Power Systems

Transfer Switches: What to Specify and Why

PowerHour webinar series for consulting engineers

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September 14th, 2021

(1PDH issued by Cummins)

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- Use the Zoom Q&A Panel to submit questions, comments, and feedback throughout the event. Time is allotted at the end of the PowerHour to address Q&A.
- If the audio connection is lost, disconnected or experiences intermittent connectivity issues, please check your audio connection through the "Join Audio" or "Audio Connectivity" button at the bottom left of the Zoom application.
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Disclaimer

The views and opinions expressed in this course shall not be considered the official position of any regulatory organization and shall not be considered to be, nor be relied upon as, a Formal Interpretation.

Participants are encouraged to refer to the entire text of all referenced documents. In addition, when it doubt, reach out to the Authority Having Jurisdiction.

Meet your panelists

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Cummins Inc.

Course Objectives

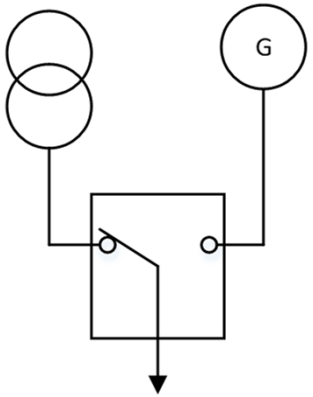
Transfer Switches: What to Specify and Why

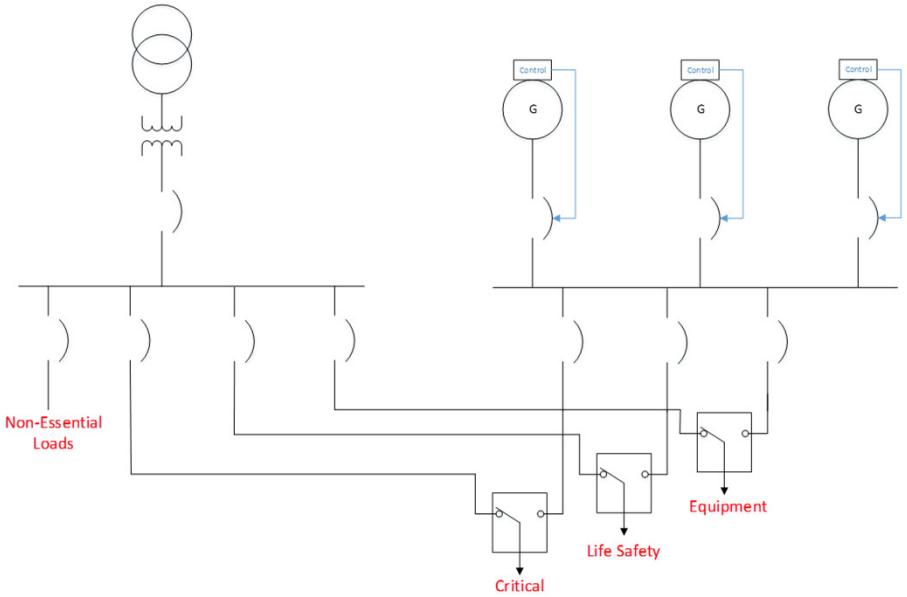
Transfer switches are critical components in the power system and they are applied in a wide variety of applications. This course is intended to provide participants with an overview of performance-based requirements related to transfer switches. Participants will learn what to specify for their projects and why. The main sections covered are codes and standards, actuator, transition modes, short-circuit WCR, controls, protection, accessories, and service and support.

After completing this course, participants will be able to:

- Discuss performance-based requirements for transfer switches
- Recognize certain specification to avoid or not to permit in the specification
- Recognize the availability of specification selection tools and utilize the AIA MasterSpec® Tool

Transfer Switches Are Vital!



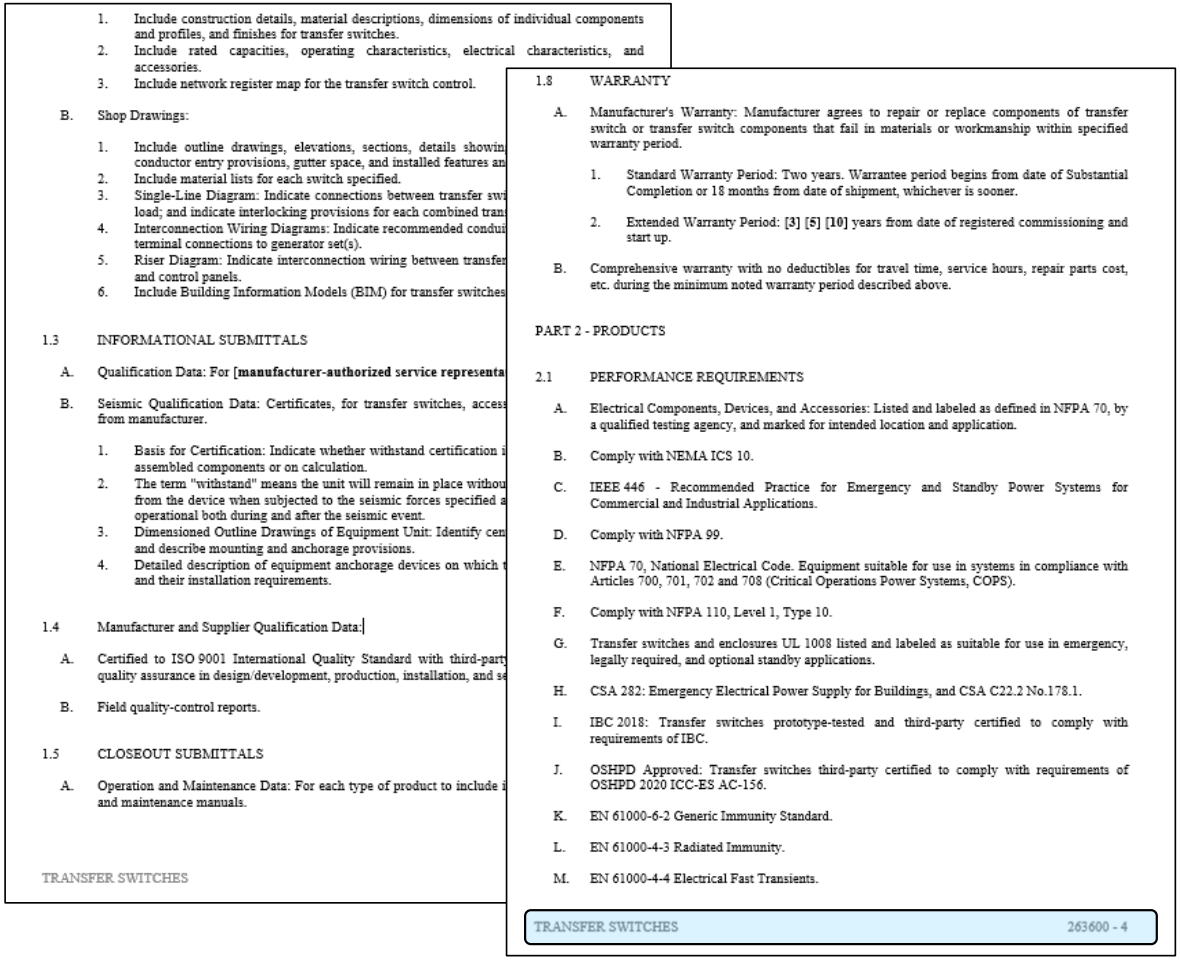


What To Consider When Specifying A Transfer Switch

- Switch type (automatic, non-automatic)
- Service-entrance or non-service-entrance
- Transition type (open, closed)
- Application (utility-gen, gen-gen, utility-utility)
- Grounding schemes (separately derived, non-separately derived)
  - Drives 4-pole or 3-pole transfer switches
- Switch positions (2-positions, 3-positions)
  - 3-positions are ideal for load shedding and stored energy loads
- Cable sizes and entry requirements (top entry, bottom entry)
- Enclosures (NEMA Type 1, 3R, 4, 4x, 12)
- Voltage & frequency (600VAC, 480VAC / 50Hz, 60Hz)
- Current rating (3000A, 2000A, 800A)
- Fault current capability (WCR: 65kA, 85kA, 100kA)
- Selective coordination (WCR & listed OCPD)
- Codes & standards (UL, CSA, NFPA, NEMA, ISO, IBC, OSHPD, EN)

Section 263600 – Transfer Switches

- Part 1 – General
- Part 2 – Products
- Part 3 – Execution



1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.
2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.
3. Include network register map for the transfer switch control.

B. Shop Drawings:

1. Include outline drawings, elevations, sections, details showin conductor entry provisions, gutter space, and installed features an
2. Include material lists for each switch specified.
3. Single-Line Diagram: Indicate connections between transfer swi load; and indicate interlocking provisions for each combined tran
4. Interconnection Wiring Diagrams: Indicate recommended condui terminal connections to generator set(s).
5. Riser Diagram: Indicate interconnection wiring between transfe and control panels.
6. Include Building Information Models (BIM) for transfer switches

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For **[manufacturer-authorized service representa**

B. Seismic Qualification Data: Certificates, for transfer switches, acces from manufacturer.

1. Basis for Certification: Indicate whether withstand certification i assembled components or on calculation.
2. The term "withstand" means the unit will remain in place withou from the device when subjected to the seismic forces specified a operational both during and after the seismic event.
3. Dimensioned Outline Drawings of Equipment Unit: Identify cen and describe mounting and anchorage provisions.
4. Detailed description of equipment anchorage devices on which t and their installation requirements.

1.4 Manufacturer and Supplier Qualification Data:

A. Certified to ISO 9001 International Quality Standard with third-part quality assurance in design/development, production, installation, and se

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include i and maintenance manuals.

TRANSFER SWITCHES

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.

1. Standard Warranty Period: Two years. Warrantee period begins from date of Substantial Completion or 18 months from date of shipment, whichever is sooner.

2. Extended Warranty Period: **[3] [5] [10]** years from date of registered commissioning and start up.

B. Comprehensive warranty with no deductibles for travel time, service hours, repair parts cost, etc. during the minimum noted warranty period described above.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NEMA ICS 10.

C. IEEE 446 - Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.

D. Comply with NFPA 99.

E. NFPA 70, National Electrical Code. Equipment suitable for use in systems in compliance with Articles 700, 701, 702 and 708 (Critical Operations Power Systems, COPS).

F. Comply with NFPA 110, Level 1, Type 10.

G. Transfer switches and enclosures UL 1008 listed and labeled as suitable for use in emergency, legally required, and optional standby applications.

