



# **New Developments in Emergency Lighting Control**

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**Mitch Hefter**  
Senior Systems Engineer, Signify



Mitch Hefter has been working in lighting controls for over 40 years. He has played a major role in setting entertainment technology standards, promoting electrical safety and developing certification for entertainment industry electricians. He was instrumental in the development of DMX512. Mitch is a founding member of the Entertainment Services and Technology Association Technical Standards Program (ANSI E1) and co-chairs the Electrical Power Working Group. He has worked on updates to the National Electrical Code since 1981, representing the Illuminating Engineering Society on Code Panel 15 since 1997. He is a co-vice-chair of the IES Lighting Controls Committee and works on several IES task groups. A senior systems engineer at Signify, Hefter is also a Fellow of the U.S. Institute for Theatre Technology, a recipient of the USITT Founders Award in 1993, and was awarded Honorary Lifetime Membership in 2014.

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**Steve Terry**  
Director of Standards and Industry Relations, ETC



Steve is currently the Director of Standards & Industry Relations at ETC. From 2004-2017, he was the Vice President of Research & Development at ETC, where he led the group that is responsible for global development of new products. He was appointed a member of National Electrical Code Panel 15 in 1994, and has served as the USITT representative to Code Panel 15 ever since. He is a member of many UL Standards Technical Panels including those for UL924—Emergency Lighting and Power Equipment, UL1008—Transfer Equipment, and UL8750—LED Equipment for Use in Lighting Products. He has been directly involved in many changes to NEC article 700—Emergency Systems—that have been critical to the changes in emergency control systems required by the move to LED emergency luminaires. He chaired the USITT Committee that wrote the internationally-accepted DMX512 standard for digital communications in lighting systems in 1986. He was inducted as a Fellow of the USITT in 2006.

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.



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## Learning Objectives

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At the end of this course, participants will be able to:

1. Learn and understand changes in emergency lighting requirements in the 2020 NEC and UL standards, including their impact on Power over Ethernet (PoE) systems.
2. Understand the difference between Bypass and Transfer methods of control and where each is appropriate.
3. Understand what qualifies a luminaire as a Directly Controlled Emergency Luminaire and where they are used in an emergency lighting system
4. Understand the landscape of available classes of Emergency Lighting Control devices and where each is appropriate.



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## Overview - Emergency Systems

- Emergency systems maintain a specific degree of illumination or provide power for essential equipment for ensuring the safety of human life if the normal power supply fails.
- These are Life Safety systems - you cannot simply address the economics or commercial concerns - the methods applied involves people's lives; some applications may require a more expensive approach.

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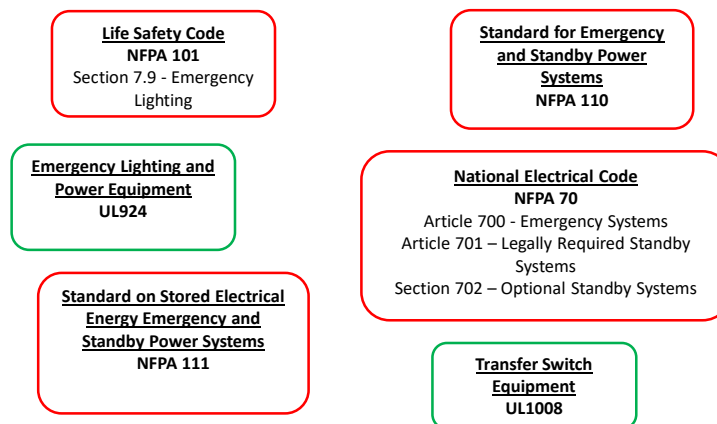
## Overview - Emergency Systems

- Advancements in control technology and energy management have made compliance with the National Electrical Code®, Article 700, Emergency, more complex, with more design choices.
- “It’s [UL] Listed” does not mean “It’s the right application.”
- Significant changes in emergency systems have been driven by:
  - Aesthetic design requirements to use the *same* luminaires for normal and emergency illumination
  - Lower “power cost of foot candles” caused by LED’s

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## The Constellation of Emergency Lighting Standards



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## NEC® Article 700 – Emergency Systems

- NEC® sections 700.1 and 700.2 make it clear that emergency systems are to automatically provide power and illumination, therefore switching or control in lighting circuits must be automatically forced on in order to comply.

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## Legally Required & Optional Standby

- Standby Systems are NOT Emergency Systems as defined by the NEC® and are not designed to ensure life safety via safe egress.
  - Article 701 is for Legally Required Standby Systems
    - Article 701 provides for lighting and power to areas for first responders or repair crews
    - Up to 60 second power up vs. 10 seconds required for Emergency
  - Article 702 is for Optional Standby Systems
    - Article 702 provides for lighting and power to prevent discomfort or serious damage to a process or product

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## UL 1008 vs UL 924

- **UL 1008** covers the requirements for automatic, non-automatic (manual), and by-pass/isolation transfer switches intended to provide for lighting and power for use in:
  - Emergency systems in accordance with NEC® Articles 517 - Health Care Facilities & 700 - Emergency Systems
  - Branch Circuit Emergency Lighting Transfer Switches (BCELTS)
  - Transfer switches for use in NEC® Article 701 - Legally Required Standby Systems
  - Transfer switches for use in optional standby systems in accordance with NEC® Article 702

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## UL 1008 vs UL 924

- **UL 924** covers the requirements for emergency lighting and power 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
    - Exit Signs
    - Emergency Luminaires and Unit Equipment
    - Automatic Load Control Relays
    - Directly Controlled Luminaires and associated “bypass” equipment
    - Dimmer or relay systems used under 700.23

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## New Control Concepts in UL 924 for 2018

- 4.18.1 EMERGENCY LIGHTING CONTROL DEVICE (ELCD) – A separate or integral device intended to perform one or more EMERGENCY LIGHTING CONTROL FUNCTIONS. Upon loss of normal power, an ELCD defaults to a position that does not disrupt the flow of emergency power to any controlled emergency load.
- Purposely generic to cover equipment that has “not been thought of yet” — UL 924 is now an evolving standard.

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## More New Control Concepts in UL 924 for 2018

- 4.18.2 EMERGENCY LIGHTING CONTROL FUNCTION (ELCF) – An activity related to the performance of an emergency lighting system, including but not necessarily limited to one or more of the following:
  - a) Sensing normal power status and transmitting a normal power status signal to a separate or integral device;
  - b) Interpreting a normal power status signal (receiving and translating to some other type of signal);
  - c) Controlling the lighting output level (e.g., changing “off” to “on”; “dim” to “full”);
  - d) Distributing emergency power or control signals among connected devices;
  - e) Simulating a loss of normal power (for manual testing or self-test/self-diagnostic purposes).

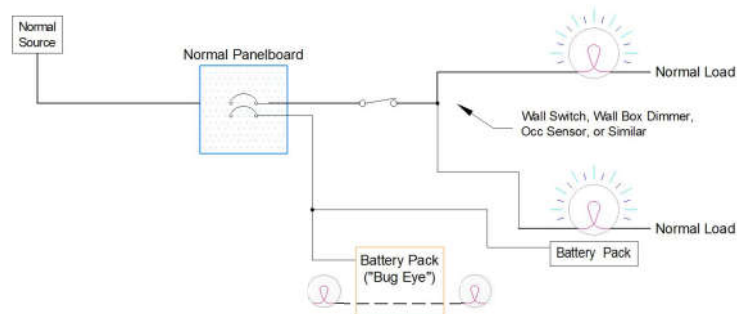
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## Independent System w/ integral power source (Unit Equipment)

- Advantage – simplicity.
- Disadvantages – aesthetics.

