



Welcome

**Review of NEC Article 700
Emergency Systems**

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ESL Power Systems, Inc.

Corona, CA



ESL designs and manufactures innovative electrical engineering solutions and products of unparalleled quality to assist businesses worldwide safely connect their equipment.

- Fully integrated, OEM/Custom Manufacturer
- Established in 1991
- (2) production facilities totaling over 50,000 square feet
- 100% Employee Owned (ESOP)
- Products installed in over 64 countries
- Multiple UL files (508A, 1008, 231, 891, 50...)
- Port Terminal, Industrial, Military, Emergency Power, Entertainment and Truck-trailer shore power

ESL's Product Lines



Wayside Power for Connecting Locomotives



Shore Power to Connect Ships



Safety Interlocked Disconnect Cabinets for E-RTG Applications



Reefer Outlet Assemblies for Refrigerated Containers



Custom Solutions



eTRUconnect® - Refrigerated Truck Trailer Shore Power



Show Switch Power Distribution for Theatres/Arenas



Shipyard Power Distribution Units



Emergency Power Connection Equipment for Roll up generators



Industrial Portable Power



Speaker

Tom Zinchuk

Sr. Technical Advisor

Tom Zinchuk holds a Bachelor of Science in Electrical Engineering from Lowell Technological Institute in Lowell MA and a Masters in Electric Power Engineering from Rensselaer Polytechnic Institute in Troy NY. He began his career in East Pittsburgh PA with Westinghouse in the Power Circuit Breaker Division where he worked as an Engineer and Testing Lab Supervisor. Tom eventually migrated to California where he held the title of Product Development Engineer and later Engineering Manager at Crouse-Hinds. He later moved to Kansas City MO where he worked for Milbank Manufacturing as Engineering Manager. Now, a 15-year veteran at ESL, he has served as Engineering Manager, Sr. Sales Engineering Manager and currently answers to the title of Sr. Technical Advisor. Tom's current role allows him the responsibility as key engineering counsel for all of engineering, sales, marketing, product development and R&D. Tom holds 4 patents which include a circuit breaker mechanical interlock system and an automatic trip circuitry in power connectors which are key components for ESL's StormSwitch® and eTRUconnect® product lines respectively. He has also contributed to numerous articles for trade publications with a focus on emergency power connection solutions and intermodal port terminal applications.





Part I. General



700.2 Definitions

Emergency Systems:

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.



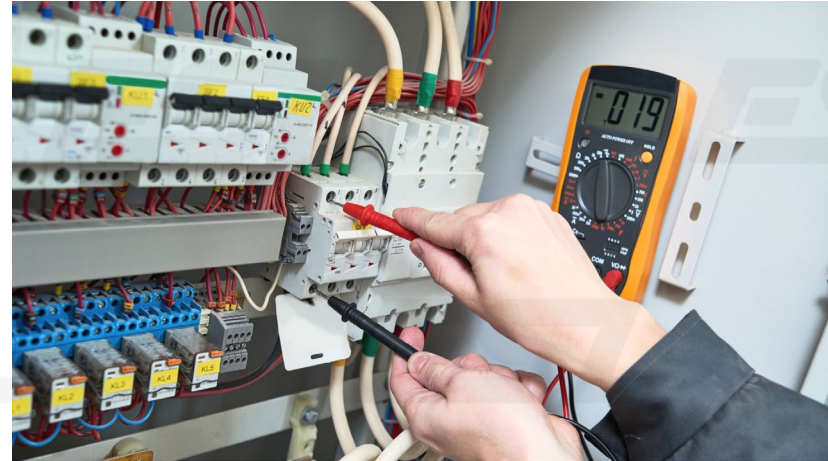
Question:

What if a town council decides that the local bank or restaurant should remain operational during a power outage. Is this a legally required system?



