for repairs or replacement, retesting, and making good. Engineer to determine whether repair or replacement is appropriate.

### **3.9 EXISTING SYSTEMS**

- .1 Connect into existing piping systems at times approved by Engineer.
- .2 Be responsible for damage to existing plant by this work.

**END OF SECTION**

## **Part 1        General**

### **1.1        REFERENCES**

- .1 American Society of Testing and Materials International (ASTM)
  - .1 ASTM A307-04, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  - .2 ASTM A563-04a, Specification for Carbon and Alloy Steel Nuts.
- .2 Factory Mutual (FM)
- .3 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
  - .1 MSS SP58-2002, Pipe Hangers and Supports - Materials, Design and Manufacture.
  - .2 MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.
  - .3 MSS SP89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .4 Underwriter's Laboratories of Canada (ULC)

## **Part 2        Products**

### **2.1        SYSTEM DESCRIPTION**

- .1 Design Requirements:
  - .1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
  - .2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP58.
  - .3 Design hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.

### **2.2        GENERAL**

- .1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS SP58.
- .2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

### **2.3        PIPE HANGERS**

- .1 Finishes:
  - .1 Pipe hangers and supports: galvanized or painted with zinc-rich paint after manufacture.

- .2 Ensure steel hangers in contact with copper piping are copper plated or epoxy coated.
- .2 Hanger rods: threaded rod material to MSS SP58:
  - .1 Ensure that hanger rods are subject to tensile loading only.
- .3 Pipe attachments: material to MSS SP58:
  - .1 Attachments for steel piping: carbon steel black.
  - .2 Attachments for copper piping: copper plated black steel.
  - .3 Oversize pipe hangers and supports.

## **2.4 RISER CLAMPS**

- .1 Steel or cast iron pipe: galvanized or black carbon steel to MSS SP58, type 42
- .2 Copper pipe: carbon steel copper plated to MSS SP58, type 42.
- .3 Bolts: to ASTM A307.
- .4 Nuts: to ASTM A563.

## **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 datasheet.

### **3.2 INSTALLATION**

- .1 Install in accordance with:
  - .1 Manufacturer's instructions and recommendations.

### **3.3 HANGER SPACING**

- .1 Fuel oil piping: up to NPS 2: every 1.8 m.
- .2 Within 300 mm of each elbow.

### **3.4 HANGER INSTALLATION**

- .1 Install hanger so that rod is vertical under operating conditions.
- .2 Adjust hangers to equalize load.
- .3 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.

**3.5 FINAL ADJUSTMENT**

- .1 Adjust hangers and supports:
  - .1 Ensure that rod is vertical under operating conditions.
  - .2 Equalize loads.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCES**

- .1    Canadian General Standards Board (CGSB)
  - .1        CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.
  - .2        CAN/CGSB-24.3-92, Identification of Piping Systems.

**1.2                DELIVERY, STORAGE, AND HANDLING**

- .1    Packing, shipping, handling and unloading:
  - .1        Deliver, store and handle materials in accordance with manufacturer's written instructions.

**Part 2            Products**

**2.1                MANUFACTURER'S EQUIPMENT NAMEPLATES**

- .1    Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.
- .2    Lettering and numbers raised or recessed.
- .3    Information to include, as appropriate:
  - .1        Equipment: manufacturer's name, model, size, serial number, capacity.
  - .2        Motor: voltage, Hz, phase, power factor, duty, frame size.

**2.2                EXISTING IDENTIFICATION SYSTEMS**

- .1    Apply existing identification system to new work.
- .2    Where existing identification system does not cover for new work, use identification system specified this section.

**2.3                PIPING SYSTEMS GOVERNED BY CODES**

- .1    Identification:
  - .1        Fuel Oil: to CSA/CGA B139.

**2.4                IDENTIFICATION OF PIPING SYSTEMS**

- .1    Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.
- .2    Pictograms:



- .1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.
- .3 Legend:
  - .1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.
- .4 Arrows showing direction of flow:
  - .1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.
  - .2 Use double-headed arrows where flow is reversible.
- .5 Extent of background colour marking:
  - .1 To full circumference of pipe or insulation.
  - .2 Length to accommodate pictogram, full length of legend and arrows.
- .6 Materials for background colour marking, legend, arrows:
  - .1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.
  - .2 Other pipes: pressure sensitive plastic-coated cloth or vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.
- .7 Colours and Legends:
  - .1 Where not listed, obtain direction from Engineer.
  - .2 Colours for legends, arrows: to following table:

Background colour:	Legend, arrows:
Yellow	BLACK
Green	WHITE
Red	WHITE
  - .3 Background colour marking and legends for piping systems:

<u>Contents</u>	<u>Background colour marking</u>	<u>Legend</u>
No. 2 fuel oil suction	Yellow	# 2 FUEL OIL
No. 2 fuel oil return	Yellow	# 2 FUEL OIL

## 2.5 VALVES, CONTROLLERS

- .1 Brass tags with 12 mm stamped identification data filled with black paint.
- .2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

## 2.6 CONTROLS COMPONENTS IDENTIFICATION

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

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

## **2.7 LANGUAGE**

- .1 Identification in English.

## **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 datasheet.

### **3.2 TIMING**

- .1 Provide identification only after painting has been completed.

### **3.3 INSTALLATION**

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2 Provide ULC and CSA registration plates where required by respective agency.

### **3.4 NAMEPLATES**

- .1 Locations:
  - .1 In conspicuous location to facilitate easy reading and identification from operating floor.
- .2 Standoffs:
  - .1 Provide for nameplates on hot and/or insulated surfaces.
- .3 Protection:
  - .1 Do not paint, insulate or cover.

### **3.5 LOCATION OF IDENTIFICATION ON PIPING SYSTEMS**

- .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.
- .2 Adjacent to each change in direction.
- .3 At least once in each small room through which piping or ductwork passes.
- .4 On both sides of visual obstruction or where run is difficult to follow.
- .5 On both sides of separations such as walls, floors, partitions.

- .6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.
- .7 At beginning and end points of each run and at each piece of equipment in run.
- .8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .9 Identification easily and accurately readable from usual operating areas and from access points.
  - .1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

### **3.6 VALVES, CONTROLLERS**

- .1 Valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or closed "S" hooks.
- .2 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by Owner. Provide one copy (reduced in size if required) in each operating and maintenance manual.
- .3 Number valves in each system consecutively.

### **3.7 CLEANING**

- .1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1            General**

**1.1            FUEL OIL SYSTEMS**

- .1    Environmental protection systems:
  - .1    Test oil storage tank leakage detection system using manufacturer's recommended procedures.
  - .2    Test spill protection and over-fill protection systems using manufacturer's recommended procedures.
- .2    Fuel oil pump (existing pump P-52):
  - .1    Check strainers on pump inlet, relief valve on pump outlet with discharge to oil return piping, pressure gauge on strainer inlet, pump inlet and pump discharge.
  - .2    Verify pump performance.
  - .3    Pump performance within plus 20% and minus 0% of design. Notify owner if pump is not meeting performance requirement.
- .3    Operational Tests:
  - .1    Charge system and verify operation.
  - .2    Verify adequacy of flow rates and pressure from storage facilities to burners.
  - .3    Verify accurate metering of fuel to burners.
- .4    Notify authorities having jurisdiction to enable witnessing of tests as required.

**Part 2            Products**

**2.1            NOT USED**

- .1    Not Used.

**Part 3            Execution**

**3.1            NOT USED**

- .1    Not Used.

**END OF SECTION**

## **Part 1            General**

### **1.1                REFERENCES**

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ASME-B16.3-2006, Malleable-Iron Threaded Fittings: Classes 150 and 300.
- .2 ASTM International
  - .1 ASTM A47/A47M-99(2004), Standard Specification for Ferritic Malleable Iron Castings.
  - .2 ASTM A53/A53M-07, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
  - .3 ASTM B61-08, Standard Specification for Steam or Valve Bronze Castings.
  - .4 ASTM B75M-99(2005), Standard Specification for Seamless Copper Tube Metric.
- .3 CSA International
  - .1 CSA-B139-09, Installation Code for Oil Burning Equipment.
  - .2 CSA-B140.0-03, Oil Burning Equipment: General Requirements.
  - .3 CSA-C282-05, Emergency Electrical Power Supply for Buildings.
- .4 Green Seal Environmental Standards (GSES)
  - .1 Standard GS-11-2008, 2nd Edition, Paints and Coatings.
- .5 Manufacturers Standardization Society of the Valve and Fitting Industry (MSS)
  - .1 MSS-SP-80-08, Bronze Gate, Globe, Angle and Check Valves.
- .6 National Association of Corrosion Engineers (NACE)
  - .1 NACE SP0169-2007, Control of External Corrosion on Underground or Submerged Metallic Piping Systems.
- .7 Underwriter's Laboratories of Canada (ULC)
  - .1 ULC ORD-C107.12-1992, Line Leak Detection Devices for Flammable Liquid Piping.
- .8 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

### **1.2                ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Product Data:
  - .1 Provide manufacturer's printed product literature, specifications and datasheets for piping, fittings and equipment and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Indicate on manufacturer's catalogue literature the following: valve model.

- .2 Test Reports:
  - .1 Submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

### **1.3 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with manufacturer's written instructions.

## **Part 2 Products**

### **2.1 FILL VENT AND CARRIER PIPE**

- .1 Steel: to ASTM A53/A53M, Schedule 40, continuous weld or electric resistance welded, screwed.
- .2 Copper: type L, soft copper tubing, to ASTM B75M.

### **2.2 STEEL PIPE COATING**

- .1 Paint: First coat to be Alkyd Anti-corrosive metal primer. Second and third coats to be Alkyd paint.

### **2.3 JOINTING MATERIAL**

- .1 Screwed fittings: pulverized lead paste.

### **2.4 FITTINGS**

- .1 Steel:
  - .1 Malleable iron: screwed, banded, Class 150 to ASME-B16.3.
  - .2 Unions: malleable iron, brass to iron, ground seat, screwed, to ASTM A47/A47M.
  - .3 Nipples: Schedule 40, to ASTM A53/A53M.

### **2.5 BALL VALVES**

- .1 NPS 2 and under: bronze body, screwed ends, TFE seal, hard chrome ball, 4 MPa, WOG.

### **2.6 LUBRICATED PLUG COCKS**

- .1 NPS 2 and under, screwed: to ASTM B61, Class 150, 1 MPa, bronze body.

### **2.7 FUEL OIL TRANSFER PUMPS**

- .1 Reuse existing.

## **2.8 OIL FILTER**

- .1 Reuse existing.

## **2.9 CLEANING SOLUTIONS**

- .1 Tri-sodium phosphate: 0.40 kg per 100 L water in system.
- .2 Sodium carbonate: 0.40 kg per 100 L water in system.
- .3 Low-foaming detergent: 0.01 kg per 100 L water in system.

## **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 datasheet.

### **3.2 PIPING**

- .1 Install piping in accordance with Section 23 05 05 - Installation of Pipework supplemented as specified.
- .2 Install oil piping system in accordance with CSA-B139.
- .3 Slope piping down in direction of storage tank unless otherwise indicated.
- .4 Above ground piping to be protected from physical impact due to impact.
- .5 Fill, vent, suction and return piping outside building:
  - .1 Grading: slope piping at 0.5% minimum back to low point.
- .6 Install buried piping in outer casings or double-wall piping to CSA-B139 or authority having jurisdiction.
- .7 Piping at tanks:
  - .1 Suction: terminate 150 mm from bottom of tank with foot valve and strainer.
  - .2 Comply with CSA-B139 or authority having jurisdiction for piping for venting at tanks.
  - .3 Fill pipes: install to comply with CSA-B139.

### **3.3 VALVES**

- .1 Install valves with stems upright or horizontal unless approved otherwise by Architect/Engineer.
- .2 Install ball valves at branch take-offs, to isolate pieces of equipment and as indicated.

### **3.4 OVERFILL AND SPILL PROTECTION**

- .1 To CSA-B139.

### **3.5 LEAK DETECTION**

- .1 Install line leak detector to ULC ORD C107.12.

### **3.6 FIELD QUALITY CONTROL**

- .1 Site Tests/Inspection:
  - .1 Test system to CSA-B139 and CSA-B140.0 and authorities having jurisdiction.
  - .2 Isolate tanks from piping pressure tests.
  - .3 Maintain test pressure during backfilling.

### **3.7 CLEANING**

- .1 Clean as follows:
  - .1 Flush after pressure test with number 2 fuel oil for a minimum of two hours. Clean strainers and filters.
  - .2 Dispose of fuel oil used for flushing out in accordance with requirements of authority having jurisdiction.
  - .3 Ensure entire installation is approved by authority having jurisdiction.
  - .4 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**



## **Part 1           General**

### **1.1           REFERENCES**

- .1 American National Standards Institute (ANSI)/The Instrumentation, Systems and Automation Society (ISA).
  - .1 ANSI/ISA 5.5-1985, Graphic Symbols for Process Displays.
- .2 American National Standards Institute (ANSI)/ Institute of Electrical and Electronics Engineers (IEEE).
  - .1 ANSI/IEEE 260.1-1993, American National Standard Letter Symbols Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).
- .3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
  - .1 ASHRAE STD 135-R2001, BACNET - Data Communication Protocol for Building Automation and Control Network.
- .4 Canadian Standards Association (CSA International).
  - .1 CAN/CSA-Z234.1-89(R1995), Canadian Metric Practice Guide.
- .5 Consumer Electronics Association (CEA).
  - .1 CEA-709.1-B-2002, Control Network Protocol Specification.
- .6 Department of Justice Canada (Jus).
  - .1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
  - .2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
- .7 Electrical and Electronic Manufacturers Association (EEMAC).
  - .1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.
- .8 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
  - .1 Material Safety Data Sheets (MSDS).
- .9 Transport Canada (TC).
  - .1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

### **1.2           ACRONYMS AND ABBREVIATIONS**

- .1 Acronyms used in EMCS:
  - .1 AEL - Average Effectiveness Level.
  - .2 AI - Analog Input.
  - .3 AO - Analog Output.
  - .4 BACnet - Building Automation and Control Network.
  - .5 BC(s) - Building Controller(s).

- .6 BMS – Building Management System
- .7 CAD - Computer Aided Design.
- .8 CDL - Control Description Logic.
- .9 CDS - Control Design Schematic.
- .10 COSV - Change of State or Value.
- .11 CPU - Central Processing Unit.
- .12 DI - Digital Input.
- .13 DO - Digital Output.
- .14 DP - Differential Pressure.
- .15 ECU - Equipment Control Unit.
- .16 EMCS - Energy Monitoring and Control System.
- .17 IDE - Interface Device Equipment.
- .18 I/O - Input/Output.
- .19 ISA - Industry Standard Architecture.
- .20 LAN - Local Area Network.
- .21 LCU - Local Control Unit.
- .22 MCU - Master Control Unit.
- .23 NC - Normally Closed.
- .24 NO - Normally Open.
- .25 OS - Operating System.
- .26 O&M - Operation and Maintenance.
- .27 OWS - Operator Work Station.
- .28 PC - Personal Computer.
- .29 PCI - Peripheral Control Interface.
- .30 PCMCIA - Personal Computer Micro-Card Interface Adapter.
- .31 PID - Proportional, Integral and Derivative.
- .32 RAM - Random Access Memory.
- .33 ROM - Read Only Memory.
- .34 TCU - Terminal Control Unit.
- .35 USB - Universal Serial Bus.
- .36 UPS - Uninterruptible Power Supply.

### 1.3 DEFINITIONS

- .1 Point Object Type: points fall into following object types:
  - .1 AI (analog input).
  - .2 AO (analog output).
  - .3 DI (digital input).
  - .4 DO (digital output).
  - .5 Pulse inputs.
- .2 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISA S5.5.

- .1 Printouts: to ANSI/IEEE 260.1.

#### **1.4 SYSTEM DESCRIPTION**

- .1 Work covered by sections referred to above consists of fully operational EMCS, including, the functionality required for new alarms, controls, and integration of such into the existing building EMCS system including graphical interface.
- .2 Design Requirements:
  - .1 Design and provide conduit and wiring linking elements of system.
  - .2 Supply sufficient programmable controllers of types to meet project requirements.

#### **1.5 SUBMITTALS**

- .1 Submit for review:
  - .1 Equipment list and systems manufacturers name within 30 days after award of contract.
  - .2 Shop drawings showing new control systems' sequences of operation.
- .2 Quality Control:
  - .1 Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.
  - .2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.
  - .3 Submit proof of compliance to specified standards with shop drawings and product data.
  - .4 Existing devices intended for re-use: report any deficiencies with existing equipment to the owner in writing if found.

#### **1.6 EXISTING CONDITIONS - CONTROL COMPONENTS**

- .1 Utilize existing control wiring where possible.
- .2 Re-use field control devices that are usable in their original configuration provided that they conform to applicable codes, standards & specifications.
  - .1 Provide for new, properly designed device where re-usability of components is uncertain.
- .3 Non-functioning items:
  - .1 Provide with report specification sheets or written functional requirements to support findings.
- .4 Submit written request for permission to disconnect controls and to obtain equipment downtime before proceeding with Work.
- .5 Assume responsibility for controls to be incorporated into EMCS after written receipt of approval
  - .1 Be responsible for repair costs due to negligence or abuse of equipment.

- .2 Responsibility for existing devices terminates upon final acceptance of EMCS.
- .6 Remove existing controls not re-used or not required. Place in approved storage for disposition as directed.

**Part 2 Products**

**2.1 EQUIPMENT**

- .1 All new EMCS equipment to be of same manufacturer as existing building control system (Johnson Controls) and/or capable of full integration and communication with existing Johnson Controls Building Management system (BMS).

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not used.

**END OF SECTION**

## **Part 1           General**

### **1.1               REFERENCES**

- .1 American National Standards Institute (ANSI).
  - .1 ANSI C12.7-1993(R1999), Requirements for Watthour Meter Sockets.
  - .2 ANSI/IEEE C57.13-1993, Standard Requirements for Instrument Transformers.
- .2 American Society for Testing and Materials International, (ASTM).
  - .1 ASTM B148-97(03), Standard Specification for Aluminum-Bronze Sand Castings.
- .3 National Electrical Manufacturer's Association (NEMA).
  - .1 NEMA 250-03, Enclosures for Electrical Equipment (1000 Volts Maximum).
- .4 Canadian Standards Association (CSA International).
  - .1 CSA-C22.1-02, Canadian Electrical Code, Part 1 (19th Edition), Safety Standard for Electrical Installations.

### **1.2               DEFINITIONS**

- .1 Acronyms and Definitions: refer to Section 25 05 01 - EMCS: General Requirements.