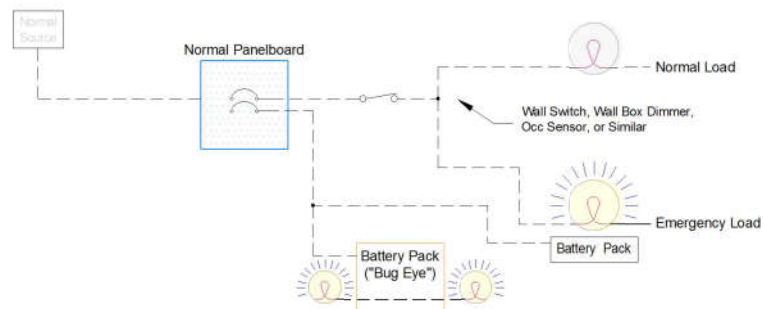


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## New in the 2011 NEC® - Revised in 2014

- **700.2 Definition**

**Relay, Automatic Load Control.** A device used to set normally dimmed or normally-off switched emergency lighting equipment to full power illumination levels in the event of a loss of the normal supply by bypassing the dimming/switching controls, and to return the emergency lighting equipment to normal status when the device senses the normal supply has been restored.

Informational Note: See ANSI/UL 924, Emergency Lighting and Power Equipment, for the requirements covering automatic load control relays.

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## New in the 2011 NEC®

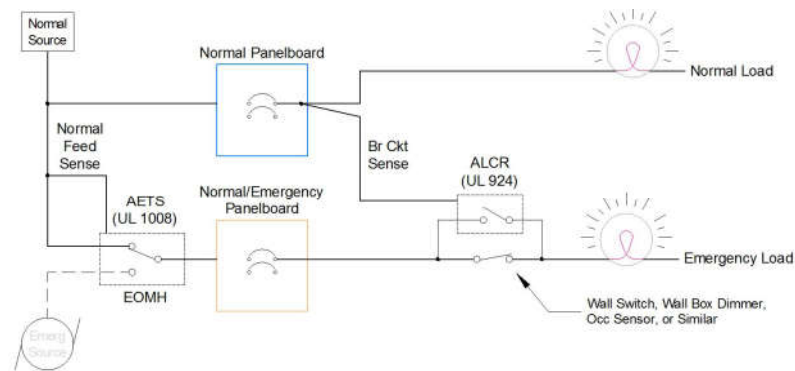
- **700.24 Automatic Load Control Relay.** If an emergency lighting load is automatically energized upon loss of the normal supply, a listed automatic load control relay shall be permitted to energize the load. The load control relay shall not be used as transfer equipment.
- Section **700.25** in the 2014 Edition.
- Section **700.26** in the 2017, 2020 Editions.

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## Bypass for Wall Switch or Wallbox Dimmer

- Advantage – simplicity.
- Disadvantages – does not work for Relay and Dimmer Systems (\*panel).

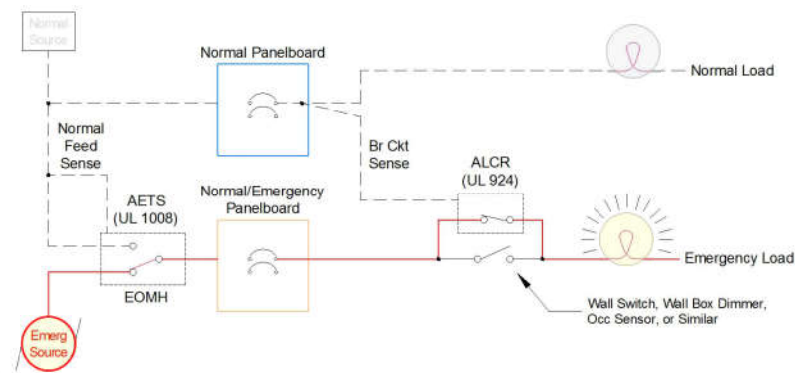


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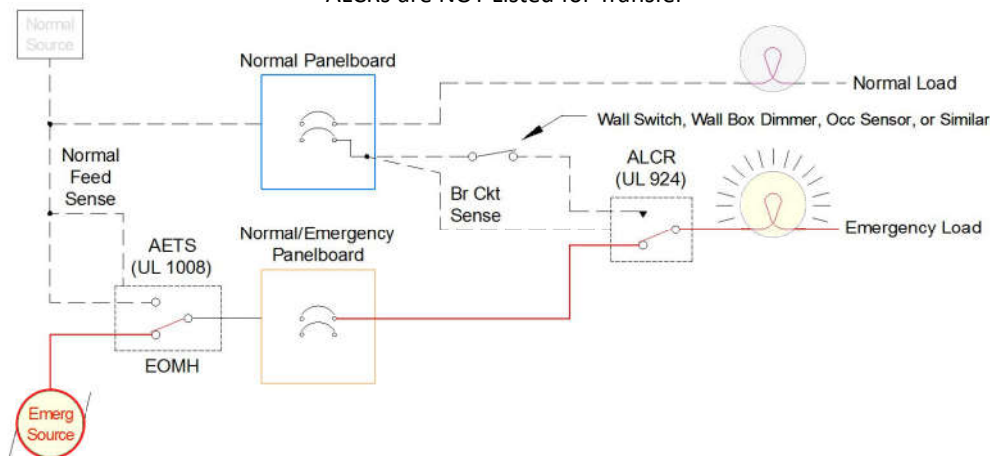
## Problem

- A number UL 924 Automatic Load Control Relay data sheets and installation instructions suggest the relays could be used for load transfer rather than bypass.
- Some of these devices are also Listed as transfer switches under UL 1008, but for use in Optional Standby Systems, NOT Emergency.
- This contributes to ongoing confusion concerning the proper application of these devices – the UL 924 Automatic Load Control Relay may be misapplied as an Automatic Emergency Transfer Switch in a branch circuit.

## UL 924 used as Transfer

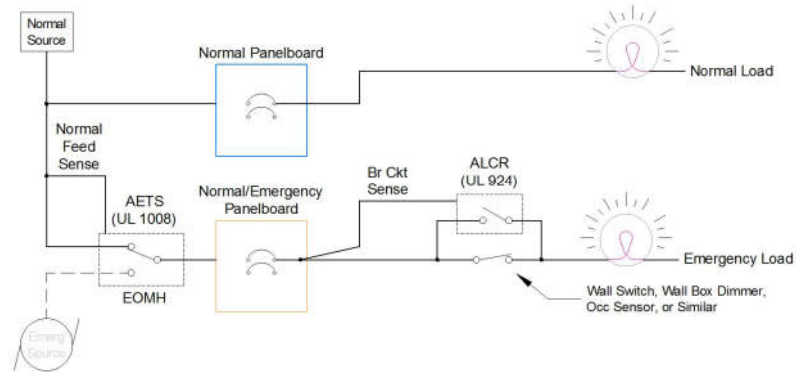
### **VIOLATION**

ALCRs are NOT Listed for Transfer



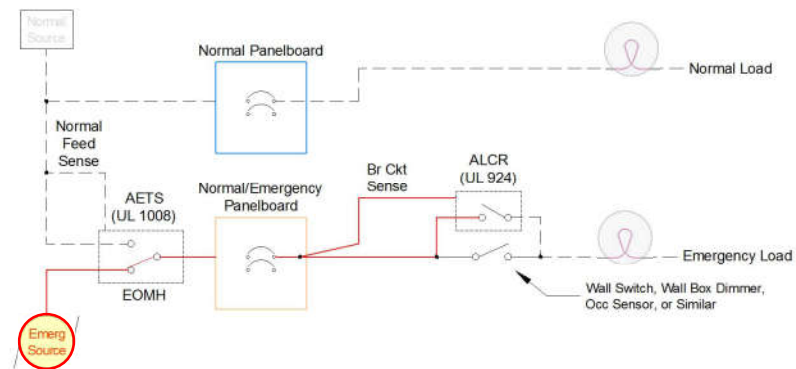
## UL 924 Bypass Wiring—Common Error

- Sensing must be from the normal source, but may seem counterintuitive because the sensing is to activate the emergency function



