

Chapter 8: [Electrical Safety](#)

Flexible Cord, Extension Cord, and Power Strip Requirements

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URL: <https://www-esh.slac.stanford.edu/eshmanual/references/electricalReqPowerCord.pdf>

1 Purpose

The purpose of these requirements is to ensure the safe use of power cords, extension cords (flexible cord sets), power strips (relocatable power taps), and adapters.

They cover selection, use, and inspection of such devices.

They apply to workers and equipment owners.

2 Requirements

2.1 Flexible Cords

This section covers the use of flexible cord as a wiring method and cord-and-plug assemblies that provide AC power for machines, laboratory equipment, and other scientific research equipment. Flexible cords are commonly used by most individuals at SLAC. Improper use of flexible cords can lead to shock hazards or fires due to overheated equipment.

Power cords (flexible cords) provide power to the equipment. Power cords may be part of the equipment (for example, the cord on a lamp fixture) or may be removable cords that are plugged into the inlet power receptacle in utilization equipment (for example, for computers and power supplies). Removable cords are typically provided by the equipment supplier and must have a wire size (gauge) sufficient to meet the power demands of the equipment.

Extension cords (flexible cord sets) provide power to equipment located too far from receptacles for the power cord to safely reach.

Power strips (relocatable power taps) are a block of electrical sockets that are attached to the end of a flexible cable, allowing multiple electrical devices to be powered from a single electrical socket. Power strips are designed for use with low-powered loads, such as computers, peripherals, or audio/video components. A power strip may include a surge suppressor.

2.1.1 Flexible Cord Use

Flexible cords and flexible cables may be used only for the following:

- Pendants
- Wiring of luminaires (for example, ceiling light fixtures)
- Connection of portable luminaires, portable and mobile signs, or appliances
- Elevator cables
- Wiring of cranes and hoists
- Connection of utilization equipment to facilitate frequent interchange
- Prevention of the transmission of noise or vibration
- Appliances where the fastening means and mechanical connections are specifically designed to permit ready removal for maintenance and repair, and the appliance is intended or identified for flexible cord connection
- Connection of moving parts
- Where specifically permitted elsewhere in [NFPA 70](#)
- Between an existing receptacle outlet and an inlet, where the inlet provides power to an additional single receptacle outlet. The wiring interconnecting the inlet to the single receptacle outlet must be an NFPA 70, Chapter 3 wiring method. The inlet, receptacle outlet, and Chapter 3 wiring method, including the flexible cord and fittings, must be a listed or labeled assembly specific for this application.

2.1.2 Flexible Cord Requirements

SLAC requirements on flexible cords are based on [NFPA 70](#). They consist of the following conditions:

- When flexible cords and cables are used in the first three conditions above, they must be equipped with an approved attachment plug and energized from a receptacle outlet.
- Only *qualified electrical workers* may install cord caps on flexible cords.
- Flexible cord and cable, attachment plugs, and receptacles must be of the proper type, size, and voltage and current rating for the intended application.
- Equipment grounding conductors that are part of flexible cords or used with fixture wires must not be smaller than 18 American Wire Gauge (AWG) copper and not smaller than the circuit conductors.

2.1.3 Disallowed Uses of Flexible Cords

The following uses of flexible cords and cables are not permitted at SLAC:

- As a substitute for the fixed wiring of a structure
- Run through holes in walls, structural ceilings, suspended ceilings, dropped ceilings, or floors
- Run through doorways, windows, or similar openings
- Attached to building surfaces (see [NFPA 70](#) for details)
- Concealed behind building walls, structural ceilings, suspended ceilings, dropped ceilings, or floors
- Installed in electrical raceways, unless specifically allowed by NFPA 70 provisions covering electrical raceways

2.2 Extension Cords

Extension cords provide a convenient method of bringing AC power to a device that is not located near a power source. They are also used as temporary power sources. As such, extension cords are heavily used. They are also often involved in electrical code and safety violations.

Warning Improper use of extension cords can lead to shock hazards. In addition, use of an undersized extension cord results in an overheated cord and insufficient voltage delivered to the device, thus causing device or cord failure and a fire hazard.

2.2.1 Extension Cord Requirements

SLAC requirements for use of extension cords are as follows:

- Extension cords must be approved (by Underwriters Laboratories [UL] or another *nationally recognized testing laboratory [NRTL]*, or by a SLAC Electrical Equipment Inspection Program inspector) and properly maintained with no exposed live parts, exposed ungrounded metal parts, damage, or splices.
- Extension cords must be made of a heavy duty or extra heavy duty rated cable and must be a continuous length.
- Extension cords must have a minimum conductor size of 16 AWG¹ (1.5 mm²).
- Around construction sites, in damp areas, or in an area where a person may be in direct contact with a solidly grounded conductive object, such as working in a vacuum tank, extension cords must be protected by a ground-fault circuit interrupter (GFCI). The GFCI can consist of a special circuit breaker, a GFCI outlet, or an extension cord with a built-in GFCI. (See [Electrical Safety Manual](#), Section 8.6.)
- Extension cords must be of sufficient current-carrying capacity to power the device. An undersized cord is a fire hazard.
- Extension cords must be three-conductor (grounded), even if the device has a two-conductor cord. Never use two-conductor extension cords at SLAC.
- Only qualified electrical workers may make repairs to extension cords.