700.3 Tests and Maintenance:

- A. **Conduct or Witness Test.** The authority having jurisdiction shall conduct or witness a test of the complete system upon installation and periodically thereafter.
- B. **Tested Periodically.** Systems shall be tested periodically on a schedule approved by the authority having jurisdiction to ensure the systems are maintained in proper operating condition.
- C. **Maintenance.** Emergency system equipment shall be maintained in accordance with the manufacturer instructions and industry standards.
- D. **Written Record.** A written record shall be kept of such tests and maintenance.
- E. **Testing Under Load.** Means for testing all emergency lighting and power systems during maximum anticipated load conditions shall be provided.



700.3 Tests and Maintenance (continued):

F. Temporary Source of Power for Maintenance or Repair of the Alternate Source of Power.

- If the system relies on a **single** alternate source of power which will be disabled for maintenance or repair, then:
 - Provide a **permanent** switching means to connect a portable or temporary alternate source of power.
 - Connection of the portable or temporary alternate source of power shall **not** require modification of the permanent wiring.
 - Transfer of power between the normal power source and the alternate power source shall occur in **(10) seconds** or less.
 - The connection point for the portable/temporary source shall be marked with phase rotation and system bonding requirements.
 - The switching means shall include a contact point that shall annunciate at a location **remote** from the generator or at another facility monitoring system to indicate that the permanent emergency source is disconnected from the emergency system.



700.4 Capacity and Rating

Emergency system equipment shall:

- A. Be suitable for the available fault current at its terminals.
- B. Have adequate capacity in accordance with Article 220 (Branch-Circuit, Feeder and Service Load Calculations).
- C. Selective load pickup, load shedding and peak load shaving is permitted in order to ensure adequate power to:
 - Emergency circuits
 - Legally required standby circuits
 - Optional standby circuits



700.5 Transfer Equipment

- A. **General** – Automatic, Listed (UL 1008) and Marked for Emergency Use. Prevent interconnection of normal and emergency sources of power unless it meets the requirements of Article 705 (Interconnected Electric Power Production Sources). Meter-mounted transfer switches **not** permitted.
- B. **Bypass Isolation Switches** are **permitted** to isolate the transfer equipment.
- C. **Automatic Transfer Switches** shall be electrically operated and mechanically held. Reconditioning of automatic transfer switches is **not** permitted.
- D. **Use** - Transfer Equipment shall supply only emergency loads.
- E. **Documentation** The short circuit current rating and settings shall be **field** marked on the exterior of the transfer equipment



700.6 Signals

- A. **Malfunction** – To indicate malfunction of the emergency source
- B. **Carrying Load** - To indicate that the emergency source is carrying a load.
- C. **Not Functioning** – To indicate that the battery charger is not functioning.
- D. **Ground Fault** – To indicate a ground fault condition. Requirements:
 - Voltage to ground exceeds 150V
 - Amperage is 1000A or more
 - Located at, or ahead of, emergency source main disconnect
 - 1200A maximum ground fault setting
 - Action instructions in event of ground fault (located at or near the ground-fault sensor)



Question:

What is the purpose of the annunciator contact within the emergency system?



700.7 Signs

- A. **Emergency Sources** – Placed at the Service Equipment, indicating the type and location of each on-site emergency power source.
- B. **Grounding** – If the removal of a grounding or bonding connection in the normal power source equipment interrupts the grounding electrode connection to the alternate power source(s), a warning sign at the normal power source equipment is required stating:

WARNING

SHOCK HAZARD EXISTS IF GROUNDING
ELECTRODE CONDUCTOR OR BONDING JUMPER
CONNECTION IN THIS EQUIPMENT IS REMOVED
WHILE ALTERNATE SOURCE(S) IS ENERGIZED.



700.8 Surge Protection

A listed SPD shall be installed in or on all emergency systems switchboards and panelboards





Part II.