## UL 924 Bypass Wiring—Common Error

- UNSAFE
- Sensing Normal/Emergency Power instead of Normal; control is not bypassed;





## Activity to Address Misapplication

- UL STP Task Group adds UL 1008 BCELTS
  - A new class of device within the scope of UL 1008 – Branch Circuit Emergency Lighting Transfer Switch (BCELTS); these devices retain the same basic functionality as a traditional transfer switch with somewhat less prescriptive spacing requirements and no mechanical hold provisions of UL 1008 / NEC® 700.5(C).
  - Added to UL 1008 in 2015.
  - Only for Lighting Circuits – not power.
  - Added to the 2017 NEC®.

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## Internal Dimmer or Relay Electronic Bypass

- Advantage – can use dimmer or relay cabinet Listed for Emergency under UL 924 under provisions of NEC® section 700.23. Relay cabinets specifically were added in 2014.
- Disadvantage – the requirement for all circuits to be installed per Article 700, determining the emergency feeder capacity along with meeting selective coordination requirements, and concerns regarding the complexity of the equipment and comfort level of the engineer or inspector with this approach.

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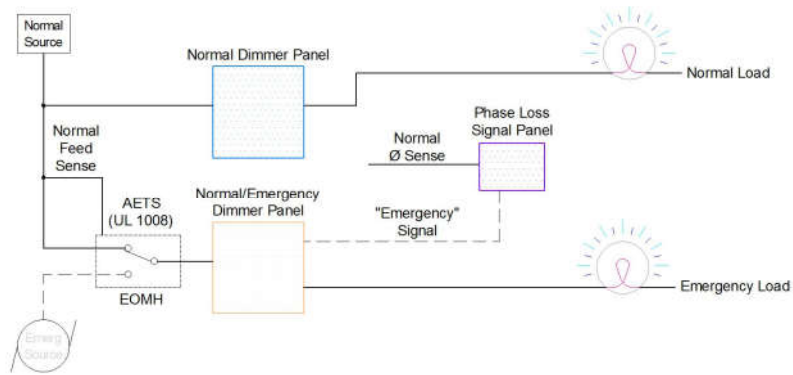
## New language in 2020 NEC®

- **700.23 Dimmer and Relay Systems.** A dimmer or relay system containing more than one dimmer or relay and listed for use in emergency systems shall be permitted to be used as a control device for energizing emergency lighting circuits. Upon failure of normal power, the dimmer or relay system shall be permitted to selectively energize only those branch circuits required to provide minimum emergency illumination using a control bypass function. Where the dimmer or relay system is fed by a normal/emergency source from an upstream transfer switch, normal power sensing for this function shall be permitted to be from a normal-only power source upstream of the transfer switch. All branch circuits supplied by the dimmer or relay system cabinet shall comply with the wiring methods of Article 700.

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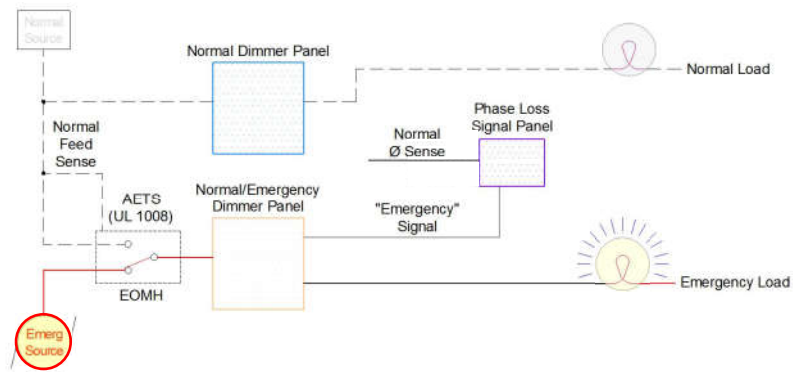
## Internal Dimmer or Relay Electronic Bypass



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## Internal Dimmer or Relay Electronic Bypass



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## New in the 2017 NEC®

- Definition (700.2)
  - **Branch Circuit Emergency Lighting Transfer Switch (BCELT)**. A device connected on the load side of a branch circuit protective device that transfers only emergency lighting loads from the normal utility supply to a continuously available synchronous or asynchronous emergency supply.

Informational Note: See ANSI/UL 1008 Transfer Switch Equipment for the requirements covering branch circuit emergency lighting transfer switches.

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## New in the 2017 NEC®

- **700.25 Branch Circuit Emergency Lighting Transfer Switch (BCELT)**. Emergency lighting loads fed by branch circuits rated at not greater than 20A shall be permitted to be transferred from the normal branch circuit to an emergency branch circuit using a listed branch circuit emergency lighting transfer switch. The mechanically held requirement of section 700.5(C) shall not apply to listed branch circuit emergency lighting transfer switches.

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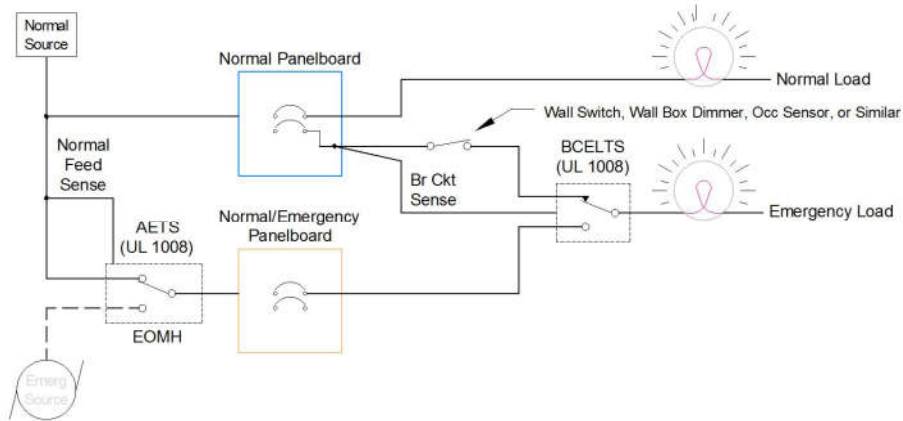
## New in the 2017 NEC®

- Branch Circuit Emergency Lighting Transfer Switch (BCELTS).
  - BCELTS is potentially more cost effective due to the removal of the mechanical hold requirement, yet it still meets all the stringent UL1008 requirements for fault current, endurance, and source interconnection prevention.

