EMERGENCY LIGHTING AND CONTROL

I. Overview

Emergency lighting control options are rapidly expanding in response to growing needs by design professionals and building owners to save energy and achieve aesthetic and functional design objectives. Yet emergency lighting – part of a building's life safety system – remains highly regulated, making system design and product selection a challenging and often confusing task. The introduction of next generation automatic load control relays designed and listed for use on emergency lighting circuits warrants the attention of designers and owners because of the significant performance benefits offered by these innovative, code-compliant products.

This paper provides background on the many codes governing emergency lighting. It explains why specifiers in some regions are having to allocate more watts per square foot to emergency lighting than they have in the past, making the energy waste of always-on lighting designs a significant operating expense. The paper also discusses a variety of emergency lighting and control options, and the benefits of each, and offers the reader important criteria to consider when evaluating emergency lighting control options.

II. Background on emergency lighting requirements

Emergency lighting is required in all public buildings to facilitate egress and protect life safety. In general, emergency lighting is required to come on automatically within ten seconds after a loss of power and must operate for a minimum of 90 minutes (although designers should consider the size and nature of the building to ensure that this time frame is adequate for orderly evacuation). Emergency lighting requirements include extensive regulations for exit signage, but this article only addresses the associated lighting requirements.

The amount and quality of emergency lighting, in addition to the wiring requirements for emergency circuits, are spelled out by a wide variety of local and national codes, some of which include conflicting information. Exceptions in codes, and specific requirements for different uses and occupancies, further complicate interpreting the codes. A recent trend in some state and local code updates, including those of large metropolitan areas such as Los Angeles and San Francisco, is to change the word "average" to "minimum" in relation to the level of illumination (in most cases, one footcandle) required for egress. Meanwhile, some national codes still only require an average level of illumination. Since final interpretation of the codes is left to the AHJ (authority having jurisdiction), and since approved emergency lighting must be

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in place for a building to receive a certificate of occupancy, designers may be advised to plan for the more stringent requirements.

Key national codes and standards governing aspects of emergency lighting include publications of the National Fire Protection Association (NFPA), Underwriters Laboratories (UL) and the Uniform Building Code (UBC), among others.

See the sidebar for references to specific codes and standards covering emergency lighting requirements.

III. Emergency lighting and control solutions

Wiring for emergency circuits must be kept separate from normal wiring to prevent faults from affecting the operation of emergency systems, and only lighting designated as emergency may be included on an emergency circuit. Because of these requirements, several basic solutions to emergency lighting have become standard practice, but these solutions include aesthetic and operational drawbacks.

Unit equipment, or battery pack lighting, is perhaps the most straightforward solution as power and lighting are self-contained. However, this equipment must be provided in addition to a complete general illumination scheme as the Life Safety Code states that such lights cannot provide the principal lighting of an area. In addition, the units stand out visually, detracting from the design of an otherwise pleasing space. Unit inverters – battery packs, typically installed

Reviewing the Regulations

NFPA 101
The National Fire Protection Agency's Life Safety Code (NFPA 101) specifies illumination requirements for particular areas in buildings with different occupancies that must be immediately available to facilitate egress in the event of an emergency. These requirements are discussed in Article 7.8 "Illumination of Means of Egress," Article 7.9 "Emergency Lighting," and articles dealing with specific occupancies. While egress lighting and emergency lighting do have separate definitions, one set of lighting is typically used to meet the requirements of both definitions.

NEC
NFPA 70, the National Electrical Code, defines what kinds of equipment may be used, and the installation and maintenance practices that must be followed, to meet the illumination requirements of the Life Safety Code. The NEC discusses Emergency Systems in Article 700, and defines them as "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 NEC also defines Legally Required Standby Systems (Article 701) and Optional Standby Systems (Article 702), which are often confused with Emergency Systems, since all are designed for use in the event of power failures, emergencies, natural disasters, fire, terrorist attack, etc. To clarify, Emergency Systems are those essential for safety to life, Legally Required Standby

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Systems are extra systems required for specific types of buildings to provide power to aid in fire fighting, rescue operations, control of health hazards, etc., and Optional Standby Systems are those intended to minimize the disruption to business caused by power failures. The equipment and installation requirements vary for each type of system, but NEC Article 700.5 permits a single alternate power source to provide power for all three systems. However, since priority must be given to power Emergency Systems, separate wiring and equipment is used for each system so that loads can be picked up and shed in the correct order.

Testing requirements
Both NFPA 101 and the NEC require periodic functional testing of emergency lighting equipment.

Building codes
Building codes including the UBC and the IBC as well as state and local codes also define emergency lighting levels and uniformity requirements, installation parameters and testing and recordkeeping requirements.

UL
Underwriters Laboratories tests and approves the components of emergency systems to be safe for a specific use. Two distinct listing categories apply to emergency lighting and power control equipment: UL 1008 and UL 924. UL 1008, Automatic Transfer Switches for Use in Emergency Systems, applies to the switching gear that transfers the power feed for the emergency circuits from the normal source to the emergency source and back. UL 924, Standard for Safety for Emergency Lighting and Power Equipment, applies to most of the components downstream of the transfer switch. All components of an emergency circuit must be appropriately designed and listed.

in fluorescent fixtures – offer a more aesthetic solution, but require significant maintenance.

