
CONTENTS

	<u>PAGE</u>
Article 700 - Emergency Systems _____	1
Quiz #1 - Article 700 _____	22
Article 701 - Legally Required Standby Systems _____	25
Article 702 - Optional Standby Systems _____	36
Article 705 - Interconnected Electric Power Production ____	41
Article 706 - Energy Storage Systems _____	55
Quiz #1 - Articles 701 -- 706 _____	72
Article 708 - Critical Operations Power Systems (COPS) _	73
Article 710 - Stand-Alone Systems _____	87
Article 722 - Cables for Power Limited _____	91
Quiz #1 - Articles 708 -- 720 _____	103
Article 724 - Class 1 Power Limited Circuits and Remote Control Circuits and Signaling Circuits _____	108
Article 725 - Class 2, and Class 3 Circuits _____	116
Quiz #1 & #2 - Article 724 - 725 _____	128

CONTENTS

	<u>PAGE</u>
Article 726 - Class 4 Fault Managed Power Systems _____	132
Article 728 - Fire-Resistive Cable Systems _____	141
Article 750 - Energy Management Systems _____	144
Quiz #1 - Articles - 726 -- 750 _____	148
Article 760 - Fire Alarm Systems _____	149
Article 770 - Optical Fiber Cables _____	169
Quiz #1 - Articles - 760-770 _____	188
Article 800 - General Requirements Com. Circuits _____	191
Article 805 - Communications Circuits _____	220
Article 810 - Radio and Television Equipment _____	228
Quiz #1 - Articles - 800-810 _____	238
Article 820 - Community Antenna TV and Radio Systems	241
Article 830 - Network-Powered Broadband Systems _____	246
Article 840 - Premises-Powered Broadband Systems _____	259
Quiz #1 - Articles - 820 -- 840 _____	265
ANSWERS _____	267

Part I. General

700.1 Scope. This article applies to the electrical safety of the installation, operation, and maintenance of emergency systems consisting of circuits and equipment intended to supply, distribute, and control electricity for illumination, power, or both, to required facilities when the normal electrical supply or system is interrupted.



Informational Note #1 Emergency systems are generally installed in places of assembly where artificial illumination is required for safe exiting and for panic control in buildings subject to occupancy by large numbers of persons, such as hotels, theaters, sports arenas, health care facilities, and similar institutions. Emergency systems may also provide power for such functions as ventilation where essential to maintain life, fire detection and alarm systems, elevators, fire pumps, public safety communications systems, industrial processes where current interruption would produce serious life safety or health hazards, and similar functions.

Informational Note #2: For further information regarding wiring and installation of emergency systems in health care facilities, see Article 517.

Informational Note #3: For further information regarding performance and maintenance of emergency systems in health care facilities, see NFPA 99-2018, *Health Care Facilities*.

Informational Note #4: For specification of locations where emergency lighting is considered essential to life safety, see NFPA 101-2018, *Life Safety Code*.

Informational Note #5: For further information regarding performance of emergency and standby power systems, see NFPA 110-2019, *Standard for Emergency and Standby Power Systems*.

700.2 Reconditioned Equipment. Reconditioned transfer switches shall **not** be permitted.

700.3 Tests and Maintenance.

(A) Commissioning Witness Test. The **authority having jurisdiction** shall conduct or witness the commissioning the test of the complete system upon installation and **periodically** afterward.

(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 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.