### **1.3               SUBMITTALS**

- .1 Manufacturer's Instructions:
  - .1 Submit manufacturer's installation instructions for specified equipment and devices.

### **1.4               EXISTING CONDITIONS**

- .1 Cutting and Patching: as specified herein.
- .2 Repair surfaces damaged during execution of Work.
- .3 Turn over to Engineer existing materials removed from Work not identified for re-use.

## **Part 2           Products**

### **2.1               GENERAL**

- .1 Control devices of each category to be of same type and manufacturer.
- .2 External trim materials to be corrosion resistant.
- .3 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.

- .4 Transmitters and sensors to be unaffected by external transmitters including walkie talkies.
- .5 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.
- .6 Outdoor installations: use weatherproof construction in NEMA 4 enclosures.
- .7 Devices installed in user occupied space not exceed Noise Criteria (NC) of 35. Noise generated by any device must not be detectable above space ambient conditions.

## **2.2 TANK LEVEL SWITCHES**

- .1 Requirements:
  - .1 Provide independent auxiliary high level alarm (wired directly to shut off pump P-52, with alarm back to BMS).
  - .2 Provide control float with high level (pump off), low level (pump on) and low alarm level.
  - .3 For mounting into openings on top of generator sub-base fuel tank.
  - .4 Maximum operating temperature: 120 degrees C, minimum operating temperature: -30 degrees C.
  - .5 Adjustable setpoint and differential.

## **2.3 WIRING**

- .1 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. Other cases use FT4 wiring.
- .2 Wiring must be continuous without joints.
- .3 Sizes:
  - .1 Field wiring to digital device: #18AWG or 20AWG stranded twisted pair.
  - .2 Analog input and output: shielded #18 minimum solid copper or #20 minimum stranded twisted pair.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.
- .2 Install field control devices in accordance with manufacturers recommended methods, procedures and instructions.
- .3 Fire stopping: provide fire stopping as required to maintain fire rating integrity.
- .4 Electrical:

- .1 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.
- .2 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.
- .3 Install communication wiring in conduit.
  - .1 Provide complete conduit system to link Building Controllers, field panels and OWS(s).
  - .2 Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems.
  - .3 Maximum conduit fill not to exceed 40%.
  - .4 Design drawings do not show conduit layout.
- .4 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Wiring in mechanical rooms, wiring in service rooms and exposed wiring must be in conduit.

### **3.2 IDENTIFICATION**

- .1 Identify field devices to match identification used throughout building.

### **3.3 AIR FLOW MEASURING STATIONS**

- .1 Protect air flow measuring assembly until cleaning of ducts is completed.

### **3.4 TESTING AND COMMISSIONING**

- .1 Calibrate and test field devices for accuracy and performance.

**END OF SECTION**

**Part 1           General**

**1.1             SEQUENCING**

- .1     Sequence of operation of new control elements connected to existing EMCS:
  - .1     New fuel day tank to be complete with level detection as follows:
    - .1     (LL) Low Alarm Level – Low level alarm to be activated.
    - .2     (L) Low – Pump P-52 to turn on to fill tank.
    - .3     (H) High – Pump P-52 to turn off.
    - .4     (HH) High Alarm Level – Independent Auxiliary high level switch to shut off power to Pump P-52 and alarm to be activated. Shut off to be hard wired to operate independently of BMS system operation.
  - .2     New underground fuel piping in trench to be equipped with leak detection.
    - .1     Leak detection to activate TraceTek system alarm if a leak is detected. Alarm to report back to BMS system for fuel leak.
  - .3     Generator Operation and alarms:
    - .1     Generator control module to report status and alarm points back to BMS.
- .2     All alarms to be integrated into Johnson Controls BMS communication systems.
- .3     Sequencing of generator controls to be by generator supplier. Connection of generator controls to building EMCS by mechanical EMCS contractor. Generator to operate independently of building EMCS system. Controls connection to be status communication only.

**Part 2           Products**

**2.1             NOT USED**

- .1     Not Used.

**Part 3           Execution**

**3.1             FRONT END GRAPHICS**

- .1     EMCS contractor to add all new control and alarm points into graphical interface of front end Johnson controls BMS system.

**END OF SECTION**



**Part 1            General**

**1.1                SUMMARY**

- .1 Section Includes:
  - .1 General requirements that are common to NMS sections found in Division 26.

**1.2                REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA C22.1-12, Canadian Electrical Code, Part 1 (22th Edition), Safety Standard for Electrical Installations.
  - .2 CSA C282-09, Emergency Electrical Power Supply for Buildings.
- .2 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)
  - .1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.
- .3 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

**1.3                DESIGN REQUIREMENTS**

- .1 Operating voltages: to CAN3-C235.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
  - .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.
- .3 Language operating requirements: provide identification nameplates and labels for control items in English.

**1.4                SUBMITTALS**

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS in accordance with Section 01 47 15 - Sustainable Requirements: Construction and Section 02 61 33 - Hazardous Materials.
- .3 Shop drawings:
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Canada.
  - .2 If changes are required, notify Departmental Representative and Consultant of these changes before they are made.

- .4 Quality Control: in accordance with Section 01 45 00 - Quality Control.
  - .1 Provide CSA certified equipment and material.
  - .2 Where CSA certified equipment and material is not available, submit such equipment and material to authority having jurisdiction inspection authorities for special approval before delivery to site.
  - .3 Submit test results of installed electrical systems and instrumentation.
  - .4 Permits and fees: in accordance with General Conditions of contract.
  - .5 Submit, upon completion of Work, load balance report as described in PART 3 - Load Balance.
  - .6 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Departmental Representative.

## **1.5 QUALITY ASSURANCE**

- .1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.
- .2 Qualifications: electrical Work to be carried out by qualified, licensed electricians who hold valid Master Electrical Contractor license or apprentices in accordance with authorities having jurisdiction.
  - .1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.
  - .2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.
- .3 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

## **1.6 DELIVERY, STORAGE AND HANDLING**

- .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal.

## **1.7 SYSTEM STARTUP**

- .1 Instruct Departmental Representative and operating personnel in operation, care and maintenance of systems, system equipment and components.
- .2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.
- .3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.

**Part 2 Products**

**2.1 MATERIALS AND EQUIPMENT**

- .1 Provide material and equipment in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Material and equipment to be CSA certified. Where CSA certified material and equipment are not available, obtain special approval from inspection authorities before delivery to site and submit such approval as described in PART 1 - Submittals.
- .3 Factory assemble control panels and component assemblies.

**2.2 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS**

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.
- .2 Control wiring and conduit, wiring and connections below 50 V which are related to control systems and specified in mechanical sections and as shown on mechanical drawings.

**2.3 WARNING SIGNS**

- .1 Warning Signs: in accordance with requirements of authority having jurisdiction inspection authorities Departmental Representative Consultant.
- .2 Porcelain enamel signs, minimum size 175 x 250 mm.

**2.4 WIRING TERMINATIONS**

- .1 Ensure lugs, terminals, screws used for termination of wiring are suitable for copper conductors.

**2.5 EQUIPMENT IDENTIFICATION**

- .1 Identify electrical equipment with nameplates and labels as follows:
  - .1 Nameplates: lamicoid, matt white finish face, black core, lettering accurately aligned and engraved into core mechanically attached with self tapping screws.
  - .2 Sizes as follows:

**NAMEPLATE SIZES**

Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

- .2 Labels: embossed plastic labels with 6mm high letters unless specified otherwise.

- .3 Wording on nameplates and labels to be approved by Consultant prior to manufacture.
- .4 Allow for minimum of twenty-five (25) letters per nameplate and label.
- .5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .6 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .7 Terminal cabinets and pull boxes: indicate system and voltage.

## 2.6 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, numbered coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1.

## 2.7 CONDUIT AND CABLE IDENTIFICATION

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15m intervals.
- .3 Colours: 25mm wide prime colour and 20mm wide auxiliary colour.

	Prime	Auxiliary
up to 250 V	Yellow	
up to 600 V	Yellow	Green

## 2.8 FINISHES

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
  - .1 Paint outdoor electrical equipment "equipment green" finish.
  - .2 Paint indoor switchgear and distribution enclosures light gray to EEMAC 2Y-1.

## 2.9 FIRE-STOPPING

- .1 Fire-stop all pipe, duct, conduit, and wire penetrations through floors and walls designated as fire and/or smoke separations.
- .2 Fire-stopping materials to meet ULC CAN 2S115.
- .3 Preparation of surfaces and installation of fire-stopping materials shall be carried out as per manufacturer's instructions.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.
- .2 Do underground systems in accordance with CSA C22.3 No.1 except where specified otherwise.

**3.2 NAMEPLATES AND LABELS**

- .1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

**3.3 CONDUIT AND CABLE INSTALLATION**

- .1 Install conduit and sleeves prior to pouring of concrete.
  - .1 Sleeves through concrete: schedule 40 steel pipe sized for free passage of conduit, and protruding 50mm.
- .2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .3 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.

**3.4 LOCATION OF OUTLETS**

- .1 Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.
- .2 Do not install outlets back-to-back in wall; allow minimum 150mm horizontal clearance between boxes.
- .3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000mm, and information is given before installation.

**3.5 MOUNTING HEIGHTS**

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise.
  - .1 Local switches: 1400mm.
  - .2 Wall receptacles:
    - .1 General: 300mm.
    - .2 In mechanical rooms: 1400mm.

- .3 Panelboards: as required by Code or as indicated.

### **3.6 CO-ORDINATION OF PROTECTIVE DEVICES**

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

### **3.7 FIELD QUALITY CONTROL**

- .1 Load Balance:
  - .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
  - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
  - .3 Provide upon completion of work, load balance report as directed in PART 1 - Submittals: phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
- .2 Conduct following tests in accordance with Section 01 45 00 - Quality Control:
  - .1 Power distribution system including phasing, voltage, grounding and load balancing.
  - .2 Circuits originating from branch distribution panels.
  - .3 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
  - .4 Insulation resistance testing:
    - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
    - .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
    - .3 Check resistance to ground before energizing.
- .3 Carry out tests in presence of Departmental Representative.
- .4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .5 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
  - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

- .6 Verification requirements in accordance with Section 01 47 17 - Sustainable Requirements: Contractor's Verification, include:
  - .1 Materials and resources.
  - .2 Storage and collection of recyclables.
  - .3 Construction waste management.
  - .4 Resource reuse.
  - .5 Recycled content.
  - .6 Local/regional materials.
  - .7 Certified wood.
  - .8 Low-emitting materials.

### **3.8 CLEANING**

- .1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .2 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

**END OF SECTION**

**PART 1        General**

**1.1            INTENT**

- .1        This Section specifies electrical requirements relating to the commissioning of electrical components and applies to all applicable sections in Division 26.
- .2        Related Sections:
  - .1        Section 019100 – Commissioning - General
- .3        Commissioning of building electrical components in affected renovation areas is of the utmost importance to ensure the successful operation of this building. The building renovations will not be considered complete until all components have been demonstrated to work precisely in accordance with the Contract requirements.
- .4        Responsibility for the satisfactory completion of the building and demonstration that the requirements of the commissioning are satisfied rests with the Contractor, who will employ and pay for any specialist supervision, inspection and testing as required to complete the work described.
- .5        The commissioning process consists of:
  - .1        Component verifications per this Section.
  - .2        Integrated Component Performance Verification Testing and Demonstration per Section 01 91 13.
- .6        Read this Section in conjunction with related Sections, which specify portions of electrical commissioning work. Refer also to Division 1.
- .7        Except where otherwise specified, arrange and pay for the testing and related requirements specified in this and related Sections.
- .8        If test results do not conform to applicable requirements, repair, replace or adjust components. Repeat testing as necessary until results acceptable to the Engineer are achieved.

**1.2            VERIFICATION AND REPORTING**

- .1        General:
  - .1        Component Verification Testing shall be conducted per this Section.
  - .2        Submit completed verification and test reports immediately after inspections and/or tests are performed.
  - .3        Record all data gathered on site on approved verification forms with completed shop drawing data.
  - .4        Provide the Engineer with original of each completed verification form.
  - .5        Maintain one photocopy on site of all data taken during commissioning.
  - .6        Maintain one copy of all final reports on site up to interim acceptance of the work for reference purposes.



- .7 All final verification forms are to be typewritten.
- .8 Submit to engineer for approval.
- .9 Make corrections and re-submit as requested by Engineer.

### **1.3 SCHEDULE**

- .1 Prior to starting and testing of components, prepare a schedule for the required testing.
- .2 Provide sufficient notice minimum 21 calendar days prior to commencing tests.
- .3 Engineer may witness all or any portion of the component testing.
- .4 Contractor to be present for and participate in all tests.
- .5 Unless otherwise specified in writing by the Engineer all testing and related requirements specified herein will be performed prior to the issue of the Interim Certificate of Completion.

### **1.4 COORDINATION**

- .1 Coordinate all sub-trades, manufacturers, suppliers and other specialists as required to ensure all phases of work shall be properly organized prior to commencement of each particular testing procedure. Establish all necessary manpower requirements.
- .2 Where any components require testing prior to starting, ensure that such work has been completed and approved prior to starting of these components. In particular, the requirements specified in Division 23, 25 and 26 shall be coordinated by the Contractor to complete the commissioning requirements

### **1.5 COMMISSIONING MEETINGS**

- .1 Provide the appropriate representation at the scheduled commissioning meetings as outline in Section 01 91 13.

### **1.6 PRESIDING AUTHORITIES**

- .1 Starting procedures defined in this section may duplicate verification conducted by presiding authorities. To facilitate expedient turnover of the building, arrange for authorities to witness procedures in a manner that avoids unnecessary duplication of tests.
- .2 Obtain certificates of approval, acceptance and comply with rules and regulations of authorities having jurisdiction. Provide originals of all certificates to engineer.

### **1.7 CORRECTION OF DEFICIENCIES**

- .1 Identify, record, resolve and correct all contract deficiencies found during commissioning.

### **1.8 COMPLIANCE WITH DEFINED PROCEDURES**

- .1 Failure to follow the specific instructions defined herein pertaining to correct starting procedures may result in re-evaluation of components by independent testing agency

selected by engineer at contractors expense. Should results reveal components have not been started in accordance with specified requirements, components may be rejected. If required, remove components from site and replace. Replacement components shall also be subject to full starting procedures. Using the same procedures specified on the originally installed components.

## **1.9 TESTING CONDUCTED BY ENGINEER**

- .1 The Engineer may select and conduct at random, components to be re-tested.
- .2 Testing of any component by the Engineer does not reduce the Contractors obligations for complete testing and start-up of that component.
- .3 The Engineer will be responsible for the direct costs of any Engineer's testing excepting Contractor's support.
- .4 Contractor will provide, without cost, support for these tests.
- .5 Making all test equipment and instrumentation available to the Engineer.
- .6 Operating appropriate components.
- .7 Any tests duplicated by the Engineer will be conducted under the same terms of reference applied to the Contractor.
- .8 The Contractor can choose to witness any testing conducted by the Engineer.
- .9 Should any component fail under Engineer's testing the Contractor will correct the deficiency and re-test to the satisfaction of the Engineer at the Contractor's expense.

## **1.10 SPECIALTY AGENT AND TESTING LABORATORIES**

- .1 All reports generated by special testing agencies or testing laboratories shall be submitted by the Contractor to the Engineer.
- .2 All agencies and testing laboratories shall be pre-approved by the Engineer and have acceptable facilities and qualifications.

## **PART 2 Products**

### **2.1 CONTRACTOR INSTRUMENTS TESTING**

- .1 Provide two-way radios, ladders and other equipment as required to complete the program and as outlined in this Specification.
- .2 Provide all safety equipment required for personnel involved in the starting, testing, adjusting and balancing program.
- .3 Provide a list of equipment and instruments which will be used in starting, testing, and adjusting of electrical equipment for approval and review by the Engineer.

- .4 Use instruments supplied or calibrated by approved laboratory or manufacturer. Show the Engineer the current calibration certificate for each instrument to be used. Provide a copy of the calibration certificates with test reports

### **PART 3 Execution**

#### **3.1 GENERAL**

- .1 Contractor and manufacturer startup and proving to be carried out in accordance with the respective Section.

#### **3.2 COMPONENT VERIFICATIONS**

- .1 The component verification forms will be completed by the Contractor as follows:
  - .1 The 'Specified' requirements shall be completed by the Contractor at the shop drawing submission stage.
  - .2 The 'Shop Drawing' information shall be completed by the Contractor at the shop drawing submission stage.
  - .3 The 'Installed' information shall be completed by the Contractor.
- .2 The component verification forms will be provided to the Contractor for information and convenience and will not relieve the Contractor of responsibility for verification of components not included on the verification forms.
- .3 A verification form is to be completed for each component requiring verification.
- .4 Component verification forms will be approved and subject to random verification by the Engineer.

#### **3.3 PERFORMANCE VERIFICATION TESTING**

- .1 All Contractor and manufacturer startup and proving tests are to be completed and approved by the Engineer prior to conducting the defined Performance Verification Tests.
- .2 All component verifications shall be completed by the Contractor and approved by the Engineer prior to conducting the defined Performance Verification Test.
- .3 The Contractor will complete the Contractor verification portion of the Performance Verification Test form prior to notifying the Engineer that the components are ready for verification.
- .4 Performance Verification Testing shall be Scheduled and conducted by the Contractor.
- .5 Performance Verification Tests as per the verification forms will be conducted in the presence of the Engineer.

#### **3.4 PERFORMANCE VERIFICATION TEST FORMS**

- .1 Refer to Test Forms in Section 26 05 10A.