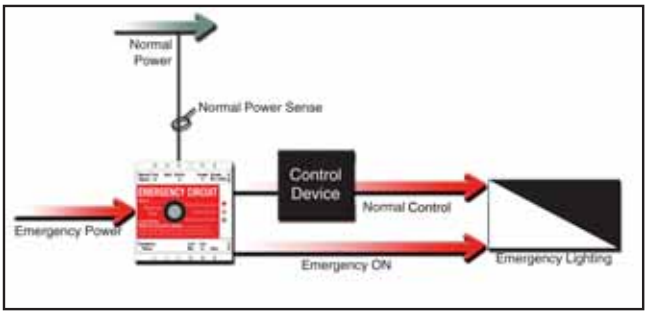
If a central auxiliary power system will be available, many engineers prefer to lay out a general lighting design that is fed from two sources. Most of the lighting is fed from normal electrical panels, while selected fixtures – those located to provide the required levels of egress lighting – are fed by separate emergency circuits. To address code sections that require egress lighting to be on when the space is occupied and that limit switching options on emergency circuits, the emergency lighting is usually designed to be always-on, burning 24 hours a day. The obvious drawbacks to this approach are wasted power and the inflexibility of control, especially in spaces requiring lighting to be switched off or dimmed for presentations or other activities.

Control options

For facilities with complex lighting control requirements such as theaters, all of the lighting may be powered from a normal lighting panel and controlled as a single system during normal building operation. To meet code requirements, selected branch circuits must be automatically switched to an emergency power source during the loss of normal power. UL 1008-listed emergency transfer equipment installed on the circuits designated as normal/emergency will appropriately switch them between power sources. This transfer function, which

involves switching both the hot and neutral conductors, is complex. Transfer switches must be designed to withstand available fault currents and provide specific switching delays to prevent the normal and emergency power sources from being interconnected. Such transfer equipment is expensive for use on branch circuits.

Another option for some locations is to install separate normal and emergency lighting circuits with parallel controls on each. However, the controls on the emergency side must be automatically bypassed if power is lost to ensure that emergency lighting comes on as required. This can often be accomplished using a UL 924-listed automatic load control relay (ALCR) to shunt power around the control device when normal power fails.



An ALCR can shunt power around a control device when normal power fails.

Unlike the UL 1008 transfer options previously discussed, the ALCR does not switch between normal and emergency power – a critical distinction. The UL 924 ALCR monitors normal power and switches the hot conductor of the emergency line around the control device when needed. In the case of dimmers this is often the best solution, as the ALCR is considerably less expensive than a transfer switch. For applications using non-dimming controls there are several drawbacks, beginning with the undesirable choice of installing controls on the emergency circuit. This approach requires not only the installation of the shunt (or bypass) device, but also a separate set of controls, which increases the cost and the complexity of the project.

When switching controls are being used, a better solution is to only install controls on the normal lighting circuits and employ a UL 924-listed automatic load control relay so that it causes the emergency lighting to follow the state of the normal lighting except in the case of a power loss. Many newer generation UL 924 ALCRs have the ability to receive a switching signal from the line after the control device in addition to sensing the normal power line before the device, and are appropriate for this kind of application.

In this scenario, when normal power is present at the control device, the ALCR

As Defined by UL924 Standard

AUTOMATIC LOAD CONTROL RELAY – A device intended to energize, to appropriate power or illumination levels, switched or normally off emergency circuits from an emergency supply in the event of failure of the normal supply, and to de-energize the emergency circuits when the normal supply is restored.

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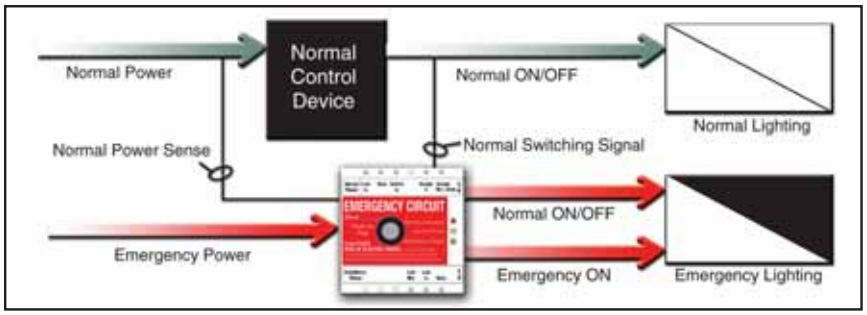
switches the emergency lights that it is feeding on or off in parallel with the control device. However, when normal power to the control device is lost for any reason, the ALCR forces the emergency lights on regardless of the on/off status of the control device. This allows building owners and designers to leverage the utility of their normal control devices, such as time-controlled relays and occupancy sensors, while complying with code requirements for emergency lighting circuits. By sensing normal power at the branch circuit level, this solution also ensures that emergency lighting comes on in response to all power failures, whether local or building-wide.