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

If the emergency system relies on a single alternate source of power, which will be disabled for maintenance or repair, the emergency system shall include permanent switching means to connect a portable or temporary alternate source of power, that shall be available for the duration of the maintenance or repair. The permanent switching means to connect a portable or temporary alternate source of power shall comply with the following:

- (1) Connection to the portable or temporary alternate source of power shall not require modification of the permanent system wiring.
- (2) Transfer of power between the normal power source and the emergency power source shall be in accordance with 700.12.
- (3) The connection point for the portable or temporary alternate source shall be marked with the phase rotation and system bonding requirements.
- (4) The switching means, including the interlocks, shall be listed and provided with mechanical or mechanical and electrical interlocking to prevent inadvertent interconnection of power sources.
- (5) 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.
- (6) The permanent connection point for the temporary generator shall be located outdoors and shall not have cables from the connection point to the temporary generator routed through exterior windows, doors, or similar openings,
- (7) A permanent label shall be field applied at the permanent connection point to identify the system voltage, maximum amperage, short-circuit current rating of the load side of equipment supplied, and ungrounded conductor identification in accordance 210.5.



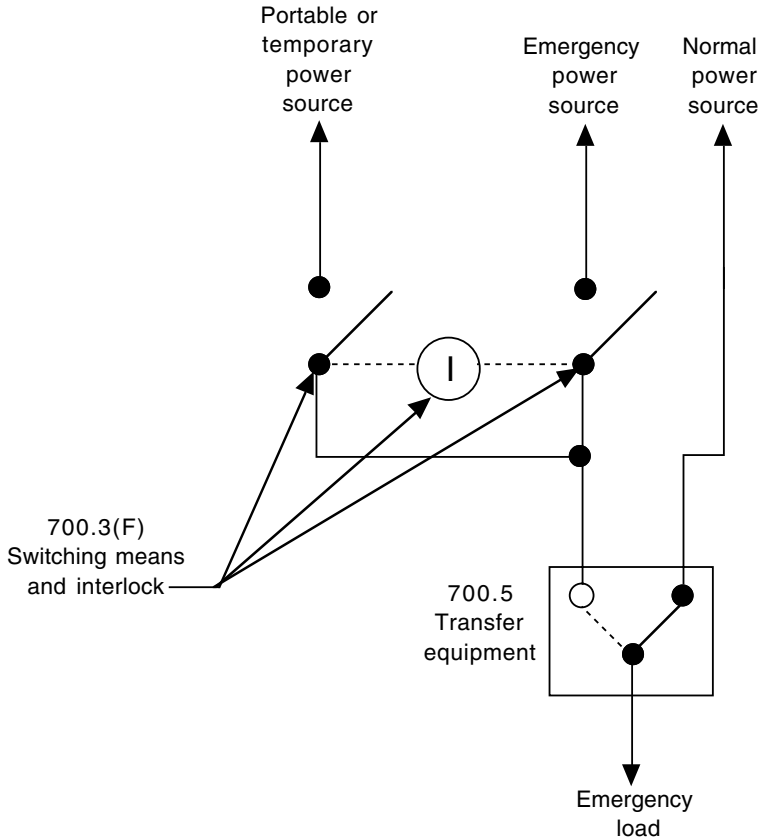
It shall be permissible to use manual switching to switch from the permanent source of power to the portable or temporary alternate source of power and to use the switching means for connection of a load bank.

Informational Note: There are many possible methods to achieve the requirements of 700.3(F).

Exception: The permanent switching means to connect a portable or temporary alternate source of power, for the duration of the maintenance or repair, shall not be required where any of the following conditions exists:

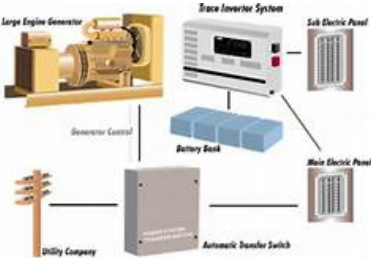
- (1) All processes that rely on the emergency system source are capable of being disabled during maintenance of the emergency source of power.

- (2) The building or structure is unoccupied and fire protection systems are fully functional and do **not** require an alternate source of power.
- (3) Other temporary means can be substituted for the emergency system.
- (4) A permanent alternate emergency source, such as, but not limited to, a second on-site standby generator or separate electric utility service connection, capable of supporting the emergency system, exists.



