Ask the Experts:
Transfer Switch Fundamentals

PowerHour webinar series for consulting engineers
Experts you trust. Excellence you count on.

September 17th, 2020
Start Time: 2:00 EST / 11:00 PST
(1PDH issued by Cummins)
Welcome!

Cummins PowerHour webinar series is designed to help our engineer partners to...

- Keep up to date on products, technology, and codes and standards development
- Interact with Cummins experts and gain access to ongoing technical support
- Participate at your convenience, live or on-demand
- Earn Professional Development Hours (PDH)

Technical tips:
- Audio is available through teleconference or Zoom application.
- Attendees are in “listen only” mode throughout the event.
- 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.
- Report technical issues using the Zoom Q&A Panel.
Course Objectives

Ask the Experts: Transfer Switch Fundamentals
Transfer switches come in a variety of types for use in a wide array of applications. Sizing to meet the needs of a power system, coordination with overcurrent protective devices, optimizing communication and controls, and accurately specifying for performance and reliability can be a complicated job. Our experts at Cummins are here to help! This roundtable webinar will center around a set of questions we commonly see from Consulting Engineers, as well as an opportunity for live questions.

After completing this course, participants will be able to:
• Identify key design attributes to automatic transfer switches and their role in a power system.
• Develop a better understanding of some of the common pitfalls in the ATS selection process and how to avoid them.
• Identify UL 1008 requirements for transfer switch withstand and closing ratings.
Asking a Question:

Q&A Button:
- For technical questions on today’s topic
- Ask at anytime
- Not all questions may get answered but we’ll do our best!

Chat Button:
- For general PowerHour or Zoom questions
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 in doubt, reach out to the Authority Having Jurisdiction.
Meet your panelists

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What are the Components in a Power System?
What are the Components in a Power System?

- Paralleling Generator Sets
- Distribution Board
- Transfer Switches
- Digital Master
- Digital Cloud Solutions
- Grid
- Loads
What is a Transfer Switch?
What is a Transfer Switch?

- Monitors the availability and quality of two connect power sources
- Transfers power consumed by electrical loads connected to the transfer switch output between two sources based on source availability
What are the Key Considerations When Selecting a Transfer Switch?
What are the Key Considerations When Selecting a Transfer Switch?

- Switch type
- Transition type
- Application
- Grounding schemes
- Cable sizes and entry requirements
- Enclosures
- Voltage
- Current
- Fault current
- Selective coordination
- Type of load in the systems per Codes & Standards
What Applications Should I Consider the Different Types of ATSs?
What Applications Should I Consider the Different Types of ATSs?

- **Automatic Transfer Switch**
  - Controller
  - Load

- **Service Entrance Rated Transfer Switch**
  - Integrated Service Disconnect
  - Load
  - Generator OCPD
  - ATS

- **Bypass Isolation Transfer Switch**
  - Load
  - MTS
  - ATS
What Benefits / Requirements Lead to Bypass Transfer Switches in Mission Critical Applications?
What Benefits / Requirements Lead to Bypass Transfer Switches in Mission Critical Applications?

- Code compliance!
  - NEC (Mission Critical Facilities)
  - NFPA 99 Health Care Facilities Code
  - Joint Commission (Healthcare)
  - OSHPD (California Office of Statewide Health Planning and Development)

- Utmost reliability and redundancy
  - Facilitate system maintenance
How Should I Choose Between the Main Transition Types?
How Should I Choose Between the Main Transition Types?

1. Open Transition
   “Break before make” transfer
   *Watch out*: Inductive load residual voltage decay rates

1.a. Delayed Transition
   • Adjustable neutral position delay
   • Flexible, simple, reliable
   • Best option for large motors
   • Step loading generators possible

1.b. In-Phase Transition
   • Based on synchronization of sources
   • “Fast” – typically 30ms – 50ms delay
   • Okay for resistive loads and small inductive loads

2. Closed Transition
   “Make before break” transfer
   *Watch out*: Safeguards and extensive documentation required by utility may add cost and complexity
When Should I Consider Two Position vs. Three Position Switches?
When Should I Consider Two Position vs. Three Position Switches?

2 Position “Double Throw”

3 Position “Neutral Position Delay”

Good choice for switches requiring:
- Delayed Transition
- Load shed – won’t transfer to “dead” source
What are some of the Common Time Delay Settings for Emergency Standby?
What are some of the Common Time Delay Settings for Emergency Standby?

1) ATS control detects failure of normal source
2) ATS programmed time before start signal
3) ATS control sends start signal to generator set control
4) Generator set control initiates engine start sequence
5) Generator set engine starts
6) Generator set reaches “Ready to Load”
7) ATS transitions from normal to neutral position
8) ATS transfer time delay
9) ATS transitions from neutral to emergency position

0 – 1 Seconds based on application

4 – 8.5 Seconds based on generator set configuration

0.5 – 1.5 Seconds based on transfer switch and application
More on NFPA 110 Time to Readiness:

Related Content
NFPA 110 Time to Readiness
White Paper
PowerHour Recording
Review: What is a WCR Rating?
Review: What is a WCR Rating?

