

# Transfer Switches: Understanding Why UL 1008 Is a Critical Requirement

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# Executive Summary

■ **There is a growing need for emergency backup power systems in data centers, hospitals and many other facilities. A critical component of many of those systems is the transfer switch.**

■ **Transfer switches should be certified to UL 1008 requirements. UL 1008 requires rigorous testing of transfer switches. It is designed to ensure reliability and durability.**

■ **Despite the importance of UL 1008, most facility executives are not aware of what UL standard their transfer switches are certified to.**

## It's easy to take transfer switches for granted... But it's also risky.

With the growing emphasis on emergency and standby power, facility executives are taking a closer look at the elements of the backup power system. One critical element of that system is the transfer switch. Facility executives count on their transfer switches to perform when they need to switch from the utility's electricity supply to backup generators. Mostly, transfer switches perform. But there have been notable failures.

At an Amazon Web Services data center in Virginia, an automatic transfer switch didn't work properly in May 2010, when the data center needed to shift from utility power to its generators after a vehicle hit a utility pole nearby. As a result, some Amazon customers lost cloud computing service for an hour. In 2010, Codero's Phoenix data center experienced a power outage. The generators started as expected,

but an automatic transfer switch failed. In January 2010, a NaviSite data center lost power when a transfer switch failed during a utility outage caused by a thunderstorm.

To ensure that transfer switches perform as expected, it's important that they comply with UL 1008. That standard sets out a series of rigorous requirements that include "withstand & closing ratings or WCR" (which cover severe fault currents, bolted faults and short circuits within the electrical distribution system); tests to ensure that the device can carry rated currents; and endurance tests specifying the number of cycles that the transfer switch must achieve and still perform its intended function.

But transfer switches are not the only devices that are used to transfer power. And other types

of switching devices do not have to meet UL 1008 and thus do not offer the assurance of having met the strict testing requirements needed for qualification to that standard.

Most transfer switch failures don't make the news the way the ones cited above did. But failures do occur. In a survey co-sponsored by Building Operating Management magazine and ASCO Power Technologies, 20 percent of respondents whose facilities have transfer switches reported at least one failure of a switch in the past five years. (See Figure 1 on page 3.) In one case, "both sides of the switch closed at the same time during a test. The switch exploded," a respondent reported. Another respondent indicated the transfer switch failure "caused elevators to lock out." A third commented that the transfer switch "failed to energize a critical Intensive Care Unit circuit."

■ **Figure 1. Have you had any failure of a transfer switch in the past 5 years? R=647**

|     |     |
|-----|-----|
| Yes | 20% |
| No  | 80% |

Transfer switch failures happen in a variety of ways. But a third of respondents who experienced failures reported that the switch completely failed and became totally inoperational. (See Figure 2.)

■ **Figure 2. Which of the following accurately describes the transfer switch failure(s)? R=123**

|  |     |
|--|-----|
| Controls failed but mechanical switch continued to operate | 49% |
| Switch completely failed and became totally inoperational  | 33% |
| Switch mechanically locked up with controls working        | 20% |
| Failure of switch caused damage to other equipment         | 5%  |
| Others   | 7%  |

(Responses add to more than 100 percent because multiple answers were allowed.)

The transfer switches that failed were not necessarily old units. (See Figure 3.) The same number of failures was reported in the survey for units less than five years old and units 15 or more years old.

■ **Figure 3. How long was the transfer switch(es) in service when the first failure(s) occurred? R=107**

|                                |     |
|--------------------------------|-----|
| Less than 1 year               | 7%  |
| 1 year to less than 5 years    | 18% |
| 5 years to less than 10 years  | 29% |
| 10 years to less than 15 years | 21% |
| 15 years to less than 20 years | 9%  |
| 20 years or more               | 16% |

(Responses add to more than 100 percent because multiple answers were allowed.)

And transfer switch failures left a significant number of facilities without power, the survey shows. Of respondents who experienced failures, 42 percent reported that their facilities lost power. (See Figure 4.) And more than half who lost power said that facility loads were without power for an hour or more. (See Figure 5.)