**END OF SECTION**

**INDUSTRIAL Air Circuit Breaker COMMISSIONING FORM**

**Form E-1**

Breaker ID: \_\_\_\_\_  
 Manufacturer: \_\_\_\_\_  
 Model No.: \_\_\_\_\_  
 Type (Fixed or Draw-out): \_\_\_\_\_  
 Voltage / Phase: \_\_\_\_\_

Panel ID: \_\_\_\_\_  
 Amp Frame/Trip: \_\_\_\_\_  
 IC Rating (kA): \_\_\_\_\_  
 Solid State Trip Unit: \_\_\_\_\_

INDICATE ACCEPTANCE  
 WITH A ( ✓ ) MARK  
**CONTRACTOR CxA**

**INSTALLATION REVIEW**

**COMMENTS**

Equipment Conforms to Shop Drawings	( )	( )
Nameplate Complete	( )	( )
Breaker Identification Lamicoids	( )	( )
Cable Phasing Identified Correctly	( )	( )
Breaker Bolts Torqued	( )	( )
Breaker Cable Lugs Tightened	( )	( )
Red Lacquer All Bolted Connections	( )	( )
Breaker Interrupting Capacity OK	( )	( )
Relay Trip Settings Confirmed	( )	( )
Clearance for Draw-out Breakers	( )	( )
Breaker Lock-Off Device	( )	( )
Condition / Cleanliness of Assembly	( )	( )
Rackout Mechanism	( )	( )
Breaker Mechanical Operation	( )	( )
Test Results Reviewed	( )	( )

**TEST RESULTS**

Attach Independent Testing Agent Report Sheets

**REMARKS** .....

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POSITION/ TITLE	SIGNATURE	DATE
Building Owner/Representative		
Building Operations and Maintenance Staff		
Cx Authority		
Design Consultants		
Contractors/Subcontractor		
Manufacture / Independent Testing Specialists		

**FUSED DISCONNECT SWITCH COMMISSIONING FORM**

**Form E-2**

Switch ID.:	_____	Fuse Manufacturer:	_____
Manufacturer:	_____	Fuse Type:	_____
Model No.:	_____	Fuse Size:	_____
Amp Rating:	_____	Voltage / Phase:	_____
IC Rating (kA):	_____		

INDICATE ACCEPTANCE  
 WITH A ( ✓ ) MARK

<u>INSTALLATION REVIEW</u>	<b>CONTRACTOR</b>	<b>CxA</b>	<u>COMMENTS</u>
Equipment Conforms to Shop Drawings	( )	( )	
Nameplate Complete	( )	( )	
Switch Identification Lamicoids	( )	( )	
Cable Phasing Identified Correctly	( )	( )	
Breaker Bolts Torqued	( )	( )	
Breaker Cable Lugs Tightened	( )	( )	
Red Lacquer All Bolted Connections	( )	( )	
Switch Interrupting Capacity OK	( )	( )	
Fuse Rating Confirmed	( )	( )	
Switch Lock-off Device	( )	( )	
Door Interlock	( )	( )	
Condition / Cleanliness of Assembly	( )	( )	
Test Results Reviewed	( )	( )	

**TEST RESULTS**

Attach Independent Testing Agent Report Sheets

**REMARKS**.....

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POSITION/ TITLE	SIGNATURE	DATE
Building Owner/Representative		
Building Operations and Maintenance Staff		
Cx Authority		
Design Consultants		
Contractors/Subcontractor		
Manufacture / Independent Testing Specialists		

**DIGITAL METERING COMMISSIONING FORM**

**Form E-3**

Unit ID.:	_____	Panel Location:	_____
Manufacturer:	_____	CT Model No.:	_____
Model No.:	_____	CT Ratio:	_____
System Config.:	_____	PT Model No.:	_____
Comm. Port:	_____	PT Ratio:	_____

INDICATE ACCEPTANCE  
 WITH A ( ✓ ) MARK

<u>INSTALLATION REVIEW</u>	<u>CONTRACTOR</u>	<u>CxA</u>	<u>COMMENTS</u>
Equipment Conform to Shop Drawings	( )	( )	
Nameplate Complete	( )	( )	
Wiring Identification Complete	( )	( )	
Check Unit Power Supply	( )	( )	
Check CTs	( )	( )	
Check PTs	( )	( )	
Mounting	( )	( )	
System Parameters Correctly Setup	( )	( )	
All Measurement Digital Display OK	( )	( )	
User Programming Complete	( )	( )	
Test Block Installed	( )	( )	
Test Plugs Provided	( )	( )	
Remote Monitoring	( )	( )	
Networking	( )	( )	
Test Results Reviewed (see page 2)	( )	( )	

**REMARKS**.....  
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POSITION/ TITLE	SIGNATURE	DATE
Building Owner/Representative		
Building Operations and Maintenance Staff		
Cx Authority		
Design Consultants		
Contractors/Subcontractor		
Manufacture / Independent Testing Specialists		

**GENERATOR COMMISSIONING FORM**

**Form E-4**

Unit ID.:	_____	Gen. Breaker Size:	_____
Location:	_____	Voltage:	_____
Manufacturer:	_____	kW / kVA:	_____
Model No.:	_____	Rated Amp:	_____
Phase/Wire/Hz:	_____	Power Factor:	_____
Serial No.:	_____	Battery:	_____

INDICATE ACCEPTANCE  
 WITH A ( ✓ ) MARK

<u>INSTALLATION REVIEW</u>	<u>CONTRACTOR</u>	<u>CxA</u>	<u>COMMENTS</u>
Equipment Conform to Shop Drawings	( )	( )	
Generator Set:			
Nameplate Complete	( )	( )	
Identification Lamicoid	( )	( )	
Cable Phasing Identification	( )	( )	
Terminal Phasing Identified	( )	( )	
Spring Vibration Isolators	( )	( )	
Exhaust System	( )	( )	
Ventilation (Rad)	( )	( )	
Clearance from Adjacent Surfaces	( )	( )	
Block Heater and Thermostat	( )	( )	
Check Oil Level and Filter	( )	( )	
Check Engine Coolant	( )	( )	
Grounding of Equipment	( )	( )	
Battery Bank and Charger:			
Nameplate Complete	( )	( )	
Battery Cell Links	( )	( )	
Ventilation	( )	( )	
Cable Connections and Polarity	( )	( )	
Check Fuel System	( )	( )	
Tests Results Reviewed	( )	( )	

**TEST RESULTS**

- Attach: (1) Generator Factory Test Results  
 (2) Manufacturer's Site Testing Records  
 (3) Noise Level Measurement  
 (4) Load Test Results

**REMARKS** .....

POSITION/ TITLE	SIGNATURE	DATE
Building Owner/Representative		
Building Operations and Maintenance Staff		
Cx Authority		
Design Consultants		
Contractors/Subcontractor		
Manufacture / Independent Testing Specialists		

**GENERATOR CONTROL PANEL COMMISSIONING FORM**

**Form E-5**

Unit ID.: \_\_\_\_\_ Location: \_\_\_\_\_  
 Manufacturer: \_\_\_\_\_ Model No.: \_\_\_\_\_

INDICATE ACCEPTANCE  
 WITH A ( ✓ ) MARK

<u>INSTALLATION REVIEW</u>	<u>CONTRACTOR</u>	<u>CxA</u>	<u>COMMENTS</u>
Equipment Conform to Shop Drawings	( )	( )	
Control Panel:			
Nameplate Complete	( )	( )	
Identification Lamicoïd	( )	( )	
Metering and Gauges	( )	( )	
Wiring & Terminals Identified	( )	( )	
Mounting and Supports	( )	( )	
Equipment Cleanliness	( )	( )	
Clearance Around Panel	( )	( )	
<u>OPERATIONAL CHECKS</u>			
Engine Control Panel:			
Oil Pressure Gauge	( )	( )	
Water Temperature Gauge	( )	( )	
Cranking Limiter Relay	( )	( )	
Tachometer	( )	( )	
Generator Control Panel:			
Voltmeter & Selector Switch	( )	( )	
Ammeter & Selector Switch	( )	( )	
Voltage Regulator	( )	( )	
Frequency Meter	( )	( )	
Elapsed Time Meter	( )	( )	
Engine Alarm Panel:			
Gen. Off/Start/Auto Switch	( )	( )	
Silence Switch & Pilot Light	( )	( )	
Alarm Lights & Horn Operational for:			
Low Oil Pressure	( )	( )	
High Water Temperature	( )	( )	
Low Oil Pressure Shutdown	( )	( )	
High Water Temperature Shutdown	( )	( )	
Overspeed Shutdown	( )	( )	
Overcranking Shutdown	( )	( )	

**REMARKS** .....

POSITION/ TITLE	SIGNATURE	DATE
Building Owner/Representative		
Building Operations and Maintenance Staff		
Cx Authority		
Design Consultants		
Contractors/Subcontractor		
Manufacture / Independent Testing Specialists		





**TRANSFER SWITCH COMMISSIONING FORM**

**Form E-7**

Unit ID.:	_____	Fed From:	_____
Location:	_____	Feeder Size:	_____
Manufacturer:	_____	Bus (Al or Cu):	_____
Model No.:	_____	Bypass Switch:	_____
Volt/Phase/Pole:	_____	Interrupting Rating:	_____
Rated Amp:	_____	Serial No.:	_____

INDICATE ACCEPTANCE  
 WITH A ( ✓ ) MARK

<u>INSTALLATION REVIEW</u>	<u>CONTRACTOR</u>	<u>CxA</u>	<u>COMMENTS</u>
Equipment Conform to Shop Drawings	( )	( )	
Nameplate Complete	( )	( )	
Identification Lamicoid	( )	( )	
Warning Signs	( )	( )	
Bus Phasing Identified	( )	( )	
Cable Phasing Identification	( )	( )	
All Bus Bolts Properly Torqued	( )	( )	
Red Lacquer All Bolted Connections	( )	( )	
Mechanical - Electrical Interlock Devices	( )	( )	
Condition of Contacts and Alignment	( )	( )	
Condition of Arc Chutes and Insulators	( )	( )	
Condition of Assembly & Paint Finish	( )	( )	
Lubrication and Cleanliness	( )	( )	
Check All Wiring Connections	( )	( )	
All Devices Correctly Identified	( )	( )	
Emergency Contacts for Aux. Controls	( )	( )	
Time Delay Relays: Settings Confirmed	( )	( )	
Drip Hood	( )	( )	
Grounding of Equipment	( )	( )	
Test Results Reviewed	( )	( )	

**TEST RESULTS**

Attach Independent Testing Agent Report Sheets

**REMARKS** .....

POSITION/ TITLE	SIGNATURE	DATE
Building Owner/Representative		
Building Operations and Maintenance Staff		
Cx Authority		
Design Consultants		
Contractors/Subcontractor		
Manufacture / Independent Testing Specialists		

**GROUNDING COMMISSIONING FORM**

**Form E-8**

INDICATE ACCEPTANCE  
 WITH A ( ✓ ) MARK

**GROUNDING TEST REVIEW**

**CONTRACTOR CxA**

**COMMENTS**

Perform ground continuity and resistance tests ( ) ( )  
 In affected areas including but not limited to: main  
 and sub distribution panels, motors, generator and  
 enclosure, control panels, building steel work, and  
 transfer switch ( ) ( )  
 Perform tests before energizing electrical system ( ) ( )  
 Disconnect ground fault indicator during tests ( ) ( )  
 Tabulate data and attach to this report ( ) ( )  
 Use of a recognized, commercially available ground  
 Resistance test operated by trained personnel ( ) ( )

**TEST RESULTS**

Attach Testing Report Sheets

**REMARKS**.....  
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POSITION/ TITLE	SIGNATURE	DATE
Building Owner/Representative		
Building Operations and Maintenance Staff		
Cx Authority		
Design Consultants		
Contractors/Subcontractor		
Manufacture / Independent Testing Specialists		

**End of Section**

**Part 1            General**

**1.1                SECTION INCLUDES**

- .1            Materials and installation for wire and box connectors.

**1.2                RELATED SECTIONS**

- .1            Section 01 74 19 - Construction/Demolition Waste Management And Disposal.

**1.3                REFERENCES**

- .1            Canadian Standards Association (CSA International)
  - .1            CAN/CSA-C22.2No.18-98, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
  - .2            CSA C22.2No.65-93(R1999), Wire Connectors.
- .2            Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
  - .1            EEMAC 1Y-2, 1961 Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).
- .3            National Electrical Manufacturers Association (NEMA)

**1.4                WASTE MANAGEMENT AND DISPOSAL**

- .1            Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
- .2            Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3            Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4            Divert unused wiring materials from landfill to metal recycling facility as approved by Engineer Consultant.

**Part 2            Products**

**2.1                MATERIALS**

- .1            Pressure type wire connectors to: CSA C22.2No.65, with current carrying parts of copper sized to fit copper conductors as required.
- .2            Fixture type splicing connectors to: CSA C22.2No.65, with current carrying parts of copper alloy sized to fit copper conductors 10 AWG or less.
- .3            Bushing stud connectors: to EEMAC 1Y-2 NEMA to consist of:

□

- .1 Connector body and stud clamp for stranded copper conductors.
  - .2 Clamp for stranded copper conductors bar.
  - .3 Stud clamp bolts.
  - .4 Bolts for copper conductors.
  - .5 Sized for conductors as indicated.
- .4 Clamps or connectors for armoured cable, flexible conduit, as required to:  
CAN/CSA-C22.2No.18.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Remove insulation carefully from ends of conductors and:
  - .1 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2No.65.
  - .2 Install fixture type connectors and tighten. Replace insulating cap.
  - .3 Install bushing stud connectors in accordance with EEMAC 1Y-2 NEMA.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1            Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.

**1.2                REFERENCES**

- .1            CSA C22.2 No .0.3-96, Test Methods for Electrical Wires and Cables.

**1.3                PRODUCT DATA**

- .1            Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

**1.4                WASTE MANAGEMENT AND DISPOSAL**

- .1            Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal, and with the Waste Reduction Workplan.
- .2            Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.
- .3            Fold up metal banding, flatten and place in designated area for recycling.

**Part 2            Products**

**2.1                BUILDING WIRES**

- .1            Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
- .2            Copper conductors: size as indicated, with 1000 V insulation of chemically cross-linked thermosetting polyethylene material rated RWU90.

**2.2                MINERAL-INSULATED CABLES**

- .1            Conductors: solid bare soft-annealed copper, size as indicated.
- .2            Insulation: compressed powdered magnesium oxide or silicon dioxide to form compact homogeneous mass throughout entire length of cable.
- .3            Outer covering: annealed seamless copper sheath, Type M1 rated 600 V, 250 degrees C.
- .4            Two hour fire rating.
- .5            Connectors: factory installed and tested approved for MI cable.
- .6            Termination kits: field installed approved for MI cable.

**Part 3 Execution**

**3.1 GENERAL CABLE INSTALLATION**

- .1 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - (0-1000 V).
- .2 Cable Colour Coding: to Section 26 05 00 Common Work Results for Electrical.
- .3 Conductor length for parallel feeders to be identical.
- .4 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
- .5 Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.

**3.2 INSTALLATION OF BUILDING WIRES**

- .1 Install wiring as follows:
  - .1 In conduit systems in accordance with Section 26 05 34.
  - .2 In trenches in accordance with Section 26 05 44.

**3.3 INSTALLATION OF MINERAL-INSULATED CABLES**

- .1 Install cable exposed, securely supported by hangers and as per manufacturer instructions.
- .2 Support 2 hour fire rated cables at 1 m intervals and as per manufacturer instructions.
- .3 Make cable terminations by using factory-made kits.
- .4 Cable terminations: as per manufacturer requirements.
- .5 Where cables are through concrete wall or floor, sleeve for entry/exit of cables.
- .6 Do not splice cables unless indicated.

**END OF SECTION**

**Part 1            General**

**1.1                SECTION INCLUDES**

- .1            Materials and installation for connectors and terminations.

**1.2                RELATED SECTIONS**

- .1            Section 01 33 00 - Submittal Procedures.
- .2            Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
- .3            Section 26 05 33 - Raceway and Boxes for Electrical Systems.

**1.3                REFERENCES**

- .1            Canadian Standards Association (CSA International)
  - .1            CSA C22.2 No. 65-03. Wire Connectors..
  - .2            CSA C22.2 No.41-M1987(R1999), Grounding and Bonding Equipment.

**1.4                PRODUCT DATA**

- .1            Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

**1.5                WASTE MANAGEMENT AND DISPOSAL**

- .1            Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
- .2            Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3            Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4            Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Engineer.

**Part 2            Products**

**2.1                CONNECTORS AND TERMINATIONS**

- .1            Copper compression connectors to CSA C22.2No.65-03 as required sized for conductors.
- .2            2 way joint boxes dry location type in accordance with Section 26 05 33 - Raceway and Boxes for Electrical Systems.
- .3            Use VFD connectors OR connector rated for Class II, Groups E, F and G hazardous locations between VFDs and motor connections.

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**Part 3          Execution**

**3.1              INSTALLATION**

- .1      Install stress cones, terminations, and splices in accordance with manufacturer's instructions.
- .2      Install VFD connectors between VFDs and motor connections.
- .3      Bond and ground as required to CSA C22.2No.41.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1        Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
- .2        Section 26 05 00 - Common Work Results - Electrical.

**1.2                WASTE MANAGEMENT AND DISPOSAL**

- .1        Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
- .2        Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3        Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4        Divert unused metal materials from landfill to metal recycling facility as approved by Engineer.
- .5        Fold up metal banding, flatten and place in designated area for recycling.

**Part 2            Products**

**2.1                EQUIPMENT**

- .1        Clamps for grounding of conductor: size as required to electrically conductive underground water pipe.
- .2        Grounding conductors: bare stranded copper, tinned, soft annealed, size as indicated.
- .3        Insulated grounding conductors: green.
- .4        Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
  - .1        Grounding and bonding bushings.
  - .2        Protective type clamps.
  - .3        Bolted type conductor connectors.
  - .4        Thermit welded type conductor connectors.
  - .5        Bonding jumpers, straps.
  - .6        Pressure wire connectors.

**Part 3 Execution**

**3.1 INSTALLATION GENERAL**

- .1 Install complete permanent, continuous grounding system including, conductors, connectors, accessories. Where EMT is used, run ground wire in conduit.
- .2 Install connectors in accordance with manufacturer's instructions.
- .3 Protect exposed grounding conductors from mechanical injury.
- .4 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .5 Soldered joints not permitted.
- .6 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.
- .7 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.
- .8 Connect building structural steel and metal siding to ground by welding copper to steel.
- .9 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end and load end.
- .10 Ground secondary service pedestals.
- .11 Make special provision for installing electrodes that will give acceptable resistance to ground value where rock or sand terrain prevails. Ground as indicated.

**3.2 SYSTEM AND CIRCUIT GROUNDING**

- .1 Install system and circuit grounding connections to neutral of secondary 600V system.

**3.3 EQUIPMENT GROUNDING**

- .1 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, switchgear, duct systems, frames of motors, motor control centres, starters, control panels, building steel work, distribution panels.

**3.4 GROUNDING BUS**

- .1 Ground items of electrical equipment in electrical room to existing ground bus with individual bare stranded copper connections size 2/0AWG.

**3.5 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Consultant and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.
- .4 Disconnect ground fault indicator during tests.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1        Section 01 74 19 - Construction/Demolition Waste Management And Disposal.

**1.2                WASTE MANAGEMENT AND DISPOSAL**

- .1        Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
- .2        Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3        Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4        Divert unused metal materials from landfill to metal recycling facility as approved by Engineer.
- .5        Fold up metal banding, flatten and place in designated area for recycling.

**Part 2            Products**

**2.1                SUPPORT CHANNELS**

- .1        U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted.

