METROLINX

Transfer Switch Specification

Specification 26 36 23

Revision 01
Date: March 2023

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Amendment Record Sheet

Amendment in Clause No.	Date of Amendment	Description of Changes
1.2.3	March 2023	Added 'the latest version of'
1.2.8. 1.3.3, 2.6	March 2023	Updated monitoring requirements and numbering on electrical nomenclature and identification specification
2.2.1. u (5), 2.2.1 cc	March 2023	Updated and added transfer switch requirements
3.1.2 c (3), 3.3.3 d (3)	March 2023	Added factory testing requirements and Updated field commissioning requirements

LIST OF CONTENT

1. GENERAL

1.1. SCOPE OF WORK

1.1.1. Labour, products, equipment and services necessary for both Manual Transfer Switch (MTS) and Automatic Transfer Switch (ATS) work in accordance with the Contract Documents.

1.1.2. Transfer Switch (TS) can refer to both Manual Transfer Switch (MTS) and Automatic Transfer Switch (ATS) throughout this Section.

1.2. DESIGN REQUIREMENTS

1.2.1. The equipment furnished and the equipment installation, wiring methods and materials used shall conform to the latest edition of the Ontario Electrical Safety Code, Electrical Safety Authority (ESA) Bulletins and Supplements issued by the Electrical Safety Authority, and the applicable Metrolinx Standards. In case of any conflicts, the more stringent requirement shall apply.

1.2.2. Design equipment and systems to all applicable standards of CSA, ULC, IEEE, ESA.

1.2.3. Design equipment and systems to the latest version of GO DRM.

1.2.4. Design equipment and systems to standards and codes to be latest editions adopted by and enforced by local authorities having jurisdiction (AHJ).

1.2.5. Devices selected in accordance with this Section shall be in accordance with the voltage, frequency, phase, ampacity, interrupting capacity, withstand rating, options and protection requirements shown on the Contract Drawings.

1.2.6. TS shall be designed to transfer equipment load from one power supply to an alternate power supply under loaded conditions. This can be done with a manual transfer or and automatic transfer method.

1.2.7. TSs must be monitored both locally and remotely and be supervised by the Building Automation System (BAS).

1.2.8. TS shall monitor voltage, frequency, active power (kW), apparent power (kVA), reactive power (kVAR), power factor, kWh and current on phases of normal power supply, alternate power supply and load side.

1.2.9. Where a backup generator is used as shown on the Contract Drawings, the ATS shall initiate startup and shutdown of the backup generator. The ATS shall transfer load from normal supply to backup generator when the generator reaches rated frequency and voltage pre-set adjustable limits. The TS shall transfer load from backup generator to normal power supply when normal power is restored, confirmed by sensing of voltage on phases above adjustable pre-set limit for adjustable time. The TS shall shut down the backup generator after running unloaded to cool down using adjustable time delay relay.

1.2.10. TS shall include an bypass/isolation switch to place the components in a bypass mode which allows maintenance of the TS without interrupting power. Bypass methods using electronic controls and electronically operated breakers are not to be used. The bypass/isolation switch shall bypass both the normal power supply path and the alternative power supply path.