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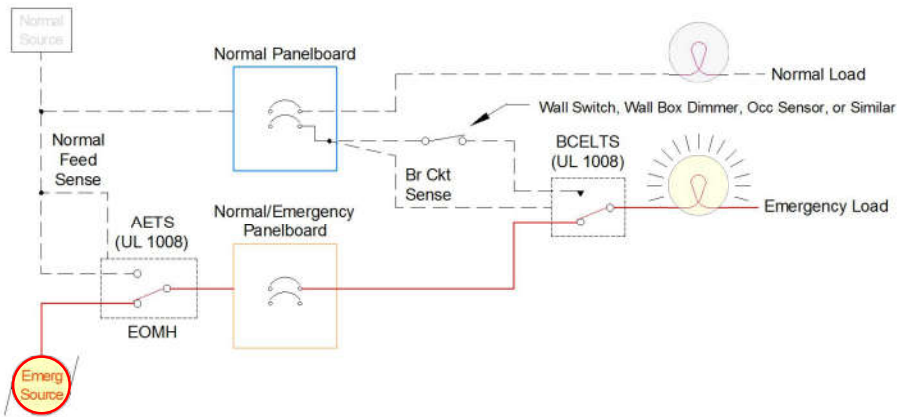
### Branch Circuit Emergency Lighting Transfer Switch (BCELTS).



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### Branch Circuit Emergency Lighting Transfer Switch (BCELTS).



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## Where is a BCELTS more useful than an ALCR?

- Since many systems use an upstream ATS, why use another transfer switch on a branch circuit?
- Where a controlled dimmer or relay panel contains only a few emergency lighting circuits, it can be useful to transfer them to an emergency panel in order to resolve issues of reduced-size emergency feeders and load shedding.

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## New in the 2014 NEC® - Enhanced in 2020

- **700.24 Directly Controlled Luminaires.** Where emergency illumination is provided by one or more directly controlled emergency luminaires that respond to an external control input, or loss thereof, to bypass normal control upon loss of normal power, such luminaires and external bypass controls shall be individually listed for use in emergency systems.
- 2017 Edition added a definition, refined in 2020:
- **Emergency Luminaire, Directly Controlled.** An emergency luminaire that has a control input for an integral dimming or switching function that drives the luminaire to ~~full~~ the required illumination level upon loss of normal power.

Informational Note: See ANSI/UL924, Emergency Lighting and Power Equipment for information covering directly controlled luminaires.

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## 2020 NEC® Handbook Commentary on 700.24

Directly controlled emergency luminaires are those containing any type of control input that is used in setting the luminaire to the required emergency illumination level when normal power fails and emergency power is present. This control input can be as simple as built-in sensing of normal power. It can also be an analog control input such as 0-10V, or a more complex digital input. Some types of directly controlled emergency luminaires force their output to full brightness by disconnection of the control input from the normal control system using an automatic load control relay or other listed bypass device. Other types rely on an active signal from an emergency control system to set the required illumination level.

Section 700.24 recognizes that input or loss of input qualify as direct control of the emergency luminaires. Required listing for use in emergency systems of directly controlled emergency luminaires and controlling devices provides evaluation for predictable operation and reliability under the wide variety of conditions that may be present at failure of normal power.

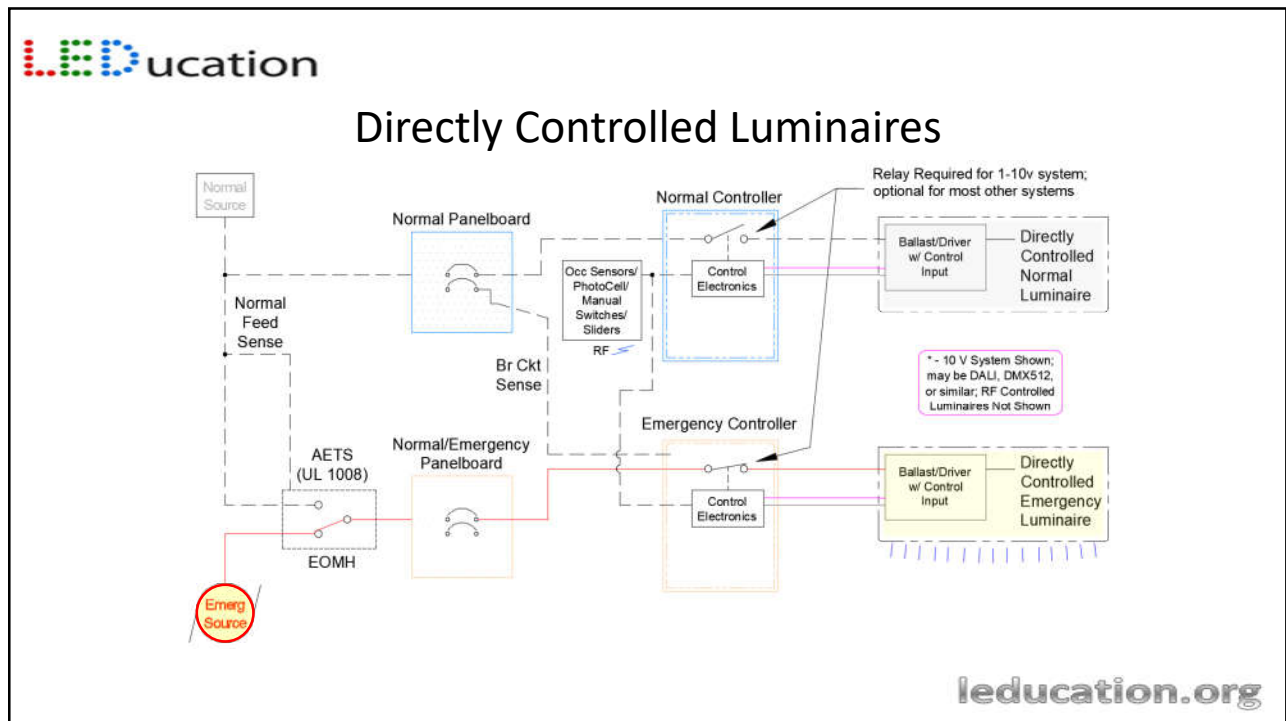
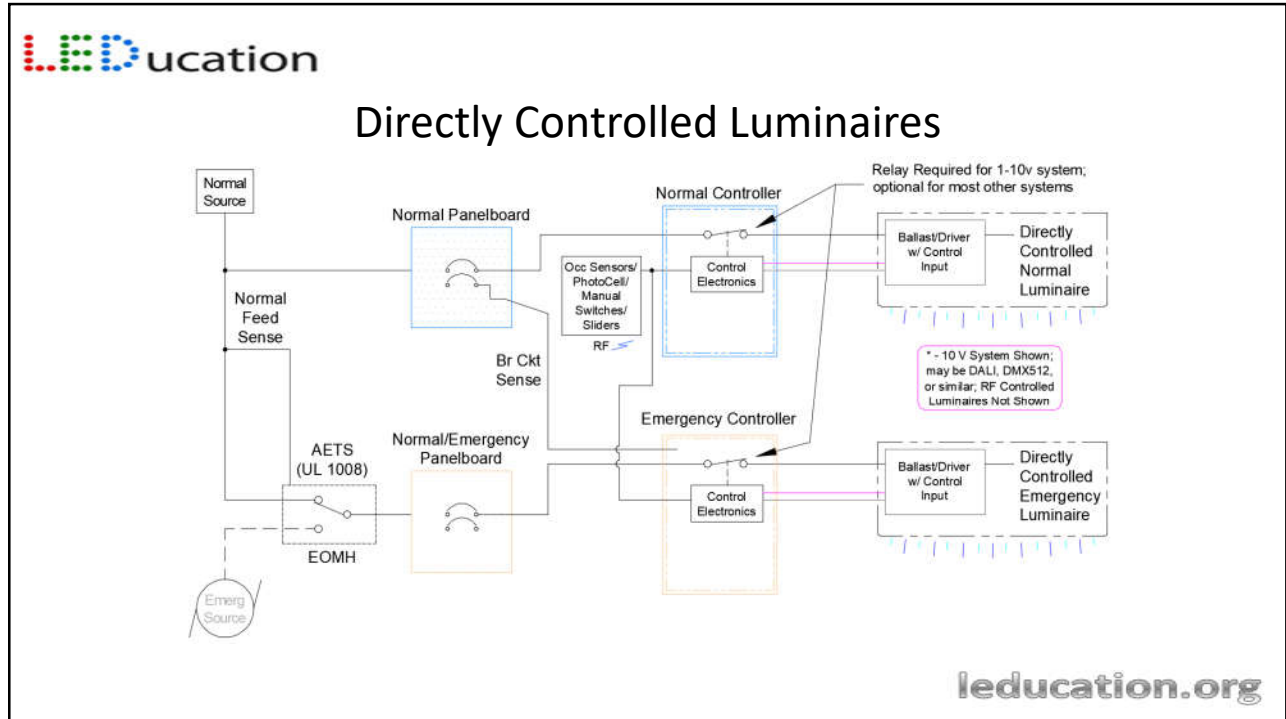
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## Directly Controlled Luminaire Examples

