

SECTION 26 3600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes transfer switches rated 600 V and less, including the following:
 - 1. Automatic Transfer Switches (ATS).
 - 2. Closed Transition Transfer Switches (CTTS).
 - 3. Bypass/isolation switches.
- B. Related Sections include the following:
 - 1. Division 26 Section "Engine Generators" for interfacing with Emergency Power Systems.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, accessories and catalog data sheets.
- B. Shop Drawings: "Typical" drawings are not acceptable. Provide project specific drawings for each transfer switch. Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
 - 1. Wiring Diagrams: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Qualification Data: For manufacturer.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Features and operating sequences, both automatic and manual.

2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.4 QUALITY ASSURANCE

- A. **Manufacturer Qualifications:** Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.
- B. **Source Limitations:** Obtain automatic transfer switches and bypass/isolation switches through one source from a single manufacturer.
- C. **Electrical Components, Devices, and Accessories:** Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NEMA ICS 1.
- E. Comply with NFPA 70.
- F. Comply with NFPA 110.
- G. Comply with UL 1008 unless requirements of these Specifications are stricter.
- H. Comply with most current edition of the Northwestern University Design Standards.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store enclosed transfer switches indoors in clean, dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers.

1.6 PROJECT CONDITIONS

- A. ***(Delete This Paragraph If Not Required)*** [Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by The University or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 1. **Notify the University no fewer than [two] calendar weeks in advance of proposed interruption of electric service.**
 2. **Indicate method of providing temporary electric service.**
 3. **Do not proceed with interruption of electrical service without the University's Chief Electrician's written permission.**
 4. **The University Lock-out/Tag-out procedures shall be used with Contractor controlled locks and tags.**
 5. **Comply with NFPA 70E.]**

- B. Installation Pathway: Remove and replace building components and structures to provide pathway for moving transfer switches into place.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for transfer switches, including clearances between transfer switches and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Ambient Temperature: Not exceeding 40 deg C.
 - 2. Altitude: Not exceeding 6600 feet (2010 m).

1.7 COORDINATION

- A. Coordinate sensor-communication module package with the University's SCADA system for successful transmission and remote readout of remote monitoring data specified in this Section.
- B. Floor mounted switches: Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Sections.

1.8 WARRANTY

- A. Comply with Division 1 requirements.
- B. The automatic transfer switch shall be provided with a ten year warranty, covering all parts, labor, travel and expenses during the first two years, followed by seven years of replacement parts coverage. Warranty shall commence on startup. Warranty shall not be dependent upon customer purchase of additional equipment or preventive maintenance contracts.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide products by:
 - 1. Contactor Transfer Switches:
 - a. Russelectric, Inc. "RTS" type (Chicago).
 - b. Or equal products when approved in writing by the University's Chief Electrician:
 - 1) ASCO 7000 Series (Evanston).
 - 2) Caterpillar. (Evanston only)
 - 3) Cummins. (Evanston only)
 - 4) Kohler. (Evanston only)

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

- A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- B. Transfer switches shall be seismic certified, capable of operating successfully after being subjected to a minimum IBC 200% g Earthquake Test. Testing shall be performed and verified by an independent, A2LA accredited, testing laboratory, in accordance with IBC 2006.
- C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
1. A color, ¼ VGA minimum, graphical display shall be provided for viewing data and setting operational parameters. Parameters shall also be available for viewing remotely and limited control through a front accessible USB communications port with keypad.
 2. All control components and wiring shall be front accessible. All control wires shall be multi-conductor minimum 18 gauge 600-volt SIS switchboard type point to point harness. All control wire terminations shall be identified with tubular sleeve-type markers.
 3. The Controller shall provide high intensity LED's for the following:
 - a. Source Availability - Indicates the source voltage and frequency are within pre-set parameters.
 - b. Source Connected - Indicates the source main contacts closed and the load being served from the source.
 - c. XFER Inhibit - Indicates that the ATS is being inhibited from automatic operation to the unconnected source.
 - d. Alarm: Indicates an alarm condition is active.
 - e. TD Active: Indicates that a transfer switch time delay is actively timing.
 4. For ease of navigation, the display shall include the following:
 - a. Soft Keys – Change function based on user location in the menu structure.
 - b. Dedicated Navigational Keys – Home, Scroll Up, End, Escape and Enter.
 - c. Dedicated Pushbuttons for Alarm Reset, Test, Control and Information.
- D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- E. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
- F. The automatic transfer switch shall be capable of transferring successfully in either direction with 70% of rated voltage applied to the switch terminals.