■ **Figure 4. Did any of the transfer switch failures leave your facility without power? R=125**

|                |     |
|----------------|-----|
| Yes            | 42% |
| No             | 56% |
| Not applicable | 2%  |

■ **Figure 5. How long were your facility loads without power? R=53**

|                                  |     |
|----------------------------------|-----|
| A minute or less                 | 11% |
| More than a minute to 30 minutes | 26% |
| More than 30 minutes to 1 hour   | 13% |
| More than 1 hour to 2 hours      | 13% |
| More than 2 hours to 6 hours     | 21% |
| More than 6 hours to 1 day       | 11% |
| Greater than 1 day               | 6%  |

(Responses add to more than 100 percent because multiple answers were allowed.)

According to the survey, failures can be traced to a variety of issues, including power surges, lack of maintenance, age of equipment and poor design. (See Figure 6.)

■ **Figure 6. What were the major reasons for transfer switch failure(s)? R=125**

|                     |     |
|---------------------|-----|
| Power surge         | 22% |
| Lack of maintenance | 21% |
| Age                 | 18% |
| Poor design         | 14% |
| Poor application    | 7%  |
| Operator error      | 3%  |
| Other               | 31% |

(Responses add to more than 100 percent because multiple answers were allowed.)

Jacob L. Huske, PE, vice president of Environmental Systems Design, says that the most common causes of failures of contactor-based transfer switches that he has heard about were poor maintenance, or a misapplication of the transfer switch that resulted in power outages due to nuisance tripping of a circuit breaker external to the transfer switch during a transfer.

“I have found that many transfer switch failures are the result of shorted-out rectifiers,” observes Christopher A. Wade, principal consultant for Resilient Mission Critical Solutions. Previously, Wade oversaw the global strategy, planning, engineering and facilities operations for mission critical data centers for a Fortune 100 company.

Another potential problem Wade mentions is human error. In one case, he says, the transfer switch was left in manual mode for a couple of months following completion of maintenance work. So, when needed, the transfer switch did not operate. “Needless to say, that was a career limiting situation,” notes Wade.



# Ensuring Transfer Switch Reliability

Despite failures, transfer switches can be extremely reliable, provided that they are properly selected and maintained. The starting point is to ensure that the switch is qualified and certified to the correct UL standard. For transfer switches, that's UL 1008.

"Transfer switch equipment tends to be very reliable when properly applied and maintained, so failures of UL 1008 transfer switches are rare," says Huske.

UL 1008 was established in 1970 by Underwriters Laboratories to guard against transfer switch failures and resultant potential fires. A performance standard as well as a design and construction standard, UL 1008 requires transfer switches to undergo rigorous testing by an independent testing and certification agency.

According to the Seventh Edition of UL 1008, published in July 2012, the standard applies to automatic transfer switches (ATS), manual transfer switches, closed transition transfer switches, and hybrid transfer switches. UL 1008 also covers fire pump transfer switches, bypass/isolation switches, softload transfer switches and transfer switches used as service equipment.

To meet UL 1008 listing requirements, a transfer switch must meet the construction requirements specified in the standard and pass a series of stringent tests. From the facility executive's perspective, UL 1008 transfer switches offer safe and dependable transfer of electrical power from the utility main to backup emergency power generators during mandatory compliance testing and when emergency power is actually needed.

"UL 1008 is almost always the standard used for enclosed, contactor-type transfer switch equipment applied in the United States, including equipment installed in mission critical facilities," explains Huske. **"Where transfer switch equipment is used for transferring critical load in legally required emergency power applications or healthcare facilities, UL 1008 is generally the only standard that the authority having jurisdiction (AHJ) will accept."**

The dependability and safety of UL 1008 transfer switches are "very important," says John Ferguson, director of facilities for Regional West Medical Center in Nebraska. "As a hospital, we have to keep our operations safely going, even in power outage situations, to protect the lives of our patients and our staff who are caring for them."

Ferguson isn't alone in seeing the importance of UL 1008 listed transfer switches. Harris of Cushman & Wakefield calls the UL 1008 automatic open transition transfer switches his client uses for its life safety generator "very important."

