



Understanding control of emergency lighting circuits—2010 update

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Evaluating the appropriate use of a UL 1008 emergency transfer switch or a simpler UL 924 Load Control Relay to energize an emergency lighting circuit

MUCH OF THE MATERIAL IN THIS ARTICLE originally appeared in the Summer 2004 issue of *Protocol*. The subject of emergency lighting control has been an ongoing debate, coupled with changes to codes and standards, as well as an increased market awareness of the issues. As such, we thought it was time to update the original 2004 material.

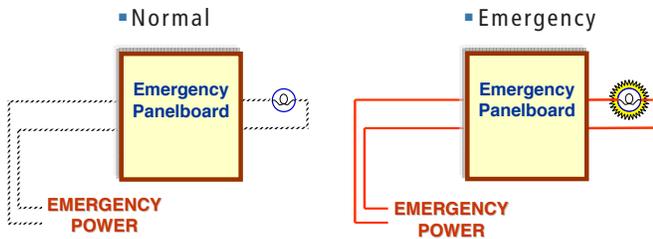
For some time, the proper control of emergency lighting circuits has been a topic of hot debate for manufacturers, systems integrators, and specifying electrical engineers. Much of the debate has centered on the proper application of the many codes and standards that apply to emergency lighting. These include:

- ANSI/NFPA 70—the *National Electrical Code (NEC®)* Article 700—Emergency Systems
- *NEC* Article 701—Legally Required Standby Systems
- *NEC* Article 702—Optional Standby Systems
- *NFPA 110—Standard for Emergency and Standby Power Systems*
- *NFPA 101—Life Safety Code*
- Underwriters Laboratories (UL) *Standard 924—Emergency Lighting and Power Equipment*
- Underwriters Laboratories (UL) *Standard 1008—Transfer Switch Equipment*. UL 1008 covers transfer switches that are rated for use in emergency systems and for other applications.

Unless noted otherwise in this article, we are examining UL 1008 transfer switches for *emergency systems* only. (See sidebars for more information about the NEC and these UL standards).

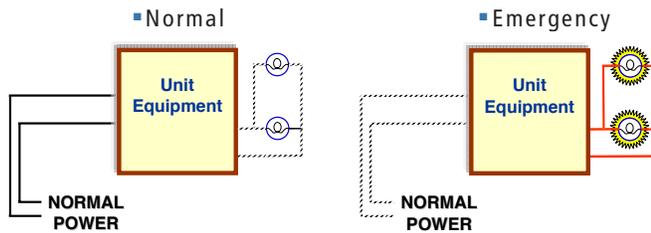
Each of these standards focuses on a specific area of emergency or standby lighting and power, or describes a specific piece of equipment somewhere in the path of the emergency or standby lighting or power circuit. However, it is not always easy to answer all application questions by searching these standards, since they often point at each other, creating a circular answer, or in many cases, a lack of an answer. For the entertainment and architectural lighting control industry, one of the burning questions has been: “Where is it appropriate to use a UL 1008 emergency transfer switch, and where can a simpler UL 924 Load Control Relay be used to energize an emergency lighting circuit?”

Due to the relative cost and complexity of UL 1008 emergency transfer switches, for many years the industry kept asking whether such a switch was really necessary for dimmer branch circuits, especially since in all likelihood there was *another* UL 1008 switch somewhere in the building, transferring a main feeder between normal and emergency power. The answer to this question is not a simple one, and it requires a review of the full spectrum of options in the emergency lighting toolbox. Each of the following cases has a place in the design of emergency lighting systems. It should be noted that these case drawings have been simplified to illustrate functionality, and do not contain every detail of the circuits they describe.