H. CSA 282: Emergency Electrical Power Supply for Buildings, and CSA C22.2 No.178.1.

I. IBC 2018: Transfer switches prototype-tested and third-party certified to comply with requirements of IBC.

J. OSHPD Approved: Transfer switches third-party certified to comply with requirements of OSHPD 2020 ICC-ES AC-156.

K. EN 61000-6-2 Generic Immunity Standard.

L. EN 61000-4-3 Radiated Immunity.

M. EN 61000-4-4 Electrical Fast Transients.

TRANSFER SWITCHES 263600 - 4

Section 263600 – Transfer Switches

- General
  - Action Submittal
  - Shop Drawing
  - Qualification Data
  - Manufacturer Certification
  - Field Quality Control
  - Closeout Submittals
  - Quality Assurance
  - Source Limitation
  - Warranty
- Products
  - Performance requirements
  - Contactor Type
  - Transfer Switch Accessories
  - Source Quality Control
- Execution
  - Installation
  - Connections
  - Field Quality Control
  - Demonstration
  - Service and Support
  - Service Agreement
  - Training

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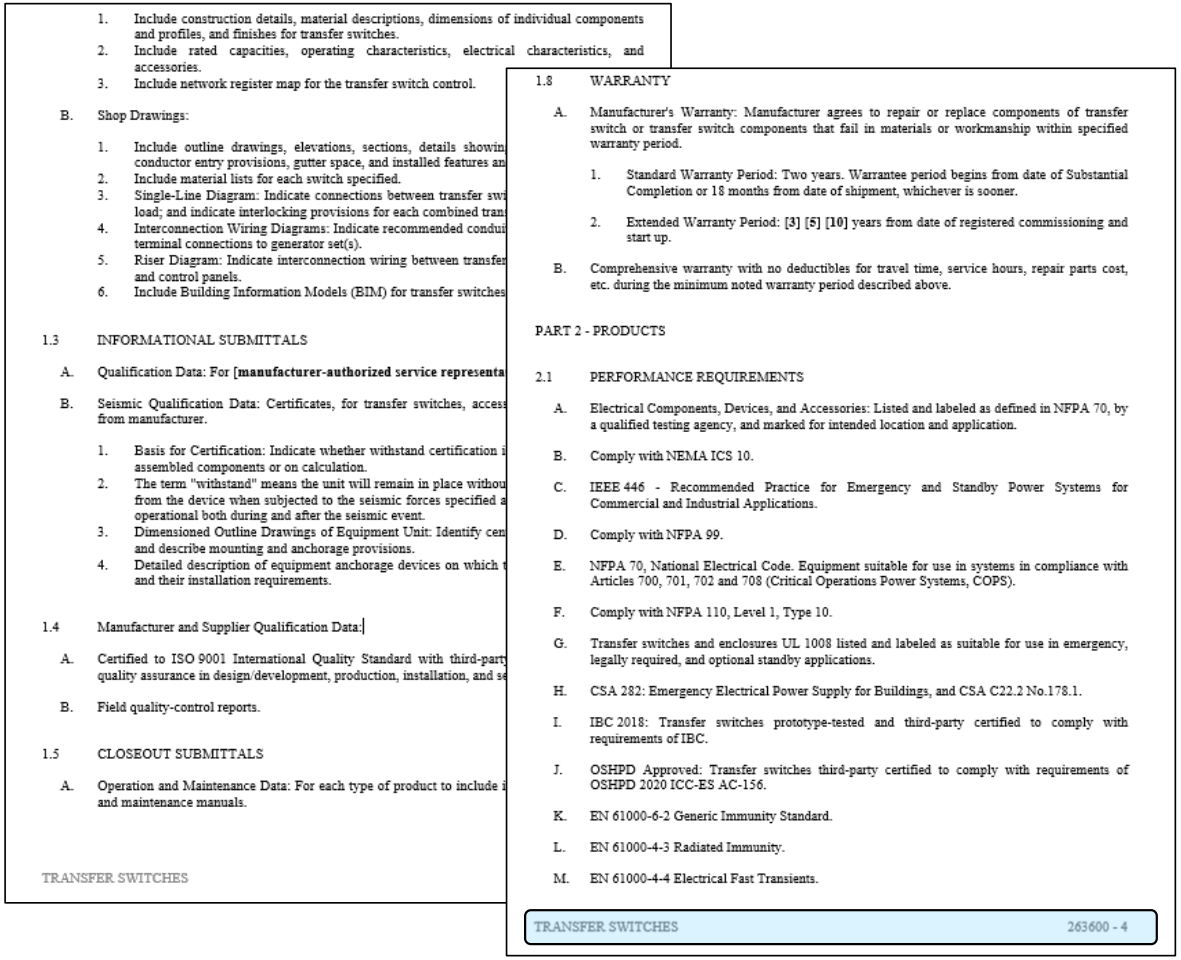

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TRANSFER SWITCHES 263600 - 4

Codes and Standards

- UL 1008 Standard for Safety - Transfer Switch Equipment
- CSA 282: Emergency Electrical Power Supply for Buildings, and CSA C22.2 No.178.1
- NFPA 70, National Electrical Code. Equipment suitable for use in systems in compliance with Articles 700, 701, 702 and 708 (Critical Operations Power Systems, COPS)
- NFPA 99 Standard for Health Care Facilities
- NFPA 110, Level 1, Type 10 Standard for Emergency and Standby Power Systems (Note: this is for the entire system)

National Electrical Manufacturers Association

Codes and Standards

- IBC 2018: Transfer switches prototype-tested and third-party certified to comply with requirements of IBC
- OSHPD Approved: Transfer switches third-party certified to comply with requirements of OSHPD 2020 ICC-ES AC-156
- Contacts shall be 100% Restriction of Hazardous Substances (RoHS) compliant
- EMC:
  - EN 61000-6-2 Generic Immunity Standard
  - EN 61000-4-3 Radiated Immunity
  - EN 61000-4-4 Electrical Fast Transients
  - EN 61000-4-2 Electrostatic Discharge
  - EN 61000-4-6 Conducted Immunity
  - EN 61000-4-8 Power Frequency Magnetic Field

OSHPD

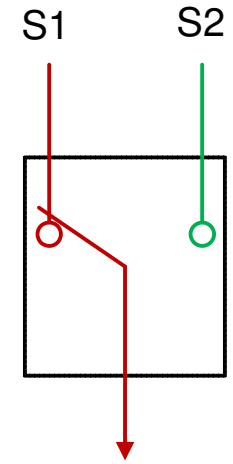
IBC®
INTERNATIONAL BUILDING CODE

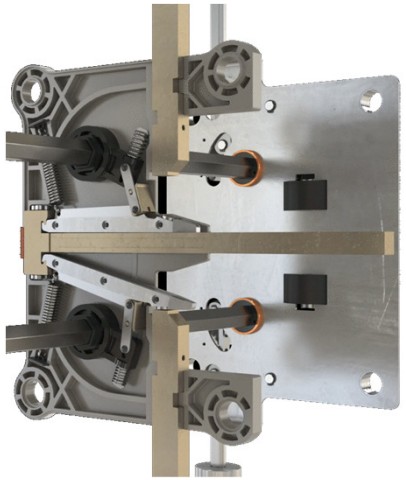
RoHS
COMPLIANT

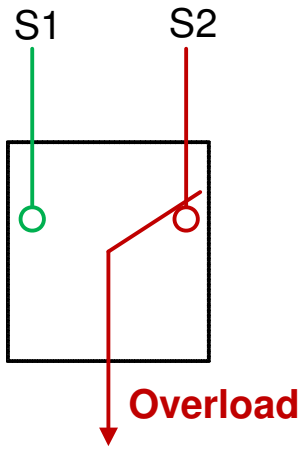
EMC

Switch Mechanism

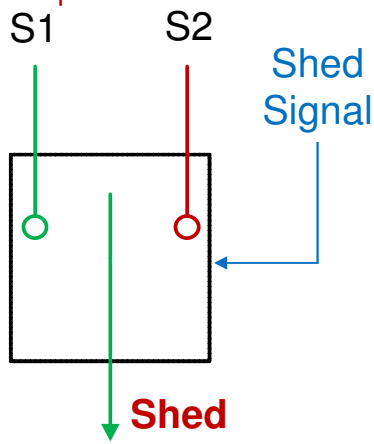
- Switch action: double throw; mechanically held in both directions
- The transfer switch operation shall include the ability to switch to an open position (both sources disconnected) for load shedding from the generator set
- Note 1: three position switch (S1, S2, center off position)
  - Center off position is also called neutral position
- Note 2: the National Electrical Code (NEC) allows the alternate power source to supply emergency, legally required, and optional system loads where the source has adequate capacity or where automatic selective load shed is provided as needed to ensure adequate power.





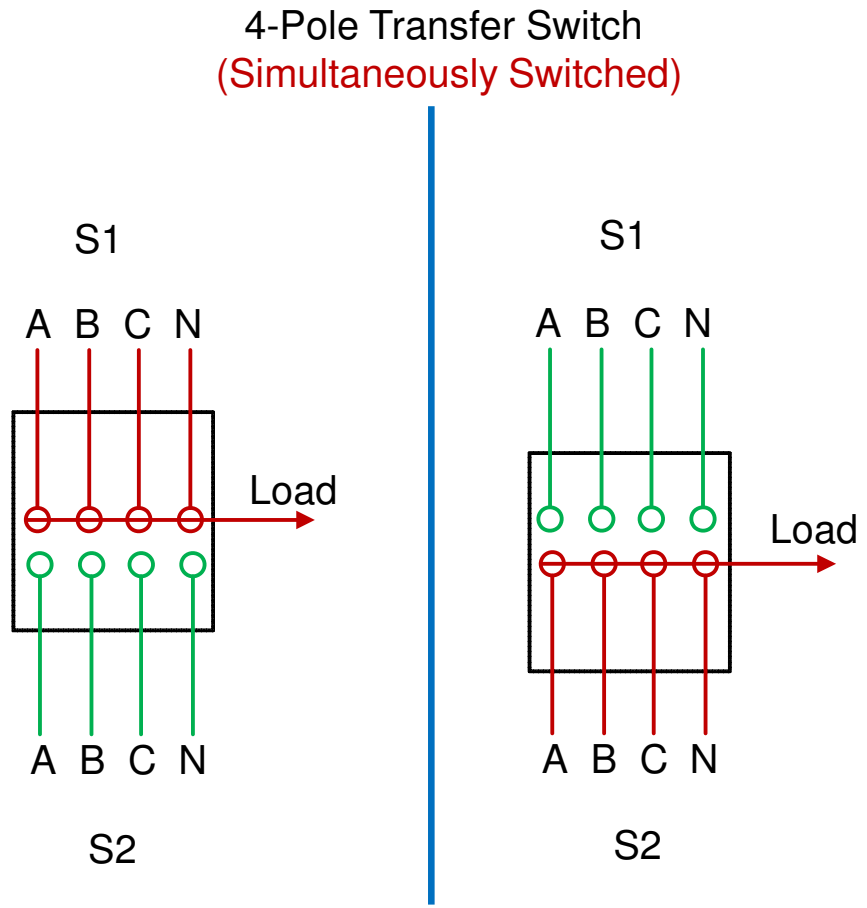


Switch in neutral position



Neutral Switching

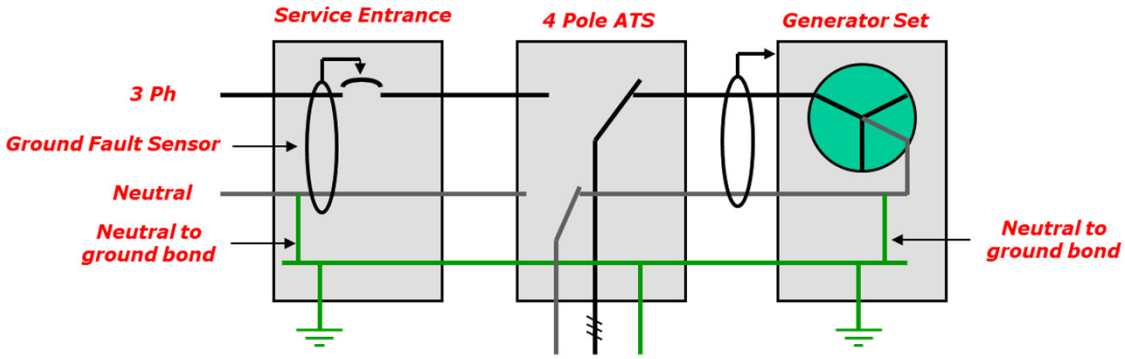
- Neutral switching: Where four pole switches are indicated, provide neutral pole switched simultaneously with phase poles
- The neutral bus shall be sized to carry 100% of the current designated on the switch rating.
- Overlapping neutral contacts are unacceptable
- Note:
  - The overlapping neutral contact is a complex mechanism which introduces failure modes that don't exist with conventional four pole switches
  - The overlapping neutral contact does not have the same fault withstand capability as the phase contacts
  - Overlapping neutral compromises ground fault detection systems