1.3. RELATED WORKS

1.3.1. Section 26 05 00 - Electrical General Requirements.

1.3.2. Section 26 05 21 - Electrical Conductors and Cables.

1.3.3. Section 26 05 23 – Electrical Identification and Nomenclature

1.3.4. Section 26 28 00 - Circuit Breakers and Fuses.

1.3.5. Section 26 32 00 - Backup Power Supply Generator.

1.3.6. Section 26 37 00 - Outdoor Load Bank.

1.4. REFERENCE STANDARDS

1.4.1. Ontario Electrical Safety Code (OESC).

1.4.2. Ontario Building Code (OBC).

1.4.3. Metrolinx Standards, Drawings and Specifications.

1.4.4. GO Design Requirement Manual (DRM).

1.4.5. Metrolinx Electrical Safety Document.

1.4.6. CSA Z462, Workplace Electrical Safety.

1.4.7. CAN3 C235, Preferred Voltage Levels for AC Systems, 0 to 50,000V.

1.4.8. CAN3-Z299.4, Quality Assurance Program - Category 4.

1.4.9. ANSI, American National Standards Institute.

1.4.10. CSA, Canadian Standards Association.

1.4.11. NEMA, National Electrical Manufacturer's Association.

1.4.12. EEMAC, Electrical Equipment Manufacturer's Association of Canada.

1.4.13. IEEE, Institute of Electrical and Electronics Engineers.

1.4.14. ANSI/NEMA ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.

1.4.15. CAN/CSA C22.2 No. 4, Enclosed Switches.

1.4.16. CAN/CSA-C22.2 No. 5-02 - Moulded-Case Circuit Breakers, Moulded-Case Switches and Circuit-Breaker Enclosures.

1.4.17. CAN/CSA-C22.2 No. 94-M91 (R2001) - Special Purpose Enclosures.

1.4.18. CAN3-C13, Instrument Transformers.

1.4.19. CSA C22.1-02 - Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.

1.4.20. CSA C22.2 No. 5, Moulded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures.

1.4.21. CSA C22.2 No.94, Enclosures for electrical equipment, non-environmental considerations

1.4.22. CSA C22.2 No. 178, Automatic Transfer Switches.

1.4.23. IEC 947-6-1, Automatic Transfer Switching.

1.4.24. NEMA No. ICS 10 Industrial Control and Systems AC Transfer Switch Equipment.

1.4.25. OESC, Ontario Electrical Safety Code.

1.4.26. UL1008, Automatic Transfer Switches for Use in Emergency Systems.

1.4.27. UL98, Standard for Enclosed and Dead Front Switches.

1.4.28. Underwriters Laboratories of Canada.

1.4.29. SSPC, Surface Preparation Standards.

1.5. SPARE PARTS

1.5.1. Not applicable.

1.6. TRAINING

1.6.1. Contractor shall train Metrolinx personnel, including training on transfer switch components, operations, safety, and troubleshooting.

1.6.2. Contractor shall allow for two separate training sessions to fully train Metrolinx personnel in all the equipment provided in the Contract.

1.7. WARRANTY

1.7.1. The contractor shall provide a manufacturer warranty for the work of this section with a minimum warranty period of five years after acceptance by Metrolinx.

1.8. DELIVERY, STORAGE AND HANDLING

1.8.1. Contractor to protect equipment from damage, weather and moisture in accordance with Manufacturer's instructions. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

1.8.2. Contractor to handle to Manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage.

1.9. SUBMITTALS

1.9.1. Product Data Package

a) Submit manufacturer's Product data indicating:

1) Technical data, supplemented by bulletins, component illustrations, detailed views, technical descriptions of items, and parts lists;

2) Performance criteria, compliance with appropriate reference standards, characteristics, limitations, and troubleshooting protocol; and

3) Product transportation, storage, handling, and installation requirements.

1.9.2. Shop Drawings Package

a) Submit manufacturer's shop drawing indicating:

1) Elevations, and details, dimensions, gauges, finishes, cable entry/exit locations, interior/exterior component layouts, and relationship to adjacent construction;

2) Single line diagram indicating controls and relays;

3) Electrical Schematic(s) showing internal wiring, and customer connection terminals;

4) Make, model and type of transfer switches;

5) Description of equipment operation including:

i) Automatic starting and transfer to backup generator and back to normal power (where applicable);

ii) Test control and manual control; and

iii) Automatic backup generator shutdown (where applicable).

6) Identification; and

7) Copies of manufacturer's design test certificates.

1.9.3. Commissioning Package

a) Submit the following:

1) Identification: Manufacturer's name, type, year, serial number, number of units, capacity, and identification of related systems;

2) Functional description detailing operation and control of components;

3) Performance criteria and maintenance data;

4) Safety precautions;

5) Installation manual. Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product;

6) Operating manual. Include instructions for operating equipment;

7) Maintenance manual. Include troubleshooting guidelines/protocol and recommended equipment for analysis and repair. Include routine preventative maintenance and lubrication schedule. List special tools, maintenance materials, and replacement parts;

8) Component parts availability including names and addresses of spare part suppliers;

9) Source quality control test results; and

10) Field quality control test results.