**Part 3            Execution**

**3.1                INSTALLATION**

- .1        Secure equipment to solid masonry, tile and plaster surfaces with lead anchors.
- .2        Secure equipment to poured concrete with expandable inserts.
- .3        Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .4        Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .5        Fasten exposed conduit or cables to building construction or support system using straps.
  - .1        One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
  - .2        Two-hole steel straps for conduits and cables larger than 50 mm.
  - .3        Beam clamps to secure conduit to exposed steel work.

- .6 Suspended support systems.
  - .1 Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.
  - .2 Support 2 or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.
- .7 For surface mounting of two or more conduits use channels at 3000mm on centre spacing.
- .8 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .9 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .10 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .11 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Consultant.
- .12 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

**END OF SECTION**

**Part 1            General**

**1.1                SHOP DRAWINGS AND PRODUCT DATA**

- .1        Submit shop drawings and product data for cabinets in accordance with Section 01 33 00 - Submittal Procedures.

**1.2                WASTE MANAGEMENT AND DISPOSAL**

- .1        Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal, and with the Waste Reduction Workplan.
- .2        Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.
- .3        Fold up metal banding, flatten and place in designated area for recycling.

**Part 2            Products**

**2.1                JUNCTION AND PULL BOXES**

- .1        Welded steel construction with screw-on flat covers for surface mounting.
- .2        Covers with 25 mm minimum extension all around, for flush-mounted pull and junction boxes.

**Part 3            Execution**

**3.1                JUNCTION AND PULL BOXES INSTALLATION**

- .1        Install pull boxes in inconspicuous but accessible locations.
- .2        Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 30 m of conduit run between pull boxes.

**3.2                IDENTIFICATION**

- .1        Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2        Install size 2 identification labels indicating system name voltage and phase.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCES**

- .1            CSA C22.1-2006, Canadian Electrical Code, Part 1.

**1.2                WASTE MANAGEMENT AND DISPOSAL**

- .1            Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal, and with the Waste Reduction Workplan.
- .2            Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

**Part 2            Products**

**2.1                OUTLET AND CONDUIT BOXES GENERAL**

- .1            Size boxes in accordance with CSA C22.1.
- .2            102 mm square or larger outlet boxes as required for special devices.
- .3            Gang boxes where wiring devices are grouped.
- .4            Blank cover plates for boxes without wiring devices.
- .5            347 V outlet boxes for 347 V switching devices.
- .6            Combination boxes with barriers where outlets for more than one system are grouped.

**2.2                SHEET STEEL OUTLET BOXES**

- .1            Electro-galvanized steel utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48 mm.

**2.3                CONDUIT BOXES**

- .1            Cast FD aluminum boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle.

**2.4                OUTLET BOXES FOR NON-METALLIC SHEATHED CABLE**

- .1            Electro-galvanized, sectional, screw ganging steel boxes, minimum size 76 x 50 x 63 mm with two double clamps to take non-metallic sheathed cables.

**2.5                FITTINGS - GENERAL**

- .1            Bushing and connectors with nylon insulated throats.

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- .2 Knock-out fillers to prevent entry of debris.
- .3 Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Support boxes independently of connecting conduits.
- .2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
- .3 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 Canadian Standards Association (CSA)
  - .1 CAN/CSA C22.2 No. 18-98, Outlet Boxes, Conduit Boxes, and Fittings and Associated Hardware.
  - .2 CSA C22.2 No. 56-1977(R1999), Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - .3 CSA C22.2 No. 83-M1985(R1999), Electrical Metallic Tubing.
  - .4 CSA C22.2 No. 211.2-M1984(R1999), Rigid PVC (Unplasticized) Conduit.
  - .5 CAN/CSA C22.2 No. 227.3-M91(R1999), Flexible Nonmetallic Tubing.

**1.2 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal, and with the Waste Reduction Workplan.
- .2 Place materials defined as hazardous or toxic waste in designated containers.
- .3 Ensure emptied containers are sealed and stored safely for disposal away from children.
- .4 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

**Part 2 Products**

**2.1 CONDUITS**

- .1 Electrical metallic tubing (EMT): to CSA C22.2 No. 83.
- .2 Rigid pvc conduit: to CSA C22.2 No. 211.2.
- .3 Flexible metal conduit: to CSA C22.2 No. 56, steel aluminum liquid-tight flexible metal.
- .4 Flexible pvc conduit: to CAN/CSA-C22.2 No. 227.3.

**2.2 CONDUIT FASTENINGS**

- .1 One hole steel straps to secure surface conduits NPS 2 50 mm. Two hole steel straps for conduits larger than NPS 2 50 mm.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits at 3000m oc.

- .4 Threaded rods, 6 mm dia., to support suspended channels.

### **2.3 CONDUIT FITTINGS**

- .1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.
- .2 Factory "ells" where 90E bends are required for NPS 1 25 mm and larger conduits.
- .3 Watertight connectors and couplings for EMT. Set-screws are not acceptable.

### **2.4 EXPANSION FITTINGS FOR RIGID CONDUIT**

- .1 Weatherproof expansion fittings with internal bonding assembly suitable for 100mm linear expansion.
- .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection in all directions.
- .3 Weatherproof expansion fittings for linear expansion at entry to panel.

### **2.5 FISH CORD**

- .1 Polypropylene.

## **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 Conceal conduits except in mechanical and electrical service rooms in unfinished areas.
- .3 Surface mount conduits except as indicated on the drawing.
- .4 Use electrical metallic tubing (EMT) except in cast concrete above 2.4 m not subject to mechanical injury.
- .5 Use rigid pvc conduit underground in corrosive areas.
- .6 Use flexible metal conduit for connection to motors in dry areas connection to recessed incandescent fixtures without a prewired outlet box connection to surface or recessed fluorescent fixtures work in movable metal partitions.
- .7 Minimum conduit size for lighting and power circuits: NPS 3/4 19 mm.
- .8 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.

- .9 Mechanically bend steel conduit over 19 mm dia.
- .10 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .11 Install fish cord in empty conduits.
- .12 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- .13 Dry conduits out before installing wire.

### **3.2 SURFACE CONDUITS**

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on suspended or surface channels.
- .5 Do not pass conduits through structural members except as indicated.
- .6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

### **3.3 CONDUITS UNDERGROUND**

- .1 Slope conduits to provide drainage.
- .2 Waterproof joints (pvc excepted) with heavy coat of bituminous paint.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1        Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
- .2        Section 26 05 00 - Common Work Results - Electrical.

**1.2                REFERENCES**

- .1        Canadian Standards Association, (CSA International)
- .2        Insulated Cable Engineers Association, Inc. (ICEA)

**1.3                WASTE MANAGEMENT AND DISPOSAL**

- .1        Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
- .2        Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3        Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4        Unused sealant material must not be disposed of into sewer system, into streams, lakes, onto ground or in other location where it will pose health or environmental hazard.
- .5        Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Engineer.
- .6        Do not dispose of preservative treated wood through incineration.
- .7        Do not dispose of preservative treated wood with other materials destined for recycling or reuse.
- .8        Dispose of treated wood, end pieces, wood scraps and sawdust at sanitary landfill approved by Engineer.
- .9        Fold up metal banding, flatten and place in designated area for recycling.

**Part 2            Execution**

**2.1                CABLE INSTALLATION IN DUCTS**

- .1        Install cables as indicated in ducts.
  - .1        Do not pull spliced cables inside ducts.

- .2 Install multiple cables in duct simultaneously.
- .3 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.
- .4 To facilitate matching of colour coded multiconductor control cables reel off in same direction during installation.
- .5 Before pulling cable into ducts and until cables are properly terminated, seal ends of lead covered cables with wiping solder; seal ends of non-leaded cables with moisture seal tape.
- .6 After installation of cables, seal duct ends with duct sealing compound.

## **2.2 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Perform tests using qualified personnel. Provide necessary instruments and equipment.
- .3 Check phase rotation and identify each phase conductor of each feeder.
- .4 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.
- .5 Pre-acceptance tests.
  - .1 After installing cable but before splicing and terminating, perform insulation resistance test with 1000 V megger on each phase conductor.
  - .2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.
- .6 Acceptance Tests
  - .1 Ensure that terminations and accessory equipment are disconnected.
  - .2 Ground shields, ground wires, metallic armour and conductors not under test.
  - .3 High Potential (Hipot) Testing.
    - .1 Conduct hipot testing in accordance with manufacturer's ICEA recommendations.
  - .4 Leakage Current Testing.
    - .1 Raise voltage in steps from zero to maximum values as specified by ICEA for type of cable being tested.
    - .2 Hold maximum voltage for specified time period by ICEA manufacturer.
    - .3 Record leakage current at each step.
- .7 Provide Consultant with list of test results showing location at which each test was made, circuit tested and result of each test.
- .8 Remove and replace entire length of cable if cable fails to meet any of test criteria.

**END OF SECTION**

**Part 1            General**

**1.1            SECTION INCLUDES**

- .1        Materials and components for dry type transformers up to 600 V primary, equipment identification and transformer installation.

**1.2            RELATED SECTIONS**

- .1        Section 01 33 00 - Submittal Procedures.
- .2        Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .3        Section 26 05 00 - Common Work Results - Electrical.

**1.3            REFERENCES**

- .1        CSA International
  - .1        CAN/CSA-C22.2 No.47-M90(R2007), Air-Cooled Transformers (Dry Type).
  - .2        CSA C9-02(R2007), Dry-Type Transformers.
  - .3        CAN/CSA-C802.2-06, Minimum Efficiency Values for Dry Type Transformers.
- .2        National Electrical Manufacturers Association (NEMA)

**1.4            ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Product Data:
  - .1        Submit manufacturer's instructions, printed product literature and data sheets for dry type transformers and include product characteristics, performance criteria, physical size, finish and limitations.

**1.5            CLOSEOUT SUBMITTALS**

- .1        Operation and Maintenance Data: submit operation and maintenance data for dry type transformers for incorporation into manual.

**1.6            DELIVERY, STORAGE AND HANDLING**

- .1        Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2        Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3        Storage and Handling Requirements:
  - .1        Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2        Store and protect dry type transformers from nicks, scratches, and blemishes.

- .3 Replace defective or damaged materials with new.

## **Part 2 Products**

### **2.1 DESIGN DESCRIPTION**

- .1 Use transformers of one manufacturer throughout project and in accordance with CAN/CSA-C22.2No.47, CSA-C9.
- .2 Design.
  - .1 Type: Dry Type.
  - .2 3 phase, 30 kVA, 600 V input, 120/208 V output, 60 Hz.
  - .3 Voltage taps: standard.
  - .4 Insulation: Class 220, 150 degrees C temperature rise.
  - .5 Basic Impulse Level (BIL): standard.
  - .6 Hipot: standard.
  - .7 Average sound level: standard
  - .8 Impedance at 17 degrees C: standard
  - .9 Enclosure: CSA, removable metal front panel.
  - .10 Mounting: ceiling or floor.
  - .11 Finish: in accordance with Section 26 05 00 - Common Work Results for Electrical.
  - .12 Copper windings.
  - .13 Winding configuration to be as noted on drawings.
  - .14 Voltage Regulation to be 4% or better.

### **2.2 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Label size: 7.
- .3 Nameplate wording: TX-G.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Mount dry type transformers up to 75 kVA in ceiling OR on floor.
- .2 Ensure adequate clearance around transformer for ventilation.
- .3 Install transformers in level upright position.



- .4 Remove shipping supports only after transformer is installed and just before putting into service.
- .5 Loosen isolation pad bolts until no compression is visible.
- .6 Make primary and secondary connections in accordance with wiring diagram.
- .7 Energize transformers after installation is complete.

### **3.2 EXAMINATION**

- .1 Verify that delivered transformers is free of physical defects and visible damage:

### **3.3 CLEANING**

- .1 Progress Cleaning: leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.
- .3 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

### **3.4 PROTECTION**

- .1 Protect delivered products and components from damage during transportation.
- .2 Repair damage to adjacent materials caused by dry type transformers transportation.

**END OF SECTION**

**Part 1            General**

**1.1                SECTION INCLUDES**

- .1            Materials and installation for non-fused disconnect switches.

**1.2                RELATED SECTIONS**

- .1            Section 01 33 00 - Submittal Procedures.
- .2            Section 01 35 30 - Health and Safety Requirements.
- .3            Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
- .4            Section 26 05 01 - Common Work Results - Electrical.

**1.3                REFERENCES**

- .1            Canadian Standards Association (CSA International).
  - .1            CAN/CSA C22.2 No.4-M89 (R2000), Enclosed Switches.
  - .2            CSA C22.2 No.39-M89 (R2003), Fuseholder Assemblies.

**1.4                SUBMITTALS**

- .1            Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

**1.5                HEALTH AND SAFETY**

- .1            Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

**1.6                WASTE MANAGEMENT AND DISPOSAL**

- .1            Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
- .2            Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3            Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4            Separate for reuse and recycling and place in designated containers Steel Metal Plastic waste in accordance with Waste Management Plan.
- .5            Fold up metal banding, flatten and place in designated area for recycling.

**Part 2 Products**

**2.1 DISCONNECT SWITCHES**

- .1 Non-fusible, horsepower rated disconnect switch in CSA Enclosure, to CAN/CSA C22.2 No.4 size as required.
- .2 Provision for padlocking in on-off switch position by three locks.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Quick-make, quick-break action.
- .5 ON-OFF switch position indication on switch enclosure cover.

**2.2 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Indicate name of load controlled on size 4 nameplate.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install disconnect switches complete with fuses if applicable.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American Petroleum Institute (API)
  - .1 API Std. 650-2007(A2008), Welded Steel Tanks for Oil Storage 11th Edition.
- .2 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-3.6-2000, Amend. 2, Regular Sulphur Diesel Fuel.
- .3 Canadian Environmental Protection Act (CEPA)
  - .1 CCME PN 1326-2008, Environmental Code of Practice for Aboveground and Underground Storage Tank Systems for Petroleum Products and Allied Petroleum Products.
- .4 CSA International
  - .1 CSA-B139-09, Installation Code for Oil Burning Equipment.
  - .2 CSA C282-09, Emergency Electrical Power Supply for Buildings.
- .5 International Organization for Standardization (ISO)
  - .1 ISO 3046-1-2002, Reciprocating Internal Combustion Engines - Performance - Part 1: Declarations of Power, Fuel and Lubricating Oil Consumptions, and Test Methods - Additional requirements for engines for general use.
- .6 National Electrical Manufacturers Association (NEMA)
  - .1 NEMA MG 1-2006(R2007), Motors and Generators.
- .7 Underwriters' Laboratories of Canada (ULC)
  - .1 CAN/ULC-S601-07, Standard for Shop Fabricated Steel Aboveground Horizontal Tanks for Flammable and Combustible Liquids.
  - .2 ULC-S603-00, Standard for Steel Underground Tanks for Flammable and Combustible Liquids.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature, specifications and data sheets for power generators and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Alberta of Canada, and include:
    - .1 Engine: make and model, with performance curves.

- .2 Alternator: make and model.
- .3 Voltage regulator: make, model and type.
- .4 Battery: make, type and capacity.
- .5 Battery charger: make, type and model.
- .6 Alternator control panel: make and type of meters and controls.
- .7 Governor type and model.
- .8 Automatic engine enclosure ventilation system.
- .9 Cooling air requirements in m<sup>3</sup>/s.
- .10 Flow diagrams for:
  - .1 Diesel fuel.
  - .2 Cooling air.
- .11 Dimensioned drawing showing complete generating set mounted on steel base, including vibration isolators, exhaust system, drip trays, and total weight.
- .12 Continuous full load output of set at 0.8 PF lagging.
- .13 Description of set operation including:
  - .1 Automatic starting and transfer to load and back to normal power, including time in seconds from start of cranking until unit reaches rated voltage and frequency.
  - .2 Manual starting.
  - .3 Automatic shut down and alarm on:
    - .1 Overcranking.
    - .2 Overspeed.
    - .3 High engine temp.
    - .4 Low lube oil pressure.
    - .5 Short circuit.
    - .6 Alternator over voltage.
    - .7 Lube oil high temperature.
    - .8 Over temperature on alternator.
  - .4 Manual remote emergency stop.

### 1.3 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for diesel generator for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Include in Operation and Maintenance Manual instructions for particular unit supplied and not general description of units manufactured by supplier and:
  - .1 Operation and maintenance instructions for engine, alternator, control panel, battery charger, battery, fuel system, engine enclosure ventilation system, exhaust system and accessories, to permit effective operation, maintenance and repair.
  - .2 Technical data:
    - .1 Illustrated parts lists with parts catalogue numbers.

- .2 Schematic diagram of electrical controls.
- .3 Flow diagrams for:
  - .1 Fuel system.
  - .2 Lubricating oil.
  - .3 Cooling system.
- .4 Certified copy of factory test results.
- .5 Maintenance and overhaul instructions and schedules.
- .6 Precise details for adjustment and setting of time delay relays or sensing controls which require on site adjustment.

#### **1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Packaging Waste Management: remove for reuse and return of pallets, crates, padding and packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

#### **1.5 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Include:
  - .1 2 fuel filter replacement elements.
  - .2 2 lube oil filter replacement elements.
  - .3 2 sets of fuses for control panel.
  - .4 Special tools for unit servicing.

#### **1.6 MANUFACTURER QUALIFICATIONS**

- .1 This system shall be supplied by an original equipment manufacturer (OEM) who has been regularly engaged in the production of engine-alternator sets, outdoor generator-set enclosure, and associated controls for a minimum of 25 years, thereby identifying one source of supply and responsibility.
- .2 The manufacturer shall have printed literature and brochures describing the standard series specified, not a one of a kind fabrication.
- .3 Manufacturer's authorized service representative shall meet the following criteria:
  - .1 Certified, factory trained, industrial generator technicians
  - .2 Service support 24/7
  - .3 The Service location in Lethbridge or Calgary
  - .4 Response time of 4 hours

- .5 Service & repair parts in-stock at performance level of 95%
- .6 Offer optional remote monitoring and diagnostic capabilities
- .4 The entire generator assembly including Sound attenuating enclosure, diesel engine & sub-base fuel tank shall fit concrete pad footprint as shown on drawing E101.

## **1.7 WARRANTY**

- .1 Manufacturer shall provide base warranty coverage on the material and workmanship of the generator set for a minimum of twenty-four (24) months for Emergency Standby product from registered commissioning and start-up.

## **Part 2 Products**

### **2.1 SYSTEM DESCRIPTION**

- .1 Generating system shall be from the same factory and consist of:
  - .1 Sound attenuating enclosure.
  - .2 Diesel engine.
  - .3 Alternator.
  - .4 Alternator control panel.
  - .5 Battery charger and battery.
  - .6 Automatic engine enclosure ventilation system.
  - .7 Fuel supply system.
  - .8 Exhaust system.
  - .9 Steel mounting base.
  - .10 Sub-base fuel tank.
- .2 System designed to operate as Emergency Standby in CFIA Lethbridge Facility.