3-Pole Vs. 4-Pole

- Ground fault sensing depends on being able to sense ground fault current. In order to accurately sense ground fault current, it must return to its source on a known path relative to ground fault CTs. In basic emergency standby systems there are two rules to follow to meet these requirements:

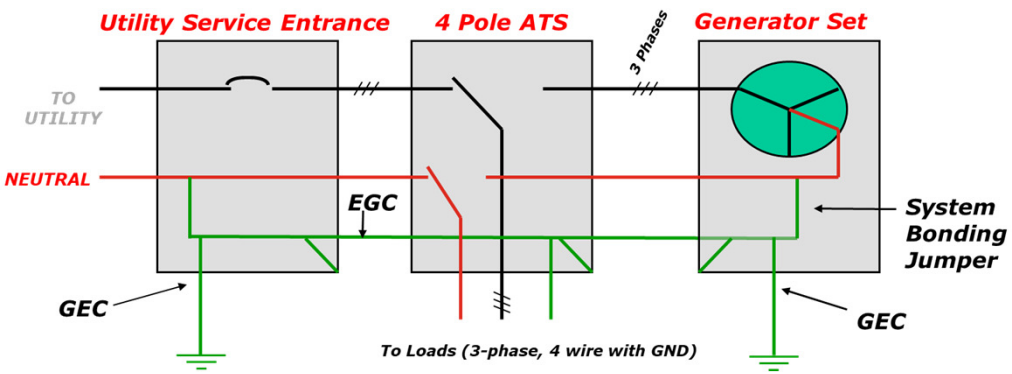
  1. There can only be one neutral/ground connection on any neutral bus at one time
  2. Ground fault sensors must be downstream (or on the load side) of the bonding connection



- In order to meet both rules when connected to either the normal or the emergency source the neutral must be switched using a 4-pole transfer switch

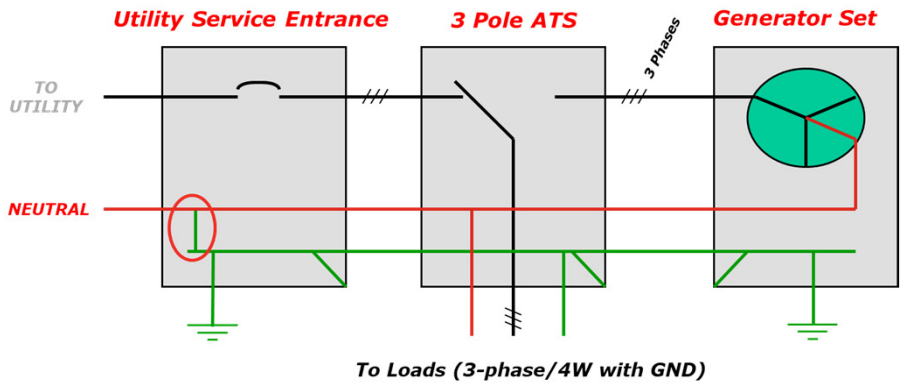
Separately / Non-Separately Derived System

Separately Derived System



- **No direct electrical connection between sources** (Neutrals are not connected)
- **Generator Neutral is solidly bonded to Ground - Jumper**

Non-Separately Derived System



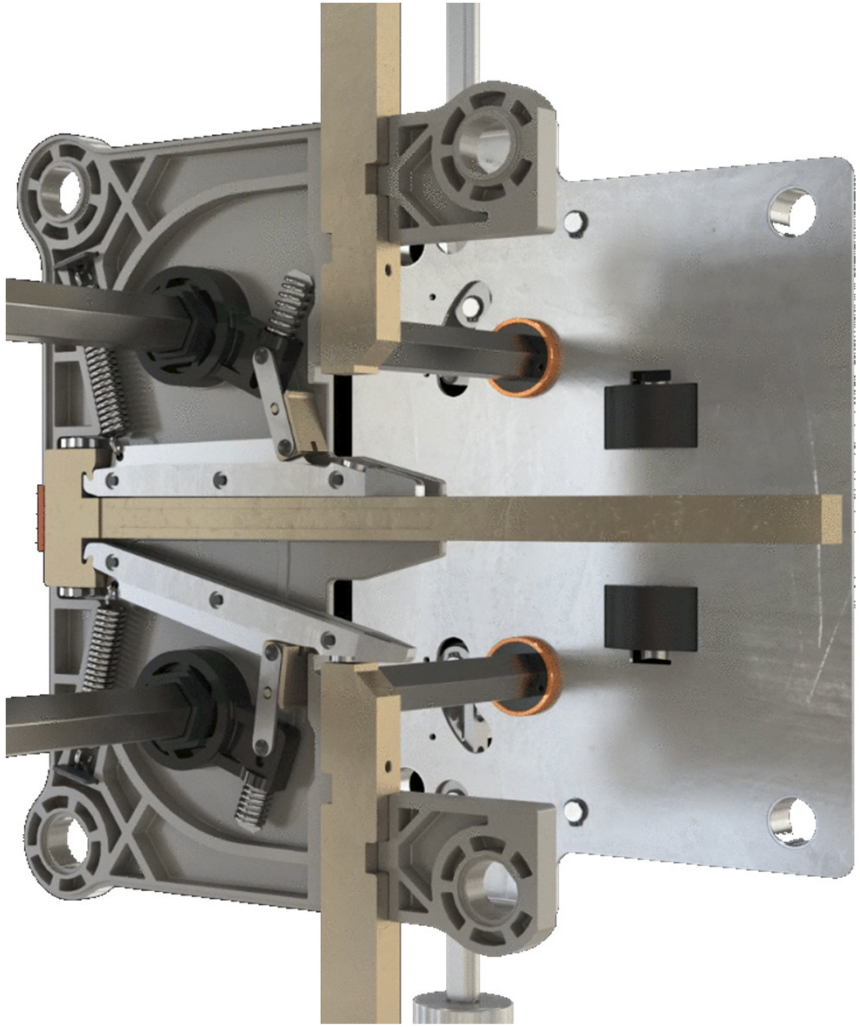
- **Common Neutral for entire system**
- **Neutral is connected to ground at the Service**, Not at the generator set

EGC (Equipment Grounding Conductor), ties enclosures together

GEC (Grounding Electrode Conductor)

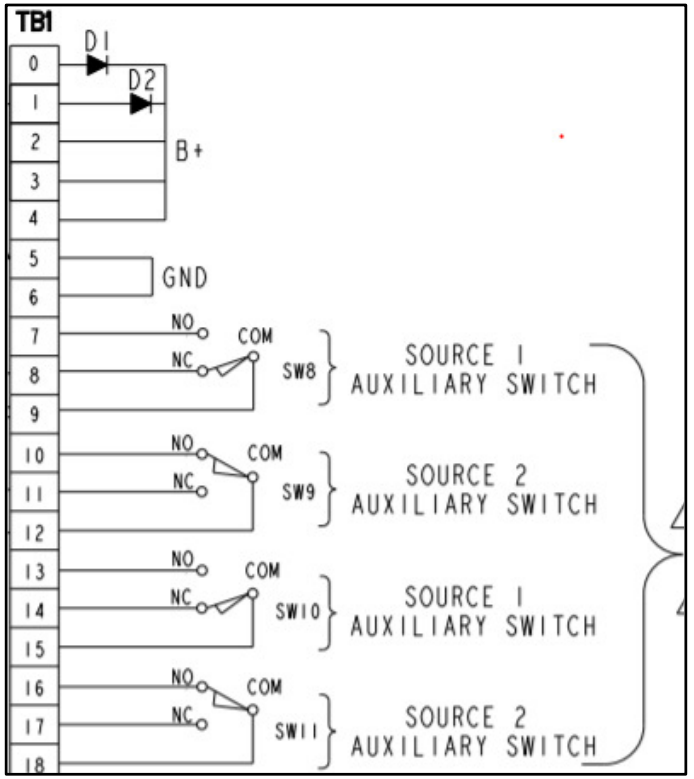
Switch Mechanism

- Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition
- Main switch contacts shall be high pressure silver tungsten alloy brazed-on. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent inter-phase flashover.



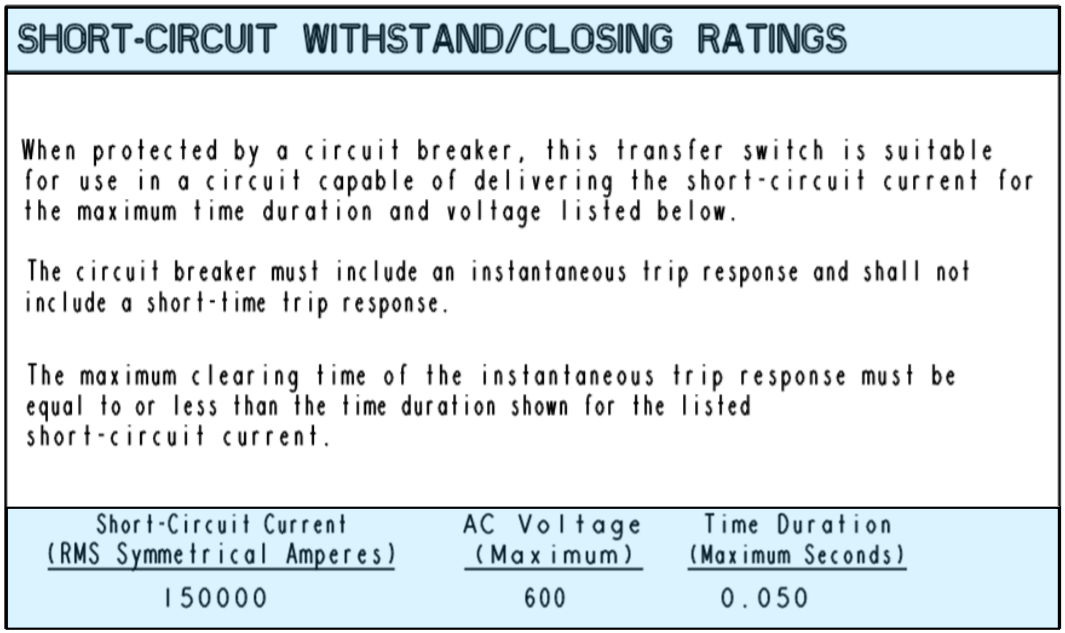
Auxiliary Contacts

- Shall be driven by transfer switch mechanism, rated 10A at 250VAC or 5A at 30VDC minimum
- Auxiliary contacts shall be isolated



Fault-Current Withstand and Closing Ratings

- Fault-Current Withstand and Closing Ratings (WCR): UL 1008 WCR must be listed as meeting the requirements for use with protective devices at installation locations, under specified fault conditions
- WCR must be based on use of the same set of contacts for withstand test and closing test. WCR must be adequate for duty imposed by protective devices at installation locations



SHORT-CIRCUIT WITHSTAND/CLOSING RATINGS

When protected by a circuit breaker, this transfer switch is suitable for use in a circuit capable of delivering the short-circuit current for the maximum time duration and voltage listed below.