Case 1—Emergency-only lights on an emergency-only circuit

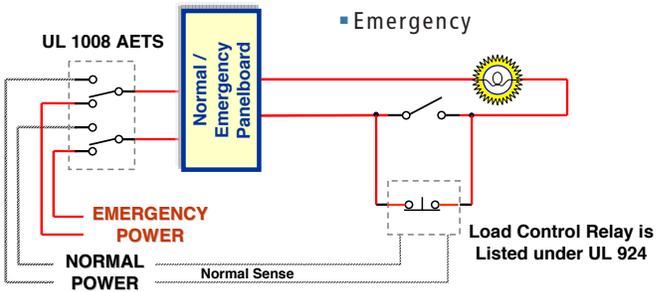
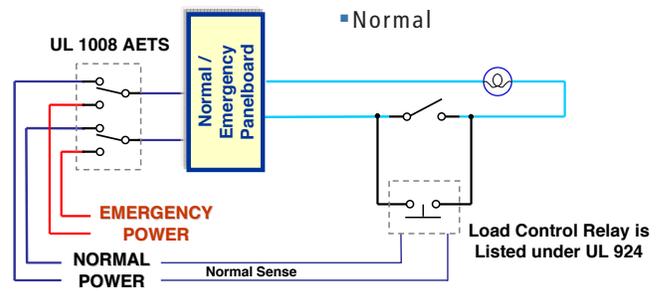
The Case 1 arrangement is probably the simplest possible way to energize emergency lighting fixtures. A number of emergency-only luminaires are dedicated to providing the minimum illumination levels required by the *NFPA 101—Life Safety Code* or local building codes. The lighting fixtures are fed from a dedicated emergency-only breaker panel fed directly from the emergency power source, which may be a generator or UPS (uninterruptable power supply). When the source comes online, the lights are energized without any switching or transfer equipment. The one disadvantage to this arrangement is that the emergency fixtures will be dark when normal power is present. This may be a visually unacceptable situation for the architect or lighting designer.



Case 2—Designated emergency lights with self-contained power source

Case 2 is familiar to anyone who has used self-contained battery pack emergency lights, sometimes called “unit equipment.” These units are listed under UL 924 and contain a power source (usually a battery), a charger, and a load control relay. The unit is connected to normal power, which provides charging current for the battery. When normal power fails, the load control relay energizes the load. When normal power returns, the load is extinguished. For many years, battery packs were the norm for emergency lighting. They are inexpensive, but battery maintenance and the car-headlight look of the unit can be problematic. Case 2 also can use similar unit equipment that uses a recessed emergency luminaire, which is more aesthetically pleasing than a car-headlight battery pack.

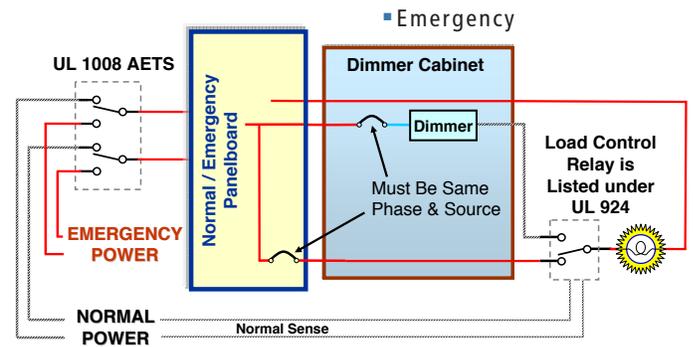
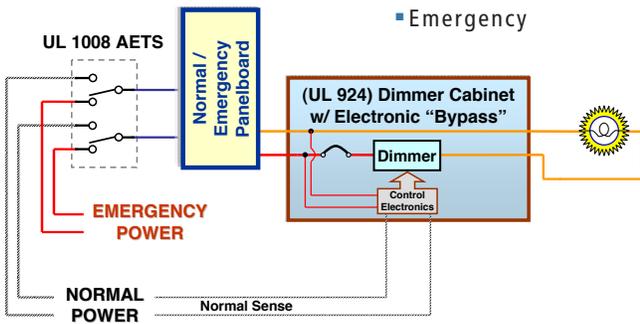
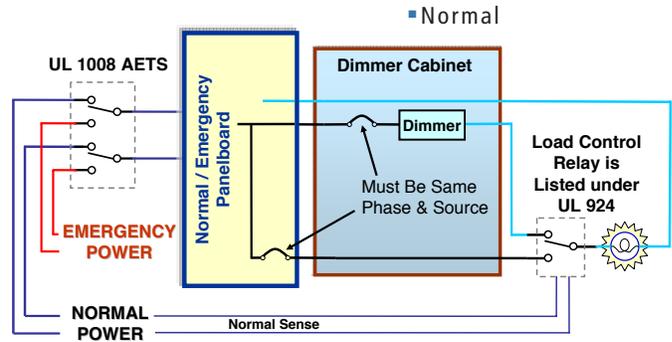
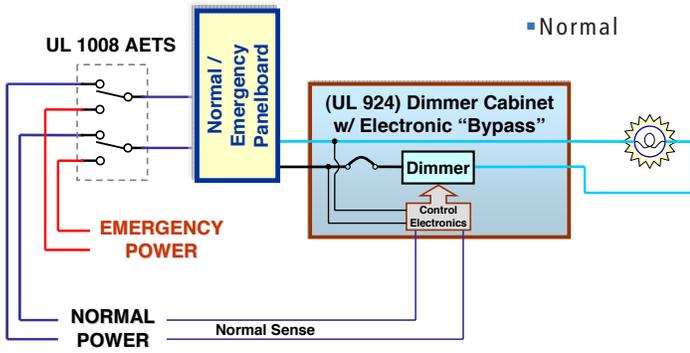
Case 3 introduces the concept of using the same fixture for both normal and emergency use. Normal/emergency lights are fed via a normal/emergency breaker panel and a wall switch, wall-box dimmer, or other wall-box-mounted control device. When normal power fails, an upstream UL 1008 emergency transfer