Circuit Wiring



700.10 Wiring, Emergency Systems

- A. **Identification** – Emergency circuits shall be **permanently marked** so they are readily identified as a component of an emergency circuit:
1. All boxes and enclosures
 2. All exposed cable or raceways at intervals not to exceed 25 ft.
- Receptacles supplied from the emergency system shall have a distinctive color or marking on the receptacle cover plates or the receptacle.
- B. **Wiring** - Emergency wiring shall be kept entirely independent of all other wiring and equipment with the following exceptions:



700.10 Wiring, Emergency Systems (continued)

- 1) Wiring from normal power source located in transfer equipment enclosures.
- 2) Wiring supplied from two sources in the exit or emergency luminaires.
- 3) Wiring from two sources in a listed load control relay supplying exit or emergency luminaires, or in a common junction box attached to exit or emergency luminaires.
- 4) Wiring within a common junction box attached to unit equipment containing only the branch circuit supplying the unit equipment and the emergency circuit supplied by the unit equipment.



700.10 Wiring, Emergency Systems (continued)

- 5) Wiring from an emergency source to supply emergency **and** other (non-emergency) loads in accordance with the following:
 - a) Separate vertical switchgear sections (with or without common bus) shall be used to separate emergency loads from all other loads.
 - b) For the common bus mentioned above
 - No overcurrent protection at the source
 - or
 - If provided, selectively coordinated with the next downstream overcurrent device in the **nonemergency** system.
 - c) Emergency wiring shall not originate from the same section as other circuits.
 - d) It is permissible to have feeder(s) supplying distribution equipment between the emergency source and the point where the emergency loads are separated from all other loads.



700.10 Wiring, Emergency Systems (continued)

C. Wiring Design and Location – Emergency wiring circuits shall be designed and located so as to minimize the hazards that might cause failure due to flooding, fire, icing, vandalism, and other adverse conditions.

D. Fire Protection

1. Occupancies – Emergency systems shall meet 2 through 4 of this section for the following types of occupancies:

1. Assembly occupancies of more than 1000 persons
2. Buildings above 75 feet in height
3. Educational occupancies with more than 300 occupants



700.10 Wiring, Emergency Systems (continued)

2. **Feeder-Circuit Wiring** – shall meet one of the following:
 1. Cable or Raceway installed in spaces or areas that are fully protected by an approved automatic fire protection system.
 2. Protected by a listed electrical circuit protective system with a minimum 2-hour fire rating.
 3. A listed fire-resistive cable system with a minimum 2-hour fire rating.
 4. Protected by a listed fire-rated assembly that has a minimum fire rating of 2 hours and contains only emergency circuits.
 5. The cable or raceway is encased in a minimum of 2” of concrete
3. **Feeder-Circuit Equipment** – shall be located either in spaces fully protected by an approved automatic fire protection system or in spaces with a 2-hour fire protection rating.
4. **Generator Control Wiring** – Control conductors installed between the transfer equipment and the emergency generator shall be kept entirely independent of all other wiring and shall meet the conditions of 700.10(D)(2). The integrity of the generator remote start circuit shall be monitored for broken, disconnected, or shorted wires. **Loss of integrity shall start the generator(s)**





Part III.

SOURCES OF POWER



700.12 General Requirements — In the event of normal power supply loss, emergency lighting, emergency power, or both shall be available within the time required for the application, but **not to exceed** 10 seconds. The supply system for emergency purposes shall be one or more of the types of systems described in 700-12(C) through (H). Unit equipment in accordance with 700.12(I) shall satisfy the requirements of this article.

A. Power Source Considerations – Consideration shall be given to the occupancy and the type of service to be rendered, whether of minimum duration (evacuation of a theater), or a longer duration of indefinite period of time due to trouble either inside or outside the building (storm, flood, fire)



700.12 General Requirements (continued)

B. Equipment Design and Location – to minimize hazards that might cause complete failure due to flooding, fires, icing, and vandalism. (same as Wiring Design and Location). Equipment for sources of power as described in 700.12(C) through (H) shall be installed in spaces fully protected by approved automatic fire protection systems or in spaces with 2-hour fire rating where located within:

1. Assembly occupancies for more than 1000 people
2. Buildings above 75 feet in height with any of the following occupancy classes:
 - Assembly
 - Educational
 - Residential
 - Detention and correctional
 - Business
 - Mercantile
3. Educational occupancies with more than 300 occupants



700.12 General Requirements (continued)

C. **Storage Battery** – shall be of suitable rating and capacity to supply the total load for a minimum of 1-1/2 hours, without the voltage dropping below 87-1/2 % of normal. Automotive type batteries shall **not** be used. An automatic battery charging means shall be provided.