- **Withstand** test (starts with contacts closed):
  - A specified fault current is applied for either:
    - A specific duration
    - OR
    - Until a specific OCPD trips

- **Closing** test (starts with contacts open then close):
  - The same transfer switch must close onto the fault current under the same conditions used in the withstand test

- **Rating** is per UL 1008; which sets the pass/fail standards
  - The same set of contacts are used for both tests: withstand and closing
Review Coordination Challenges from an ATS Perspective?
Selective Coordination is required for emergency, legally required standby and critical operations power systems circuits
- **NEC-2017, 700.32, 701.27, and 708.54** “…over-current devices shall be selectively coordinated…”

- Selective coordination will require time delays to be set on OCPDs
  - In the example shown, A **must** trip after B → Time delay on A
- Time delay setting of OCPD A will depend on the available fault current from either source & the device B trip curve characteristic
- For the duration of the OCPD A time delay, the ATS must be able to:
  - Withstand the fault
  - Close into the fault
- Transfer switches manufacturer will publish a **Withstand and Close** rating
Help me Decide: Which Rating Should I Select?
Help me Decide: Which Rating Should I Select?

- UL 1008 requires all ATS to have a withstand and closing rating (WCR)
- Rating can either be time based or specific OCPD (breaker/fuse) based
- OCPD based ratings allow for higher WCR ratings but requires the ATS to be protected by a “listed” breaker or fuse
- Allowing for either time based or specific breaker based ratings enables flexibility for a cost effective design

<table>
<thead>
<tr>
<th>OCPD devices allowed are Listed by transfer switch manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuse/ Current Limiting breaker</td>
</tr>
<tr>
<td>Breaker Rating</td>
</tr>
<tr>
<td>Time Duration Rating (0.05 s/3 cycle)</td>
</tr>
<tr>
<td>Short time Rating (0.5 s/30 cycle)</td>
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</tbody>
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- Increase in trip time
- Increase in arc flash incident energy
- Ease of Selective Coordination
- Decrease in WCR rating

Help me Decide: Which Rating Should I Select?
More on WCR and Selective Coordination:

Related Content

**Withstand and Close Ratings**
- White Paper
- PowerHour Recording

Related Content

**Selective Coordination**
- White Paper
What is the Difference between a Separately and Non-Separately Derived System?
What is the Difference between a Separately and 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
When Should I Consider a 3 Pole vs. 4 Pole ATS?
When Should I Consider a 3 Pole vs. 4 Pole ATS?

- Choice depends on grounding scheme of the system
- NFPA70 (NEC) requires some systems to have ground fault protection (GFP)
  - E.g. ≥1000 A; Solidly grounded wye; >150 V L-N
- Two rules for proper ground fault sensing:
  - Rule #1: There must be only one neutral to ground connection on any neutral bus at one time
  - Rule #2: Ground fault sensors must be downstream from the bonding connection

EGC (Equipment Grounding Conductor)
GEC (Grounding Electrode Conductor)
More on Grounding and Protection:

Grounding and Neutral Switching

White Paper

White Paper

White Paper

This is the first part of a two part white paper. Part one addresses system grounding arrangements for AC generators used in emergency and standby systems. The methods of system grounding covered include solid grounding and high-resistance grounding, with additional discussion of systems that are ungrounded. The second part addresses switching the neutral conductor with 4-pole transfer switches where ground fault protection systems are provided on the normal power source and where ground fault indication is provided on the emergency/standby generator.

System and equipment grounding

Careful consideration of the grounding arrangements of AC generators used in emergency and standby power systems is essential for optimal continuity of power to the load. System considerations for AC generators used in emergency and standby systems include selection of a system grounding method for the generator, when to use four pole transfer switch equipment, requirements for indication of a ground fault on the generator, and the methods used in transfer equipment for switching the neutral pole.

The term “grounding” describes and encompasses both systems grounding and equipment grounding. The basic difference between system and equipment grounding is that system grounding involves grounding circuit conductors that are current carrying under normal operation, whereas equipment grounding involves grounding all non-current carrying metallic parts that explore the circuit conductors. A grounding electrode or several grounding electrodes tied together at a point provides the reference ground and the means for connection to earths.

System grounding refers to the intentional connection between the generator’s neutral and the ground. The source of neutral power for the system is typically a utility supplied transformer and the source of emergency or standby power is typically an owner-supplied on-site generator set. The power system conductor connected to ground becomes the grounded conductor, which is typically the neutral circuit conductor.
Q&A

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

After the PowerHour, a complete list of questions and answers will be published on powersuite.cummins.com.

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Additional Resources

Cummins White Papers
- **White Paper** (NFPA 110 Time to Readiness)
- **White Paper** (WCR Ratings)
- **White Paper** (Selective Coordination)
- **White Paper** (Protective Relays)
- **White Paper** (Grounding and Switching of Neutral)
- **White Paper** (Grounding and Switching of Neutral)
- **White Paper** (Start Signal Integrity)

Cummins PowerHour On-Demand Webinars
- **PowerHour Recording** (NFPA 110 Time to Readiness)
- **PowerHour Recording** (WCR Ratings)
- **PowerHour Recording** (NEC 2017 changes)
Closing

Watch out for a follow-up email including:

▪ A link to the webinar recording and copy of the presentation
▪ A certificate issuing one professional development hour (1 PDH)

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Please contact Michael Sanford if you have any questions related to the PowerHour webinar (michael.sanford@cummins.com)

Upcoming PowerHour Webinars:

October: Healthcare Power System Installations and Case Studies
November: Overcurrent Protection for NEC Life Safety Emergency Power Systems
December: Standby Power Systems Service Requirements for Life-Safety Applications