And Ken Cooper, chief engineer at Sands Regency Casino Hotel, says that UL 1008 transfer switches perform "very well, as long as they have proper maintenance" and are tested periodically.

From Wade's point of view, there are two major benefits of using UL 1008. One is that it simplifies the inspection process on code-required emergency power systems. "The reliability of backup power systems is impacted by switchgear design," says Wade. "The UL 1008 standard has typically been specified for legally required standby and emergency power systems (e.g., systems used for critical loads in hospitals). It is applicable for equipment up to 600 V (it does not address medium voltage), and is written for the simple standalone transfer switches. The basic UL 1008 standard does not address the reliability requirements as the system becomes more complex with multiple sources of power (utility and generators) and with the introduction of tie circuit breakers."

■ Figure 7. Which of the following UL Standards is your transfer switch(es) certified to? R=633

|          |     |
|----------|-----|
| UL 67    | 1%  |
| UL 98    | 2%  |
| UL891    | 2%  |
| UL1008   | 5%  |
| Not sure | 92% |
| Others   | 1%  |

(Responses add to more than 100 percent because multiple answers were allowed.)

The other major benefit of UL 1008 revolves around the device testing requirements of the standard. “UL 1008 really relates to testing devices to validate that they will operate safely and reliably as intended,” says Wade. “UL 1008 is designed to be a self-contained standard for a switch assembly and has very stringent requirements for endurance testing. It contains overload, endurance and interruption testing criteria in addition to all mechanical construction requirements to ensure safe operation of the switch.”

Wade points out that the mechanical interlocking requirements of UL 1008 are significant. Mechanical interlocking is a useful safety feature for the open transition transfer of two sources. “Some modern circuit breakers surpass the endurance requirements in the industry standards,” Wade says. “Therefore, the key specification item is the circuit breaker endurance. Mechanical interlocking can be specified for open transition transfer on simple systems where the switchgear arrangement makes it physically possible. However, mechanical interlocking is not possible in many switchgear arrangements, and electrical interlocks have successfully been employed for many years. Either method of interlocking (mechanical or electrical) prevents



the accidental paralleling of the two sources, thus increasing safety.”

Despite the importance of UL 1008, the results of the survey suggests that most facility executives are unfamiliar with it. Among respondents with transfer switches, only 5 percent said that their switches were certified to UL 1008. (See Figure 7.) The overwhelming majority — 92 percent — said that they weren’t sure about the standard to which their devices were certified. This is eye opening information when the transfer switch is considered by most people knowledgeable on power distribution systems to be the “heart” of power systems.

As noted earlier, 20 percent of survey respondents experienced transfer switch failures in the past five years. In those cases, 97 percent

of survey respondents were not sure what certification those failed switches had, if any.

One reason that some facility executives may not know which standard their devices are certified to is that transfer switches can last a very long time. For example, Dave Lopes, chief engineer for ABM Engineering, has some experience with failed transfer switches and is replacing them with UL 1008 listed units. He’s unsure whether the replaced units were UL listed “because they were vintage units.” He guesses the original switches were installed around 1970 to protect power transfer to the commercial high-rise’s elevators, the main building emergency riser, and the emergency generator.

■ **Figure 8. Who ensured that your transfer switch(es) was certified to its appropriate standard? R = 649**

|  |     |
|--|-----|
| You  | 10% |
| Design Engineer who designed your facility     | 49% |
| Installing Contractor                          | 47% |
| Authorities who approved occupancy certificate | 26% |
| No one   | 1%  |
| Not sure                                       | 15% |

(Responses add to more than 100 percent because multiple answers were allowed.)

## Finding Expertise

Scott Blackman, facilities management and commissioning regional manager at Syska Hennessy, recommends that facilities executives consider tapping the resources of a reputable engineering firm to help them select the proper transfer switches for their business' needs.

“The facility manager has tremendous experience across a broad range of operations for his or her building,” says Blackman. “The advantage an engineering firm offers is that it has multiple clients with various business needs using transfer switches in many different buildings. That expertise allows the engineer to refine the transfer switch selection process, based on his or her experience with what works and what doesn't for numerous buildings and situations.”