Energy savings

In the past, the power consumption of always-on emergency lighting was considered negligible. This attitude is changing as emergency lighting is making up a higher percentage of a building's lighting load. Most current codes allow the lighting in an office building to consume 1.2 watts per square foot. Newer codes will reduce this allowance to .9 watts per square foot. Additionally, interpretations of, and changes to, emergency lighting codes requiring minimum (not average) illumination levels mean that emergency lighting may require more watts per square foot.



A next generation ALCR controls emergency lighting in tandem with normal lighting unless power fails.

IV. Benefits of controlling emergency lighting

As previously illustrated, in many cases emergency lighting can easily be controlled in tandem with normal lighting using automatic load control relays, and there are several reasons to do so.

Most engineers use about .25 watts per square foot for emergency lighting, though in some cases they may be able to use as little as .15. This means that emergency lighting currently consumes about 12 to 21 percent of an average building's lighting load. When the newer codes take effect, this percentage will increase. Over half of this power usage can be eliminated simply by turning these lights off along with normal lighting, after hours

and on weekends. Even greater savings may be achieved with occupancy-based controls.

Control flexibility

In many areas of a building there are good reasons to want full control of all the lighting during normal operations. This simply could be for design considerations, or it could be for any variety of practical reasons. Occupants of conference rooms, classrooms or lecture halls might want to turn off all the general lighting for an AV presentation, movie or lecture. Spaces with sufficient daylighting may not benefit from always-on lighting in aisle ways. Codes are also beginning to provide wattage allowances as incentives for turning emergency lights off at certain times.

Similarly, there are compelling reasons to want the ability to turn emergency lighting on even when the power does not fail. Building owners and managers might benefit from having emergency lighting activated by a security or fire alarm system to provide an added measure of safety during any kind of incident. They also need to be able to easily turn on emergency lighting for code-required testing and may want to use the lighting for emergency preparedness drills.

V. Best practices for controlling emergency lighting

Emergency lighting can be safely, reliably and economically controlled to save energy and meet design requirements and code restrictions by following these guidelines:

1. Avoid installing normal controls on the emergency circuit whenever possible. Instead, use a device that will switch emergency lighting in tandem with normal lighting and automatically switch emergency lighting on when power is lost.
2. When you must install a control device (such as a dimmer) on an emergency circuit, be certain that the device will be completely bypassed in case of a power loss.
3. Use only those products specifically designed and UL-listed for use on emergency circuits for these applications. While unlisted components could be installed to function similarly to an approved transfer switch or ALCR, the lack of a proper listing carries numerous risks for designers and building owners. Inspectors may balk at signing off a project using unlabeled devices. Because the components may not have been subjected to rigorous testing, they could fail in a critical situation. Additionally, insurance adjusters could cite the presence of unlisted equipment as a reason to delay or reduce claims related to emergency losses.
4. Monitor the normal power on the branch circuit close to the actual load, not just at a main power feed. By doing this, the system will respond to local faults and failures, providing maximum utility and addressing code requirements relating to branch circuits.
5. Review technical specifications. In

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addition to a proper UL listing, devices specified for emergency circuits should be designed and constructed to minimize failures and still offer protection in case of malfunction. When selecting equipment, avoid devices using fusing which is prone to failure. Select devices using zero cross switching technology to extend relay life. Understand that normally closed relays are used in emergency controls so that if they do fail, they will fail with the emergency lights on.

6. To protect maintenance personnel, select devices with clear visual indicators showing the presence of emergency and normal power. In the same vein, ensure that all equipment on an emergency circuit carries proper warning labels.
7. Consider testing requirements when designing emergency circuits. Codes require that emergency systems be tested periodically (usually every 30 days, with longer intervals for extended testing) and that records be kept for inspection by the AHJ. Specified products should offer convenient test options. Remote switches may be desirable if the devices will be inconveniently located.

VI. Summary

In response to a growing need to save energy and provide optimal lighting control, designers are turning to UL 924-listed ALCRs to control emergency lighting circuits. ALCRs are intended to ensure that required emergency lighting comes on when needed, while being controlled at other times, usually in tandem with normal devices such as relays or occupancy sensors. The ALCR (and its load) is fed from one of the building's emergency power branch circuits and will always have power available to it. It is not a transfer switch and does not switch between normal and emergency power. Rather, it senses the normal power line and energizes its load whenever needed, providing monitoring at the branch circuit level to ensure proper operation during local or building-wide power failures.

VII. Additional references

For more information about emergency lighting and control, please consult the following sources:

NFPA 101 Life Safety Code

NFPA 70 National Electrical Code

NFPA 110 Standard for Emergency and Standby Power Systems

IESNA Lighting Handbook

Emergency Lighting Section, NEMA, NEMA Guide to Emergency Lighting

Building codes applicable to your area UL, OSHA, ADA and ANSI

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