### **2.2 ENGINE-GENERATOR SET**

- .1 Factory-assembled and tested, engine-generator set.
- .2 Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
  - .1 Rigging Information: Indicate location of each lifting attachment, generator-set center of gravity, and total package weight in submittal drawings.
- .3 Capacities and Characteristics:
  - .1 Power Output Ratings: Electrical output power rating for Standby operation of not less than 800.0kW, at 80 percent lagging power factor, 347/600, Series Wye, Three phase, 4-wire, 60 hertz.
  - .2 Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component. The engine-generator nameplate shall include information of the power output rating of the equipment.

- .4 Generator-Set Performance:
  - .1 Steady-State Voltage Operational Bandwidth: 0.5 percent of rated output voltage from no load to full load.
  - .2 Steady-State Frequency Operational Bandwidth: 0.25 percent of rated frequency from no load to full load.
  - .3 Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
  - .4 Transient Frequency Performance: Not more than 15 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within 5 seconds. On application of a 100% load step the generator set shall recover to stable frequency within 10 seconds.
  - .5 Output Waveform: At full load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for any single harmonic. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50.
  - .6 Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds without damage to generator system components. For a 1-phase, bolted short circuit at system output terminals, system shall regulate both voltage and current to prevent over-voltage conditions on the non-faulted phases.
  - .7 Start Time: Comply with C282-09; NFPA 110, Level 1, Type 10, system requirements.
  - .8 Ambient Condition Performance: Engine generator shall be designed to allow operation at full rated load in an ambient temperature under site conditions, based on highest ambient condition. Ambient temperature shall be as measured at the air inlet to the engine generator for enclosed units, and at the control of the engine generator for machines installed in equipment rooms.

## 2.3 DIESEL ENGINE

- .1 Diesel engine: to ISO 3046-1.
- .2 Turbo charged, synchronous speed 1800 rpm.
- .3 Capacity:
  - .1 Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability.
    - .1 Under following site conditions:
      - .1 Altitude: 3,050 feet (930 m).
      - .2 Ambient temperature: -40 degrees C to 40 degrees C.
      - .3 Relative humidity: 0 ~ 95 %.
  - .2 Emergency Standby Power (ESP): Per ISO 8528: The maximum power available during a variable electrical power sequence, under the stated operating conditions,



for which a generating set is capable of delivering in the event of a utility power outage or under test conditions for up to 200 hours of operation per year with the maintenance intervals and procedures being carried out as prescribed by the manufacturers. The permissible average power output (Ppp) over 24 hours of operation shall not exceed 70 percent of the ESP unless otherwise agreed by the RIC engine manufacturer.

- .4 Cooling System: Closed loop, liquid cooled
  - .1 The generator set manufacturer shall provide prototype test data for the specific hardware proposed demonstrating that the generator will operate in a weather proof enclosure at rated standby load in an outdoor ambient condition of 40 degrees C.
  - .2 Liquid cooled: heavy duty industrial radiator mounted on generating set base with engine driven pusher type fan to direct air through radiator from engine side.
  - .3 Coolant: Ethylene glycol anti-freeze non-sludging above -46 degrees C, with anticorrosion additives as recommended by engine manufacturer.
  - .4 Size of Radiator overflow tank: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
  - .5 Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
  - .6 Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
  - .7 Block heater: thermostatically controlled lube oil or liquid coolant heater connected to line side of automatic transfer switch to allow engine to start in room ambient -10 degrees C.
    - .1 Switch and fuse in heater circuit, mounted in engine-alternator control cubicle and fed from line side of automatic transfer switch.
- .5 Governor: Adjustable isochronous, with speed sensing. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate as appropriate to the state of the engine generator. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous states.

Mechanical hydraulic with:

- .1 Steady state speed band of plus or minus 0.5%.
  - .2 Speed regulation no load to full load 5% maximum.
- Or Electronic type, electric actuator, speed droop externally adjustable from isochronous to 5%, temperature compensated with steady state speed maintenance capability of plus or minus 0.25%.
- .6 Lubrication system: the following items are mounted on engine or skid:
    - .1 Lube oil pump: shall be positive displacement, mechanical, full pressure pump. Pressure lubricated by engine driven pump.

- .2 Filter and Strainer: Provided by the engine manufacturer of record to provide adequate filtration for the prime mover to be used. Lube oil filter: replaceable, full flow type, removable without disconnecting piping.
- .3 Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- .4 Lube oil cooler.
- .5 Oil level dip-stick.
- .7 Starting system: 12 or 24V, as recommended by the engine manufacturer; electric, with negative ground.
  - .1 Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at: -40 degrees C to 40 degrees C.
  - .2 Cranking Cycle: As required by NFPA 110 for level 1 system.
  - .3 Battery Cable: Size as recommended by engine manufacturer for cable length as required. Include required interconnecting conductors and connection accessories.
  - .4 Battery Compartment: Factory fabricated of metal with acid-resistant finish.
  - .5 Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation. The battery charging alternator shall have sufficient capacity to recharge the batteries with all parasitic loads connected within 4 hours after a normal engine starting sequence.
  - .6 Battery Chargers: Unit shall comply with UL 1236, provide fully regulated, constant voltage, current limited, battery charger for each battery bank. It will include the following features:
    - a. Operation: Equalizing-charging rate based on generator set manufacturer's recommendations shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
    - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 degree C to plus 40 degree C to prevent overcharging at high temperatures and undercharging at low temperatures.
    - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
    - d. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
    - e. Provide LED indication of general charger condition, including charging, faults, and modes. Provide a LCD display to indicate charge rate and

battery voltage. Charger shall provide relay contacts for fault conditions as required by NFPA110.

f. Enclosure and Mounting: NEMA, Type 1, wall-mounted cabinet.

- .8 Vibration isolated engine instrument panel with:
  - .1 Lube oil pressure gauge.
  - .2 Lube oil temperature gauge.
  - .3 Lube oil dip-stick.
  - .4 Coolant temperature gauge.
  - .5 Coolant level sensor.
  - .6 Running time meter: non-tamper type.
- .9 Guards to protect personnel from hot and moving parts.
  - .1 Locate guards so that normal daily maintenance inspections can be undertaken without their removal.
- .10 Drip trays.

## 2.4 ALTERNATOR

- .1 Alternator: to NEMA MG1.
- .2 Due to extensive harmonic generating equipment (such as VFD) usage in the existing facility, alternator shall be oversized. **Oversized** alternator shall be capable of accepting maximum 1500 kVA in a single step and be capable of recovering to a minimum of 90% of rated no load voltage. Following the application of the specified kVA load at near zero power factor applied to the generator set.
- .3 Output at 40 degrees C ambient:
  - .1 100% full load continuously.
- .4 Revolving field, brushless, single bearing.
- .5 Drip proof.
- .6 Amortisseur windings.
- .7 Synchronous type.
- .8 Dynamically balanced rotor permanently aligned to engine by flexible disc coupling.
- .9 Exciter: The excitation system shall utilize a brushless exciter with a three phase full wave rectifier assembly protected against abnormal transient conditions by a surge protector. Photo-sensitive components will not be permitted in the rotating exciter. The alternator shall include a permanent magnet generator (PMG) for excitation support. The system shall supply a minimum short circuit support current of 300% of the rating for 10 seconds.

- .10 Alternator shall meet temperature rise standards of UL2200 (120 degrees C). The insulation system material shall be class "H" capable of withstanding 150 degrees C temperature rise.
- .11 Alternator shall use a single, sealed bearing design. The rotor shall be connected to the engine flywheel using flexible drive disks. The stator shall be direct connected to the engine to ensure permanent alignment.
- .12 Alternator shall be protected against overloads and short circuit conditions by advanced control panel protective functions. To ensure precision protection and repeatable trip characteristics, these functions must be implemented electronically in the generator control panel -- thermal magnetic breaker implementation are not acceptable.
- .13 An alternator strip heater shall be installed to prevent moisture condensation from forming on the alternator windings. A tropical coating shall also be applied to the alternator windings to provide additional protection against the entrance of moisture. .
- .14 Voltage regulator: thyristor controlled rectifiers with phase controlled sensing circuit:
  - .1 Stability: 0.25 % maximum voltage variation at any constant load from no load to full load.
  - .2 Regulation: 1.5 % maximum voltage deviation between no-load steady state and full-load steady state.
  - .3 Transient: 20 % maximum voltage dip on one-step application of 0.8 PF full load.
  - .4 Transient: 12 % maximum voltage rise on one-step removal of 0.8 PF full load.
  - .5 Transient: 1 s maximum voltage recovery time with application or removal of 0.8 PF full load.
- .15 Alternator: capable of sustaining 300% rated current for period not less than 10 s permitting selective tripping of down line protective devices when short circuit occurs.

## **2.5 CONTROLS AND MONITORING**

- .1 Engine generator control shall be microprocessor based and provide automatic starting, monitoring, protection and control functions for the unit.
- .2 Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. (Switches with different configurations but equal functions are acceptable.) When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.
- .3 Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate

alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.

- .4 Configuration: Operating and safety indications, protective devices, system controls, engine gages and associated equipment shall be grouped in a common control and monitoring panel. Mounting method shall isolate the control panel from generator-set vibration. AC output power circuit breakers and other output power equipment shall not be mounted in the control enclosure.
- .5 Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:
  - .1 AC voltmeter (3-phase, line to line and line to neutral values).
  - .2 AC ammeter (3-phases).
  - .3 AC frequency meter.
  - .4 AC kW output (total and for each phase). Display shall indicate power flow direction.
  - .5 AC kVA output (total and for each phase). Display shall indicate power flow direction.
  - .6 AC Power factor (total and for each phase). Display shall indicate leading or lagging condition.
  - .7 Ammeter-voltmeter displays shall simultaneously display conditions for all three phases.
  - .8 Emergency Stop Switch: Switch shall be a red “mushroom head” pushbutton device complete with lock-out/tag-out provisions. Depressing switch shall cause the generator set to immediately stop the generator set and prevent it from operating.
  - .9 Fault Reset Switch: Supply a dedicated control switch to reset/clear fault conditions.
  - .10 DC voltmeter (alternator battery charging).
  - .11 Engine-coolant temperature gauge.
  - .12 Engine lubricating-oil pressure gauge.
  - .13 Running-time meter.
  - .14 Generator-voltage and frequency digital raise/lower switches. Rheostats for these functions are not acceptable. The control shall adjustment of these parameters in a range of plus or minus 5% of the voltage and frequency operating set point (not nominal voltage and frequency values.) The voltage and frequency adjustment functions shall be disabled when the paralleling breaker is closed.
  - .15 Fuel tank derangement alarm.
  - .16 Fuel tank high-level shutdown of fuel supply alarm.
  - .17 AC Protective Equipment: The control system shall include over/under voltage, reverse kVAR, reverse kW, over load (kW) short circuit, over current, loss of voltage reference, and over excitation shut down protection. There shall be a ground fault alarm for generator sets rated over 1000 amps, overload warning, and overcurrent warning alarm.

- .18 Status LED indicating lamps to indicate remote start signal present at the control, existing shutdown condition, existing alarm condition, not in auto, and generator set running.
- .19 A graphical display panel with appropriate navigation devices shall be provided to view all information noted above, as well as all engine status and alarm/shutdown conditions (including those from an integrated engine emission control system). The display shall also include integrated provisions for adjustment of the gain and stability settings for the governing and voltage regulation systems.
- .20 Panel lighting system to allow viewing and operation of the control when the generator room or enclosure is not lit.
- .21 Data Logging: The control system shall log the latest 20 different alarm and shut down conditions, the total number of times each alarm or shutdown has occurred, and the date and time the latest of these shutdown and fault conditions occurred.
- .22 DC control Power Monitoring: The control system shall continuously monitor DC power supply to the control, and annunciate low or high voltage conditions. It shall also provide an alarm indicating imminent failure of the battery bank based on degraded voltage recover on loading (engine cranking).
- .6 Control Heater: Generator sets that are installed in outdoor enclosures, or are in tropical or coastal environments shall be provided with control heaters for anti-condensation protection.
- .7 Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.
  - .1 Overcrank shutdown.
  - .2 Coolant low-temperature alarm.
  - .3 Control switch not in auto position.
  - .4 Battery-charger malfunction alarm.
  - .5 Battery low-voltage alarm.

## 2.6 CONTROLS PROTOCOL AND EXISTING BMS/DDC SYSTEM

- .1 Existing BMS/DDC system in CFIA Lethbridge facility is “Johnson Controls”, it has BACnet control protocol.
- .2 Engine generator control protocol shall be **BACnet** compatible to match or be able to communicate with existing “Johnson Controls” BMS system.

## 2.7 STEEL MOUNTING BASE

- .1 Complete generating set mounted on structural steel base of sufficient strength and rigidity to protect assembly from stress or strain during transportation, installation and under operating conditions on suitable level surface.
- .2 Assembly fitted with vibration isolators and control console resiliently mounted.
  - .1 Install engine vibration isolation as recommended by manufacturer.
- .3 Sound insulation pads for installation between isolators and concrete base.

## 2.8 EXHAUST AND INTAKE SYSTEM

- .1 The engine exhaust emissions shall meet the EPA Tier 2 emission requirements for standby power generation.
- .2 The manufacturer shall supply its recommended stainless steel, flexible connector to couple the engine exhaust manifold to the exhaust system. A rain cap will terminate the exhaust pipe after the silencer. All components must be properly sized to assure operation without excessive back pressure when installed.
- .3 The manufacturer shall supply a critical grade exhaust silencer as standard. Silencer shall be enclosure roof mounted.
- .4 For genset in a weather or sound attenuated enclosure, all exhaust piping from the turbo-charger discharge to the silencer shall be thermally wrapped to minimize heat dissipation inside the enclosure.
- .5 The engine intake air is to be filtered with engine mounted, replaceable, dry element filters.

## 2.9 COOLING AIR SYSTEM

- .1 Engine ventilating system:
  - .1 Cold air inlet/outlet damper assembly.
  - .2 Air discharge and intake gooseneck weatherhoods.
  - .3 Thermostat.
  - .4 Replaceable air intake filters.

## 2.10 FUEL SYSTEM

- .1 Fuel: to ASTM D975#2 Diesel Fuel.
- .2 Solid injection, mechanical fuel transfer pump with hand primer, fuel filters and air cleaner, fuel rack solenoid energized when engine running. The engine fuel system shall be installed in strict compliance to the engine manufacturer's instructions.
- .3 Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
- .4 Fuel storage tanks: to API Standard 650, ULC labelled.
  - .1 Above ground tank: to ULC-S601.
- .5 Sub-base fuel tank:
  - .1 The packaging shall include a double wall, sub-base mounted, UL142 listed fuel tank. The tank shall be sized to provide **12 hours** of run time.
  - .2 Sub-base fuel tank shall meet the structural and mechanical integrity requirements for mounting generator set and outdoor enclosure directly on top.

- .3 The tank shall include fuel suction and return connections to the generator, normal and emergency vents, secondary containment emergency vent and rupture basin sensor, mechanical fuel level indication and a stub-up area convenient for electrical conduit entry. Rupture basin sensor shall be tied in to the building DDC control system. Fuel tank shall have an additional supply and return connection for supply and return from main fuel storage tank for existing building; these connections shall be adjacent to new fuel pipes stub-up locations from trench in this project, refer to mechanical drawings for details. Transfer will be by existing building fuel transfer pump. Tank shall be shipped with these connections capped to allow use of the generator prior to final connections to building fuel transfer pump system.
- .4 In addition to manufacturer supplied fuel sensors equipped in tank which will be connected to generator control panel for alarm purpose; sub-base fuel tank shall have tank openings for mechanical contractor to install sensors and associated control wiring including fuel level sensors and controls for:
  - low-low level;
  - low level;
  - high level; and
  - high-high level

The above 4 sensors will be directly tied into existing building BMS/DDC control system, and control system fill and alarms from existing main fuel storage tank for existing building in accordance with mechanical drawings and specifications. These fuel system control components and connections to existing building BMS/DDC control system to be by Mechanical Contractor.
- .5 Generator sub-base fuel tank shall have tank openings as noted below (if it's not standard manufacturer opening) in addition to any other code required openings:
  - One 50mm diameter float control opening into sub-base tank;
  - One 50mm diameter fuel supply opening for supply of pumped fuel from existing main building fuel tank;
  - One 40mm fuel return opening for return of fuel to existing main building fuel tank;
  - One 50mm diameter vent opening from sub-base tank;
  - One 50mm diameter pressure relief vent opening from sub-base tank to meet ULC requirements;
  - One 50mm diameter pressure relief vent opening from sub-base tank interstitial space to meet ULC requirements;
  - One normal direct fill port (to be used during interim generator testing period for initial fill of fuel tank, and later to be plugged and sealed);
  - Supply and return openings to the generator.
- .6 The fuel tank shall have removable drip trays to secure genset coolant and oil against accidental spills.
- .7 The fuel tank must be supplied by the engine-generator set manufacturer.



## 2.11 GENERATOR OVERCURRENT AND FAULT PROTECTION

- .1 The generator set shall be provided with a ULC Listed/CSA Certified protective device that is coordinated with the alternator provided to prevent damage to the generator set on any possible overload or overcurrent condition external to the machine. The protective device shall be listed as a utility grade protective device under UL category NRGU. The control system shall be subject to ULC follow-up service at the manufacturing location to verify that the protective system is fully operational as manufactured. Protector shall perform the following functions:
  - .1 Initiates a generator kW overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
  - .2 Under single phase or multiple phase fault conditions, or on overload conditions, indicates an alarm conditions when the current flow is in excess of 110% of rated current for more than 10 seconds.
  - .3 Under single phase or multiple phase fault conditions, operates to switch off alternator excitation at the appropriate time to prevent damage to the alternator.
  - .4 The operator panel shall indicate the nature of the fault condition as either a short circuit or an overload.
  - .5 Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot greater than 120% of nominal voltage.
  - .6 The protective system provided shall not include an instantaneous trip function.
- .2 Circuit Breaker:
  - .1 Air Circuit Breaker (ACB) to: ANSI/IEEE C37.13 and CSA C22.2 No.5. OR Insulated Case Circuit Breaker (ICCB) to: NEMA AB1/AB3 and UL 489 or UL 1066.
  - .2 Fixed type, 600 V class.
    - .1 Continuous current rating: 1000 A. 100% Rated of Frame Size when Mounted on Generator.
    - .2 Trip rating: 1000 A.
    - .3 Interrupting rating: 65kAIC Minimum, rms symmetrical.
  - .3 Solid-state tripping system consisting of 1 current sensor per pole, 1 solid-state trip unit and self-powered trip actuator. Trip unit shall also employ the following functions:
    - .1 Adjustable Ground Fault Pick-up
    - .2 Adjustable Long Time Pickup and Delay
    - .3 Adjustable Short Time Pickup and Delay
    - .4 Instantaneous Trip
    - .5 Visual indication of mode of trip following an automatic trip operation.
  - .4 Breaker with normal stored energy, closing mechanism to provide quick-make operation for all ratings.
  - .5 Breaker with on-off indicator and spring charged/discharged indicator.
  - .6 **Breaker to provide a spare set of lugs for future temporary load bank connection.**

- .7 Optional features:
  - .1 Control relay
  - .2 Remote close.
  - .3 Lockout devices.
  - .4 Padlocking provision.
  - .5 Operation counter.
- .8 Fabrication
  - .1 Circuit Breaker assembly to CAN/CSA-C22.2 No.31:
    - .1 Hinged locked doors on front for generator and removable access covers on rear.
  - .2 Install wiring to instrument transformers, relays, terminal strips and circuit breaker controls.