1.10. QUALITY ASSURANCE

1.10.1. All electrical items shall be approved by CSA and/or ULC and be acceptable to authority having jurisdiction.

1.10.2. Manufacturer shall be a company specializing in manufacturing the products specified in this Specification with minimum 5 years documented experience, with service facilities within 160 km of Project location. Vendor shall be an authorized distributor of specified Manufacturer with minimum 5 years documented experience.

1.10.3. Manufacturer shall be responsible for ensuring the compatibility of all components of the unit.

2. PRODUCTS

2.1. GENERAL

2.1.1. The transfer switch shall be able to withstand the environmental conditions stated in Section 26 05 00 without damage or degradation of operating characteristics.

2.1.2. Products shall be free of defects in material and workmanship.

2.1.3. All materials and parts used in the product shall be new, of current manufacture, of best industrial grade, and free from defects and imperfections.

2.1.4. Adequate size and quantity of ground lugs shall be provided and shall conform to OESC. Where a ground bus is provided, it shall be a full-length copper ground bus bonded to the frame with adequate size and quantity of ground lugs and shall conform to OESC.

2.1.5. Where load bus bars are utilized, they shall be tin-plated round-edge high conductivity copper and be sized for 100% continuous load rating of the TS, in accordance with NEMA, CSA and UL guidelines. The short circuit withstand rating of the completed bus assembly shall be not less than the short circuit fault current of the system.

2.1.6. Provision shall be made to terminate all incoming and outgoing power cables and grounding conductors. Connections shall be via screw type cable lugs.

2.1.7. Provision shall be made for both top and bottom cable entry to the TS.

2.2. TRANSFER SWITCH (TS) REQUIREMENTS

2.2.1. The following requirements apply to ATS's and MTSs.

a) TS shall include a bypass/isolation switch.

b) TS shall be break-before-make transfer logic.

c) TS power contacts used shall operate in a quick-make/quick-break manner, the speed of which shall be independent of supply voltage or speed of operation by manual means.

d) TSs shall be electrically operated and mechanically held.

e) TS ratings shall be in accordance with the Contract Drawings. The Contract Drawings will indicate:

1) Voltage;

2) Current;

3) Frequency;

4) Phase configuration;

5) Quantity of switched poles;

6) External cable sizes;

7) Load Inrush value;

8) Interrupting Capacity; and

9) Withstand rating

f) TS current ratings shall be based on all classes of load including resistive, and motor loads without de-rating.

g) The TS shall be rated and certified for service entrance applications.

h) The power switching devices shall be fix-mounted, utilize fully enclosed contacts and the withstand and closing rating shall be equal to or exceed the required withstand rating of the complete mechanism.

i) The TS shall permit manual mechanical operation of the TS directly on the power switching devices while the system is energized and carrying rated load. All safety interlocks shall be operational for this type of manual operation.

j) TS to include a manual operating handle for maintenance. Handle shall permit operator to stop contacts at any point throughout entire travel to allow inspection and service of contacts when required.

k) A control circuit isolation plug shall be provided to isolate all control circuitry inside the TS to facilitate maintenance procedures. When isolated, there shall be no voltage present on the control circuitry.

l) The TS design shall provide front accessible components and wiring for easy serviceability. Power or control connections, which are not readily serviceable while the TS is mounted in its enclosure, are not acceptable. Inspection of contacts, movable or stationary shall be possible from front of TS without disassembly of operating linkages and without disconnection of power conductors.

m) The TS power switching devices shall be both mechanically and electrically interlocked to prevent the two supplies from being interconnected.

n) Where the Contract Drawings show that the TS is used as the main service connection point, it shall incorporate an isolating mechanism and over current protection on the normal power supply to allow operation as the main service disconnect in accordance with OESC requirements.

o) TS control power must be obtained from the supply being transferred to. The controls shall not require any connection to external power supplies. TS requiring power from the engine starting (or other) battery are not acceptable.

p) TS control module shall be microprocessor based. The control module 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 communication module (protocol defined on Contract Documents).

q) TS control module shall be connected to the TS by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the TS for routine maintenance. Circuit logic shall be provided on multi-layer printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers.

r) TS control module shall be enclosed with a protective cover and be mounted separately from the TS for safety and ease of maintenance. The protective cover shall include a built-in pocket for storage of the operator's manuals.

s) All TS control module connections shall be wired to a common terminal block to simplify field-wiring connections.

t) Where a form-C TS is used, it shall not be possible to engage a neutral position (neither on normal power or alternate power).

u) Bypass/Isolation Construction

1) Bypass/isolation switch shall be mechanically operated, mechanically held switch connected to bypass TS in both normal and alternate positions

2) All main contacts and operating linkages of the bypass/isolation switch shall be the same as the TS, except that the operation shall be manual.