700.4 Capacity and Rating.

(A) Capacity. An emergency system shall have adequate capacity in accordance Parts I through IV of Article 220 or another approved method. The system capacity shall be sufficient for rapid load changes and transient power and energy requirements associated with any expected loads.



(B) Selective Load Management. The alternate power source shall be permitted to supply emergency, legally required standby, and optional standby system loads where the source has adequate capacity or where load management (that includes automatic selective load pickup and load shedding) is provided as needed to ensure adequate power to the following in order priority:

- (1) Emergency circuits
- (2) Legally required standby circuits
- (3) Optional standby circuits, in that order of priority

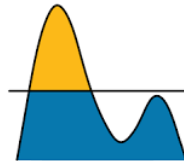
(C) Parallel Operation. Parallel operation of the emergency source(s) shall consist of the sources specified in 700.4(C)(1) and (C)(2).



(C)(1) Normal Source. The emergency source shall be permitted to operate in parallel with the normal source in compliance with Part I or Part II of Article 705 where the capacity required to supply the emergency load is maintained at all times. Any operating condition that results in less than the required emergency source capacity shall initiate a system malfunction signal in accordance with 700.6(A).

Parallel operation shall be permitted for satisfying the test requirements of 700.3(B), provided all other conditions of 700.3 are met.

Informational Note: Peak load shaving is one application for parallel source operation.



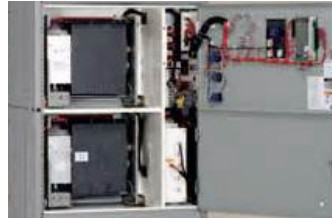
(C)(2) Emergency source. Emergency sources shall be permitted to operate in parallel where the necessary equipment to establish and maintain a synchronous condition is provided.

700.5 Transfer Equipment.

(A) General. Transfer equipment shall be automatic, listed, and marked for emergency use, and **approved by the authority having jurisdiction.** Transfer equipment shall be designed and installed to prevent the inadvertent interconnection of normal and emergency sources of supply in any operation of the transfer equipment. Transfer equipment and electric power production systems installed to permit operation in parallel with the normal source shall meet the requirements of Article 705. Meter-mounted transfer switches shall **not** be permitted for emergency system use.



(B) Bypass Isolation Transfer Switches. Means shall be permitted to bypass and isolate the transfer equipment. Where bypass isolation transfer switches are used, inadvertent parallel operation shall be prevented.



(C) Automatic Transfer Switches. Automatic transfer switches shall be electrically operated and mechanically held.

(D) Redundant Transfer Equipment. If emergency loads are supplied by a single feeder, the emergency power system shall include redundant transfer equipment or a bypass isolation transfer switch to facilitate maintenance as required in 700.3(C) without jeopardizing continuity of power. If the redundant transfer equipment or bypass isolation transfer switch is manual (or automatic), then it shall be actively supervised by a qualified person when the primary (automatic) transfer equipment is disabled for maintenance or repair.

QUALIFIED



Exceptions: The requirement for redundancy with the transfer equipment shall **not** apply where any of the following conditions exist.

(1) All processes that rely on the emergency system source are capable of being disabled during maintenance or repair activities without jeopardizing the safety to human life.

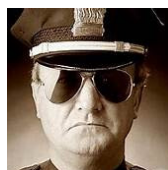


(2) The building or structure is unoccupied and fire protection systems are fully functional and do not require an alternate power source.

(3) Other temporary means shall be permitted to be substituted for the emergency system.

(4) A written emergency plan that includes mitigation actions and responsibilities for **qualified persons** to address the recognized site hazards for the duration of the maintenance or repair activities shall be developed and implemented. The emergency plan shall be made available to the AHJ.

Get it in WRITING!



(E) Use. Transfer equipment shall supply only emergency loads.

Informational Note: Transfer equipment that supplies emergency loads provides separation of this load type from any others and is independent of any equipment used to combine or parallel sources.