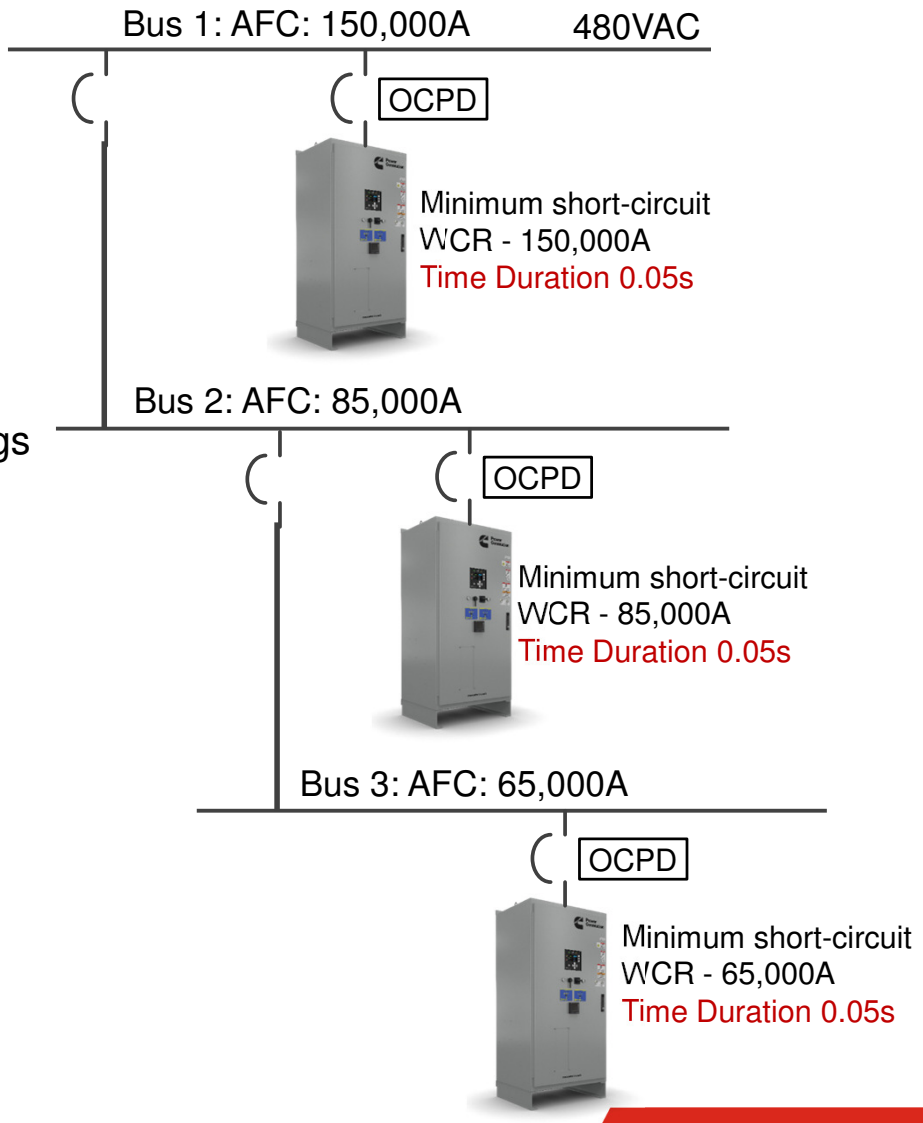
The circuit breaker must include an instantaneous trip response and shall not include a short-time trip response.

The maximum clearing time of the instantaneous trip response must be equal to or less than the time duration shown for the listed short-circuit current.

Short-Circuit Current (RMS Symmetrical Amperes)	AC Voltage (Maximum)	Time Duration (Maximum Seconds)
150000	600	0.050

Fault Current Capability

- Determine the available fault current at the switch location from the short-circuit analysis
- Select transfer switches with appropriate short-circuit ratings
  - Transfer switches must be rated for the available fault current at their line side terminals and protected by an OCPD selected appropriately
- Select appropriate OCPD
  - Time based: generic UL 489 circuit breaker that clears the fault current within the time specified on the label
  - Specific breaker: tested with the transfer switch



AFC: Available Fault Current

Specifying Withstand and Closing Rating

- Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in project under the fault conditions indicated, based on testing in accordance with UL 1008
- Transfer switches shall have a time-duration Withstand and Closing Rating (WCR) of at least 0.05 seconds (3 cycles at 60 Hz)
  - Note: typically used with UL891 switchboards with UL489 circuit breakers
- Short-time WCR shall be rated for a duration of 0.5 seconds (30 cycles at 60 Hz)
  - Note: required with UL1558 switchgear with UL1066 power circuit breakers
- Transfers switches with Withstand Ratings only and without Closing Rating shall not be acceptable. This applies for Short-time and Time Duration WCR Ratings

LV Switchboards Vs. Switchgear

- **Switchboard**
- UL891: Standard for Switchboards
  - Dead-front Switchboard
  - Circuit breakers are typically UL489 MCCB/ICCB
    - Can contain UL-1066 breakers
  - Circuit breakers not required to be in individual compartments
  - Evaluated for short-circuit 0.05s (3 cycles) ONLY and NO short-time test
  - Instantaneous trip-response is required
  - Short-circuit 150KAIC, e.g.
  - Basic office, commercial building, and retail

- **Switchgear**
- UL1558: Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear
  - (IEEE C37.20.1 design & NEMA C37.51 test)
  - Metal-enclosed power circuit breaker switchgear
  - Circuit breakers are UL1066 (LVPCB)
    - No molded case circuit breakers
  - Circuit breakers required to be in separate metal compartments
  - Evaluated for short-circuit 0.067s (4 cycles) and short-time 0.5s (30 cycles)
  - Instantaneous can be turned off
  - Short-circuit 200KAIC, e.g.
  - Healthcare, hospitals

Transfer Switch Application Example 1

- The transfer switch is fed by a UL 1558 switchgear
  - UL-1066 breaker have a short-time trip response
  - The transfer switch must have a short-time rating
  - The short-time response of the circuit breaker must be coordinated with short-time current rating of the transfer switch as listed on the transfer switch nameplate

UL 1558 Switchgear

Breaker has short-time trip response.
AFC: 125,000A

Short-time WCR:
125,000A @600 VAC
for 0.5 seconds

Transfer Switch Application Example 2

- The transfer switch is fed by a UL 891 switchboard
  - UL489 circuit breaker
  - The circuit breaker must include an instantaneous trip response
  - Circuit breaker must trip in 0.05s (3 cycles) or faster

UL 891 Switchboard

Breaker has instantaneous trip response
AFC: 65,000A

Time-Based WCR:
65,000A @600 VAC
for 0.05 seconds (3-Cycles)

Transition Types: Open Transition

- Automatic Open-Delayed-Transition: Pauses or stops in intermediate position to momentarily disconnect both sources, with transition controlled by programming in the automatic transfer-switch controller Interlocked to prevent the load from being closed on both sources at the same time.
  - Sources must be mechanically and electrically interlocked to prevent closing both sources on the load at the same time
  - Fully automatic break-before-make operation with center off position
- Automatic Open-Fast Transition Sync: No intentional time delays but waits for sources to be synchronized for all three parameters: phase, voltage, and frequency. Intended for relatively small stored energy loads such as small motors
- Automatic Open-Fast Transition No Sync: No intentional time delays and no synchronization needed

Stored Energy Loads Power Transfer

- Programmed Neutral Switch Position: Switch operator with programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Adjustable pause from 0 to 600 seconds minimum
  - This is Open-Delayed-Transition

- Voltage decays exponentially (independent of motor speed)
- NEMA MG-1 recommends a delay of 1.5 Motor Open Circuit Time Constant
  - Voltage will be at 22% of nominal

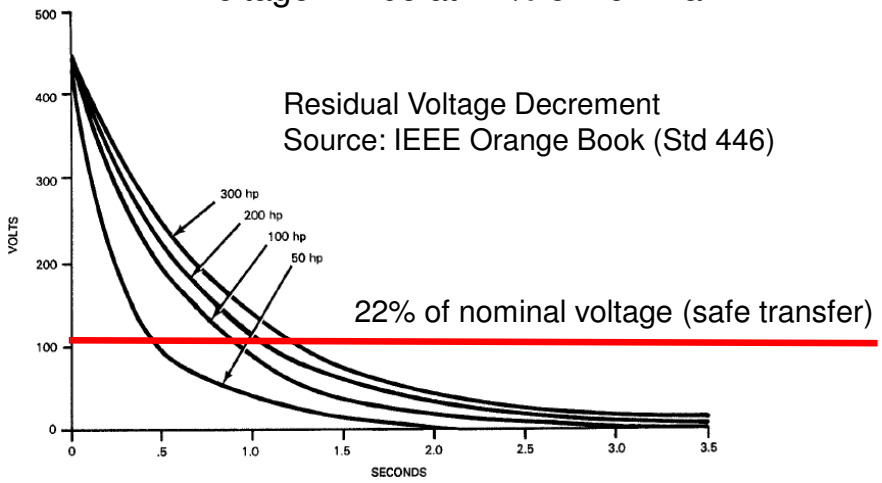


Figure 4-14—Induction motor open-circuit voltage decay (based on constant speed)

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  - Fully automatic break-before-make operation with center off position
  - Fully automatic break-before-make operation with transfer when two sources have near zero phase difference

  For example: large stored energy loads. See previous slide

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  For example: small stored energy loads and resistive loads

- Automatic Open-Fast Transition No Sync: No intentional time delays and no synchronization needed

  For example: resistive loads

Transition Types: Closed Transition

- Automatic Hard, Closed-Transition: Make-before-break transition type that executes a load transfer by momentarily paralleling both sources before transferring load between sources.
- Both sources must be synchronized (phase, voltage, and frequency) and connected to load for as short a time as possible during a transfer or retransfer
- Synchronizers and sync checks that only synchronize/check phase and frequency, but not voltage, are unacceptable
- Note 1: when specifying closed transition operation, there might be a need to specify protective relays
  - 62PL Parallel Timer
  - 32R Reverse Power
  - 86LO Lockout
- Note 2: for added redundancy and maybe required by most utilities - shunt trip breaker on normal or emergency source