3) The bypass/isolation switch shall be the overlapping type. The main contacts of the bypass switch shall be mechanically locked in both the normal bypass and the alternate bypass positions without the use of hooks, latches, magnets or springs and shall be silver-tungsten alloy, protected by arcing contacts. The switching mechanism shall provide "Quick-Make," "Quick-Break" operation of the contacts.

4) Bypass/isolation switch rating shall match ATS ratings.

5) The bypass/isolation switch shall provide three operating modes: "Closed", "Test", and "Open". The "Test" mode shall permit testing of the entire emergency power system, including the automatic transfer switches with no interruption of power to the load. The "Open" mode shall completely isolate the automatic transfer switch from all source and load power conductors. In "Open" mode, it shall be possible to completely withdraw the automatic transfer switch for inspection or maintenance to confirm to code requirements without removal of power conductors or the use of any tools.

v) Power Quality Monitoring

1) Monitor each phase of normal supply voltage and frequency. Supply is deemed unhealthy when voltage drops below adjustable voltage threshold or when frequency varies more than 3% from rated nominal value.

2) Monitor each phase of alternate supply voltage and frequency. Supply is deemed unhealthy when voltage drops below adjustable voltage threshold or when frequency varies more than 3% from rated nominal value.

3) Monitor each line of load voltage and frequency for synchronization purposes. TS shall Inhibit transfer until supply side and load side are synchronised.

w) Pilot lights shall be provided as follows:

1) TS on "Normal Power Supply" – green LED;

2) TS on "Alternate Power Supply" – red LED;

3) "Normal Power Supply" available. – green LED;

4) "Alternate Power Supply" available. – green LED; and

5) "Bypass Active" available. – green LED.

x) Auxiliary contact shall be provided as follows:

1) TS on "Normal Power Supply" – three (3) auxiliary contact voltage free, form C type, rated at 10 A, 120 V;

2) TS on "Alternate Power Supply" – three (3) auxiliary contact voltage free, form C type, rated at 10 A, 120 V;

3) "Normal Power Supply" available– three (3) auxiliary contact voltage free, form C type, rated at 10 A, 120 V;

4) "Alternate Power Supply" available – three (3) auxiliary contact voltage free, form C type, rated at 10 A, 120 V; and

5) "Bypass Active" available – three (3) auxiliary contact voltage free, form C type, rated at 10 A, 120 V.

y) Where shown on the Contract Drawings an enclosure strip heater c/w thermostat shall be provided. An enclosure strip heater shall be supplied inside the TS enclosure and shall be controlled by an adjustable thermostat. An external power supply rated 120VAC, single phase, 15A over current protected branch circuit is to be supplied by Others.

z) Where shown on the Contract Drawings a shunt Trip shall be provided for the "Normal Supply". A shunt trip device shall be provided in the normal supply transfer power switching device to provide remote tripping capability for load shedding or load dumping purposes. Shunt trip device shall be rated for 24 Vdc 10 A control power, which is to be supplied by an external supply with required logic and over current protection.

aa) Where shown on the Contract Drawings a shunt Trip shall be provided for the "Alternate Supply". A shunt trip device shall be provided in the alternate supply transfer power switching device to provide remote tripping capability for load shedding or load dumping purposes. Shunt trip device shall be rated for 24 Vdc 10 A control power, which is to be supplied by an external supply with required logic and over current protection.

bb) The TS and control module shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) requirements of the applicable standards.

cc) A minimum four-line, 20-character LCD display and keypad shall be provided for viewing all available data and settings desired operational parameters. The operational parameters shall be available for viewing and modification through the BAS system.