Case 3—Normal/emergency lights on switches or wall-box dimmers

switch automatically transfers the feeder of the breaker panel to an emergency power source. At the same time, a UL 924 load control relay senses the loss of normal power upstream from the transfer switch and bypasses the switch or dimmer, forcing the load on, no matter what the position of the switch or dimmer. Note that the UL 924 load control relay is not performing a transfer function, but merely a bypass or shunt function. Thus it is only required to switch the hot leg of the branch circuit. Some normal-power control devices, however, do not allow shunting, and thus require a double-throw load control relay to disconnect the load from the normal control device before applying power to the load. While the double-throw construction of the relay can be misleading, this break-before-make bypass is *not* a transfer function. Case 3 always relies on the upstream UL1008 emergency transfer switch for the transfer function.

Case 4 extends the use of the same luminaires for both normal and emergency use, because the fixtures are fed by a dimmer rack or relay cabinet that is listed for emergency use under UL 924, as well as the more conventional UL 508/UL 891 listing. The dimmer rack contains a load control relay, or an electronic bypass method. When normal power fails, the entire feeder to the dimmer rack is transferred to an emergency source by an upstream UL 1008 emergency transfer switch. Controls sensing normal feeder failure upstream from the transfer switch cause the internal load control relays or electronic bypass devices to energize selected circuits by bypassing dimmers, and forcing loads on, no matter what the state of the dimmer control system. Only those loads needed to reach minimum emergency footcandle levels are energized, as allowed by



Case 4—Normal/emergency lights on a UL 924-Listed dimmer rack or relay cabinet

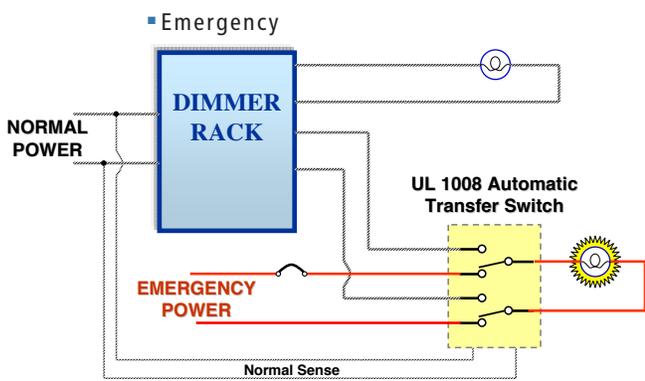
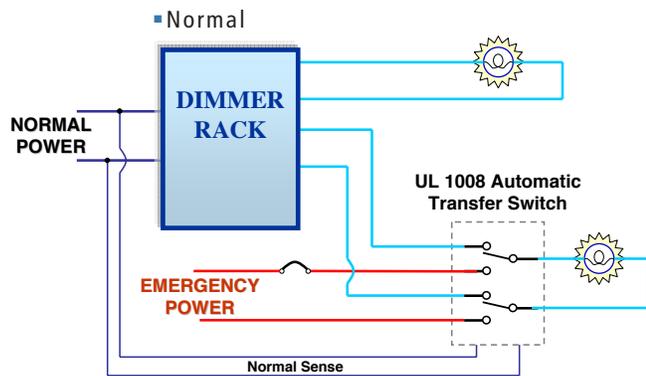
Case 4A—Normal/emergency lights on a dimmer system with an external UL 924 load control relay