Non-Automatic Switch Type

- Non-Automatic Operation: Control continues to monitor sources and displays source availability but requires user action to operate transfer switch using manual selector switches.
  - Transfer Operation: Electrically actuated by Source Selector Switch to switch load to either Source 1 or Source 2 if the source is energized.
  - Source Selector Switch: Three-position, momentary-contact, rotary switch that initiates transfer to "Source 1" or "Source 2" with spring-return to center position once released.
- Note: Non-automatic is not the same as manual operation

Transfer Switch Control

- Microprocessor-based control with sealed membrane panel
- Transfer switch sensing configurable from the control or PC-based service tool. DIP switches or other electromechanical devices are unacceptable
- UV-protected, color alphanumeric display which immediately shows the following information:
  - Date and time
  - Source 1/Source 2 voltage
  - Load KVA
  - Transfer switch name
  - Whether the control is password protected
  - Source availability
  - To which source the load is connected
  - Preferred source indication
  - Active banner that shows time delays, inhibits and test statuses
- Real-Time Clock: Adjustable via control HMI for user set date and time in 24-hour format, including user function for daylight saving time

Password Protection

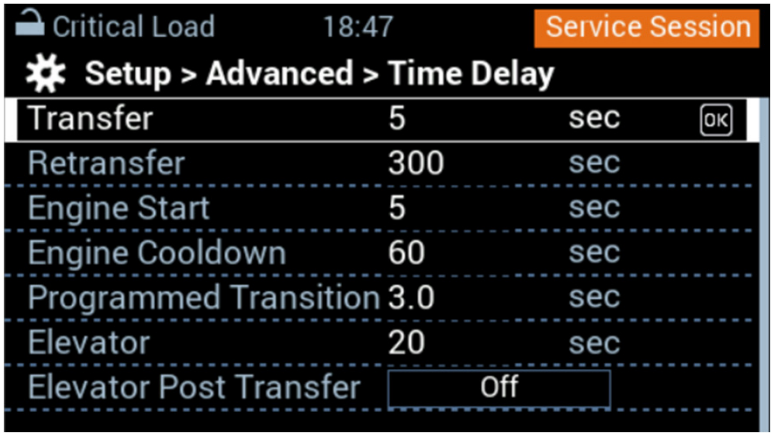
- Three levels of password security designed to restrict user access, and display will display visually if password is enabled:
  - User Level: Modifiable password that prevents unauthorized users from accessing setup screen and initiating tests using the test button on operator panel.
  - Advanced: Password that allows users access to advanced parameters.
  - Service: Password that allows users (authorized services technicians only) access to advanced and service screens.

Voltage Sensing and Protection

- Integrated true RMS voltage sensing on all three phases, on both sources (S1, S2) without external transformers shall be provided
- Monitors and compares the phase rotation of each source against the system phase rotation
- Monitor both sources and detect when a neutral current exceeds the current threshold
- Sync check function with the ability to determine when both sources are within specified tolerances of frequency, voltage, and relative phase difference before transferring load
  - Sync checks that only based on frequency and phase measurements but not voltage measurements are unacceptable
- Capable of detecting loss of phase on all three phases
- Monitors both sources (S1 and S2) (three-phase system only) to detect when there is a significant voltage difference between the different phases of the source

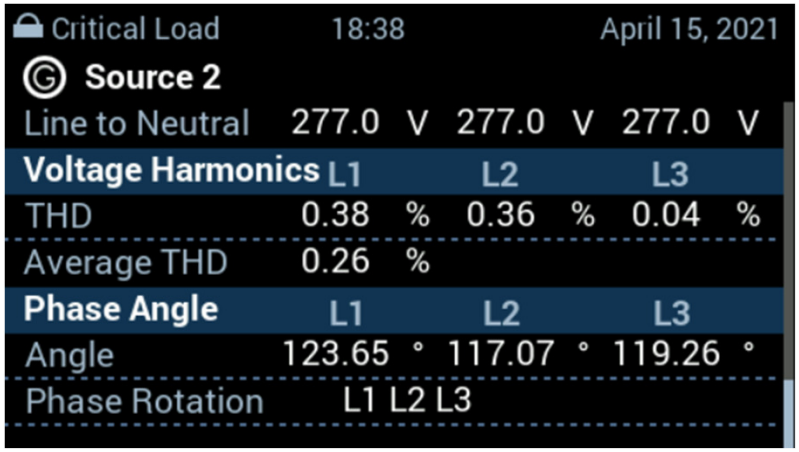
Time Delays

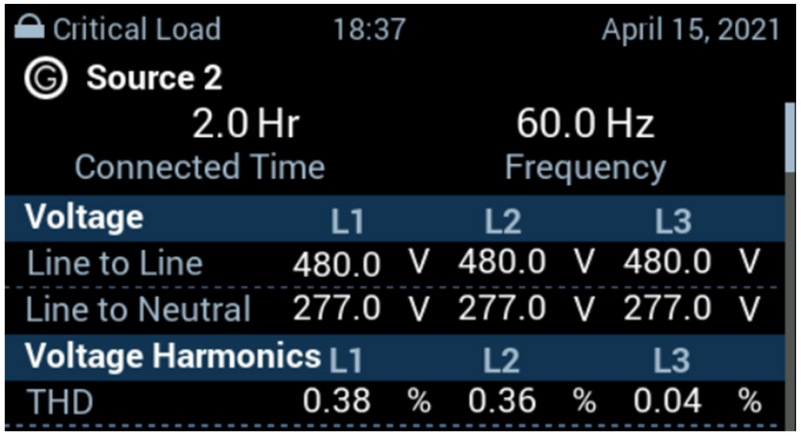
- Adjustable time delays built into the transfer switch control; external modules to accomplish these delays are unacceptable
  - Time Delay Engine Start (0 to 3,600s)
    - Prevents nuisance start of the generator
  - Time Delay Engine Cooldown (0 to 3,600s)
    - Allows the engine to cooldown after load is removed
  - Normal to Emergency (0 to 15,549s)
    - Allows the emergency source to stabilize before transferring
  - Retransfer Time Delay (0 to 15,549s)
    - Allows the normal source to be stable before transferring
  - Programmed Transition Time Delay (0 to 600s)
    - Allows the switch stay is in the neutral position before transferring
  - Elevator Pre-Transfer Time Delay (0 to 600s)
    - Allows an elevator to attempt to reach the nearest floor and open its doors, prior to a loss of power
  - Elevator Post-Transfer Time Delay(0 to 600s)
    - Energizes elevator pre-transfer output for an additional period after connecting to destination source



Power Quality Metering

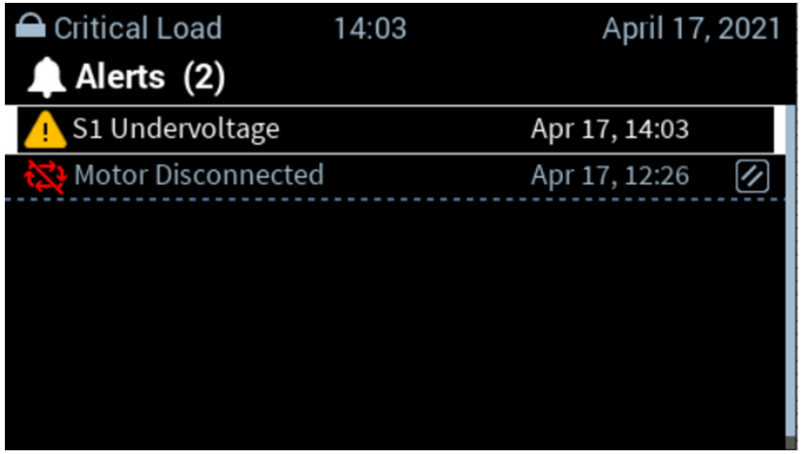
- Load metering capability fully integrated into main transfer switch control. External modules are unacceptable. The following parameters are measured and displayed
  - Line and neutral current
  - Frequency
  - Power Factor
  - Apparent, active, and reactive power
  - Apparent, active, and reactive energy
  - Total current and voltage harmonic distortion
  - Average current and voltage harmonic distortion

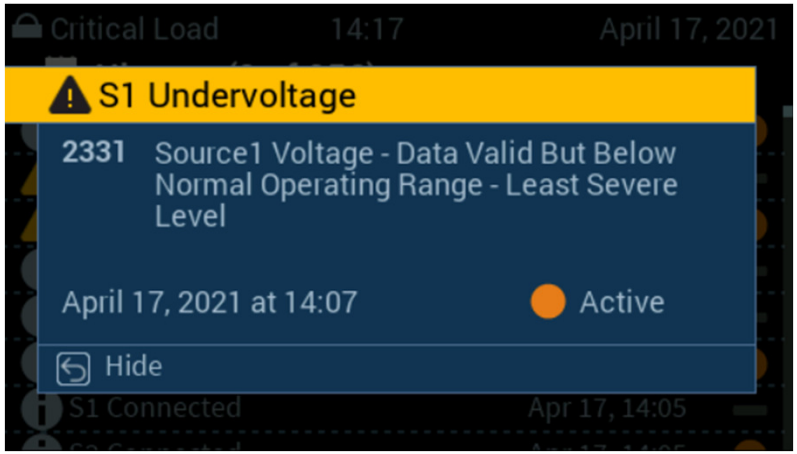




Event Data

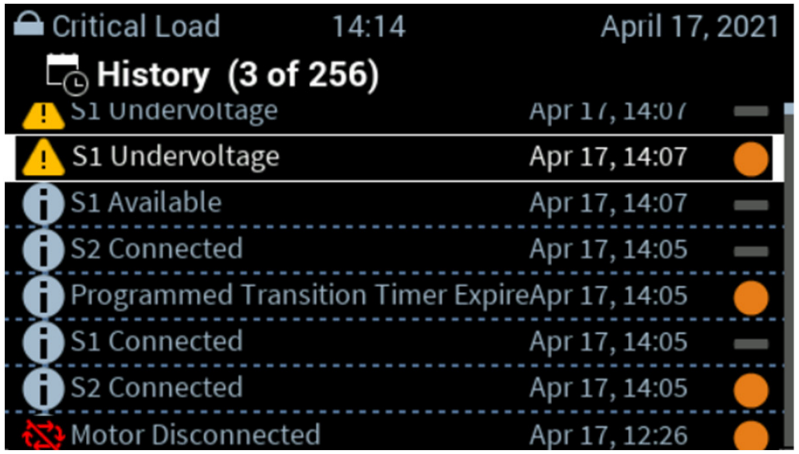
- Display all active alerts listed in chronological order, beginning with the most recent alert.
- Event information to include the following:
  - Alert type
    - Not in auto
    - Warning
    - Information
  - Fault code name
  - Fault code description
  - Date and time of occurrence
  - Fault code number