(F) Documentation. The short-circuit current rating of the transfer equipment, based on the specific overcurrent protective device type and settings protecting the transfer equipment, shall be field marked on the exterior of the transfer equipment.



700.6 Signals. Audible, visual, and facility or network remote annunciation devices shall be provided, where applicable for the purpose described in 700.6(A) through (D).

(A) Malfunction. To indicate malfunction of the emergency source.

(B) Carrying Load. To indicate that the emergency source is carrying load.

(C) Storage Battery Charging Malfunction. Storage battery charging malfunction signals indicate a charging malfunction on a battery required for source readiness, including starting the prime mover, is not functioning.



(D) Ground Fault. Ground-fault signals indicate a ground fault in solidly grounded wye emergency systems of more than 150 volts to ground and circuit-protective devices rated 1000 amperes or more. The sensor for the ground-fault signal devices shall be located at, or ahead of, the main system disconnecting means for the emergency source, and the maximum setting of the signal devices shall be for a ground-fault current of 1200 amperes. Instructions on the course of action to be taken in event of indicated ground fault shall be located at or near the sensor location.

For systems with multiple emergency sources connected to a paralleling bus, the ground fault sensor and the system bonding jumper shall be permitted to be at an alternative location.



700.7 Signs.

(A) **Emergency Sources.** A sign shall be placed at the service-entrance equipment, indicating type and location of each on-site emergency power source.



Exception: A sign shall not be required for individual unit equipment as specified in 700.12(I).

(B) **Grounding.** Where removal of a grounding or bonding connection in normal power source equipment interrupts the grounding electrode conductor connection to the alternate power source(s) grounded conductor, a warning sign shall be installed at the normal power source equipment stating:

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

The warning sign(s) or label(s) shall comply with 110.21(B).

700.8 Surge Protection. A listed SPD shall be installed in or on all emergency system switchgear, switchboards, and panelboards.

**Part II. Circuit Wiring****700.10 Wiring, Emergency System.**

(A) **Identification.** Emergency circuits shall be permanently marked so they will be readily identified as a component of an emergency circuit or system by the following methods:

(1) All boxes and enclosures (including transfer switches, generators, and power panels) for emergency circuits shall be permanently marked as a component of an emergency circuit or system.



(2) Where boxes or enclosures are **not** encountered, exposed cable or raceway systems shall be permanently marked to be identified as a component of an emergency circuit or system, at intervals not to exceed 25 feet.



Receptacles supplied from the emergency system shall have a distinctive color or marking on the receptacle cover plates or the receptacles.

(B) Wiring. Wiring from an emergency source or emergency source distribution overcurrent protection to emergency loads shall be kept entirely independent of all other wiring and equipment, unless otherwise permitted in the following:

(1) Wiring from the normal power source located in transfer equipment enclosures



(2) Wiring supplied from two sources in 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

(5) Wiring within a traveling cable to an elevator.

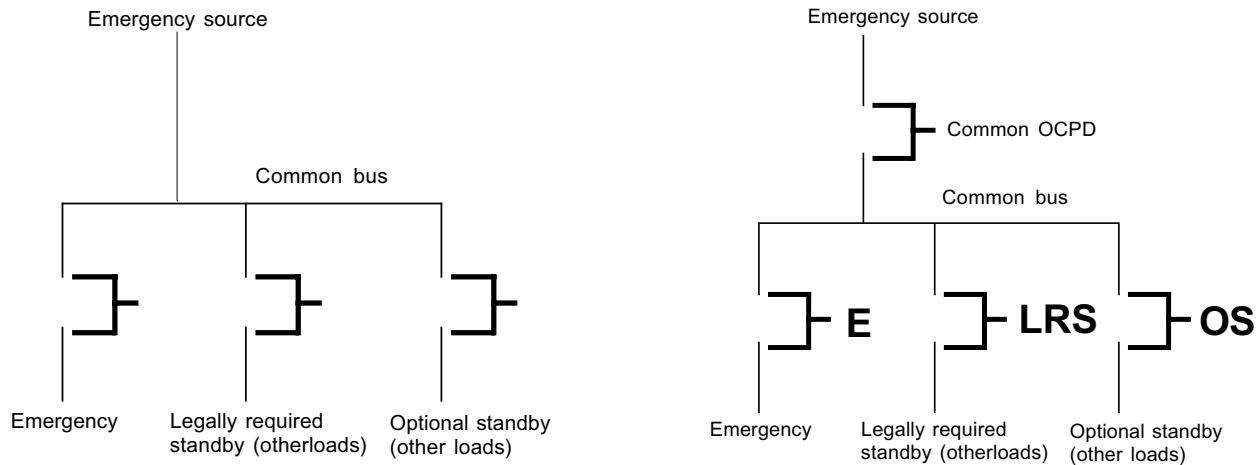
(6) Wiring from an emergency source to supply emergency and other (non-emergency) loads in accordance with the following:

a. Separate vertical switchboard sections, or separate vertical switchboard sections, with or without a common bus, or from individual disconnects mounted in separate enclosures shall be used to separate emergency loads from all other loads.

b. The common bus or separate sections of the switchgear, separate sections of the switchboard, or the individual enclosures shall be either of the following:

- (i) Supplied by single or multiple feeders without overcurrent protection at the source.
- (ii) Supplied by single or multiple feeders with overcurrent protection, provided that the overcurrent protection that is common to an emergency system and any nonemergency system(s) is selectively coordinated with the next downstream overcurrent protective device in the non-emergency system(s).

- c. Emergency circuits shall not originate from the same vertical switchgear section, vertical switchboard section, panelboard enclosure, or individual disconnect enclosure as emergency circuits.
- d. It shall be permissible to utilize single or multiple feeders to supply distribution equipment between an emergency source and the point where the emergency loads are separated from all other loads.
- e. At the emergency power source, such as a generator, multiple integral overcurrent protective devices shall each be permitted to supply a designated emergency or a designated nonemergency load, provided that there is complete separation between emergency and nonemergency loads beginning immediately after the overcurrent protective device line-side connections.



(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 the additional requirements in 700.9(D)(2) and (D)(4) in the following occupancies:

- (1) Assembly occupancies for not less than 1000 persons
- (2) Buildings above 75 feet in height
- (3) Educational occupancies with more than 300 occupants.



(2) Feeder-Circuit Wiring. Feeder-circuit wiring shall meet one of the following conditions:

- (1) The cable or raceway is installed in spaces or areas that are fully protected by an **approved** automatic fire protection system.

700.10(D)(2)

- (2) The cable or raceway is protected by a listed electrical circuit protective system with a minimum 2-hour fire rating.
- (3) The cable or raceway is a listed fire-resistive cable system with a minimum 2-hour fire rating.
- (4) The cable or raceway is protected by a listed fire-rated assembly that has a minimum fire rating of 2 hours and contains only emergency wiring circuits.
- (5) The cable or raceway is encased in a minimum of 2 inches of concrete.



(3) Feeder-Circuit Equipment. Equipment for feeder circuits (including transfer switches, transformers, and panel-boards) shall be located either in spaces fully protected by an **approved** automatic fire protection system or in spaces with a 2-hour fire resistance rating.



(4) Source Control Wiring. Control conductors installed between the emergency power supply system/stored-energy power supply system (EPSS)/(SEPSS) and transfer equipment or control systems that initiate the operation of emergency sources or initiate the automatic connection to emergency loads shall be kept entirely independent of all other wiring and shall meet the conditions of 700.10(D)(2). The integrity of source control wiring shall be monitored for broken, disconnected, or shorted wires. Loss of integrity shall result in the following actions:

- (1) *Generators.* Shall start the generator(s).
- (2) *All other sources.* Shall be considered a system malfunction and initiate the design signal(s) in 700.6(A).