(Select Paragraph 'G' or 'H' Per Job Requirements, review with University's Chief Electrician)

- G. **[Switches shall be four-pole as indicated on the drawings. A true four pole switch shall be supplied, with all four poles mounted on a common shaft. The entire fourth pole assembly, including contacts, arc chutes, etc. shall be identical to the other power poles. The fourth pole shall be switched simultaneously with, and by the same mechanism as, the main power poles. The short circuit rating of the fourth pole shall be identical to the**

ratings of the main power poles. The complete assembly shall be factory tested to ensure proper operation and compliance with the specifications requirements.]

- H. **[Switches shall be three-pole as indicated on the drawings with Neutral Terminal solid and fully rated, unless otherwise indicated.]**
- I. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
 - 1. *Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.*
 - 2. Switch Action: Double throw; mechanically held in both directions.
 - 3. Contacts: Silver composition or silver alloy for load-current switching. All automatic transfer-switch shall have separate arcing contacts.
- J. Tested Fault-Current Closing and Withstand Ratings: The transfer switch shall be UL listed in accordance with UL 1008 for 3 and 30 cycle close and withstand ratings for duty imposed by protective devices at installation locations in Project under the fault conditions indicated. Switches that are not tested and labeled by UL for 3 and 30 cycle ratings are not acceptable. In accordance with UL-1008, after completion of the short time closing and withstand testing, the same sample shall successfully pass the Temperature Test and the Dielectric Voltage-Withstand Test to verify the ability of the ATS to carry full rated current after completing the short time tests. The minimum UL listed close and withstand ratings at 480 VAC shall be as follows:

| <u>1.</u> <u>Size Amps</u> | <u>3 Cycle</u> | <u>30 Cycle</u> | <u>Current</u> <u>Limiting Fuses</u> |
|-------------------------------|----------------|-----------------|---|
| 100 – 400 | 42 Ka | 30 Ka | 200,000 a |
| 600 – 800 | 65 Ka | 42 Ka | 200,000 a |
| 1000 – 1200 | 85 Ka | 65 Ka | 200,000 a |
| 1600 – 3000 | 100 Ka | 85 Ka | 200,000 a |
- K. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with annunciator and University SCADA system.
- L. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Identification for Electrical Systems."
 - 1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
 - 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top or bottom entrance of feeder conductors as indicated.
 - 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
- M. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, or in a switchboard assembly in accordance with UL 891, unless otherwise indicated. Enclosures shall be designed to allow installation against wall or floor mounted. Cable access shall be from the front. Provide a side pull box where shown on drawings.
 - 1. Enclosure shall be constructed so that personnel are protected from energized bypass-isolation components during automatic transfer switch maintenance.

2. Automatic transfer switch components shall be removable without disconnecting external source or load power conductors.
3. Finish: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal.
4. The switch shall be operable from a dead-front location.
5. Provide copies of wiring diagrams and maintenance instructions located on the inside of enclosure door in a permanent mounting sleeve designed to hold the data.

N. Switches shall be equipped with NEMA 2-hole compression type CU lugs. The compression lugs shall be furnished with the ATS and the UL listing of the switch shall not be compromised.

O. Communications Modules:

1. Provide a web server communications gateway to accommodate digital and analog I/O serial communications over fieldbus networks using other protocols, including Modbus-RTU. It shall also serve as pass-through gateway providing access to the ATS through the University's SCADA system.
2. The Controller shall be capable of supporting Modbus TCP/IP Ethernet 10/100MBit communications or Modbus RTU via an internally mounted and self powered communications card. Include an RJ45 network connector and USB port.

P. Power quality metering:

1. Comply with Section 26 2713 "Electricity Metering" requirements.

2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts shall be mechanically locked in position in both the normal and emergency positions without the use of hooks, latches, magnets, or springs, and shall be silver-tungsten alloy. Main contacts on all size switches shall be segmented, and shall have separate arcing contacts with magnetic blowouts for positive arc-quenching and maximum contact life.

C. Switching Arrangement: The automatic transfer switch shall be double throw, actuated by one or two electrical operators, momentarily energized and connected to the transfer mechanism by a simple over-center type linkage, providing inherent "quick-break", "quick-make" operation when operated electrically or manually.