2.3. MANUAL TRANSFER SWITCH (MTS) REQUIREMENTS

2.3.1. MTS position shall be selected manually by hand using two means:

a) Local control - a control switch shall be mounted on TS front cover; and

b) Remote control - a remote control panel shall be provided with a control switch mounted on the front cover. The remote-control panel shall include a switch to select between local control or remote-control modes.

2.3.2. Supply selector switches shall be 2-position spring-return selector switch.

2.3.3. The MTS shall transfer the load to the normal supply when an operator selects the "normal supply" position on the door mounted supply selector switch provided normal supply is energized at nominal rated voltage. Similarly, the MTS shall transfer the load to the alternate supply when an operator selects the "alternate supply" position on the door mounted supply selector switch provided alternate supply is energized at nominal rated voltage.

2.3.4. The MTS shall not automatically change selected supply under any condition.

2.3.5. MTS shall include pilot lights, auxiliary contacts and power quality monitoring modules. MTS shall Inhibit transfer until supply side and load side are synchronised.

2.4. AUTOMATIC TRANSFER SWITCH (ATS) REQUIREMENTS

2.4.1. ATS to be double throw type.

2.4.2. ATS's shall be in accordance with CSA C22.2 No. 178.

2.4.3. ATS shall consist of a power mechanism and control module, interconnected for automatic operation.

2.4.4. ATS power mechanism shall be draw-out type with connected, test, and disconnected draw out positions.

2.4.5. ATS's utilizing components of moulded-case circuit breakers, contactors, or parts thereof, not intended for continuous duty or repetitive load transfer switching are unacceptable.

2.4.6. ATS shall switch automatically from normal power supply to the alternative power supply upon failure or abnormal voltage on any one phase below preset adjustable limits for adjustable period.

2.4.7. ATS sequence of operation for backup generator applications

a) Start backup generator. Upon initiation by the normal supply monitor module a time delayed start signal shall be sent to the backup generator. Time delay shall be adjustable (0 to 600 s).

b) Transfer load to alternate supply. When the alternate supply monitor module indicates that the backup generator is ready for transfer a time delayed transfer signal shall be sent to the ATS. Time delay shall be adjustable (0 to 600 s).

c) Transfer load to normal supply. When the normal supply monitor module indicates that the normal supply if healthy and is ready for transfer, a time delayed transfer signal shall be sent to the ATS. Time delay shall be adjustable (0 to 600 s). Time delay shall be bypassed in the event of alternate supply failure.

d) Backup generator shutdown. A time delayed shutdown signal shall be sent to the backup generator of a period of unloaded operation (cooldown) Time delay shall be adjustable (0 to 20 minutes).

e) Engine Exerciser: Start backup generator every 30 days; run for 60 minutes before shutting down. Bypass exerciser control if normal supply fails during exercising period. In addition, transfer load to alternate supply during engine exercising period to exercise ATS.

f) Special Condition No.1: In the case that the generator is already running with the load bank when the normal supply fails, the ATS shall send a hard-wired open command to the generator load-bank breaker to unload the generator. The generator shall not be shutdown by the ATS. Once the load-bank breaker is open and the generator is stable the ATS shall transfer load to alternate supply.

2.4.8. Provide a test switch inside the ATS enclosure, to simulate voltage failure on normal power supply and initiate transfer to alternate power supply. Provide a return to normal switch to initiate manual transfer from alternate to normal supply.

2.5. ENCLOSURE

2.5.1. Enclosures shall be in accordance with CSA-C22.2 No. 94.

2.5.2. For indoor installations, the enclosure shall be:

a) NEMA 1 rated and sprinkler proof;

b) Fabricated from minimum 14-gauge steel of adequate strength and rigidity necessary to resist all conditions of use to which it may be subjected and to support all equipment contained therein.

c) Complete with door gasket and drip hood; and

d) Cleaned, sealed, and painted with one coat rust resistant primer and two coats of ASA #61 gray enamel or polyester powder coat finish inside and out.

2.5.3. For outdoor installations, the enclosure shall be:

a) NEMA 4X;

b) Fabricated from minimum 14-gauge stainless steel of adequate strength and rigidity necessary to resist all conditions of use to which it may be subjected and to support all equipment contained therein;

c) Suitable for outdoor application with controls mounted on an interior door. Exterior door shall provide additional protection against outside environment and vandalism; and

d) TS door(s) shall be lockable.