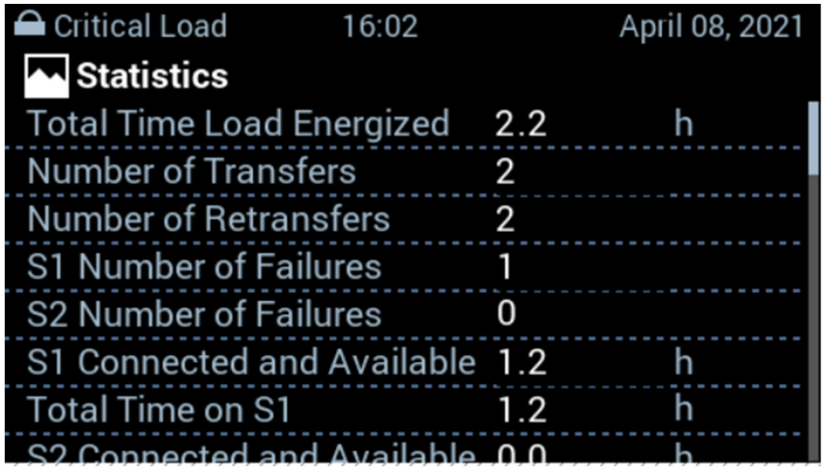
History of Events

- Event Data: Minimum of 256 events displayed in chronological order, beginning with the most recent event, about either source. Event information to include the following:
  - Fault codes
  - Active time delays
  - Power system changes
  - Tests and exercises
  - User-driven inputs (e.g., override, transfer inhibit)

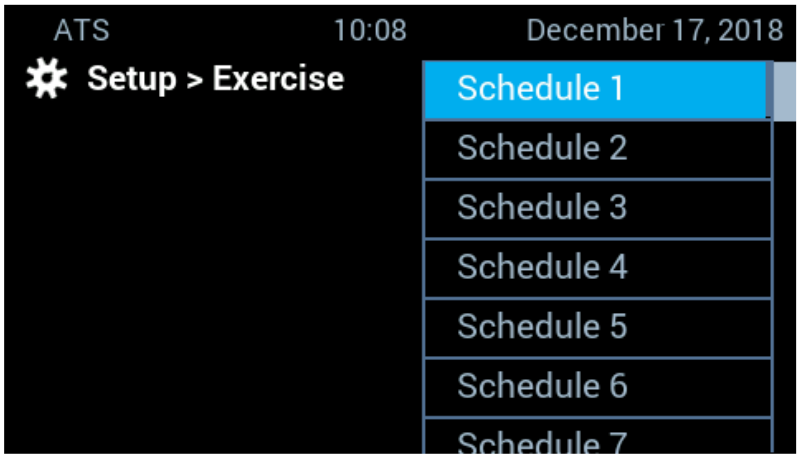


System Statistics

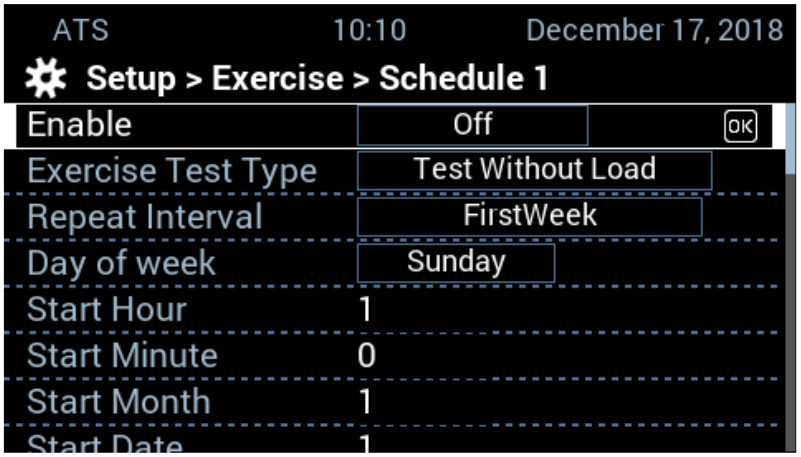
- Record and display the following source statistics
  - Total Time Load Energized
  - Number of Transfers
  - Number of Retransfers
  - S1 Number of Failures
  - S2 Number of Failures
  - S1 Connected and Available
  - Total Time on S1
  - S2 Connected and Available
  - Total Time on S2
  - Transfer Time
  - Last Transfer Due to Failure



Exerciser Function

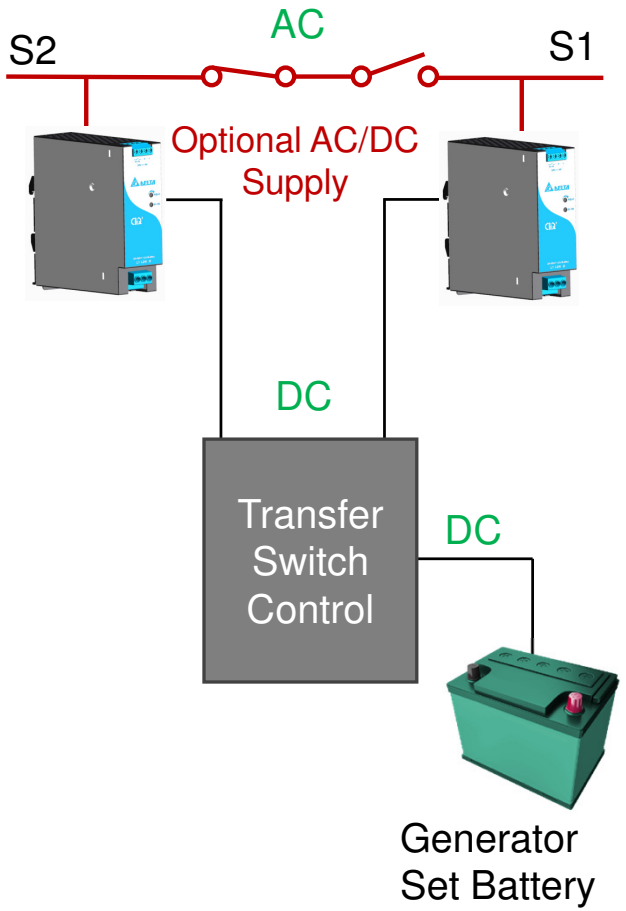


- Integrated generator set exerciser function capable of starting the generator set and transferring to it from normal source for a preset time, then retransfer and shuts down generator set after a preset cool-down period. Capable of a minimum of 12 preset exercise schedules and 12 exceptions.
- Test Type:
  - Test without load
  - Test with load
  - Transfer to standby: Transfers and keeps the load connected to the generator set (standby source) for a specified duration, regardless of the preferred source availability



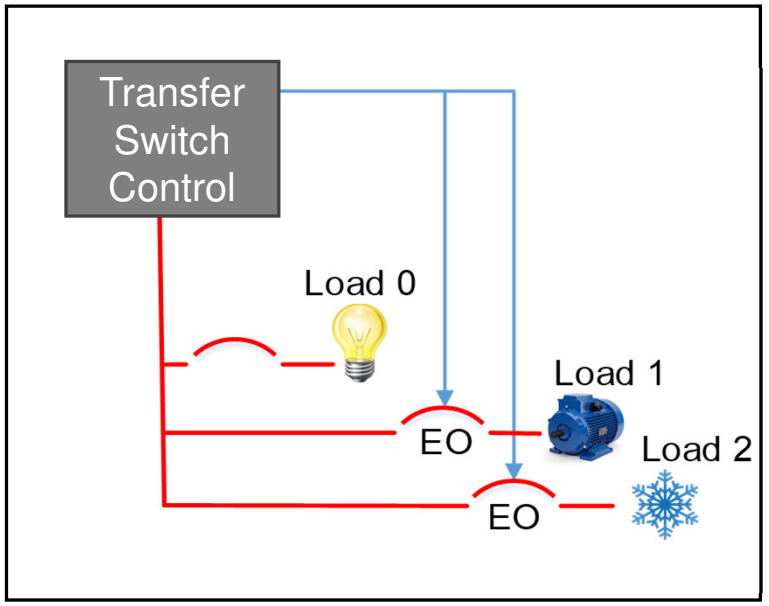
Transfer Switch Control Power Supply

- Transfer switch control shall operate through a period of loss of control power
- Integrated DC power supply shall be provided with:
  - Minimum of three diode isolated inputs to connect to three independent sources
  - Ability to automatically switch between the isolated inputs and utilize the best available DC source.
  - A minimum of 10 second ride-through, long enough for the emergency source to be available



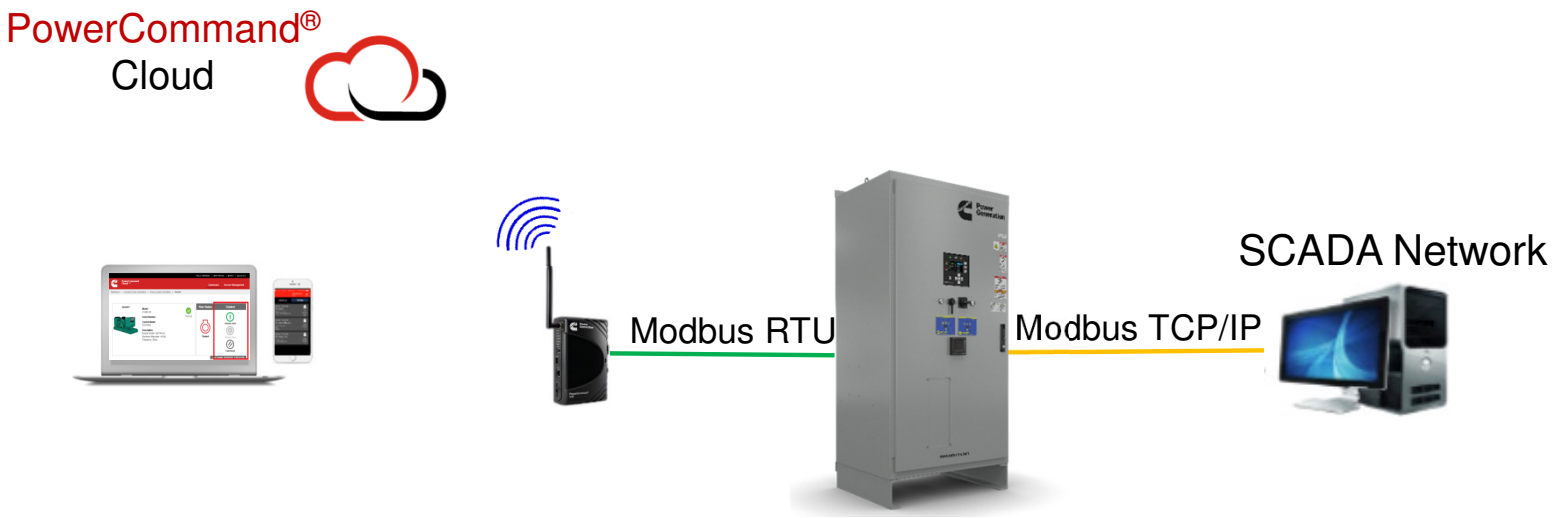
Automatic Load Management

- Integral load control (on/off sequencing) for at least two independent loads to prevent overloading the generator set source while continuing to power higher priority loads
- Capable of performing the following:
  - Add Load:
    - Block Load (Load 1 and Load 2 simultaneously).
    - Sequential time dependent load add (Load 1 then Load 2) with time delay adjustable from 0 to180 seconds.
  - Shed Load:
    - Source frequency and time-delay dependent.
    - Sheds lowest priority first.
- Capable of automatically re-adding load(s) after an overload occurs. This capable of being enabled or disabled
- Contact rating for outputs: 6 A at 250 VAC or VDC minimum