D. Generator Set

1. Prime Mover-Driven

- Approved by the AHJ
- Complies with Article 700.4 (Capacity & Rating)
- Automatic start on failure of normal service
- Automatic transfer of power
- Time delay on re-transfer in case of short time re-establishment of normal source



700.12 General Requirements (continued)

D. Generator Set (continued)

2. Internal Combustion Engines as Prime Movers

- a) On-Site Fuel Supply - sufficient for 2 hours of operation.
- b) Fuel Transfer Pumps – pump power to be connected to the emergency power system.
- c) Public Gas System, Municipal Water Supply – shall not be solely dependent for fuel source or cooling means. Exceptions (low probability of failure) with AHJ approval.
- d) Automatic Fuel Transfer – for dual fuel systems, automatic means shall be provided for transfer between fuel supplies.



700.12 General Requirements (continued)

D. Generator Set (continued)

3. Battery Power and Dampers

- If storage batteries are used for control, signal power, or means of starting the prime mover, a charger shall be provided and charged from a source other than the generator set.
- If the batteries are required for operation of the generator set (including damper operation) the charger shall also be connected to the emergency system.

4. Auxiliary Power Supply – Generator sets that require more than 10 seconds to develop power shall be permitted if an auxiliary power supply energizes the emergency system until the generator can pick up the load.



700.12 General Requirements (continued)

D. Generator Set (continued)

5. Outdoor Generator Sets

- Generator sets equipped with a readily available disconnect means compliant with Article 445.18 (Generators – Disconnecting Means) and there is line of sight to the load (facility), an additional disconnect is not required for the ungrounded conductors that serve or pass through the building
- Where the generator supply conductors terminate at a disconnect means on or in the building, the disconnect shall comply with Article 225.36 (Outside Branch Circuits and Feeders – Type of Disconnecting Means)



700.12 General Requirements (continued)

- E. Uninterruptible Power Supplies** – shall comply with 700.12(B) (Equipment Design and Location) and (C) (Storage Battery)
- F. Separate Service**
- Where approved by AHJ
 - Comply with Article 230 (Services)
 - Separate overhead service conductors, service drops, underground service conductors, or service laterals shall be installed
 - The separate service conductors shall be installed sufficiently remote both electrically and physically from any other service conductors to minimize the possibility of simultaneous failure



700.12 General Requirements (continued)

G. Fuel Cell System

- Sufficient for 2 hours of full demand operation.
- Meet requirements of Parts II through VIII of Article 692 (Fuel Cell Systems)
- If the system serves as the normal supply, it shall not serve as the sole source of power for the emergency system.

H. DC Microgrid System

- Permitted where the system is capable of being isolated from all non-emergency systems
- Sufficient for 2 hours of full demand operation.
- If the system serves as the normal supply, it shall not serve as the sole source of power for the emergency system.



700.12 General Requirements (continued)

I. Unit Equipment

1. Components of Unit Equipment

1. A rechargeable battery
2. A battery charging means
3. Provisions for lamps mounted on the equipment, and/or terminals for remote lamps
4. A relaying device to automatically energize the lamps upon failure of the supply to the equipment



700.12 General Requirements (continued)

I. Unit Equipment (continued)

2. Installation of Unit Equipment

1. Batteries to maintain the total lamp load:
 - For a minimum of 1-1/2 hours without voltage dropping below 87-1/2% of normal
 - Supply and maintain not less than 60% of the initial emergency illumination for at least 1-1/2 hours
2. Permanently fixed. Flexible cord-and-plug permitted but not to exceed 3 feet in length.
3. Branch circuit feeding the unit equipment shall be **one** of the following:
 - a. Same as that serving the normal lighting and connected ahead of any local switches
 - b. A separate circuit originating in the same panelboard as the normal lighting, shall be provided with a lock-on feature
4. Shall be clearly identified at the panelboard
5. Emergency luminaires that obtain power from the unit equipment **and** are not part of the unit equipment shall be wired per Article 700.10 (Wiring, Emergency System) and use one of the wiring methods of Chapter 3
6. Lighting serving the exterior of an exit door can be powered by the unit equipment serving that area.