1. Single operator for Life Safety/Essential switches.
2. Dual operator for Standby or Optional Load switches, and Closed Transition for **[per project requirements]** loads. The adjustable time delay between the opening of the closed contacts and the closing of the open contacts shall allow the loads to be demagnetized before transfer.

D. Manual Switch Operation: All open transition transfer switches shall be equipped with a safe manual operator designed to prevent injury to operating personnel. The manual operator shall provide the same contact to contact transfer speed as the electrical operator to prevent a flash-over from switching the main contacts slowly. Manual operation shall not require prior disconnection of electrical operators or control wiring, and shall be safe even if the electrical operator becomes energized during manual operation. The manual operator shall be external

type, operable through the door of the enclosure. Safe manual transfer shall be possible under all load conditions, either energized or non-energized. The external manual operator is not required on transfer switches equipped with a bypass switch.

E. Automatic Transfer-Switch Features:

1. Programmable Undervoltage and Frequency Sensing for Each Phase of Normal and Emergency Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 70 to 98 percent of nominal, and dropout voltage is adjustable from 72 to 100 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent. Over voltage to pick up at 102 to 110% and drop out at 100 to 108%. Over frequency sensing to pick up at 50.1 to 69.8 Hz and drop out at 50.0 to 69.7 Hz. Under – frequency sensing to pick up at 45.0 to 59.9 Hz and drop out at 45.1 to 60 .0 Hz (VFS1,2)
2. Contact to close on normal source failure to initiate engine start (CES).
3. Normal status relay (CS1A).
4. Emergency status relay (CS2A).
5. Bypass and transfer switch auxiliary contact in parallel with engine start to maintain start signal whenever load is connected to emergency source (CMES).
6. The controller shall monitor phase rotation of both sources and inhibit transfer if both sources are not the same phase rotation. Source rotation shall be field selectable as either ABC or CBA (PRR).
7. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for 3 seconds (TDES).
8. Adjustable Time Delay: transfer to emergency, adjustable 0 – 9999 seconds. Factory set at 3 seconds (TDNPS).
9. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 105 percent of nominal. Factory set for pickup at 95 percent (VFS2).
10. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 5 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored (TDPS).
11. Time delays to control transition time delay on transfer and re-transfer (TDNNP, TDNP). For dual operator and closed transition types only.
12. Test Switch: Simulate normal-source failure (XT1G).
13. Switch-Position LED Pilot Lights: (LT1, LT2) Indicate source to which load is connected (green for normal, red for emergency).
14. Bypass switch position: Green LED (LT16) to indicate bypass switch is in bypass to normal position, flashing when ATS is isolated. Red LED (LT17) to indicate bypass switch is in bypass to emergency position.
15. Provisions to accept customer supplied remote contact closure or 24 VDC signal to initiate load test (LTR).
16. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
 - a. Normal Power Supervision: (LT3) Amber light with nameplate engraved "Normal Source Available."
 - b. Emergency Power Supervision: (LT4) Amber light with nameplate engraved "Emergency Source Available."
17. Unassigned Auxiliary Contacts: Two normally closed, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac (CS1P, CS2P).

18. Unassigned Auxiliary Contacts: Two normally closed, single-pole, double-throw contacts for emergency switch position, rated 10 A at 240-V ac (CS2P).
19. Unassigned Auxiliary Contacts: Two closed, single-pole, double-throw contacts when switch is bypassed to normal and emergency switch positions, rated 10 A at 240-VAC (CB1, CB2).
20. Provide additional elevator signals on switches connected to emergency equipment branch:
 - a. Additional Form "C" contacts (two) to indicate ATS in Emergency position.
 - b. Form "C" time delay contacts (two) that change state simultaneously 0-3600 seconds before transfer in either direction and revert 0-3600 seconds after transfer is completed.
21. Engine Shutdown Timer: Time delay adjustable from zero to sixty minutes, and factory set for five minutes. Timer shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source. The transfer switch cool-down timer shall be coordinated with any engine control cool-down timers to avoid excessive unloaded operation.
22. Engine-Generator Exerciser: The controller shall include a user configurable exerciser. Exerciser shall be configurable for daily, 7 day, 14 day or 28 day exercise periods, each with (7) programmable events. The exerciser shall also be configurable as a full, 365 day exerciser with up to 24 independent exercise events. Each event shall be configurable for Test with Load and Test without Load. Each event shall include user adjustable start time, date and test duration. All time and date settings shall be stored in non-volatile EEPROM memory. The controller shall include full programmability for daylight savings time.
23. All pilot lights shall be LED, push-to-test type.