NEC section 700.23 (a new section added in 2008). Note that the behavior of other circuits in the dimmer rack needs to be known when using this approach. If non-emergency circuits continue to respond to the control system when the rack is in emergency mode, then the size of the emergency source needs to accommodate these loads as well. A better solution is to use a UL 924 dimmer rack with load-shedding capability. This will insure that non-emergency dimmers are forced into an OFF condition at the same time that emergency dimmers are forced into an ON condition when the rack is in emergency bypass mode. Note that NEC section 700.23 requires all circuits leaving the dimmer cabinet to comply with Article 700 as emergency circuits, i.e., wired separately from all normal-only circuits, whether or not they are energized to get to the required footcandle levels.

Recently, external stand-alone UL 924 load control relays have become available for bypassing circuits in a dimmer rack that does not have a native UL 924 listing. It is this Case 4A that generates the most confusion, because at first glance, the function performed by the relay looks like a transfer (which must be performed by a UL 1008 emergency transfer switch), not a bypass. However, that is not the case, and here is why: In this scenario, the load control relay switches the load between the dimmer output and an external circuit breaker connected to the same phase and power source as the dimmer. The single feeder to the dimmer rack is transferred

by an upstream UL 1008 emergency transfer switch, making one feeder operate as both the normal and emergency source for the dimmer rack. Therefore, the UL 924 Load control relay is providing a bypass rather than transfer function. As in Case 4, the state of the non-emergency circuits in the dimmer rack must be forced to OFF when in emergency mode. If not, the emergency power source must accommodate the full load connected to the rack, not just the emergency bypassed circuits. In practical terms, this gets tricky, because it requires interaction between the emergency system and the dimmer control system. A better solution may be found in Case 5.

Case 5 describes a design widely adopted by the industry. The dimmer rack is fed by normal power only, and shuts down during a normal power failure. For each normal/emergency load, both the neutral and the hot conductor are transferred to a separate emergency source via a UL 1008 branch circuit automatic (emergency) transfer switch (BATS). The switch is designed to insure that it can withstand the available fault current during transfer, and can never interconnect the normal and emergency power sources. In addition, the switch must work safely when the normal and emergency sources are on different phases and not synchronized. Case 5 is useful when a dimmer rack is fed by a very large feeder, but only a small portion of the branch circuits will be



Case 5—Normal/emergency lights on a UL 1008 branch circuit automatic (emergency) transfer switch

used for emergency. The use of the BATS allows those circuits to be selectively transferred to the emergency source without worrying about sizing the emergency source to deal with the full capacity of the dimmer rack feeder. The downside to Case 5 is the size, cost, and complexity of the UL 1008 switch.

What does UL say about emergency circuits, UL 924, and UL 1008?

Recently, a number of manufacturers of UL 924 load control relays have produced products with installation manuals that suggested the relays could be used for Case 5 applications, where the load was transferred rather than bypassed. In the Spring 2005 issue of *The Code Authority* (UL's newsletter on code issues), the article "Focus on Emergency Lighting Equipment" appears on page 3. In the second paragraph, that article states:

"An important issue to recognize is that an LCR does not switch the load between the normal and emergency supplies. Load switching of this type should only be performed by a[n emergency] transfer switch listed in accordance with UL 1008—Standard for Safety for Transfer Switch Equipment.

An LCR has only one power input source, and that is connected to the emergency power supply."

In addition the *UL White Book* clearly differentiates Automatic Transfer Switches for Use in Emergency Systems (product category WPWR), Automatic Transfer Switches for Use in Optional Standby Systems (WPXT), and Automatic Load Control Relays (product category FTBR).

It is also important to note that *NEC 700.6(C)* states two clear requirements: "Automatic transfer switches shall be *electrically operated and mechanically held*. Automatic transfer switches, rated 600 VAC and below, shall be *listed for emergency system use*." (authors' emphasis). Be aware that some products marketed as automatic transfer switches and listed under UL 1008 are for optional standby systems (*NEC Article 702*), not emergency use. These same devices may be also listed under UL 924 as an emergency bypass device. (See the sidebar on page 24 for a further discussion on the difference between an emergency circuit, a legally required standby circuit, and an optional standby circuit.)