- 1-10V (0-10V)
- DALI
- DMX512
- ZigBee
- Ethernet
  - Including Power Over Ethernet (PoE)
- 3 approaches:
  - Loss of signal
  - External input (can be a normal power sense—a “built-in ALCR”)
  - Override commands on control input

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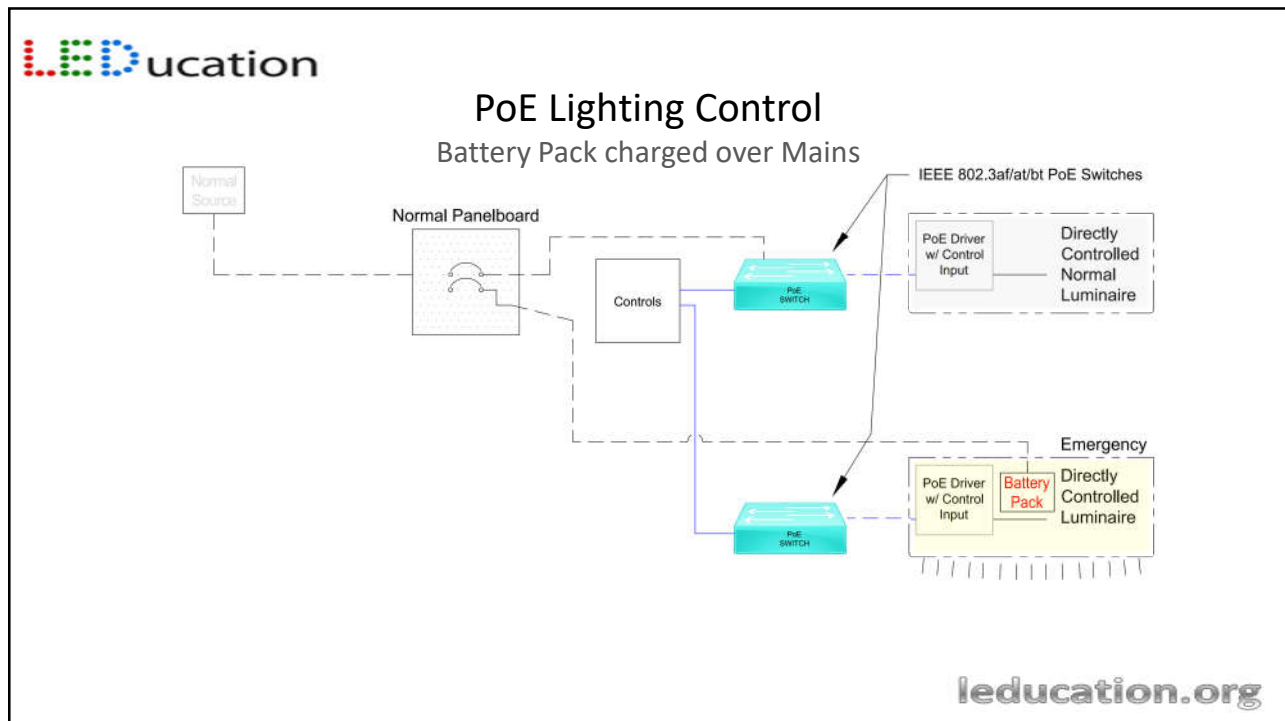
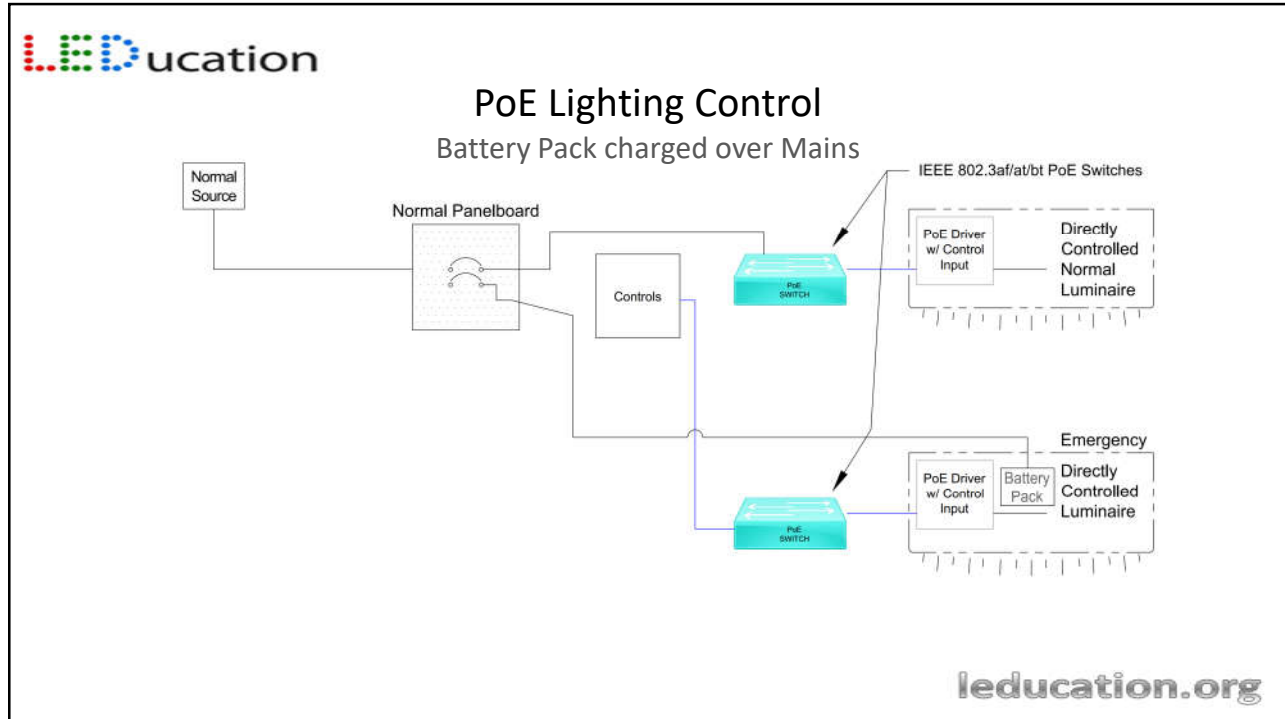