700.11 Wiring, Class-2-Powered Emergency Lighting Systems.

(A) General. Line voltage supply wiring and installation of Class 2 emergency lighting control devices shall comply with 700.10. Class 2 emergency circuits shall comply with 700.11(B) through (D).

ARTICLE 840

Premises-Powered Broadband Communications Systems



Part I. General

840.1 Scope. This article covers premises-powered broadband communications systems.

Informational Note: A typical basic system configuration consists of an optical fiber, twisted pair, or coaxial cable to the premises supplying a broadband signal to a network terminal that converts the broadband signal into component electrical signals, such as traditional telephone, video, high-speed Internet, and interactive services. Powering for the network terminal and network devices is typically accomplished through a premises power supply that might be built into the network terminal or provided as a separate unit. In order to provide communications in the event of a power interruption, a battery backup unit or an uninterruptible power supply (UPS) is typically part of the powering system.



•**Author's note:** These systems extend from an unpowered optical fiber cable, either conductive or non-conductive, that carries a broadband signal through to an optical network terminal that has a battery backup and is powered from the premises wiring system.

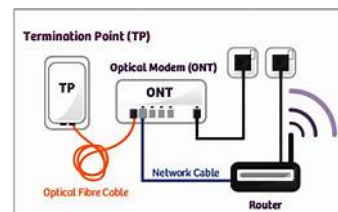
The communications cables can carry power wiring, too. But if the power exceeds 60 watts, then additional requirements apply.

Article 840 is the last Article in the NEC.

Definitions. The definitions in this section shall apply only within Article 840.

Broadband. Wide bandwidth data transmission that transports multiple signals, protocols, and traffic types over various media types

Network Terminal. A device that converts network-provided signals (optical, electrical, or wireless) into component signals, including voice, audio, video, data, wireless, optical, and interactive services, and is considered a network device on the premises that is connected to a communications service provider and is powered at the premises.



Premises Communications Circuit. The circuit that extends voice, audio, video, data, interactive services, telegraph (except radio), and outside wiring for fire alarm and burglar alarm from the service provider's network terminal to the customer's communications equipment up to and including terminal equipment, such as a telephone, a fax machine, or an answering machine.

Premises Community Antenna Television (CATV) Circuit. The circuit that extends community antenna television (CATV) systems for audio, video, data, and interactive services from the service provider's network terminal to the appropriate customer equipment.

Part II. Cables Outside and Entering Buildings

840.47 Underground Wires and Cables Entering Buildings. Direct-buried cables shall be installed to have a minimum cover of 6 inches.



At least 6 inches

Part III. Protection

840.90 Protective Devices. The requirements of 805.90 shall apply.

840.93 Grounding or Interruption. Non-current-carrying metallic members of optical fiber cables, communications cables, or coaxial cables entering buildings or attaching to buildings shall comply with 840.93(A), (B), or (C), respectively.

(A) Non-Current Carrying Metallic Members of Optical Fiber Cables. Non-current-carrying metallic members of optical fiber cables entering a building or terminating on the outside of a building shall comply with 770.93(A) or (B).

(B) Communications Cables. The grounding or interruption of the metallic sheath of communications cable shall comply with 805.93.



(C) Coaxial Cables. Where the network terminal is installed inside or outside of the building, with coaxial cables terminating at the network terminal, and is either entering, exiting, or attached to the outside of the building, 820.93 shall apply.

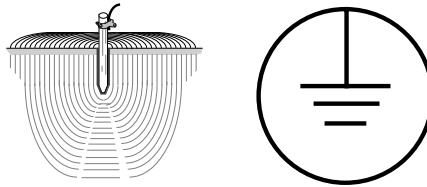


840.94 Premises Circuits Leaving the Building. Where circuits leave the building to power equipment remote to the building or outside the exterior zone of protection defined by a 150 foot radius rolling sphere, 805.90 and 805.93 shall apply.