What's coming in the 2011 edition of the *NEC*?

Two new sections were proposed and accepted by Code Panel 13 for the 2011 edition of the *NEC*:

700.2 Definition

Relay, Automatic Load Control. A device used to energize switched or normally-off lighting equipment from an emergency supply in the event of loss of the normal supply.

FPN: For requirements covering automatic load control relays, see *ANSI/UL 924, Emergency Lighting and Power Equipment*.

700.24 Automatic Load Control Relay. If an emergency lighting load is automatically energized upon loss of the normal supply, a listed automatic load control relay shall be permitted to energize the load. The load control relay shall not be used as transfer equipment.

How do I choose the right emergency control method for my application?

For each project, the emergency system designer must review the field conditions and examine the pros and cons of each approach to arrive at the most economical but safe system. The first step is usually to determine whether a true Article 700 emergency system is required or whether something less, like an Article 702 optional standby system, is acceptable. If the project includes specifying the primary automatic emergency transfer switch at the service entrance and generator, then UL 1008 equipment is

What are the differences between an Emergency Circuit, a Legally Required Standby Circuit, and an Optional Standby Circuit?

Sometimes it is easy to use the above terms interchangeably, but they are in fact different and the requirements associated with each type of circuit are different. Neither Legally Required nor Optional Standby systems are a true emergency system as defined by the *National Electrical Code*.

The scope of Article 700 of the *NEC*, states in part:

“Emergency systems are those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any governmental agency having jurisdiction. These systems are intended to automatically supply illumination, power, or both, to designated areas and equipment in the event of failure of the normal supply or in the event of accident to elements of a system intended to supply, distribute, and control power and illumination essential for safety to human life.”

The last words—“essential for safety to human life”—are critical. These emergency systems are for protecting people and allowing safe egress from a building, not for allowing business to be conducted as usual. Emergency power and illumination under Article 700 must be available 10 seconds after failure of normal power, and emergency circuits must be physically segregated from all other circuits all the way back to the terminations on the source. Transfer switches must be electrically operated and mechanically held, and have a fault-current rating.

On the other hand, Article 701—Legally Required Standby Systems—is intended to provide lighting and power to areas that would aid rescuers or repair crews. The loads in legally required standby systems, if not powered, could create hazards to people or impede rescuers. Legally required standby power must be available 60 seconds after failure of normal power. Unlike emergency system wiring, circuits for legally required standby systems do not have to be segregated from other general wiring. If legally required standby systems are involved in sharing alternate power with emergency systems, they take second priority to emergency systems.

At the bottom of the priority list Article 702—Optional Standby Systems—is intended to provide for lighting and powering equipment to prevent discomfort or serious damage to a process or product. Optional standby power is not designed to ensure the operation of life-safety systems. The *NEC* states:

“Optional Standby Systems. Those systems intended to supply power to public or private facilities or property where life safety does not depend on the performance of the system. Optional standby systems are intended to supply on-site generated power to selected loads either automatically or manually.”

Optional standby power systems are more or less an insurance policy against business disruption (e.g., HVAC, refrigeration). Wiring for optional standby systems does not have to be segregated from other general wiring.

required and *NFPA 110* will most likely apply. If the project requires a branch circuit emergency transfer switch (BATS), the expense of a UL 1008 emergency transfer switch is still required, but the auxiliary equipment specified in *NFPA 110*, such as generator start-up controls, is not. This auxiliary equipment will be provided by the primary UL 1008 transfer switch at the service entrance. If the project is to turn on an emergency circuit controlled by a wall-box dimmer, a UL 1008 emergency transfer contactor is a bit expensive, while a UL 924 bypass relay is sufficient.

After selecting the proper approach to the project, equipment must be selected that functions together as a system to meet the safety objectives of the project. A UL 1008 automatic emergency transfer switch is designed for the conditions found on feeder circuits. In addition to being safe, it must have sensing circuitry to automatically transfer on failure of the normal source to assure the transfer happens automatically and reliably.