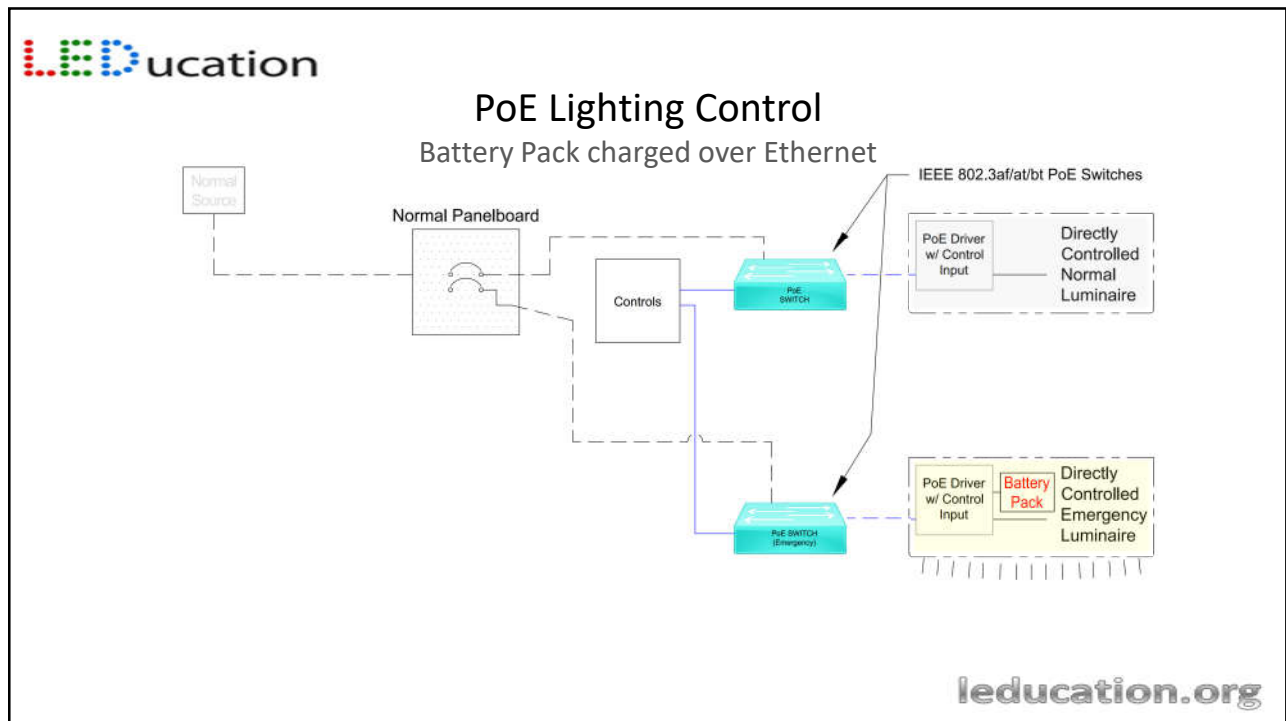
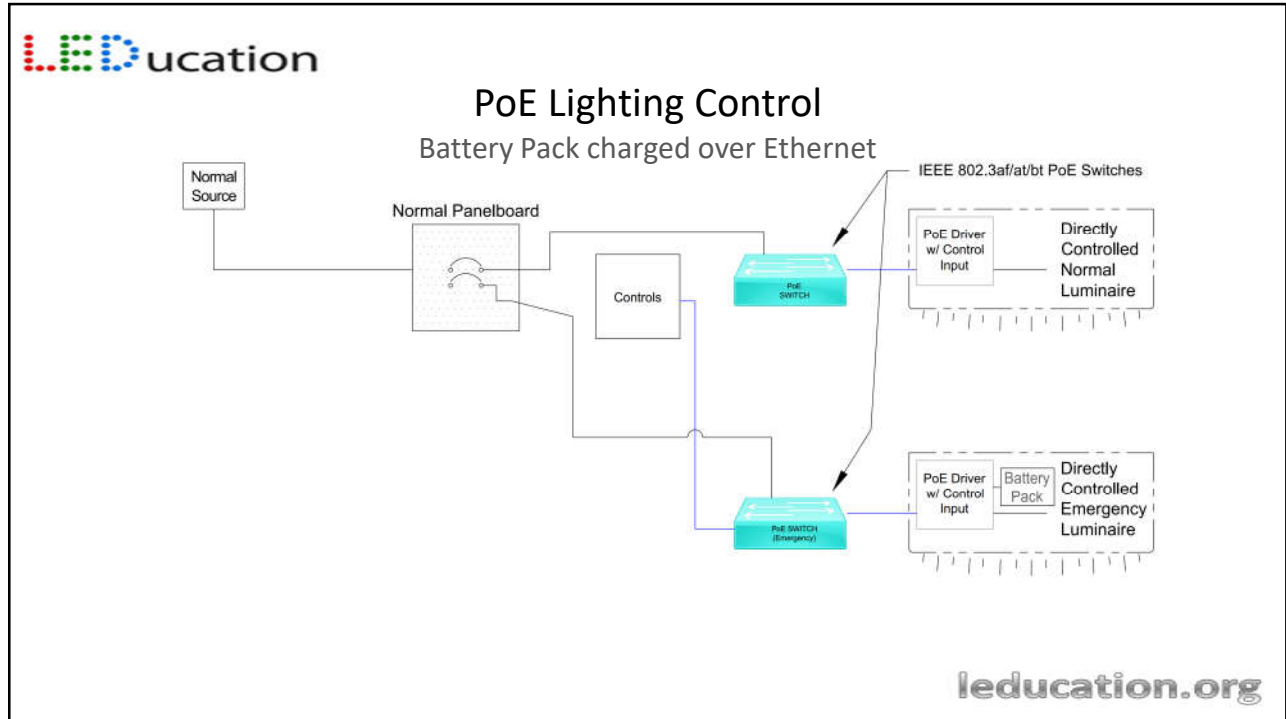
## Power Over Ethernet (PoE) Lighting