Huske agrees: “There are many application-specific considerations that must be addressed for any type of transfer equipment that will be used, and the best way to avoid problems is to have someone with extensive experience assist.”

The survey shows that most facility executives rely on outside parties to ensure that transfer switches are certified to the appropriate UL standard. (See Figure 8.)

No matter who is involved in helping select transfer equipment, it's important for the facility executive to take steps to ensure that the correct UL standard has been followed.

It's a red flag if transfer switch literature says the device merely “meets UL standards,” Drengenberg says. “(The device) may even have undergone independent testing but it might not be UL at all. They may not have tested under load conditions,” he points out. Similarly, facility executives should be wary of “per UL 1008 standards” and similar terms that suggest a product complies with UL 1008 but does not say that outright.

He recommends looking for the UL inside a circle logo and the word “listed” as well as the exact transfer switch words cited in the standard. UL 1008 transfer switches are specifically labeled as “non-automatic transfer switch,” “automatic transfer switch” or “transfer and bypass-isolation switch.” These labeling requirements are spelled out in UL's Electrical Construction Equipment Directory, commonly referred to as the “Green Book.” UL also places a code on the switch that identifies the manufacturer, according to Drengenberg. And literature or specifications should say something like “UL1008 Listed” or “tested and certified by UL 1008.”





■ Figure 9. How are your transfer switch(es) maintained? R=631

|  |     |
|--|-----|
| Using third party service providers                | 66% |
| Using in-house expertise                           | 36% |
| Using original manufacturer's service organization | 22% |
| Other  | 1%  |

(Responses add to more than 100 percent because multiple answers were allowed.)

## Put UL 1008 in writing

To avoid any misunderstanding, facilities executives who are purchasing transfer switches on their own are spelling out UL 1008 in their master construction specifications.

The Unified Facilities Guide Specification on automatic transfer switches cites UL 1008 (2012 edition) in its specifications for the Army Corps of Engineers, Naval Facilities Engineer-

ing Command (NAVFAC), Air Force Civil Engineer Support Agency (AFCEA) and NASA projects. It is also referenced in the MIL-PRF-17773C(SH), which is the Navy standard for automatic bus transfer switches installed on Navy combat vessels.

## Proactive Steps

Although proper UL certification for transfer switches is essential, it's not the whole story. Maintenance and testing are also crucial to ensure that the transfer switch will respond when needed.

"All transfer switch equipment manufacturers publish recommended schedules for maintenance and testing, so obtaining and understanding these recommendations is the best place to start," suggests Huske. "Facility executives also should engage a qualified service company to regularly perform inspections and maintenance on transfer switch equipment in their buildings."

Regional West Medical Center in Nebraska relies on a third party to do load-bank testing, as well as any repair needs uncovered, when the emergency backup system must be operated for four hours to meet Joint Commission requirements, according to Ferguson.

Harris has his transfer equipment maintained under a third-party contract. Monthly testing is performed in-house, but it is witnessed under the third-party agreement at least once a year.

Cooper, of the Sands Regency Casino Hotel, also relies on a third-party electrical contractor to make

sure his transfer switches and circuit breakers perform as expected for data center/call center operations.

The majority of survey respondents use third-party service providers to maintain their transfer switches, though many also rely on in-house expertise. (See Figure 9.)

■ **Figure 10. How often do you test transfer switches? R=630**

|                             |     |
|-----------------------------|-----|
| Monthly                     | 46% |
| Quarterly                   | 16% |
| Semiannually                | 12% |
| Annually                    | 26% |
| Less often than once a year | 5%  |
| Not sure                    | 8%  |

(Responses add to more than 100 percent because multiple answers were allowed.)

■ **Figure 11. What are the steps taken when maintaining your transfer switch(es)? R=632**

|  |     |
|--|-----|
| Contact inspection                           | 69% |
| Infrared scans of live electrical components | 53% |
| Lubrication of joints                        | 48% |
| Testing of sub-systems                       | 47% |
| Removal of dirt/debris from electrical path  | 47% |
| Not sure                                     | 23% |

(Responses add to more than 100 percent because multiple answers were allowed.)