2.4 CLOSED TRANSITION TRANSFER SWITCHES

- A. Automatic Closed-Transition Transfer Switches: Include the following functions and characteristics:
 1. Fully automatic make-before-break operation.
 2. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.
 3. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.
 - a. Initiation occurs without active control of generator.
 - b. Controls ensure that closed-transition load transfer closure occurs only when the 2 sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.
 4. Failure of power source serving load initiates automatic break-before-make transfer.
- B. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.

- C. Provide a safety signal (Dry contact outputs) for customer-connected alarm and remote breaker tripping through shunt trips on normal source circuit breakers to force the normal power feeder breaker to open in the case of a failed-closed transition.
- D. The CTTS/BPS shall be UL listed in accordance with UL 1008.

2.5 BYPASS/ISOLATION SWITCHES

- A. Comply with requirements for Level 1 equipment according to NFPA 110.
- B. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. The bypass isolation switch shall provide a safe and convenient means of manually bypassing and isolating the automatic transfer switch, regardless of the condition of position of the automatic transfer switch. The bypass isolation switch shall have the ability to be used as an emergency backup system in the event of a transfer switch failure. Include the following features for each combined automatic transfer switch and bypass/isolation switch:
 - 1. The bypass switch shall be load break design. Bypassing shall be by means of a single, externally operated handle. This handle shall allow direct, one step bypass to either Source 1 or Source 2, regardless of the position of the automatic transfer switch. The bypass isolation switch shall be purely mechanical, and bypass operation shall not be dependent upon any electrical device or interlocks for safety purposes or proper sequencing.
 - 2. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. While isolated, interlocks prevent transfer-switch operation, except for testing or maintenance.
 - 3. Drawout Arrangement for Transfer Switch: Provide physical separation from live parts and accessibility for testing and maintenance operations.
 - 4. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.
 - 5. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.
 - 6. Operability: Constructed so load bypass and transfer-switch isolation can be performed by 1 person in no more than 2 operations in 15 seconds or less.
 - 7. Legend: Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.
 - 8. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.
 - 9. Installation: Enclosure requires front and side access or front and rear as shown on drawings.
- C. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed copper bus bars; plated at connection points and braced for the indicated available short-circuit current.

2.6 SOURCE QUALITY CONTROL

- A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for

compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Floor-Mounting Switch: Anchor to floor by bolting.
 - 1. Concrete Bases: 4 inches (100 mm) high (Evanston: 6 inches high east of Sheridan Rd.), reinforced, with chamfered edges. Extend base no more than 4 inches (100 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated. Concrete, reinforcement, and formwork requirements are specified in Division 3 Sections.
- B. Wall mounted Switch: Do not attach directly to walls or structural surfaces. Attach switch to the vertical finished or structural surface behind the switch on channels such as "Unistrut".
- C. Identify components according to Division 26 Section "Identification for Electrical Systems."
- D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.
- E. List of all factory settings of relays, timers, etc; provide relay and timer settings and calibration instructions, laminated, and attached to door.

3.2 CONNECTIONS

- A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes and wire counts at no additional cost to The University if necessary to accommodate required wiring.
 - 1. Provide all wiring between transfer switches and elevator controllers to insure emergency operation.
 - 2. Provide all wiring between closed transition transfer switches and shunt trip circuit breakers to insure proper operation.
 - 3. Provide all necessary wiring between all transfer switches and generator(s) to insure proper operation.
 - 4. Provide all communications wiring between remote metering and communication modules and the University's SCADA system.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

- B. Nameplates: Label each Transfer Switch with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare and submit test reports.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
 2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
 3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
 - a. Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
 5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
 - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
 - f. Perform contact-resistance test across main contacts and correct values exceeding 500 micro-ohms and values for 1 pole deviating by more than 50 percent from other poles.
 - g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
 6. Provide load bank testing of transfer switches installed in Level 1 emergency power systems prior to connecting building load.
 7. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
 - a. Verify grounding connections and locations and ratings of sensors.
- B. Coordinate tests with tests of generator and run them concurrently.

NORTHWESTERN UNIVERSITY

PROJECT NAME _____

JOB # _____

FOR: _____

ISSUED: 03/29/2017

- C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- D. Remove and replace malfunctioning units and retest as specified above.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train the University's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Training shall consist of a minimum of two, complete 8 - hour training sessions.
- B. Coordinate this training with that for generator equipment.

END OF SECTION 26 3600