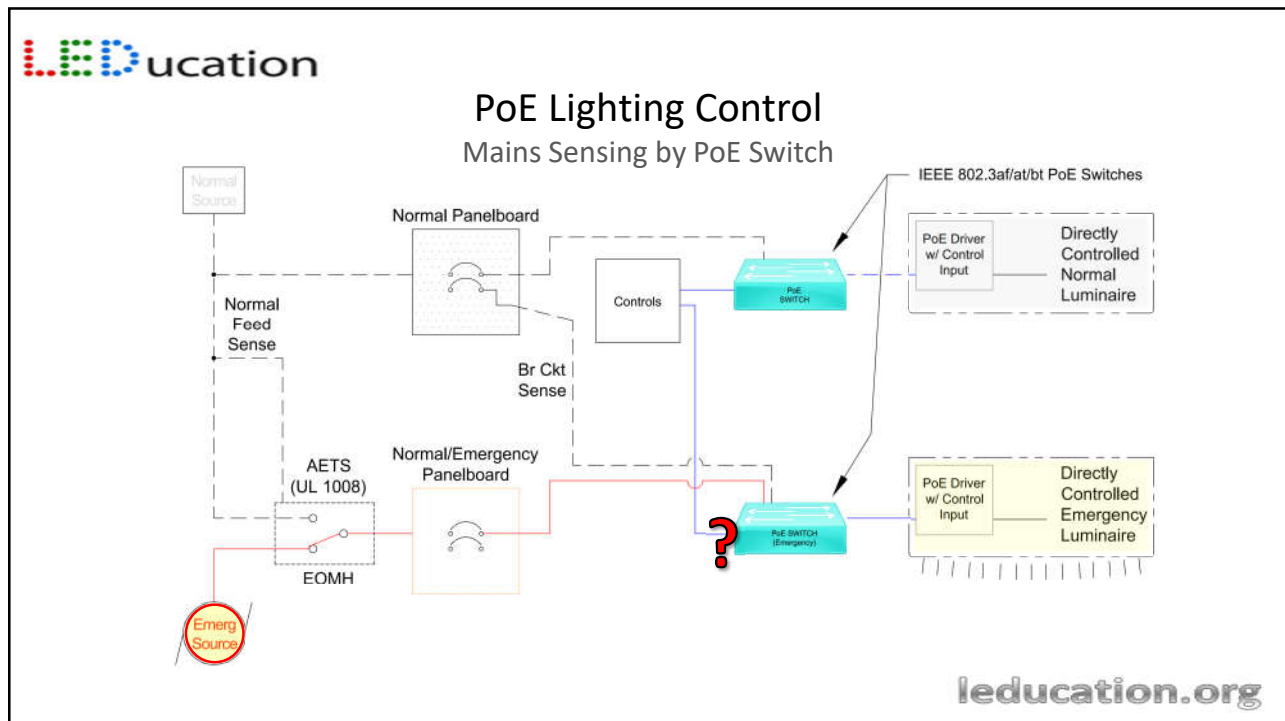
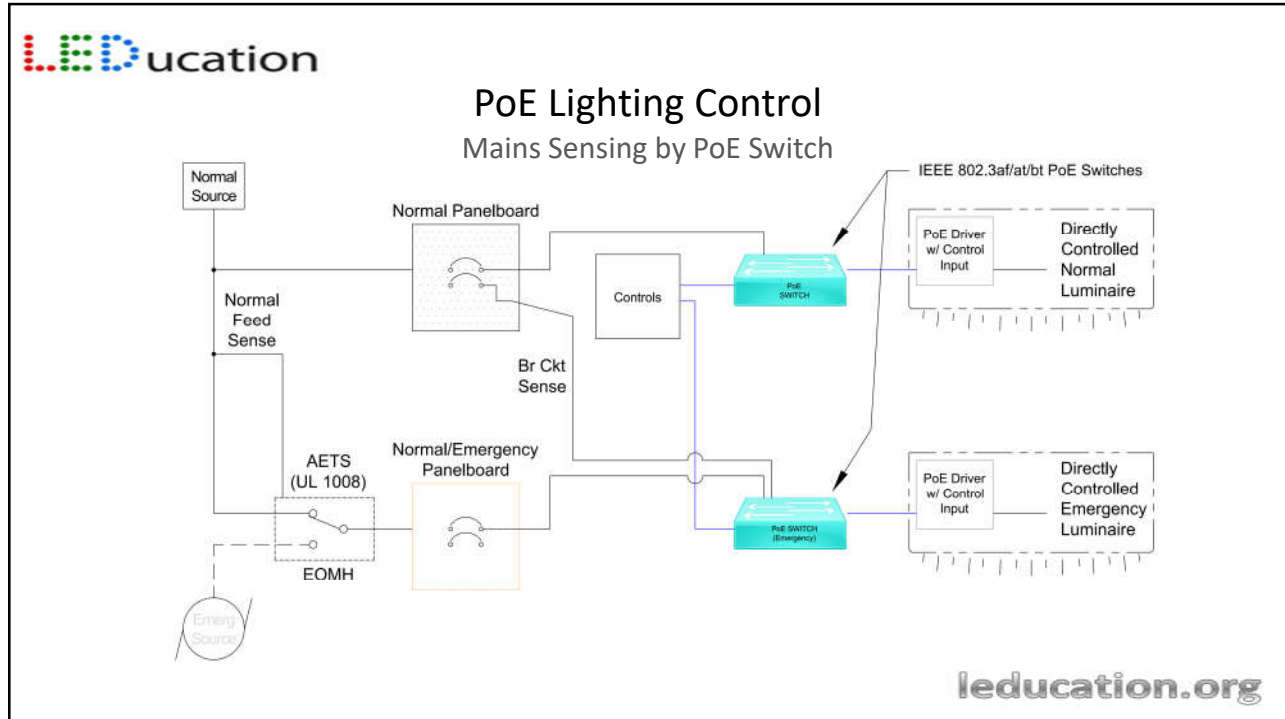
- PoE defines a way to add power onto the same cable providing Ethernet communications.
- 3 Generations
  - 802.3af – up to 15W (13W)
  - 802.3at – up to 30W (25.5W)
  - 802.3bt – up to 90 W (71.3W)
- 802.3at (PoE+) and 802.3bt, plus Cisco's proprietary UPOE (up to ~60W) have allowed development of PoE lighting.
- PoE Luminaires are Directly Controlled Luminaires.