## On-site Testing

Automatic transfer switches are electromechanical devices that have moving parts. Those moving parts can seize if they're left in the same position for months or years. Operating those moving parts regularly helps to ensure they will continue to move smoothly.

The survey shows that monthly is the most common frequency for testing transfer switches. (See Figure 10.)

That's the case at Regional West Medical Center, where the emergency backup power system and its transfer switches are put through an hour of performance testing monthly, as well as periodic load-bank testing for four-hour runs per Joint Commission requirements, according to Ferguson. Two licensed electricians are on hand and, although he's had some problems with the emergency power system, "there have been no problems with transfer switches," says Ferguson.

The National Fire Protection Association Standard 110 for emergency and standby power systems says, "the monthly test of a transfer switch shall consist of electrically operating the transfer switch from



the standard position to the alternate position and then a return to the standard position."

NFPA 110 also requires the entire emergency power supply system to be exercised at least monthly. As many emergency generators are diesel, running under light or no load conditions can cause wet stacking, which is carbon buildup in the cylinders and exhaust system, a potential fire hazard. Generator loads of 30 percent or more often are required by NFPA for monthly testing, which means the transfer switches also are being tested.

Experts suggest the best way to test the automatic transfer switch and the emergency generator to meet NFPA 110 requirements is to operate the transfer switch's test toggle and confirm that it is properly signaling the generator to start and run. Once proper signaling is verified, the building load is transferred.



Load banks offer a valuable tool for improving the reliability of an emergency power system. They are used to test the system without interrupting the critical loads. In the survey, however, only 28 percent of respondents reported using load banks for testing transfer switches. Facility executives who aren't now using load banks should evaluate whether to incorporate them into a planned maintenance strategy.

Maintenance is another key to ensuring that the transfer switch will function reliably.

Asked how their transfer switches were maintained, 23 percent of survey respondents said they were unsure, raising the question of whether they understand the importance of regular maintenance. (See Figure 11.)

"We know maintenance is paramount. Building managers need to inspect UL 1008 transfer switches monthly," Drenenberg says.

## Methodology

The ASCO Transfer Switches Survey was sent via email to a random sample of 15,000 Building Operating Management subscribers on Feb. 14, 2013. Reminders were sent to non-respondents on Feb. 20, and Feb. 22, 2013. A total of 147 subscribers chose to opt out of the survey or failed to respond due to an invalid email address, yielding a final sample of 14,853.

The survey was closed for responses on March 1, 2013. With 1,134 qualified responses returned and with a net sample of 14,853, the rate of response for the email survey was computed to be 7.6 percent. The overall estimated margin of error for this study is +/- 2.89 percent at the 95 percent confidence level.

## ■ What type of facilities are you responsible for? R = 1,133

|  |     |
|--|-----|
| Educational <small>(K-12, Colleges/Universities)</small> | 34% |
| Commercial Office  | 33% |
| Medical/Healthcare                                       | 21% |
| Data Centers   | 13% |
| Government   | 13% |
| Industrial   | 10% |
| Retail   | 8%  |
| Hospitality  | 6%  |
| Other  | 5%  |

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# Remember the business model

The type of UL 1008 transfer switch to use depends on many factors, but possibly the most critical one is the organization's business model.

To that end, Blackman recommends regularly commissioning and evaluating transfer switches to see if they still satisfy the business model. "Today's business is constantly changing and the infrastructure, including transfer switches, often is overlooked," he notes.

He recalls a client with open-transition transfer switches that were performing as designed to an older business model. However, lights flickering and other interrupting factors of regular testing were problematic under the new business model. As a result, the organization opted to retrofit with closed-transition switches.

For new construction or renovation projects, facility executives have an important role to play in making sure the organization gets what it needs. "Facility executives must know what the actual function of the facility is going to be – data center, hospital, office building – and work with the design engineers to determine what is needed," says Wade.

And, when automatic transfer switches are needed in the United States, facilities executives must be sure they are UL 1008 listed. Otherwise, they probably will not pass inspections by the authorities having jurisdiction over the facility.



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