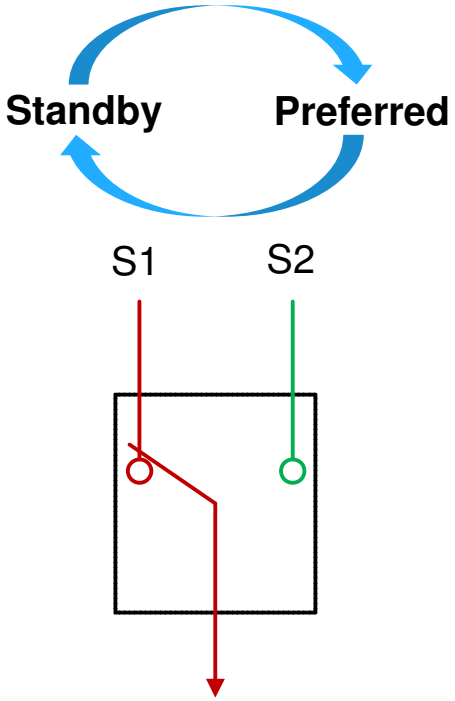
Network Communication Protocols

- Integrated communication capabilities:
  - Modbus RTU RS485 (isolated): Minimum one port.
  - Modbus Ethernet TCP/IP (isolated): Minimum two ports, with the capability to turn disable either Ethernet ports.
  - USB B-Type service-tool port with dust cover



Source Inversion

- The transfer switch control shall have a feature to enable a user to swap the physical source designations of Source 1 and Source 2 on the transfer switch such that there is no need for rewiring source connections if source inversion is needed. Source inversion shall be achieved via the HMI settings in the field.



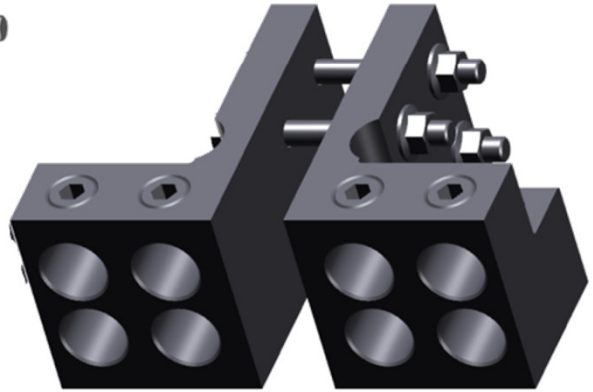
Service-Rated Transfer Switches

- Labeled as "Suitable for use only as service entrance"
- Labeled as "Suitable for use in emergency, legally required, and optional standby applications"
- Permanently marked as a service disconnect

- Disconnecting and Overcurrent Protection Device on Normal Source:
  - Transfer switches rated 800 amps or Less: molded-case circuit breaker with LSI trip unit and current ratings as indicated on plans
  - Transfer switches rated 1000 to 3000 amps: draw-out mounted, air circuit breaker with LSIG trip unit and current ratings as indicated on plans
  - Energy Reduction Maintenance Switch (ERMS): Provided on overcurrent protective devices with maximum rating of 1200 amps or higher.
  - Ground Fault Protection (GFP) in accordance with NFPA 70 *or* CSA C22.1:21

Lugs

- Three options:
  - Compression type
  - Mechanical type
  - Bus stabs (no lugs)
- Main and Neutral Lugs
- Ground Lugs and Bus-Configured Terminators
- Ground bar must be provided
- Connectors to be marked for conductor size and type in accordance with UL 1008



Enclosures

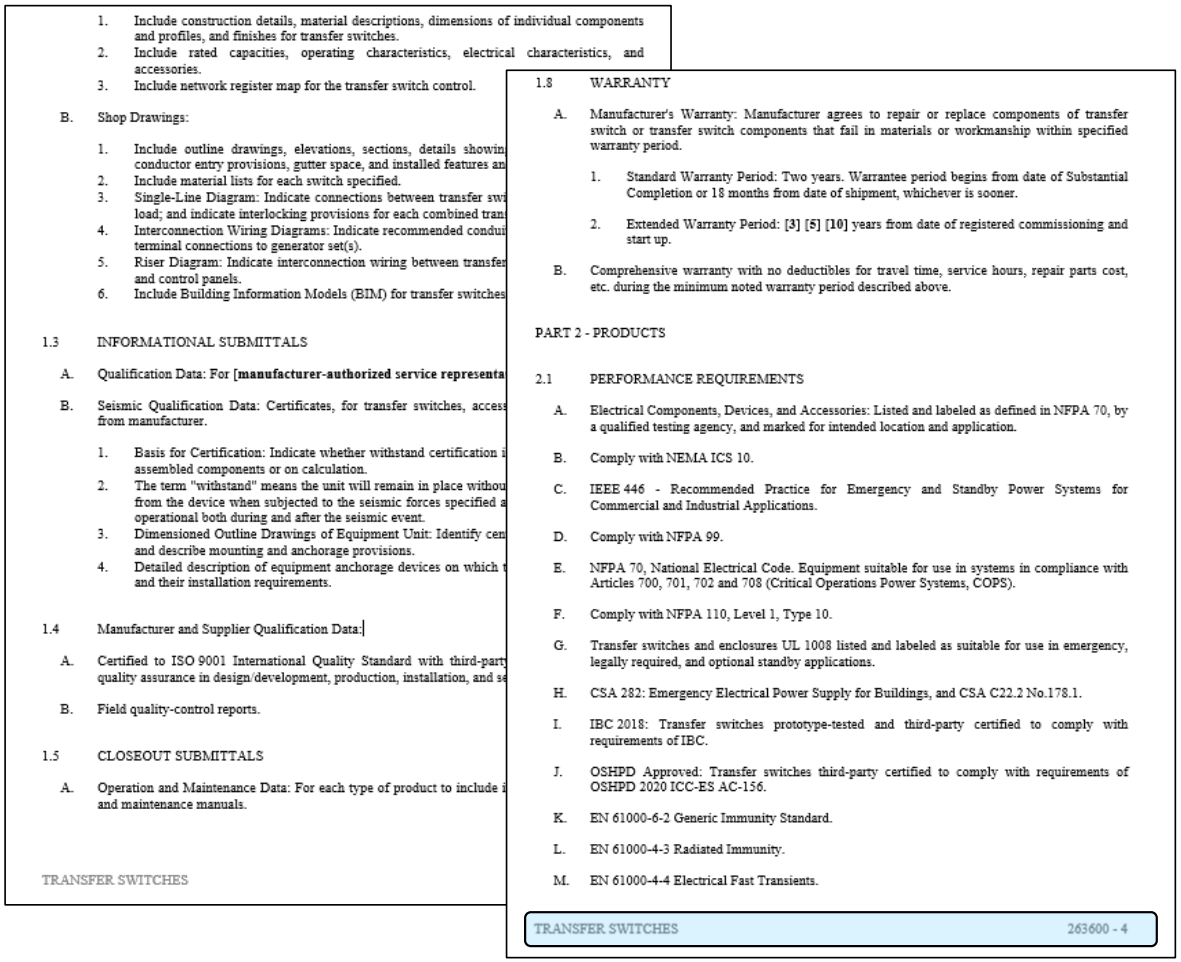
- All enclosures shall be third-party certified for compliance to NEMA ICS 6 and UL 50E, unless otherwise indicated:
  - Enclosure must accommodate wire bend space in accordance with NFPA 70, regardless of direction of conduit entry
  - Exterior cabinet doors must provide complete protection for the system's internal components. Doors must have permanently mounted key-type latches. Bolted covers or doors are unacceptable
  - Enclosures Certification: Third-party certified for their intended environment per NEMA requirements
  - Enclosure Type: NEMA 250,
    - Type 1, Type 3R, Type 4, Type 4X, Type 12

Accessories

- Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater
- Source Surge Protection Device (SPD):
  - Factory installed and wired SPDs with display and LED indicators
  - Source 1: Three-phase SPD and door-mounted display indicating when a surge event has occurred
  - Source 2: Three-phase SPD and door-mounted display indicating when a surge event has occurred
  - Individually replaceable phase SPD modules
  - Peak Surge Current Ratings: 120kA or 240kA on a either wye, resistance grounded wye, or delta system
- Remote annunciation panel display shall include the following indicators
  - Sources available, as defined by actual pickup and dropout settings of transfer-switch controls
  - Switch position
  - Switch in test mode
  - Failure of communication link

Section 263600 – Transfer Switches

- Part 1 – General
- Part 2 – Products
- Part 3 – Execution



1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.
2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.
3. Include network register map for the transfer switch control.

B. Shop Drawings:

1. Include outline drawings, elevations, sections, details showin conductor entry provisions, gutter space, and installed features an
2. Include material lists for each switch specified.
3. Single-Line Diagram: Indicate connections between transfer swi load; and indicate interlocking provisions for each combined tran
4. Interconnection Wiring Diagrams: Indicate recommended condui terminal connections to generator set(s).
5. Riser Diagram: Indicate interconnection wiring between transfe and control panels.
6. Include Building Information Models (BIM) for transfer switches

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For **[manufacturer-authorized service representa**

B. Seismic Qualification Data: Certificates, for transfer switches, acces from manufacturer.

1. Basis for Certification: Indicate whether withstand certification i assembled components or on calculation.
2. The term "withstand" means the unit will remain in place withou from the device when subjected to the seismic forces specified a operational both during and after the seismic event.
3. Dimensioned Outline Drawings of Equipment Unit: Identify cen and describe mounting and anchorage provisions.
4. Detailed description of equipment anchorage devices on which t and their installation requirements.

1.4 Manufacturer and Supplier Qualification Data:

A. Certified to ISO 9001 International Quality Standard with third-part quality assurance in design/development, production, installation, and se

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include i and maintenance manuals.

TRANSFER SWITCHES

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.

1. Standard Warranty Period: Two years. Warrantee period begins from date of Substantial Completion or 18 months from date of shipment, whichever is sooner.

2. Extended Warranty Period: **[3] [5] [10]** years from date of registered commissioning and start up.

B. Comprehensive warranty with no deductibles for travel time, service hours, repair parts cost, etc. during the minimum noted warranty period described above.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NEMA ICS 10.

C. IEEE 446 - Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.

D. Comply with NFPA 99.

E. NFPA 70, National Electrical Code. Equipment suitable for use in systems in compliance with Articles 700, 701, 702 and 708 (Critical Operations Power Systems, COPS).

F. Comply with NFPA 110, Level 1, Type 10.

G. Transfer switches and enclosures UL 1008 listed and labeled as suitable for use in emergency, legally required, and optional standby applications.