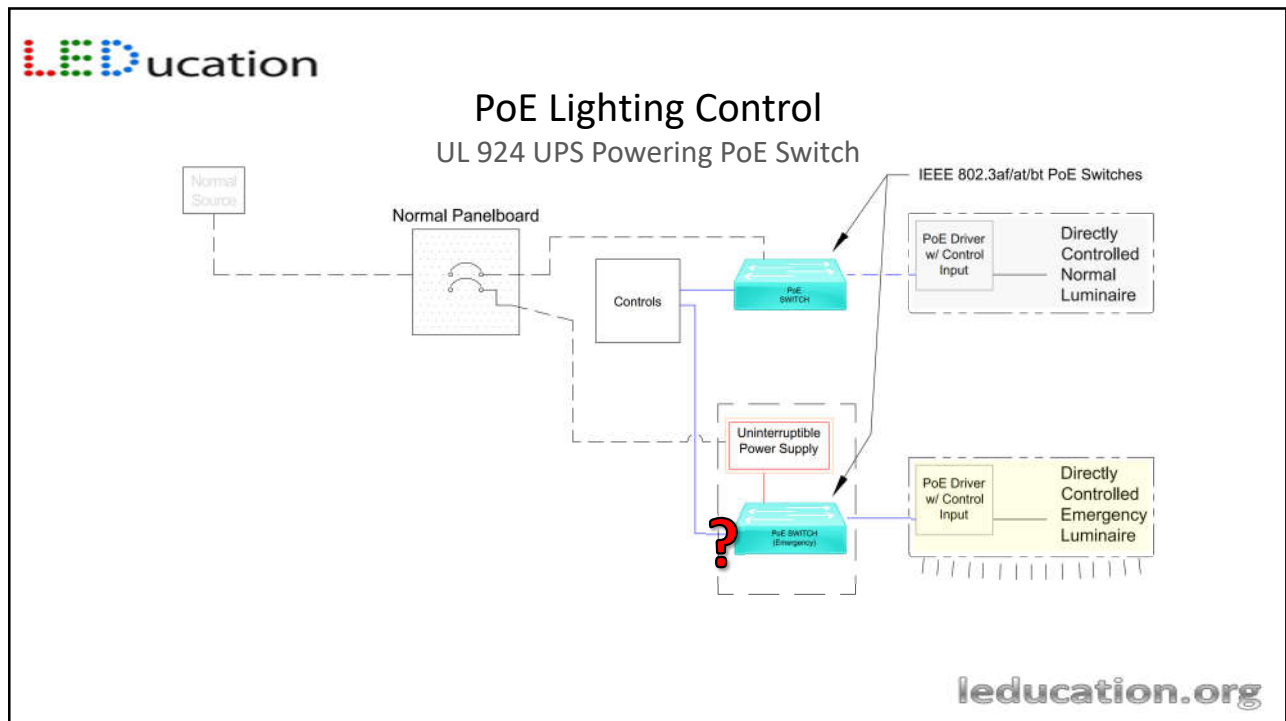
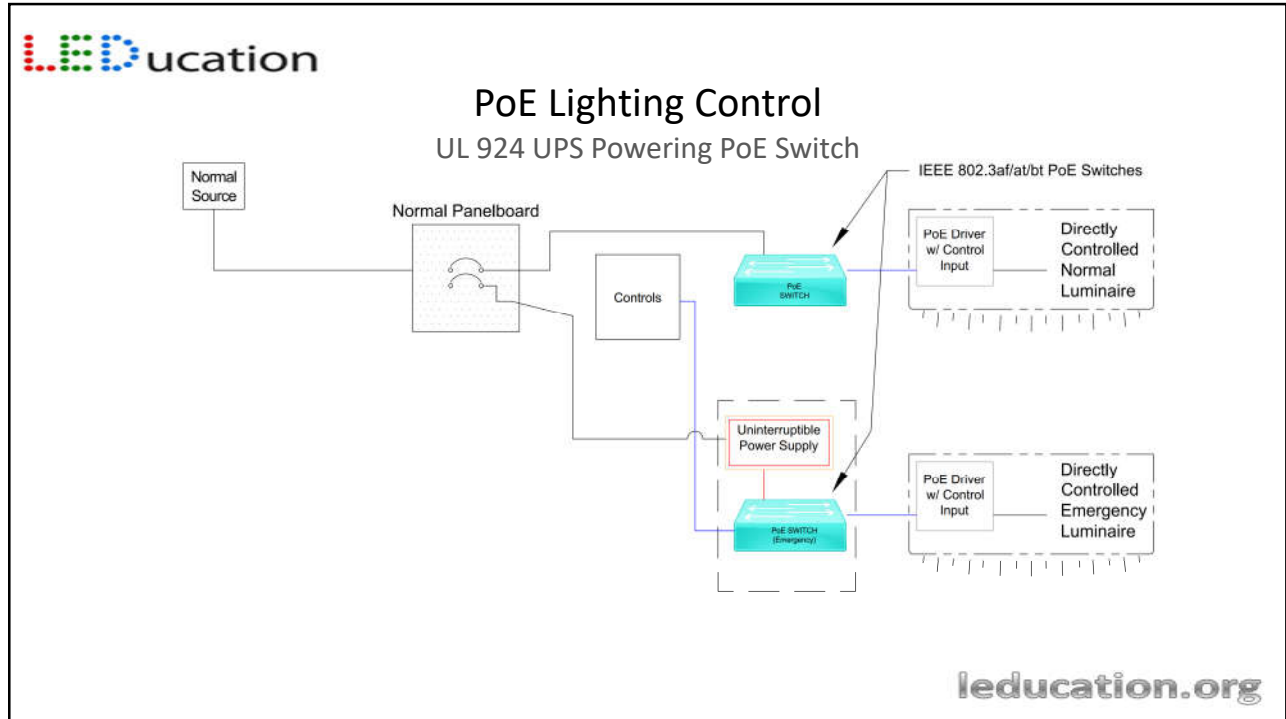
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## New in the 2020 NEC®

- **700.16 Emergency Illumination.**
- **(B) System Reliability.** Emergency lighting systems shall be designed and installed so that the failure of any illumination source cannot leave in total darkness any space that requires emergency illumination. Control devices in the emergency system shall be listed for use in emergency systems. Listed unit equipment in accordance with 700.12(I) shall be considered as meeting the requirements of this section.

Informational note: 700.23 through 700.26 provide requirements for applications of emergency control devices

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## NFPA 101 Requirements

- NFPA 101 Life Safety Code is even more stringent and prescriptive than NEC 700.16(B):
  - 7.9.2.3\*** The emergency lighting system shall be arranged to provide the required illumination automatically in the event of any interruption of normal lighting due to any of the following:
    - (1) Failure of a public utility or other outside electrical power supply
    - (2) Opening of a circuit breaker or fuse
    - (3) Manual act(s), including accidental opening of a switch controlling normal lighting facilities

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## Redundancy in design is the key to reliability

- Both NEC 700.16(B) and NFPA 101 7.9.2.3 can be met by having a minimum of *two* branch circuits, *two* overcurrent protective devices, and *two* control devices feeding emergency loads in a space.
- Where possible, emergency circuits for a space should be fed by different panels or switchboard sections.
- At some point, emergency power will come from a single breaker, but careful design of the riser diagram should minimize single points of failure.

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## Summary – **These are Life Safety Issues**

- An external UL 924 Load Control Relay may be used to bypass a wall switch, wallbox dimmer, and some occupancy sensors to energize emergency lights, but may never be used to transfer emergency lights between a normal and emergency power source.
- UL 924 Load Control Relays are used to Bypass (shunt around) a control device, NOT to transfer between two sources.
- A dimming or relay system with a dual listing under UL 924 and UL 508/UL 891/UL 916 may be used to energize emergency lights if it is installed under the provisions of NEC® section 700.23.

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## Summary – These are Life Safety Issues

- The NEC® states clear requirements: “Automatic transfer switches shall be **electrically operated and mechanically held**. Automatic transfer switches, rated 1000 VAC and below, shall be **listed for emergency system use.**” and  
“... **The load control relay shall not be used as transfer equipment.**”
- UL 1008 transfer switches are rated to transfer loads between two non-synchronous power sources.
- UL 1008 BCELTS can use an electrically operated/electrically held relay.
- Some products marketed as automatic transfer switches and listed under UL 1008 are for optional standby systems (NEC® Article 702), **not emergency use.**

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## Summary – These are Life Safety Issues

- The NEC® requires Directly Controlled luminaires used for emergency lighting to be Listed for emergency use.
- Default response of drivers to loss of Directly Controlled signals varies – i.e., there is not always a default response.
- A control system can provide a ‘full on’ directly controlled signal in emergency mode – either a separate input or on the same control input.

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