2.6. IDENTIFICATION

2.6.1. Furnish colour coding in accordance with Section 26 05 23 Electrical Identification and Nomenclature

2.6.2. Provide identification for equipment and the sub-components in accordance with Section 26 05 23 Electrical Identification and Nomenclature.

2.6.3. Provide nameplates, warning signs and labels as required by the AHJ.

3. EXECUTION

3.1. FACTORY TESTING

3.1.1. Completely assemble, wire and adjust TSs in factory.

3.1.2. The TS shall be factory tested prior to delivery to the purchaser. The following tests shall be conducted by qualified factory personnel:

a) Visual Inspection: Electrical and mechanical inspections to verify installed components are of correct ratings; meet the requirements of the project specifications and to ensure regulatory and quality requirements are met;

b) Mechanical Tests: As a minimum, the following mechanical tests shall be performed on the TS:

1) Power conductor torque verification;

2) Verification of mechanical interlock;

3) Mechanism operation/adjustment; and

4) All mechanical fasteners/wire connections tight.

c) Electrical Tests: As a minimum, the following electrical tests shall be performed on the TS:

1) Verification of electrical interlock;

2) Function test-normal operation- minimum of three (3) complete cycles;

3) Verify correct operation and timing of the following functions:

i) Normal source voltage and frequency sensing relays;

ii) Engine start sequence;

iii) Time delay upon transfer;

iv) Alternate source voltage and frequency sensing relays;

v) Automatic transfer operation;

vi) Time delay and retransfer upon normal power restoration;

vii) Engine cool down and shutdown feature;

viii) Load bank breaker trip operation; and

ix) Exerciser control bypass test.

4) Mechanism adjustment; and

5) Dielectric test.

d) Final Inspection: As a minimum, the following final inspection tasks shall be performed on the TS:

1) Calibration label/equipment labels installed and correct;

2) All safety/warning labels attached;

3) All wiring straight, neatly bundled and adequately protected;

4) All options supplied as specified;

5) Enclosure is clean, no paint imperfections; and

6) Final documentation is enclosed (Drawing(s), O&M Manual).

3.1.3. The Manufacturer shall provide upon request of the project engineer, four (4) copies of certified Factory Test Reports for the TS supplied

3.1.4. The Manufacturer arrange for Metrolinx to witness above at manufacturer's factory as part of factory acceptance testing. Notify Metrolinx at least 21 calendar days prior to set up the factory acceptance testing schedule.

3.2. INSTALLATION

3.2.1. Manufacturer's installation recommendations shall be followed by the installation team.

3.2.2. Verify that surface is suitable for TS installation.

3.2.3. Floor standing TSs must be installed on a concrete house keeping pad inside minimum height 104 mm.

3.3. FIELD COMMISSIONING

3.3.1. The TS shall be tested once installed at the project site to confirm proper operation of the system.

3.3.2. Schedule and witness testing activities shall be coordinated with the project engineer, site contractor, and Metrolinx or its designated representative(s) as required in advance of the testing.

3.3.3. Qualified local factory-trained field service representatives shall conduct the following tests:

a) Inspection: Electrical and Mechanical inspection to verify the installation is correct as recommended by the TS manufacturer and as per OESC requirements.

b) Mechanical Tests: As a minimum, the following mechanical tests shall be performed on the TS:

1) Power conductor torque verification;

2) Verification of mechanical interlock;

3) Manual TS mechanism operation; and

4) All mechanical fasteners/wire connections tight.

c) Confirmation of correct TS voltage, current and withstand ratings as is required for the application.

d) Electrical Tests: As a minimum, the following electrical tests shall be performed on the TS:

1) Meggar testing the power cabling to the TS;

2) Verification of correct power cabling phasing and phase rotation, prior to energization;

3) Full functional testing including normal power operation, alternate power operation, generator start operation, interlock operation and generator cool down operation - three (3) complete cycles of manually selecting normal power supply and alternate power supply;

4) Integrated system test with generator, load bank and utility feed; and

5) Qualified factory-trained field service personnel shall provide upon request of the project engineer four hard copies and 1 soft copy in pdf format of the field test reports noting any deficiencies that require corrective action.

END OF SECTION