## 2.12 OUTDOOR GENERATOR-SET ENCLOSURE

- .1 Description: **Sound Attenuated Skin-Tight** Steel housing. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Instruments, control, and battery system shall be mounted within enclosure. Weather proof enclosure shall be constructed of heavy gauge steel or aluminum with fixed storm proof panels.
- .2 Construction:
  - .1 Louvers: Equipped with bird screen to permit air circulation when engine is not running while excluding birds and rodents.
  - .2 Hinged Doors: With padlocking provisions. Restraint/Hold back hardware to prevent door to keep door open at 180 degrees during maintenance. Rain lips over all doors. Double-door access on both sides of the enclosure.
  - .3 Exhaust System:
    - a. Muffler Location: on enclosure roof.
  - .4 Hardware: All hardware and hinges shall be stainless steel.
  - .5 Mounting Base: Suitable for mounting on sub-base fuel tank.
  - .6 A weather proof enclosure shall be provided which allows the generator set to operate at full rated load with a static pressure drop equal to or less than 0.5 inches of water.
- .3 Engine Cooling Airflow through Enclosure: Housing shall provide ample airflow for engine generator operation at rated load in an ambient temperature of 40 degree Celsius.
  - .1 Louvers: Fixed-engine, cooling-air inlet and discharge.
  - .2 Motorized Louvers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating. Dampers shall be of a “fail open” design to allow airflow in the event of failure.
- .4 Sound Performance: Reduce the sound level of the engine generator while operating at full rated load to a maximum of 82 dBA measured at any location 7 m from the engine generator in a free field environment.

- .5 Enclosure room temperature: shall be maintained at 10°C or more at all times, except when the generator is running. This temperature shall be measured at a height not more than 1 m above the enclosure room floor. All equipment and components in the enclosure shall be suitably protected against temperature extremes created by engine operation and shall operate reliably when such extremes occur.
- .6 Electrical Provisions:
  - .1 Compliance with Canadian Electrical Code: Package shall comply with the requirements of the Canadian Electrical Code for all wiring materials and component spacing.
  - .2 Provide an internally mounted and wired electrical distribution panel to serve the engine generator and enclosure; including:
    - a. 100 amp distribution panelboard connected to a 120/208VAC utility service by the installer.
    - b. Two duplex GFI receptacles inside the enclosure, one on each side of the generator.
    - c. Factory wired normal AC service from the panelboard to the engine coolant heater, alternator heater, and battery charger.
    - d. Interior Lights with Switch: Two three-way switches controlling three AC lamps mounted in vapor tight and gasketed fixtures.
    - e. Unit equipment for emergency lighting: comply with CSA C22.2 No. 141. Sufficient lamps shall be provided to ensure that a minimum lighting level of 50 lux for 2 hours is available at all equipment locations in outdoor enclosure requiring adjustment or service.
  - .3 External Electrical Connections: All power and control interconnections shall be made within the perimeter of the enclosure.
  - .4 Electrical panel installed and pre-wired by generator outdoor enclosure manufacturer. Electrical contractor is to only install external feeder to this panel.
- .7 Finishes: Indoor and Outdoor Enclosures and Components: Powder-coated and baked over corrosion-resistant pre-treatment and compatible primer. Manufacturer's standard color.
- .8 Site Provisions:
  - .1 Lifting: Complete assembly of engine generator, enclosure, and sub base fuel tank shall be designed to be lifted into place as a single unit, using spreader bars.

## **2.13 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical. Match existing equipment identification standard at CFIA Lethbridge facility.
- .2 Control panel:
  - .1 Size 5 nameplates for controls including alternator breakers and program selector switch.
  - .2 Size 3 nameplates for meters, alarms, indicating lights and minor controls.

## **2.14 FABRICATION**

- .1 Shop assemble generating unit including:
  - .1 Skin-Tight enclosure.
  - .2 Sub-Base fuel tank.
  - .3 Engine and radiator.
  - .4 Alternator.
  - .5 Control panel.
  - .6 Battery and charger.

## **2.15 FINISHES**

- .1 Apply finishes in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Alternator control cubicle: paint inside, exterior to match engine and alternator.
- .3 Powder-coated and baked over corrosion-resistant pre-treatment and compatible primer. Manufacturer's standard color.
- .4 Supply 0.25 L of manufacturer's standard color touch-up enamel.

## **2.16 SOURCE QUALITY CONTROL**

- .1 Factory test generator set including engine, alternator, control panels, transfer switch and accessories.
- .2 Test procedure:
  - .1 Prepare blank forms and check sheet with spaces to record data and at top of first sheet record:
    - .1 Date.
    - .2 Generator set serial no.
    - .3 Engine, make, model, serial no.
    - .4 Alternator, make, model, serial no.
    - .5 Voltage regulator, make and model.
    - .6 Rating of generator set, kW, kV.A, V, A, r/min, Hz.
  - .2 Mark check sheet and record data on forms in duplicate as test proceeds.
- .3 Tests:
  - .1 With 100% rated load, operate set for 2 hours, taking readings at 30 minutes intervals, and record following:
    - .1 Time of reading.
    - .2 Running time.
    - .3 Ambient temp in degrees C.
    - .4 Lube oil pressure in kPa.
    - .5 Lube oil temp in degrees C.

- .6 Engine coolant temp in degrees C.
- .7 Exhaust stack temp in degrees C.
- .8 Alternator voltage: phase 1, 2, 3.
- .9 Alternator current: phase 1, 2, 3.
- .10 Power in kW.
- .11 Frequency in Hz.
- .12 Power Factor.
- .13 Battery charger current in A.
- .14 Battery voltage.
- .15 Alternator cooling air outlet temp.
- .2 After completion of 2 hours run, demonstrate following shut down devices and alarms:
  - .1 Overcranking.
  - .2 Overspeed.
  - .3 High engine temp.
  - .4 Low lube oil pressure.
  - .5 Short circuit.
  - .6 Alternator over voltage.
  - .7 Low battery voltage, or no battery charge.
  - .8 Manual remote emergency stop.
  - .9 High alternator temperature.
- .3 Next install continuous strip chart recorders to record frequency and voltage variations during load switching procedures. Each load change delayed until steady state conditions exist. Switching increments to include:
  - .1 No load to full load to no load.
  - .2 No load to 70% load to no load.
  - .3 No load to 20% load to no load.
  - .4 20% load to 40% load to no load.
  - .5 40% load to 60% load to no load.
  - .6 60% load to 80% load to no load.
- .4 Demonstrate:
  - .1 Automatic starting of set and automatic transfer of load on failure of normal power.
  - .2 Operation of manual bypass switch.
  - .3 Automatic shutdown of engine on resumption of normal power.
  - .4 That battery charger reverts to high rate charge after cranking.
- .5 Demonstrate low oil pressure and high engine temperature shutdown devices operation without subjecting engine to these excesses.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Locate generating unit, sub-base fuel tank, outdoor enclosure and install as indicated.
- .2 Install fuel supply system as indicated in CSA-B139.
- .3 Pipe muffler drains to nearest floor drain in outdoor Generator Enclosure.
- .4 Complete wiring and interconnections as indicated.
- .5 Start generating set and test to ensure correct performance of components.

**3.2 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Notify CFIA Representative and Consultant 10 working days in advance of test date.
- .3 Provide fuel for testing and leave full tanks on acceptance.
- .4 Demonstrate:
  - .1 Unit start, transfer to load, retransfer to normal power, unit shut down, on "Automatic" control.
  - .2 Unit start and shut down on "Manual" control
  - .3 Unit start and transfer on "Test" control.
  - .4 Unit start on "Engine start" control.
  - .5 Operation of automatic alarms and shut down devices.
- .5 Run unit on load for minimum period of 1 hour Operational Test and 4 hours Full Load Test as per CSA282-09 to show load carrying ability, stability of voltage and frequency, and satisfactory performance of dampers in ventilating system to provide adequate engine cooling. Install continuous strip chart recorders to record frequency and voltage variations during load switching procedures. Each load change delayed until steady state conditions exist. Switching increments to include:
  - .1 No load to full load to no load.
  - .2 No load to 70% load to no load.
  - .3 No load to 20% load to no load.
  - .4 20% load to 40% load to no load.
  - .5 40% load to 60% load to no load.
  - .6 60% load to 80% load to no load.
- .6 At end of test run, check battery voltage to demonstrate battery charger has returned battery to fully charged state.

**3.3 CLEANING**

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Divert unused batteries from landfill to battery recycling facility.
- .3 Divert unused lubricating oil materials from landfill to oil recycling facility.
- .4 Divert unused antifreeze from landfill to antifreeze recycling facility.
- .5 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**3.4 MAINTENANCE - CLEARANCES**

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer and CSA-B139.

**END OF SECTION**

**Part 1            General**

**1.1                SECTION INCLUDES**

- .1        Materials, components and installation for electric power generating equipment and system start-up.

**1.2                RELATED SECTIONS**

- .1        Section 01 29 00 - Payment Procedures.
- .2        Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .3        Section 01 91 13 - General Commissioning (Cx) Requirements.
- .4        Section 01 79 00 - Demonstration and Training.
- .5        Section 26 24 13.01 - Generator Switchboard to 600V.
- .6        Section 26 32 13.01 - Power Generation Diesel.

**1.3                PAYMENT PROCEDURES**

- .1        Provide payment for services of qualified diesel electric technician in accordance with Section 01 29 00 - Payment Procedures.

**1.4                REFERENCES**

- .1        Canadian Standards Association (CSA International)
  - .1        CAN/CSA - B139 - 00 (October 2001), Installation Code for Oil-Burning Equipment.
  - .2        CSA C282-09, Emergency Electrical Power Supply for Buildings.
- .2        Transport Canada - Marine Safety (TCMS)
  - .1        Approved Products Catalogue Index (APCI) - Structural Fire Prevention Item.
    - .1        Non-Combustible Material - Cloth and Paper.
- .3        Underwriters' Laboratories of Canada (ULC)
- .4        U.S. Coast Guard Equipment List (USCG)
  - .1        164.009 - May 2002, Non-Combustible Materials.

**1.5                QUALIFICATIONS**

- .1        Provide proof of diesel electric technician qualification to Consultant & Engineer.



## **1.6 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Place materials defined as hazardous or toxic in designated containers.
- .5 Divert unused metal and wiring materials from landfill to metal recycling facility.
- .6 Divert unused batteries from landfill to battery recycling facility.
- .7 Divert unused antifreeze from landfill to antifreeze recycling facility.
- .8 Fold up metal banding, flatten and place in designated area for recycling.

## **1.7 SYSTEM START-UP**

- .1 Preparation: before starting unit, carry out thorough mechanical and electrical inspection of equipment, and perform following checks and adjustments:
  - .1 Disconnect battery cables from batteries to prevent accidental starting.
  - .2 Turn engine several revolutions by means of hand-barring devices to ensure parts are free and there are no obstructions to its running.
  - .3 Check engine/generator alignment readings to ensure they match readings attained at time of manufacture.
  - .4 Check fluid levels and top up as necessary. Pre-lubricate engine and turbochargers as recommended by engine manufacturer. Install drip pan beneath engine.
  - .5 Ensure cooling system antifreeze is effective to at least minus 40 degrees C.
  - .6 Check belts for correct tension and adjust as necessary.
  - .7 Check and grease grease points.
  - .8 Check and tighten properly nuts, bolts, etc.
  - .9 Ensure safety guards are in place and properly secured.
  - .10 Check linkages for damage and freedom of movement.
  - .11 Check fuel supply system for leakage.
  - .12 Ensure fuel supply and fuel injection systems are properly primed.
  - .13 Check and tighten properly electrical connections.
  - .14 Check starting battery electrolyte level specific gravity and for proper installation.
  - .15 Check battery charger for proper operation and adjust as necessary.
  - .16 Carry out generator winding insulation resistance test. If reading is unacceptable, carry out recognized drying procedure. Do not start unit until satisfactory reading has been achieved.

- .17 Check jacket coolant heater for proper operation.
- .18 Complete additional preparations deemed necessary.
- .2 Performance verification: on completion of start-up preparations, take following action:
  - .1 Have at hand, during initial start-up, means for choking off air supply to engine air induction manifold in event of engine run away or other emergency.
  - .2 Reconnect starting battery cables to starting battery.
  - .3 Start unit only in presence of Consultant & CFIA Representative and allow to warm up. Stop unit if abnormal conditions are encountered.
  - .4 Check for and correct leakage from exhaust system, fuel system, cooling system, and lubricating oil system.
  - .5 Adjust vibration isolators.
  - .6 Observe and ensure that lubricating oil pressure and coolant temperature are within limits and no harmful vibration or sounds are evident.
  - .7 Ensure voltage is within operating parameters and automatic voltage regulator is operating correctly.
  - .8 Ensure manual voltage control is operating correctly.
  - .9 Ensure frequency is within operating parameters and electronic governor is operating correctly.
  - .10 Check engine air ventilation system for proper operation.
  - .11 Check operation of engine-mounted protective sensing devices and adjust as necessary.
  - .12 Check phase sequence of normal power supply and ensure emergency power supply are in same sequence.
  - .13 Check operation of electronic controller protection, transfer, timing, metering, and annunciator functions and adjust as necessary.
  - .14 Check operation and calibration of analog metering and adjust as necessary.
  - .15 Apply electrical load, read the metres, and correlate these readings.
  - .16 Demonstrate:
    - .1 Unit start, transfer to load, retransfer to normal power, unit shutdown, on "automatic" control.
    - .2 Unit start, transfer to load, retransfer to normal power, unit shutdown, on "full load test" control. Unit start and shutdown, on "no load test" control.
    - .3 Unit cranking, start, and shutdown by means of engine-mounted key switch.
    - .4 Run unit on load for minimum period of 5 hours to show load-carrying capability, stability of voltage and frequency, and satisfactory performance of engine ventilating system to provide adequate cooling.
    - .5 Every 1/2 hour carry out and record readings on Test Chart.
  - .17 Perform additional tests as required by Consultant and/or CFIA representative to ensure unit is operating satisfactorily.

## **1.8 OWNER'S INSTRUCTION**

- .1 Provide instruction to site operation and maintenance staff for proper care, operation, and maintenance of equipment.

## **1.9 COMMISSIONING**

- .1 Do site commissioning of the diesel electric generator unit by qualified diesel electric technician in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements.
- .2 Provide commissioning report included time delay settings, operational set points and adjustment ranges.

## **Part 2 Products**

### **2.1 MATERIALS**

- .1 Provide following materials:
  - .1 Conduits and boxes as required.
  - .2 Copper fuel lines and fittings as required.
  - .3 ULC automatic fire shut-off valve.
  - .4 Primary fuel filter/water separator.
  - .5 Insulation for exhaust system.
  - .6 Electrical components as indicated.
  - .7 Wiring material.
  - .8 Antifreeze, ethylene glycol.
  - .9 Diesel fuel; Sub-base tank initial fill, plus top-up after testing.
  - .10 Manual IPU bypass switch.
  - .11 All wiring and materials, including necessary rigid steel conduits and fittings for making connections.
  - .12 The power circuit cables refer to Electrical drawings for details.
  - .13 The control circuit cables will not be less than No. 14, RW90, multiple conductors, colour or number coded. Control circuit cables back to building through underground trench are to be Mineral-Insulated cables to maintain 2-hour fire resistance rating.
  - .14 Electronic governor control cable shall be minimum size No. 18 stranded copper conductor, shielded complete with drain wire and overall PVC jacket; refer to manufacturer recommendations.
  - .15 Battery cable shall be welding cable type, extra flexible, rope stranded copper conductor with neoprene oil-resistant insulation, sized to limit voltage drop to 5% at time of peak load.

### **Part 3            Execution**

#### **3.1                LOCATING AND MOUNTING**

- .1    Locate unit including Sub-base fuel tank, generator assembly and sound attenuating enclosure as indicated.
- .2    Fit and adjust isolators in accordance with manufacturer's installation and adjustment instruction bulletin contained in unit manual.
- .3    Do not bolt housings to foundation if isolator housing feet are equipped with 6 mm rubber sound pads.

#### **3.2                ALIGNMENT CHECK**

- .1    Since Engine-generator shaft alignment is adjusted at factory, check to ensure that no change has occurred due to shipment and handling.
- .2    Where engine and generator housings are close coupled and instruments at hand are not suitable for measuring alignment within confines of housings, just loosen engine and generator hold down bolts and ensure that each foot is carrying proportionate amount of weight and feet are level on base plate.

#### **3.3                FUEL SUPPLY SYSTEM**

- .1    Install Sub-base fuel tank in accordance with CAN/CSA-B139.
- .2    Inspect thoroughly fuel tank and lines to ensure they are clean and free of foreign material before connecting fuel system.
- .3    Install primary fuel filter/water separator and servicing shut-off valves as indicated. Provide 3 spare filter elements.
- .4    Install ULC automatic fire shut-off valve. Locate upstream of any combustible fuel system component.
- .5    Install supply and return fuel lines between engine and Sub-base fuel tank. Install flexible sections between the engine and fixed end of fuel lines from fuel tank, using materials supplied with unit if applicable.
- .6    Hard drawn copper pipe joints to be brazed or silver soldered.
- .7    Brazing or soldering alloys to have minimum melting point of 450 degrees C.
- .8    Neatly install fuel lines parallel or perpendicular to Generator Outdoor Enclosure lines with no kinks or dents.
- .9    Install soft drawn copper fuel lines using brass 45 degrees flare and pipe fittings as required and bend with correct size lever type bending tool. Entirely replace leaking fuel lines.

- .10 Protect fuel lines from mechanical damage.