On the other hand, UL 924 equipment covers a broader range of devices and applications, is subject to less rigorous testing, and may be subject to misapplication unless the system designer is careful. Unit equipment, exit luminaires, and recessed emergency luminaires will probably have all the elements required to make a functional emergency system. Other stand-alone UL 924 components may not. For instance, listed UL 924 metering devices are available to sense normal feeder failure, but they will not be of much use if not mated with a suitable power switching device. There are listed UL 924 power switching devices that, if not connected to correctly sense the upstream normal feeder, will turn the emergency illumination on when the branch circuit loses normal power but will turn off again when the generator takes over. How each piece of equipment functions must be researched in order to make the design work as a system. What doesn't work is to haphazardly choose UL 1008 listed equipment or UL 924 listed equipment and assume you have successfully completed the project.

Conclusion

From the above, it can be seen that there are a number of code-compliant methods for energizing emergency lighting circuits.

Whichever method is used, the system must meet the following rules:

- When transferring a load between a normal and emergency power source, either in a feeder or branch circuit application, a listed UL 1008 emergency transfer switch must be used.
- A dimming system with a dual listing under UL 924 and UL 508/UL 891 may be used to energize emergency lights.
- An external UL 924 load control relay may be used to bypass a switch or dimmer to energize emergency lights, but never may be used to transfer emergency lights between a normal and an emergency power source. ■

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Mitch Hefter is the Senior Project Engineer for Philips Lighting Controls. He is a Co-Chair of the ESTA Electrical Power Working Group, and a founding member of the ESTA Technical Standards Program. Mitch is the IES representative to NEC Panel 15.

Steve, Mitch, and Ken are all serving members on the ESTA Technical Standards Committee, ETCP Certified Entertainment Electricians, ETCP Recognized Electrical Trainers, and have been working on the National Electrical Code since 1980. They were jointly recognized with the USITT Founders Award for their work on dimming protocols and the NEC, and are USITT Fellows. And yes, they do claim to have lives outside the above ventures.

UL product standards and categories

Underwriters Laboratories (UL) uses product categories to describe types of equipment and their associated limitations (summarized in Guide Cards) and identified by a Category Code Number. This information is collated into the UL *White Book*, and also appears in other UL publications. More details can be found at UL.com and the *White Book* can be downloaded for free at: <http://www.ul.com/global/eng/pages/offerings/perspectives/regulator/electrical/>. Inspectors refer to the UL *White Book* to aid in determining whether a product is installed appropriately and according to its Listing. While the *White Book* does not contain data regarding specific products, product categories for specific products are found in other UL Publications and online through the UL Certifications page www.ul.com, click on “certifications.”

The UL Standards and product categories related to the main article are:

UL 1008, Transfer Switch Equipment. This standard states the requirements for automatic, non-automatic (manual), and by-pass/isolation transfer switches:

- Automatic transfer switches and by-pass/isolation switches for use in emergency systems in accordance with *National Electrical Code* Articles 517-Health Care Facilities, 700-Emergency Systems, 701-Legally Required Standby Systems, and 702-Optional Standby Systems.
- Transfer switches for use in legally required stand-by systems in accordance with *NEC* Article 701.
- Transfer switches for use in optional stand-by systems in accordance with *NEC* Article 702.

Category WPWR—Automatic Transfer Switches for Use in Emergency Systems. This category covers automatic transfer switches for use in emergency systems in accordance with *NEC* Articles 517 (Health Care Facilities) and 700 (Emergency Systems). These transfer switches are also suitable for use in legally required standby systems and in optional standby systems in accordance with *NEC* Articles 701 and 702.

Category WPXT—Automatic Transfer Switches for Use in Optional Standby Systems. This category covers automatic transfer intended for use in optional standby systems in accordance with *NEC* Article 702 (Optional Standby Systems).

UL 924, Emergency Lighting and Power Equipment. This Standard states the requirements for equipment intended to automatically supply illumination or power or both to critical areas and equipment in the event of failure of the normal supply, in accordance with *NEC* Articles 700 or 701. Examples of such equipment include but are not limited to Exit Signs, Emergency Luminaires, Unit Equipment, and Automatic Load Control Relays.

Category FTBR—Emergency Lighting and Power Equipment. This category covers electrical emergency lighting and power equipment for use in accordance with *ANSI/NFPA 101—Life Safety Code*, and *NEC* Article 700. This includes load control relays when used as a bypass or shunt, not transfer. Note: this standard covers complete systems such as unit equipment and parts of systems such as automatic load control relays.