Part IV.

**EMERGENCY SYSTEM
CIRCUITS FOR LIGHTING
AND POWER**



700.15 Loads on Emergency Branch Circuits

No appliances or lamps, other than those specified as required for emergency use, shall be supplied by emergency lighting.

700.16 Emergency Illumination

A. General – Emergency illumination shall include

- Egress lighting
- Illuminated exit signs
- All other lighting specified as necessary to provide required illumination

B. System Reliability

- Designed and installed so that failure of any illumination source cannot leave in total darkness any space that requires emergency lighting.
- Control devices shall be listed (UL 924) for use in emergency systems
- Listed unit equipment in accordance with 700.12(F) meets the provisions of this section.



700.17 Branch Circuits for Emergency Lighting

Branch circuits shall provide service from a source complying with 700.12. and must be one of the following:

1. Independent of the normal lighting supply, with automatic transfer of the power source in the event of normal source power failure.

OR

2. Two or more supplied from separate **and** complete systems with independent power sources. One of the power sources shall be part of the emergency system, the other shall be permitted to be part of the normal system. Unless both systems are used regular lighting purposes **and** both are kept lighted, then must have provision to automatically energize the other if either fail.



700.18 Circuits for Emergency Power

For branch circuits that supply equipment classed as emergency, transfer to emergency power shall be automatic upon failure of the normal source.

700.19 Multiwire Branch Circuits

The branch circuit serving emergency lighting and power circuits shall not be part of a multiwire branch circuit.



Part V.

CONTROL – EMERGENCY LIGHTING CIRCUITS



700.20 Switch Requirements

- Arranged so that only authorized person(s) have control of the emergency lighting.
- Switches connected in series or 3- and 4-way switches shall not be used.

700.21 Switch Location

- In locations convenient to authorized person(s)
- In facilities covered by Articles 518 (Assembly Occupancies) and 520 (Theaters, Performance Areas), to be located in a lobby or a place conveniently accessible from the lobby.
- Shall **not** be located in a motion picture projection booth, on a stage, or platform



700.22 Exterior Lights

If not required for illumination when there is sufficient daylight, can be controlled by an automatic light-actuated device.

700.23 Dimmer and Relay Systems

- Containing more than one dimmer or relay and listed (UL 924) for use in an emergency system, can be used as the control device for emergency lighting
- Is permitted to selectively energize only those circuits required to provide minimum emergency illumination.
- All branch circuit fed from the dimmers or relays shall comply with the wiring methods of Article 700



700.24 Directly Controlled Emergency Luminaires

That respond to an external control, or loss thereof, shall be individually listed (UL 924) for use in an emergency system.

700.25 Branch Circuit Emergency Lighting Transfer Switch

- Rated 20A or less
- A listed emergency transfer switch is allowed
- The mechanically held requirement of 700.5(C) does not apply.

700.26 Automatic Load Control Relay

If an emergency lighting load is automatically energized upon loss of normal power, a listed (UL 924) automatic load control relay is permitted. The load control relay shall not be used as the transfer equipment.





Part VI.

OVERCURRENT PROTECTION



700.30 Accessibility

Overcurrent devices in the emergency circuits shall be accessible to authorized persons only.

700.31 Ground-Fault Protection of Equipment

- The alternate source of power for the emergency system shall **not** be required to provide ground fault protection of equipment with automatic disconnecting means.
- Ground-fault **indication** shall be provided in accordance with 700.6(D), if ground fault protection is not provided.



700.32 Selective Coordination

- Emergency overcurrent devices shall be selectively coordinated with all supply-side overcurrent protective devices.
- The coordination shall be done by a licensed professional engineer or a qualified person specializing in such studies.
- The selection shall be documented and made available to authorized personnel.

EXCEPTION: Selective coordination shall not be required between two overcurrent devices connected in series if no loads are connected in parallel with the downstream device.



Q&A

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