### **3.4 BATTERIES AND CHARGER**

- .1 For dry charged batteries, activate in accordance with manufacturer's instructions in the unit manual prior to installation.
- .2 For wet batteries, inspect individually each battery cell and check electrolyte level. Check charge condition by measuring temperature and specific gravity of electrolyte. Consult manufacturer's instructions for recommended readings. If readings are lower, give batteries freshening charge until reading are reached.
- .3 Locate batteries as indicated and ensure that batteries are accessible for service. Run and protect cables to starting motor using cables supplied with unit.
- .4 Install battery charger on wall, adjacent to batteries and make connection to batteries.
- .5 Clean connections and tighten securely.
- .6 Install removable plexiglass cover on batteries.

### **3.5 EXHAUST SYSTEM**

- .1 Install exhaust pipe and silencer using material supplied with unit.
- .2 Arrange silencer above and approximately in line with engine exhaust manifold with exhaust tail pipe protruding through thimble in wall.
- .3 Extend tail pipe not less than one metre beyond outside wall.
- .4 Support silencer with hangers so no weight or stress is applied to engine exhaust manifold or turbocharger.
- .5 Install flexible exhaust pipe between silencer and manifold.
- .6 Install exhaust system fireproof insulative material, after test run.
  - .1 Removable fibreglass jacket insulation rated for 650 degrees C with stainless lacing hooks and wires.
    - .1 Jacket to be enclosed on inside by stainless steel mesh with outside cover silicone coated or aluminized fibreglass cloth: to USCG approved Non-Combustible Materials No. 164.009 and TCMS Non-Combustible Materials - Certificate No. F3-Series.
    - .2 Calcium Silicate removable insulation rated for 650 degrees C with exterior stainless steel protective cover and fastenings.

### **3.6 COOLING AND VENTILATION**

- .1 Install air outlet and inlet louvres and hoods in their respective openings.

- .2 Install louvre motors and linkages, adjust to ensure louvres are tight in closed position and give free damper movements from fully closed to fully open.
- .3 Where canvas boot is not provided, maintain 13 mm clearance between radiator and air outlet duct.
- .4 Mount thermostat in strategic position, away from inlet louvre.
- .5 Install conduits and junction boxes and make connections from louvre motors to thermostat and to 120/24 V AC transformer in panel.
- .6 Fill engine radiator with water/ethylene glycol antifreeze mix good for -40 degrees C.
- .7 Install remote radiator including piping, valves, fittings and pumps as indicated.

### **3.7 CONTROL AND TRANSFER PANEL**

- .1 Locate panels as indicated.
- .2 Make control and power circuit connections as indicated.
- .3 Identify cables at both ends.
- .4 Tag with slip-on wire maker, each wire end with number corresponding to number in panel.
- .5 Make terminations with self-insulated terminals of flanged fork or ring type.

### **3.8 ADDITIONAL WORKS**

- .1 Complete any additional work as instructed by Consultant & CFIA representative to:
  - .1 Ensure equipment is safe to operate.
  - .2 Provide complete and operating system.

### **3.9 FIELD QUALITY CONTROL**

- .1 Qualified diesel electric technician to: inspect and verify that installation of Generator unit including sub-base fuel tank, generator assembly and outdoor sound attenuating enclosure is acceptable and complete. Provide inspection report to the Consultant & CFIA.

### **3.10 DEMONSTRATION AND TRAINING**

- .1 As directed by Consultant and in accordance with Section 01 79 00 - Demonstration and Training, carry out demonstrations of complete Generator unit including sub-base fuel tank, generator assembly and outdoor sound attenuating enclosure for Project Acceptance.
- .2 Provide familiarization training of operating and maintenance staff.

- .3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.
- .4 Provide fuel required for performing diesel-generator site test and top-up after acceptance test completion.

**END OF SECTION**

**Part 1            General**

**1.1                ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Test Reports:
  - .1        Submit Factory Test.
  - .2        Co-ordinate operations tests and checks with Section 26 32 13.01 – Power Generation Diesel.

**1.2                GENERAL**

- .1        Supplier: \_\_\_\_.
- .2        Spec no.: \_\_\_\_.
- .3        Order no.: \_\_\_\_.
- .4        Requisition no.: \_\_\_\_.
- .5        Tender file no.: \_\_\_\_.
- .6        Site file: \_\_\_\_.
- .7        Unit serial no.: \_\_\_\_.
- .8        Destination: \_\_\_\_.
- .9        Against material specification and shop drawings:
  - .1        Complies: \_\_\_\_.
  - .2        Does not comply: \_\_\_\_.
  - .3        Not checked: \_\_\_\_.
- .10      Against specified performance:
  - .1        Tested OK: \_\_\_\_.
  - .2        Tested not OK: \_\_\_\_.
  - .3        Not tested: \_\_\_\_.

**1.3                ENGINE AND ACCESSORIES**

- .1        Engine:
  - .1        Make and type: \_\_\_\_.
  - .2        Model: \_\_\_\_.
  - .3        Serial No.: \_\_\_\_.
  - .4        Speed: \_\_\_\_ rpm.



- .5 Cycles: \_\_\_\_.
  - .6 No. of cylinders: \_\_\_\_.
  - .7 Cylinder arrangement: \_\_\_\_.
  - .8 Bore and stroke: \_\_\_\_ mm x \_\_\_\_ mm.
  - .9 kW \_\_\_\_ @ ntp.
  - .10 Governor: make and type: \_\_\_\_.
  - .11 Base plate, including anchor bolt holes location: \_\_\_\_.
  - .12 Aspiration: natural/pressure: \_\_\_\_.
  - .13 Engine wiring: \_\_\_\_.
- .2 Fuel system:
- .1 Make and type: \_\_\_\_.
  - .2 Number of filters: \_\_\_\_, make and type: \_\_\_\_.
  - .3 Recommended fuel oil: \_\_\_\_.
  - .4 Pumps: \_\_\_\_.
  - .5 Injectors: \_\_\_\_.
  - .6 Transfer pump: \_\_\_\_.
  - .7 Lines and fittings: \_\_\_\_.
- .3 Lubricating oil system:
- .1 Lubricating oil cooler:
    - .1 Make and type: \_\_\_\_.
  - .2 Filters:
    - .1 Number: \_\_\_\_.
    - .2 Make and type: \_\_\_\_.
  - .3 Gauges:
    - .1 Number: \_\_\_\_.
    - .2 Make and type: \_\_\_\_.
  - .4 Lubricating oil:
    - .1 Total capacity: \_\_\_\_.
    - .2 Recommended oil: \_\_\_\_.
    - .3 Recommended operating temperature: \_\_\_\_.
    - .4 Recommended operating pressure: \_\_\_\_.
    - .5 Drain valve: \_\_\_\_.
    - .6 Lines and fittings: \_\_\_\_.
    - .7 Leaks: \_\_\_\_.
- .4 Exhaust system:
- .1 Silencer: make and type: \_\_\_\_.
  - .2 Exhaust pipe size: \_\_\_\_.
  - .3 Silencer and fittings: \_\_\_\_.
  - .4 Manifold guard: \_\_\_\_.

- .5 Air intake system:
  - .1 Air cleaner: make and type: \_\_\_\_.
  - .2 Air required for combustion: \_\_\_\_ m<sup>3</sup>/min.
  - .3 Turbo charger: make and type: \_\_\_\_.
- .6 Cooling system:
  - .1 Make: \_\_\_\_.
  - .2 Fan: number \_\_\_\_, type of belts: \_\_\_\_.
  - .3 Radiator capacity: \_\_\_\_.
  - .4 Air required for cooling: \_\_\_\_.
  - .5 Engine heater: make and type \_\_\_\_, wattage: \_\_\_\_.
  - .6 Aquastat: make and type \_\_\_\_.
  - .7 Thermostat: open \_\_\_\_, close: \_\_\_\_.
  - .8 Drains: valves \_\_\_\_, leaks \_\_\_\_.
  - .9 Gauges: make and type \_\_\_\_.
- .7 Ventilating system:
  - .1 Motors: number \_\_\_\_, make and type \_\_\_\_.
  - .2 Louvres: number \_\_\_\_, make and type \_\_\_\_.
  - .3 Dampers: number \_\_\_\_, make and type \_\_\_\_.
  - .4 Thermostat: make and type \_\_\_\_.
  - .5 Transformer: make and type \_\_\_\_.
  - .6 Auxiliary potentiometer:
    - .1 Construction: \_\_\_\_.
    - .2 Dimensions: \_\_\_\_.
    - .3 Operation: \_\_\_\_.
    - .4 Linkage: \_\_\_\_.
    - .5 Wipers: \_\_\_\_.
- .8 Starting system:
  - .1 Starting motor:
    - .1 Make and type: \_\_\_\_.
    - .2 Voltage: \_\_\_\_.
    - .3 F.L. Amps: \_\_\_\_.
    - .4 Serial no.: \_\_\_\_.
  - .2 Battery:
    - .1 Make and type: \_\_\_\_.
    - .2 Nominal volts: \_\_\_\_.
    - .3 No. of cells: \_\_\_\_.
    - .4 A.H. capacity: \_\_\_\_.
    - .5 Cables: \_\_\_\_.

- .3 Battery charger:
  - .1 Make and type: \_\_\_\_.
  - .2 DC Volts - float: \_\_\_\_, DC Volts - equalize: \_\_\_\_.
  - .3 Equalize time: \_\_\_\_.
  - .4 DC Amps: \_\_\_\_.
  - .5 AC Volts: \_\_\_\_.
  - .6 AC Amps: \_\_\_\_.
  - .7 Serial no.: \_\_\_\_.
- .9 Vibration isolators:
  - .1 Make and type: \_\_\_\_.
  - .2 Spring cap: \_\_\_\_.
- .10 Flexible couplings:
  - .1 Make and type: \_\_\_\_.
- .11 Other accessories:
  - .1 Make and type/contact arrangement: \_\_\_\_.
  - .2 Fuel rack solenoid (FRS): \_\_\_\_.
  - .3 Speed switch (SS): \_\_\_\_.
  - .4 Low oil pressure switch (LOPS): \_\_\_\_.
  - .5 High coolant temperature switch (HCTS): \_\_\_\_.
  - .6 Engine control switch: \_\_\_\_.
- .12 Associated instruction books and sheets, parts books and drawings:
  - .1 Tool kit: \_\_\_\_.
  - .2 Spare parts: \_\_\_\_.

#### 1.4 GENERATOR AND CONTROLS

- .1 Alternators:
  - .1 Make and type: \_\_\_\_.
  - .2 Frame: \_\_\_\_.
  - .3 Model: \_\_\_\_.
  - .4 Serial no.: \_\_\_\_.
  - .5 Phase and wire: \_\_\_\_ PF, \_\_\_\_ Volts, \_\_\_\_ Amps, \_\_\_\_ KVA, \_\_\_\_ kW, \_\_\_\_ Speed, \_\_\_\_ Cycles.
  - .6 Alt. field amps: \_\_\_\_.
  - .7 Temp. rise: \_\_\_\_.
  - .8 Bearing: front \_\_\_\_, rear \_\_\_\_.
  - .9 Junction box: \_\_\_\_.
  - .10 Signs: DOT number \_\_\_\_, warning \_\_\_\_, air gap \_\_\_\_, terminals \_\_\_\_.

- .2 Exciter:
  - .1 Make and type: \_\_\_\_.
  - .2 Model: \_\_\_\_.
  - .3 Serial no. \_\_\_\_.
  - .4 Volts: \_\_\_\_ kW, \_\_\_\_ Amps.
  - .5 Field Amps: \_\_\_\_, field winding: \_\_\_\_.
  - .6 Temperature rise: \_\_\_\_.
  - .7 Brushless/brush/static: \_\_\_\_.
- .3 Voltage regulator:
  - .1 Make and type: \_\_\_\_.
  - .2 Serial no.: \_\_\_\_.
- .4 Regulator accessories:
  - .1 EFR/EFT: \_\_\_\_.
  - .2 VAR: \_\_\_\_.
  - .3 Transformers: \_\_\_\_.
  - .4 Change-over SW: \_\_\_\_.
  - .5 Current boost: \_\_\_\_.
  - .6 Overload and short circuit test: \_\_\_\_.
- .5 Associated instruction books and sheets, parts books and drawings:
  - .1 \_\_\_\_.

## **1.5 CONTROL PANEL AND COMPONENTS**

- .1 Control panel:
  - .1 Dimensions: \_\_\_\_.
  - .2 Weight: \_\_\_\_.
  - .3 Construction: \_\_\_\_.
  - .4 Wiring: \_\_\_\_.
- .2 Overcurrent relay:
  - .1 Make and type: \_\_\_\_.
- .3 Meters:
  - .1 Make and type: \_\_\_\_.
  - .2 Scale and accuracy: \_\_\_\_.
  - .3 Ammeter: \_\_\_\_.
  - .4 Voltmeter: \_\_\_\_.
  - .5 Elapsed time meter: \_\_\_\_.
  - .6 Hz meter: \_\_\_\_.
  - .7 kW meter: \_\_\_\_.

- .4 Transformers: \_\_\_\_.
- .1 Fuses: \_\_\_\_.
- .5 Engine - generator - transfer controller:
  - .1 Make and type: \_\_\_\_.
- .6 Associated instruction books and sheets, parts books and drawings:
  - .1 \_\_\_\_.

## 1.6 INSTRUMENT CONTROL SETTINGS

- .1 High coolant temperature switch (HCTS): \_\_\_\_.
- .2 Low oil pressure switch (LOPS): \_\_\_\_.
- .3 Overspeed switch (SS High): \_\_\_\_.
- .4 Cranking output switch (SS Low): \_\_\_\_.
- .5 Normal supply overcurrent: timed \_\_\_\_, inst. \_\_\_\_.
- .6 Emergency supply overcurrent: timed \_\_\_\_, inst. \_\_\_\_.
- .7 Normal supply voltage limits: \_\_\_\_.
- .8 Emergency supply voltage limits: \_\_\_\_.
- .9 Frequency limits: \_\_\_\_.
- .10 Time delay settings:
  - .1 Crank delay: \_\_\_\_.
  - .2 Restart: \_\_\_\_.
  - .3 Bypass: \_\_\_\_.
  - .4 Anticipated fail: \_\_\_\_.
  - .5 Engine start: \_\_\_\_.
  - .6 Emergency to normal: \_\_\_\_.
  - .7 Dead bus: \_\_\_\_.
  - .8 Cool down: \_\_\_\_.

## 1.7 REGULATION

- .1 Dot no.: \_\_\_\_.

.2 Date: \_\_\_\_.

	Load Amps	kW	Le vel	Voltage Respo nse	Level	Frequency Respo nse
(1) Cold automatic voltage control	No load					
	Transient					
	Full load					
	Transient					
Eng. Temp Room Temp	No load					
	Transient					
	1/2 load					
	Transient					
	No load					
	Transient					
	1/2 load					
	Transient					
(2) Hot Automatic voltage control	No load					
	Transient					
	Full Load					
	Transient					
Eng. Temp Room Temp	No load					
	Transient					
	1/2 load					
	Transient					
	No load					
	Transient					
	1/2 load					
	Transient					
(3) Hot and cold fixed excitation	No load					
	Transient					
	Full load					

.3 Resistances:

.1 Stator winding:

.1 Phase A: cold \_\_\_\_, hot \_\_\_\_.

.2 Phase B: cold \_\_\_\_, hot \_\_\_\_.

.3 Phase C: cold \_\_\_\_, hot \_\_\_\_.

.2 Rotor winding: cold \_\_\_\_, hot \_\_\_\_.

.3 Exciter field winding: cold \_\_\_\_, hot \_\_\_\_.

.4 Field rheostat: cold \_\_\_\_, hot \_\_\_\_.

.4 Voltage regulation:

.1 Maximum \_\_%, steady state \_\_%, 24 hour drift \_\_%.

.5 Speed reduction:

.1 Maximum \_\_%, steady state \_\_%, 24 hour drift \_\_%.

.6 Voltage adjustment ranges:

.1 With regulator rheostat: \_\_\_\_.

- .2 With field rheostat: \_\_\_\_.
- .7 Governor adjustment ranges:
  - .1 Speed changer: \_\_\_\_.
  - .2 Speed droop: \_\_\_\_.
- .8 Cold start - full load application:
  - .1 Time since run: \_\_\_\_.
  - .2 Lube oil temp: \_\_\_\_.
  - .3 Fuel oil temp: \_\_\_\_.
  - .4 Water temp: \_\_\_\_.
  - .5 Generator iron temp: \_\_\_\_.
  - .6 Room temp: \_\_\_\_.
  - .7 Level of voltage overshoot: \_\_\_\_.
  - .8 Level of frequency overshoot: \_\_\_\_.
  - .9 Time to steady state: Volt \_\_\_\_, Frequency \_\_\_\_.
  - .10 Time load applied from start: \_\_\_\_.
  - .11 Transient levels: volts \_\_\_\_, Frequency \_\_\_\_, Amps \_\_\_\_.
  - .12 Time to settled levels: Volts \_\_\_\_, Frequency \_\_\_\_, Amps \_\_\_\_.
  - .13 Settled levels: Volts \_\_\_\_, Frequency \_\_\_\_, Amps \_\_\_\_.

**1.8 HEAT RUN**

.1 Table:

Time	Generator Volts Amps				Freq	KW	Battery Charger		Temperature Degrees C			Oil	Oil Press Lbs
	1	2	3				Amps	Volts	Ambien	In	Out		

.2 Remarks:

- .1 Exhaust colour: \_\_\_\_.
- .2 Lube, oil consumption: \_\_\_\_.
- .3 Fuel consumption: \_\_\_\_.
- .4 Atmospheric conditions:
  - .1 Temp/press/humidity: \_\_\_\_.

**1.9 COUPLING ALIGNMENT**

- .1 \_\_\_\_.

**1.10 MISCELLANEOUS**

- .1 Manuals:
  - .1 Received Transport Canada (TC): \_\_\_\_ copies.
  - .2 Distributed: \_\_\_\_ copies, \_\_\_\_ site (with cabinet), \_\_\_\_ region, \_\_\_\_ airport/site maintenance \_\_\_\_ headquarters.
- .2 Shipping:
  - .1 Crate: \_\_\_\_.
  - .2 No. of pieces: \_\_\_\_.
  - .3 Dimensions: \_\_\_\_.
  - .4 Weight: \_\_\_\_.
  - .5 Valuation: \_\_\_\_.
  - .6 Date: \_\_\_\_.
  - .7 Carrier: \_\_\_\_.
- .3 Factory acceptance:
  - .1 Date: \_\_\_\_.
  - .2 Signature: \_\_\_\_, TC inspector.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**



**Part 1            General**

**1.1                SECTION INCLUDES**

- .1        Materials and installation for automatic load transfer equipment which can monitor voltage on all phases of normal power supply, initiate cranking of standby generator unit, transfer loads and shut down standby unit.