150 foot radius rolling sphere

Part IV. Grounding Methods



840.101 Premises Circuits Not Leaving the Building. Where the network terminal is served by a nonconductive optical fiber cable, or where any non-current-carrying metal member of a conductive optical fiber cable is interrupted by an insulating joint or equivalent device, and circuits that terminate at the network terminal are completely contained within the building (i.e., they do not exit the building), 840.101(A), (B), or (C) shall apply, as applicable.



(A) Coaxial Cable Shield Grounding. The shield of the coaxial cable shall be grounded by one of the following:

- (1) Any method described in 820.100 or 800.106
- (2) A fixed connection to an equipment grounding conductor as described in 250.118
- (3) Connection to the network terminal grounding terminal provided that the terminal is connected to ground by one of the methods described in 820.100 or 800.106, or to an equipment grounding conductor through a listed grounding device that will retain the ground connection if the network terminal is unplugged.



(B) Communications Circuit Grounding. Communications circuits shall **not** be required to be grounded.

(C) Network Terminal Grounding. The network terminal shall not be required to be grounded unless required by its listing. If the coaxial cable shield is separately grounded as described in 840.101(A) or 840.101 (A)(2), the use of a cord and plug for connection to the network terminal grounding connection shall be permitted.



Informational Note: If required to be grounded, a listed device that extends the equipment grounding conductor from the receptacle to the network terminal equipment grounding terminal is permitted. Sizing of the extended equipment grounding conductor is covered in Table 250.122.

840.102 Premises Circuits Leaving the Building. Where circuits leave the building to power equipment remote to the building or outside the exterior zone of protection defined by a 150 foot radius rolling sphere, the installation of communications wires and cables shall comply with 800.100 and 800.106, and the installation of coaxial cables shall comply with 820.100 and 800.106.

Part VI. Premises Powering of Communications Equipment over Communications Cables

840.160 Powering Circuits. Listed communications cables, in addition to carrying the communications circuit, shall also be permitted to carry circuits for powering listed communications equipment. Where the power supplied over a communications cable to communications equipment listed in accordance with 840.170(C). Installation of the listed 4-pair communications cables for a communications circuit or installation where 4-pair communications cables are substituted for Class 2 and Class 3 cables in accordance with 722.135(E) shall comply with 725.144.

Exception: Installing communications cables in compliance with 725.144 shall not be required for listed 4-pair communications cables where the rated current of the power source does **not** exceed 0.3 amperes in any conductor #24 AWG or larger.



Part VII. Listing Requirements

840.170 Equipment and Cables. Premises-powered broadband communications system equipment and cables shall comply with 840.170(A) through (D).

(A) Network Terminal. The network terminal and applicable grounding means shall be listed for application with premises-powered broadband communications systems.



Informational Note #1: One way to determine applicable requirements is to refer to ANSI/UI 60950-1-2014, *Standard for Safety of Information Technology Equipment*; ANSI/UL 498A-2015, *Current Taps and Adapters*; ANSI/UL 467-2013, *Grounding and Bonding Equipment*; or ANSI/UL 62368-1-2014, *Audio/Video Information and Communication Technology Equipment - Part 1: Safety Requirements*.

Informational Note #2: There are no requirements on the network terminal and its grounding methodologies except for those covered by the listing of the product.

(B) Premises Communications Wires and Cables. Communications wires and cable shall be listed and marked in accordance with 800.179.



(C) Power Source. The power source for circuits intended to provide power over communications cables to remote equipment shall be limited in accordance with Table 11(B) in Chapter 9 for voltage sources up to 60 V dc and shall be listed in either of the following:

(1) A power source shall be listed as specified in 725.121(A)(1), (A)(2), (A)(3), or (A)(4). The power source shall not have the output connections paralleled or otherwise interconnected unless listed for such interconnection.

(2) A power source shall be listed as communications equipment for limited-power circuits.

(D) Accessory Equipment. Communications accessory equipment and/or assemblies shall be listed for application with premises-powered communications systems.