H. CSA 282: Emergency Electrical Power Supply for Buildings, and CSA C22.2 No.178.1.

I. IBC 2018: Transfer switches prototype-tested and third-party certified to comply with requirements of IBC.

J. OSHPD Approved: Transfer switches third-party certified to comply with requirements of OSHPD 2020 ICC-ES AC-156.

K. EN 61000-6-2 Generic Immunity Standard.

L. EN 61000-4-3 Radiated Immunity.

M. EN 61000-4-4 Electrical Fast Transients.

TRANSFER SWITCHES 263600 - 4

Field Quality Control

- Manufacturer's Field Service: Manufacturer of transfer switches and associated equipment inspects, tests, and adjusts components, assemblies, and equipment installations, including connections, and reports results in writing
- Electrical Tests:
  - Verify settings and operation of control devices
  - Calibrate and set all relays and timers
  - Verify phase rotation, phasing, and synchronized operation
  - Perform automatic transfer tests
  - Verify correct operation and timing of the following functions:
    - Normal source voltage-sensing and frequency-sensing relays.
    - Engine start sequence.
    - Time delay on transfer.
    - Alternative source voltage-sensing and frequency-sensing relays.
    - Automatic transfer operation.
    - Interlocks and limit switch function.
    - Time delay and retransfer on normal power restoration.
    - Engine cool-down and shutdown feature

Field Quality Control

- Electrical Tests: After energizing circuits, perform each electrical test for transfer switches and demonstrate interlocking sequence and operational function for each switch at least three times.
  - Simulate power failures
  - Simulate loss of phase-to-ground voltage for each phase of normal source
  - Verify time-delay settings
  - Verify pickup and dropout voltages by data readout or inspection of control settings
  - 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

Manufacturer's Warranty

- Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period
  - Standard Warranty Period: Two years. Warrantee period begins from date of Substantial Completion or 18 months from date of shipment, whichever is sooner
  - Extended Warranty Period: 3, 5 or 10 years from date of registered commissioning and start up
- Comprehensive warranty with no deductibles for travel time, service hours, repair parts cost, etc. during the minimum noted warranty period described above

Service and Support

- The transfer switch manufacturer shall maintain service parts inventory for the entire power system at a central location which is accessible to the service location 24 hours per day, 365 days per year
- The manufacturer of the transfer switch shall maintain a central parts inventory, covering all the major components of the power system, including engines, alternators, control systems, paralleling electronics, and power transfer equipment
- The transfer switch shall be serviced by a local service organization that is trained and factory certified in transfer switch service

Service and Support

- Supplier must include a one-year service agreement in the base price. Maintenance shall be performed by factory-authorized service technicians capable of servicing both the engine generator set and the transfer switches. This agreement includes the following:
  - All electrical controls maintenance and settings
  - All auxiliary equipment as a part of the emergency systems
  - Supplier shall guarantee emergency service
  - All expendable maintenance items are to be included in this agreement
  - A copy of this agreement and a schedule must be given to Owner at time of acceptance, showing what work is to be accomplished and when

Course Objectives

Transfer Switches: What to Specify and Why

Transfer switches are critical components in the power system and they are applied in a wide variety of applications. This course is intended to provide participants with an overview of performance-based requirements related to transfer switches. Participants will learn what to specify for their projects and why. The main sections covered are codes and standards, actuator, transition modes, short-circuit WCR, controls, protection, accessories, and service and support.

Conclusions:

- Write specifications based on functions and performance
- Include specifications on service and support for transfer switches and the entire paralleling system
- Utilize industry-standard product specification selection tools such as the AIA MasterSpec®

Additional Resources

Cummins White Papers

- How to simplify electrical distribution designs and enable selective coordination strategies with transfer switch high Withstand and Closing Ratings (WCR)
- Considerations for Reliable Closed Transition Transfer Switches

HOW TO SIMPLIFY ELECTRICAL DISTRIBUTION DESIGNS AND ENABLE SELECTIVE COORDINATION STRATEGIES WITH TRANSFER SWITCH HIGH WITHSTAND AND CLOSING RATINGS (WCR)

White paper by Hassan Obeid, Global Technical Advisor

When designing a power system, sizing the electrical distribution to handle the available fault current is critical. A major challenge design engineers face when specifying transfer switches is that the available fault current and the overcurrent protection devices, specifically circuit breakers, are not known at the time specifications are written. This paper discusses how design engineers can take advantage of the high withstand and closing rating and short-time rating of transfer switches to simplify circuit breaker selection and enable effective selective coordination schemes.

Since transfer switches are applied in mission-critical and life-safety applications, superior reliability is paramount. Therefore, transfer switches are subjected to the most stringent testing requirements outlined by the leading standard in North America: UL 1008 "Standard for Safety – Transfer Switch Equipment" (UL 1008 is harmonized with Canadian standard CSA 22.2 178).

UL 1008 specifies robust testing requirements for verifying manufacturer ratings, including the Withstand and Closing Ratings (WCR).

The tests specified by UL 1008 are:

- Temperature rise test
- Dielectric voltage-withstand test
- Overload test
- Contact opening test
- Endurance test
- Short-circuit test
- Dielectric voltage-withstand test (following short-circuit withstand/closing test)
- Short-time current test (optional)

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Power Generation

Power topic #5023 | Technical information from Cummins Power Generation

Considerations for reliable closed transition transfer switches

White Paper

By Rich Scroggins, Technical Specialist, Sales Application Engineering

Closed transition transfer switches are becoming more popular for transferring power for life safety and critical processing loads. The benefits are that the emergency power system can be tested without interrupting power to loads and power can be re-transferred to the utility after a failure without interrupting power to loads. There are risks associated with closed transition transfer as two live sources are connected together. This paper reviews best practices for minimizing these risks.

Problems with closed transition transfer originate from a difference in voltage between the two sources at the instant when the two sources are connected. The difference in voltage can be caused by several factors:

- A difference in root mean square (RMS) voltage between the sources.
- A phase angle difference between the two sources.
- A transient condition on one of the sources caused by a load switching on or off or instability of one of the sources.

The instantaneous voltage difference between the sources results in a current surge from the source with the higher voltage to the source with the lower voltage at the instant of interconnection of the sources. This current is limited only by the impedance of the sources and the cable or bus connecting the sources. It is this current surge that can result in tripping breakers or, in more extreme cases, damaging equipment.

Our recommendations for minimizing risks of out-of-phase closure include:

- Recognize that all sync check systems allow for sources to be a few degrees out-of-phase at closure resulting in some level of surge current between the sources. Breakers, transfer switches and cable must be sized accordingly.
- Consider active synchronizing with voltage matching to minimize the phase and voltage differences between sources.
- Minimize the possibility of transient conditions at the moment of transfer by inhibiting multiple transfer switches from transferring at the same time and preventing other loads from cycling during the transition.
- Use a transfer switch "fail to disconnect" or maximum parallel timer relay to shunt-trip an upstream breaker to prevent extended paralleling in the event that a transfer switch fails.

- AIA MasterSpec® is the industry-standard product research and specification resource for the design professional and their firm

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263600 Transfer Switches MasterSpec

Q&A

Please type your questions, comments and feedback in the **Zoom Q&A** window.

PDH certificate, copy of the presentation, and link to the recording will be provided in a follow up email within a 1-2 business days.

Please complete the brief survey upon exiting the webinar!

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Global Technical Advisor – Systems and Controls
Cummins Inc.
.

Mariano Rojas
Senior Sales Application Engineer
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Closing

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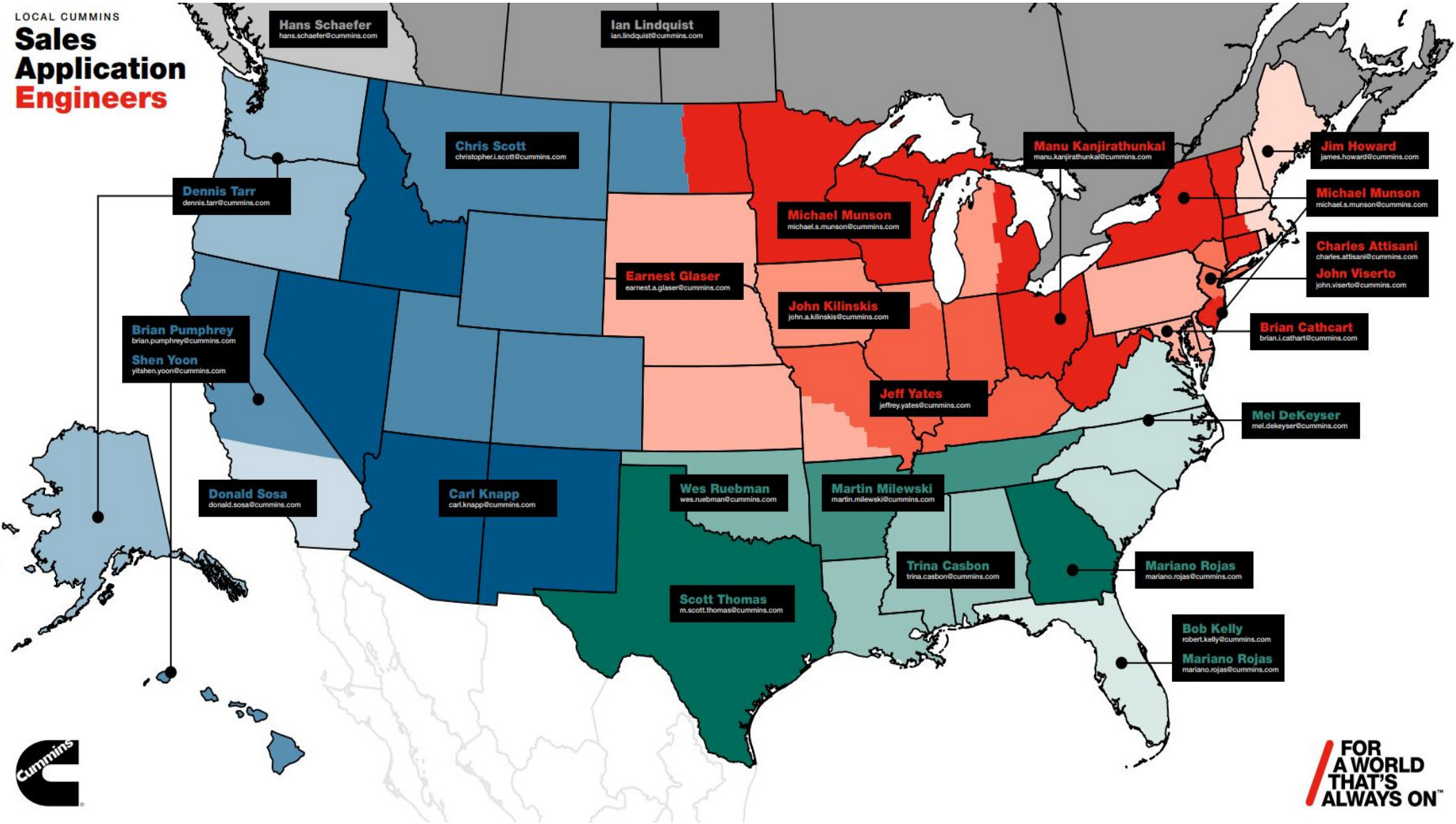

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