**1.2                RELATED SECTIONS**

- .1        Section 01 33 00 - Submittal Procedures.
- .2        Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .3        Section 01 78 00 - Closeout Submittals.
- .4        Section 26 05 00 - Common Work Results - Electrical.

**1.3                REFERENCES**

- .1        Canadian Standards Association (CSA International)
  - .1        CSA C22.2 No.178.1-2007, Automatic Transfer Switches.
  - .2        CAN/CSA C60044-1-07, Instrument Transformers.
- .2        National Fire Protection Association (NFPA) / American National Standards Institute (ANSI) / National Electrical Manufacturers Association (NEMA)
  - .1        NFPA-20-2013, Standard for the Installation of Stationary Pumps for Fire Protection.
  - .2        ANSI/NEMA ICS 2-1996(R2009), Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC, Part 8: Disconnect Devices for Use in Industrial Control Equipment.
- .3        UL 1008 - Standard for Transfer Switch Equipment
- .4        IEC 947-6-1 Low-voltage Switchgear and Control gear; Multifunction equipment; Automatic Transfer Switching Equipment
- .5        IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
- .6        UL 508 Industrial Control Equipment

**1.4                SYSTEM DESCRIPTION**

- .1        Separately mounted Fire Pump Automatic Transfer Switch to:
  - .1        Monitor voltage on phases of normal power supply.

- .2 Initiate cranking of standby generator unit on normal power failure or abnormal voltage on any one phase below preset adjustable limits for adjustable period of time.
- .3 Transfer load from normal supply to standby unit when standby unit reaches rated frequency and voltage pre-set adjustable limits.
- .4 Transfer load from standby unit to normal power supply when normal power restored, confirmed by sensing of voltage on phases above adjustable pre-set limit for adjustable time period.
- .5 Shut down standby unit after running unloaded to cool down using adjustable time delay relay.

### **1.5 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for Automatic and Manual transfer switches, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop drawings include:
  - .1 Make, model and type.
  - .2 Single line diagram showing controls and relays.
  - .3 Description of equipment operation including:
    - .1 Automatic and Manual starting and transfer to standby unit and back to normal power as per Sequence of Operation on construction drawings.
    - .2 Test control.
    - .3 Manual control.
    - .4 Automatic shutdown.

### **1.6 CLOSEOUT SUBMITTALS**

- .1 Provide operation and maintenance data for automatic load transfer equipment for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Detailed instructions to permit effective operation, maintenance and repair.
- .3 Technical data:
  - .1 Schematic diagram of components, controls and relays.
  - .2 Illustrated parts lists with parts catalogue numbers.
  - .3 Certified copy of factory test results.
  - .4 Manufacturer on-site commissioning report.

### **1.7 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect transfer switches from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

## **1.8 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal and wiring materials from landfill to metal recycling facility.

## **1.9 ACCEPTABLE MANUFACTURERS**

- .1 New Automatic transfer switches shall be from the same manufacturer of existing transfer switch for ease of maintenance and commonality of parts; new Fire Pump Automatic Transfer Switch to be ASCO Firetrol FTA903 or equivalent. Alternate bids must list any deviations from this specification.
- .2 The ATS manufacturer shall maintain a national service organization of company-employed personnel located throughout Canada. The service center's personnel must be factory trained and must be on call 24 hours a day, 365 days a year. Maximum travel distance from CFIA Lethbridge facility for service technicians shall be in Calgary.
- .3 The manufacturer shall maintain records of each switch, by serial number, for a minimum of 30 years.

## **Part 2 Products**

### **2.1 SYSTEM DESCRIPTION**

- .1 Automatic load transfer equipment to:
  - .1 Monitor voltage on phases of normal power supply.
  - .2 Initiate cranking of standby generator unit on normal power failure or abnormal voltage on any one phase below preset adjustable limits for adjustable period of time.
  - .3 Transfer load from normal supply to standby unit when standby unit reaches rated frequency and voltage pre-set adjustable limits.

- .4 Transfer load from standby unit to normal power supply when normal power restored, confirmed by sensing of voltage on phases above adjustable pre-set limit for adjustable time period.
- .5 Shut down standby unit after running unloaded to cool down using adjustable time delay relay.

## 2.2 MATERIALS

- .1 Instrument transformers: to CAN/CSA C60044-1.
- .2 Contactors: to NEMA ICS2.

## 2.3 CONTACTOR TYPE TRANSFER EQUIPMENT "TS-2"

- .1 Separately mounted Fire Pump Automatic Transfer Switch General Requirements
  - .1 The fire pump automatic transfer switch shall be factory assembled and wired and listed by Underwriters' Laboratories, Inc. for fire pump service.
  - .2 "TS-2" shall be sized to transfer existing 600V, 3Ø, 20HP fire pump c/w existing fire pump controller between normal and emergency generator power.
  - .3 The transfer switch shall conform to all requirements of the latest edition of NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection.
  - .4 Provide the transfer of 3-phase power to a fire pump controller between a utility on the normal side and a generator on the alternate (emergency) side. Alternate (emergency) disconnect/isolating means capable of indefinitely carrying the motor locked rotor current shall be supplied per NFPA 20. The disconnect/isolating switch shall be mechanically interlocked so that the enclosure door cannot be opened with the handle in the ON position, except by a hidden tool operated def eater mechanism. The enclosure door shall have a locking type handle and three point cam and roller type vault hardware. The disconnecting means and overcurrent protective devices required for the normal side of the transfer switch SHALL BE supplied, and shall meet the requirements of the latest edition of NFPA 20.
  - .5 The automatic transfer switch shall consist of an inherently double throw power transfer switch mechanism and a microprocessor control panel to provide automatic operation. The transfer switch and control panel shall be of the same manufacturer. The automatic transfer switch shall be an ASCO 7000 series with a group 5 control panel.
  - .6 The transfer switch shall be electrically operated and mechanically held. The electrical operator shall be a momentarily energized, single solenoid mechanism. The switch shall be mechanically interlocked to ensure only two possible positions, normal or emergency. Switches having a neutral position shall not be permitted.
  - .7 The switch shall be positively locked and unaffected by momentary outages, so that con-tact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life. All main contacts shall be silver composition and inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power.

- .8 Designs utilizing components of molded case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.
  - .9 The transfer switch control panel shall have a 4 line, 20 character LCD display and keypad for viewing all available data and setting desired operational parameters. Voltage and frequency on both the normal and emergency sources shall be continuously monitored. The normal source pick up shall be set at 95% of nominal voltage and the emergency source pick up set at 90% of nominal voltage and 95% nominal frequency. Source status screens shall be provided for both normal & emergency to provide digital readout of voltage, frequency and phase rotation on all 3 phases.
  - .10 The transfer switch shall have visible pilot light indication for the following conditions: TRANSFER SWITCH IN NORMAL, TRANSFER SWITCH IN EMERGENCY, NORMAL SOURCE ACCEPTED, EMERGENCY SOURCE ACCEPTED and EMERGENCY ISOLATION SWITCH OPEN. Remote alarm contacts shall be supplied as standard for the following conditions: EMERGENCY SOURCE ISOLATION SWITCH OPEN, NORMAL POWER AVAILABLE, EMERGENCY POWER AVAILABLE and TRANSFER SWITCH POSITION. An audible alarm shall sound if: EMERGENCY ISOLATION SWITCH OPEN and TRANSFER SWITCH IN EMERGENCY occurs. A SILENCE ALARM push-button shall be supplied. A selector switch shall be supplied to manually test the transfer to emergency and the retransfer to normal power.
  - .11 The separately mounted transfer switch shall be installed by qualified personnel, having knowledge of fire pump controller and transfer switch installations and knowledge of the necessary wire connections between the transfer switch and the EXISTING fire pump controller, including the load disconnect interlock to conform to NFPA 20.
- .2 Mechanically Held Transfer Switch
- .1 The transfer switch shall be electrically operated and mechanically held. The electrical operator shall be a momentarily energized, single-solenoid mechanism. The switch shall be mechanically interlocked to ensure only two possible positions: Normal or Emergency.
  - .2 All transfer switch sizes shall use only one type of main operator for ease of maintenance and commonality of parts.
  - .3 The switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.
  - .4 All main contacts shall be silver composition. Switches rated 600 amperes and above shall have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.
  - .5 Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. Switches rated 600 amps and higher shall have front removable and replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.

- .6 Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.
- .3 Microprocessor Controller
  - .1 The controller's sensing and logic shall be provided by a single built-in microprocessor for maximum reliability, minimum maintenance, and the ability to communicate serially through an optional serial communication module.
  - .2 A single controller shall provide twelve selectable nominal voltages for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to  $\pm 1\%$  of nominal voltage. Frequency sensing shall be accurate to  $\pm 0.2\%$ . The panel shall be capable of operating over a temperature range of -20 to +60 degrees C and storage from -55 to +85 degrees C.
  - .3 The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Sensing and control logic shall be provided on multi-layer printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers. The panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. The protective cover shall include a built-in pocket for storage of the operator's manuals.
  - .4 All customer connections shall be wired to a common terminal block to simplify field-wiring connections.
  - .5 The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:
    - .1 EN 55011:1991 Emission standard - Group 1, Class A
    - .2 EN 50082-2:1995 Generic immunity standard, from which:
      - EN 61000-4-2:1995 Electrostatic discharge (ESD) immunity
      - ENV 50140:1993 Radiated Electro-Magnetic field immunity
      - EN 61000-4-4:1995 Electrical fast transient (EFT) immunity
      - EN 61000-4-5:1995 Surge transient immunity
      - EN 61000-4-6:1996 Conducted Radio-Frequency field immunity
    - .3 IEEE472 (ANSI C37.90A) Ring Wave Test.
  - .4 Fault withstand rating: 42kA RMS symmetrical short circuit current. The ATS shall be UL listed in accordance with UL 1008 and be labeled in accordance with that standard's 1½ and 3 cycle, long-time ratings. ATSS which are not tested and labeled with 1½ and 3 cycle (any breaker) ratings and have series, or specific breaker ratings only, are not acceptable.

## 2.4 ENCLOSURE

- .1 The Fire Pump ATS shall be furnished in a Type 2 enclosure.
- .2 All standard and optional door-mounted switches and pilot lights shall be 16-mm industrial grade type or equivalent for easy viewing & replacement. Door controls shall be provided on a separate removable plate, which can be supplied loose for open type units.

**2.5 CONTROLLER DISPLAY AND KEYPAD**

.1 A four line, 20 character LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through the serial communications input port. The following parameters shall only be adjustable via DIP switches on the controller:

- .1 Nominal line voltage and frequency
- .2 Single or three phase sensing
- .3 Operating parameter protection
- .4 Transfer operating mode configuration  
 (Open transition, Closed transition, or Delayed transition)

All instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.

**2.6 VOLTAGE, FREQUENCY AND PHASE ROTATION SENSING**

.1 Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout, and trip setting capabilities (values shown as % of nominal unless otherwise specified):

<u>Parameter</u>	<u>Sources</u>	<u>Dropout / Trip</u>	<u>Pickup / Reset</u>
Undervoltage	N&E, 3φ	70 to 98%	85 to 100%
Overvoltage	N&E, 3φ	102 to 115%	2% below trip
Under frequency	N&E	85 to 98%	90 to 100%
Over frequency	N&E	102 to 110%	2% below trip
Voltage unbalance	N&E	5 to 20%	1% below dropout

.2 Repetitive accuracy of all settings shall be within ± 0.5% over an operating temperature range of -20°C to 60°C.

.3 Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.

.4 The controller shall be capable (when activated by the keypad or through the serial port) of sensing the phase rotation of both the normal and emergency sources. The source shall be considered unacceptable if the phase rotation is not the preferred rotation selected (ABC or CBA).

.5 Source status screens shall be provided for both normal & emergency to provide digital readout of voltage on all 3 phases, frequency, and phase rotation.

## 2.7 TIME DELAYS

- .1 An adjustable time delay of 0 to 6 seconds shall be provided to override momentary normal source outages and delay all transfer and engine starting signals. Capability shall be provided to extend this time delay to 60 minutes by providing an external 24 VDC power supply.
- .2 A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.
- .3 Two time delay modes (which are independently adjustable) shall be provided on re-transfer to normal. One time delay shall be for actual normal power failures and the other for the test mode function. The time delays shall be adjustable from 0 to 60 minutes. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.
- .4 A time delay shall be provided on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.
- .5 A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minute time delay in any of the following modes:
  - .1 Prior to transfer only
  - .2 Prior to and after transfer
  - .3 Normal to emergency only
  - .4 Emergency to normal only
  - .5 Normal to emergency and emergency to normal
  - .6 All transfer conditions or only when both sources are available
- .6 The controller shall also include the following built-in time delays for optional Closed Transition and Delayed Transition operation:
  - .1 1 to 5 minute time delay on failure to synchronize normal and emergency sources prior to closed transition transfer.
  - .2 0.1 to 9.99 second time delay on an extended parallel condition of both power sources during closed transition operation.
  - .3 0 to 5 minute time delay for the load disconnect position for delayed transition operation.
- .7 All time delays shall be adjustable in 1 second increments, except the extended parallel time, which shall be adjustable in .01 second increments.
- .8 All time delays shall be adjustable by using the LCD display and keypad or with a remote device connected to the serial communications port.

## 2.8 ADDITIONAL FEATURES

- .1 A three position momentary-type test switch shall be provided for the test / automatic / reset modes. The test position will simulate a normal source failure. The reset position shall bypass the time delays on either transfer to emergency or retransfer to normal.



- .2 A SPDT contact, rated 5 amps at 30 VDC, shall be provided for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.
- .3 Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the ATS is connected to the normal source and one contact closed, when the ATS is connected to the emergency source.
- .4 LED indicating lights (16 mm industrial grade, type 12) shall be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red).
- .5 LED indicating lights (16 mm industrial grade, type 12) shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal and emergency sources, as determined by the voltage sensing trip and reset settings for each source.

**The following features shall be built-in to the controller, but capable of being activated through keypad programming or the serial port only when required by the user:**

- .6 Provide the ability to select “commit/no commit to transfer” to determine whether the load should be transferred to the emergency generator if the normal source restores before the generator is ready to accept the load.
- .7 Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal. Both of these inhibit signals can be activated through the keypad or serial port.
- .8 An Inphase monitor shall be provided in the controller. The monitor shall control transfer so that motor load inrush currents do not exceed normal starting currents, and shall not require external control of power sources. The inphase monitor shall be specifically designed for and be the product of the ATS manufacturer. The inphase monitor shall be equal to ASCO Feature 27.
- .9 The controller shall be capable of accepting a normally open contact that will allow the transfer switch to function in a non-automatic mode using an external control device.
- .10 **Engine Exerciser** - The controller shall provide an internal engine exerciser. The engine exerciser shall allow the user to program up to seven different exercise routines. For each routine, the user shall be able to:
  - .1 Enable or disable the routine.
  - .2 Enable or disable transfer of the load during routine.
  - .3 Set the start time,
    - time of day
    - day of week

– week of month (1st, 2nd, 3rd, 4th, alternate or every)

.4 Set the duration of the run.

At the end of the specified duration the switch shall transfer the load back to normal and run the generator for the specified cool down period. A 10-year life battery that supplies power to the real time clock in the event of a power loss will maintain all time and date information.

- .11 **System Status** - The controller LCD display shall include a “System Status” screen which shall be readily accessible from any point in the menu by depressing the “ESC” key a maximum of two times. This screen shall display a clear description of the active operating sequence and switch position. For example,

*Normal Failed*

*Load on Normal*

*TD Normal to Emerg*

*2min15s*

Controllers that require multiple screens to determine system status or display “coded” system status messages, which must be explained by references in the operator’s manual, are not permissible.

- .12 **Self-Diagnostics** - The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.
- .13 **Communications Interface** – The controller shall be capable of interfacing, through an optional serial communication module, with a network of transfer switches, locally (up to 4000 ft.) or remotely through modem serial communications. Standard software specific for transfer switch applications shall be available by the transfer switch manufacturer. This software shall allow for the monitoring, control and setup of parameters.
- .14 **Data Logging** – The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in a non-volatile memory:
- .1 Event Logging
    - .1 Data and time and reason for transfer normal to emergency.
    - .2 Data and time and reason for transfer emergency to normal.
    - .3 Data and time and reason for engine start.
    - .4 Data and time engine stopped.
    - .5 Data and time emergency source available.
    - .6 Data and time emergency source not available.
  - .2 Statistical Data
    - .1 Total number of transfers.
    - .2 Total number of transfers due to source failure.

- .3 Total number of days controller is energized.
- .4 Total number of hours both normal and emergency sources are available.
- .15 **Communications Module** - A full duplex RS485 interface shall be installed in the ATS controller to enable serial communications. The serial communications shall be capable of a direct connect or multi-drop configured network. This module shall allow for the seamless integration of existing or new communication transfer devices. The serial communication interface shall be equal to ASCO Accessory 72.

## 2.9 EQUIPMENT IDENTIFICATION

- .1 Identify equipment in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Control panel:
  - .1 For selector switch and manual switch: size 4 nameplates.
  - .2 For meters, indicating lights, minor controls: use size 2 nameplates.
  - .3 Nameplates to match existing.

## 2.10 TESTS AND CERTIFICATION

- .1 Complete equipment, including transfer mechanism, controls, relays and accessories factory assembled and tested.
- .2 The complete ATS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.
- .3 Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.
- .4 The ATS manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001.
- .5 Tests:
  - .1 Operate equipment both mechanically and electrically to ensure proper performance.
  - .2 Check selector switch, in modes of operation and record results.
  - .3 Check voltage sensing and time delay relay settings.
  - .4 Check:
    - .1 Automatic starting and transfer of load on failure of normal power.
    - .2 Retransfer of load when normal power supply resumed.
    - .3 Automatic shutdown.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Locate, install and connect transfer equipment.
- .2 Check relays/solid state monitors and adjust as required.
- .3 Install and connect battery and remote alarms.

**3.2 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results – Electrical. Perform commissioning by manufacturer or manufacturer authorized technician.
- .2 Energize transfer equipment from normal power supply.
- .3 Set selector switch in "Test" position to ensure proper standby start, running, transfer, retransfer. Return selector switch to "Auto" position to ensure standby shuts down.
- .4 Set selector switch in "Auto" position and open normal power supply disconnect. Standby should start, come up to rated voltage and frequency, and then load should transfer to standby. Allow to operate for 10 min, then close main power supply disconnect. Load should transfer back to normal power supply and standby should shutdown.
- .5 Repeat, at 1h intervals, 2 times, complete test with selector switch in each position, for each test.
- .6 Submit manufacturer commissioning report in PDF format within 5 days after new transfer switches commissioning.

**3.3 CLEANING**

- .1 Progress Cleaning: leave Work area clean at end of each shift.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.
- .3 Waste Management: Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**