2.2.2 Disallowed Uses of Extension Cords

The following uses of extension cords are not permitted at SLAC:

- Used in place of permanent facility wiring.
- Run through doors, ceilings, windows, or holes in the walls. If it is necessary to run a cord through a doorway for short term use, the extension cord must be
 - Protected from damage
 - Removed immediately when no longer in use, and
 - Not a tripping hazard

1 Underwriters Laboratories (UL) 817, “Cord Sets and Power-Supply Cords” ([UL 817](#)); *Federal Register*, Volume 80, 44262, “Substantial Product Hazard List: Extension Cords” ([80 FR 44262](#))

- Daisy-chained (one extension cord plugged into another extension cord) (but see exception below)
- Overloaded. The wire size must be sufficient for the current required.
- With removed or compromised ground prong or ground protection
- Frayed or damaged

2.2.2.1 Temporary Use of Daisy-chaining

Daisy-chaining of extension cords is not generally allowed (see above), however, extension cord sets may be daisy-chained to provide power. The interconnection of cord sets must be protected from damage and may not directly rest on a surface likely to become wet.

Contact the electrical safety officer before use. Permission may be granted for short-term use where the use of a single cord is not practical, or the use of a single cord set introduces additional hazards. Examples include powering a sound system for an event in the Arrillaga soccer field (several hundred feet), or providing 480-volt power for a welding machine (to avoid ergonomic hazards with long heavy cables).

2.2.3 Acceptable Combinations

There are very few acceptable combinations of extension cords and devices. Some acceptable combinations are the following:

- Extension cord to device (electrical equipment)
- Power strip to device
- Surge protector (with cord) to device
- Direct surge protector to extension cord to device
- Direct surge protector to power strip to device

2.3 Relocatable Power Taps (Power Strips)

General purpose *relocatable power taps (power strips)* are designed for use with low-powered loads, such as computers, peripherals, or audio/video components. *Power distribution units (PDUs)* are available designed to support information technology equipment such as rack-mounted computers or research equipment.

- Only UL (or other NRTL) approved devices may be used.
- Power strips may not be permanently mounted to any facility surface. Power strips may hang from screws or hooks if they are manufactured with slots or keyholes.
- Power strips must be directly powered from a receptacle. Use of an extension cord or hard wiring is not permitted.
- In equipment racks, the preferred method of supplying 120/208-volt utility power to rack-mounted instruments is through the use of a relocatable power tap or power distribution unit specifically designed to be rack-installed.

2.4 Selection of Conductor Sizing

For all devices above, the maximum current allowed is based on the gauge (or size) of the current-carrying conductors in the cable. Two factors must be considered in selecting a cord: 1) Underwriter Laboratories has established a maximum current allowable on a conductor, and 2) the cable resistance (Ohm's law) multiplied by the current results in a voltage drop through the conductor. The voltage drop is not a determining factor for cables lengths less than 25 feet.

2.4.1 Maximum Allowable Current

Maximum allowed current versus wire size is found in the following table. (Note the Consumer Product Safety Commission has established a minimum wire size of 16 AWG for 120-volt service cords.²)

Table 1 Ampacity of Flexible Cord

Conductor Size	Amperes	
	Two Conductors	Three Conductors
18 AWG / 1 mm ²	10 A	7 A
16 AWG / 1.5 mm ²	13 A	10 A
14 AWG / 2.5 mm ²	18 A	15 A
12 AWG / 4 mm ²	25 A	20 A
10 AWG / 8 mm ²	30 A	25 A
8 AWG / 10 mm ²	40 A	35 A
6 AWG / 16 mm ²	55 A	45 A
4 AWG / 24 mm ²	70 A	60 A
2 AWG / 35 mm ²	95 A	80 A

Based on NFPA 70 Table 400.5(A)(1), "Ampacity for Flexible Cords"

2.4.2 Derating of Conductors

When using flexible cords, the minimum gauge for the conductors must be increased to avoid excessive voltage drop. The round-trip voltage drop, based on the nameplate amperage requirement of the equipment, should in general not exceed 5 percent.

2 *Federal Register*, Volume 80, Number 143 (Monday, July 27, 2015), Pages 44262–44269, "Substantial Product Hazard List: Extension Cords" ([80 FR 44262](#))

Table 2 Cord Lengths versus Gauge Number Based on Nameplate Amperage of Equipment (120-volt single-phase service, 5% voltage drop)

	18 AWG	16 AWG	14 AWG	12 AWG	10 AWG
25 ft	10 A	13 A	18 A	25 A	30 A
50 ft	N/A	12 A	18 A	25 A	30 A
75 ft	N/A	8 A	13 A	20 A	30 A
100 ft	N/A	6 A	10 A	15 A	25 A
200 ft	N/A	N/A	5 A	8 A	12 A
300 ft	N/A	N/A	N/A	5 A	8 A

Calculation of maximum current for a 5% voltage drop. Resistance of cabling can be found in the NFPA 70, Chapter 9, Table 8.

$$I_{max} = \frac{0.05 * SystemVoltage}{2 * Length * Resistance_{per\ length}}$$

3 Forms

The following forms and systems are required by these requirements:

- None

4 Recordkeeping

The following recordkeeping requirements apply for these requirements:

- None

5 References

[SLAC Environment, Safety, and Health Manual](#) (SLAC-I-720-0A29Z-001)

- [Chapter 8, “Electrical Safety”](#)
 - [Electrical Safety Manual](#) (SLAC-I-730-0A11A-002)
 - [Electrical Safety Program Site](#) (SharePoint)
- [Chapter 51, “Control of Hazardous Energy”](#)

Other Documents

- Title 16, *Code of Federal Regulations*, “Commercial Practices”, Chapter II, “Consumer Product Safety Commission”, Subchapter B, “Consumer Product Safety Act Regulations”, Part 1120, “Substantial Product Hazard List” ([16 CFR 1120](#))

- *Federal Register*, Volume 80, Number 143 (Monday, July 27, 2015), Pages 44262–44269, “Substantial Product Hazard List: Extension Cords” ([80 FR 44262](#))
- National Fire Protection Association (NFPA) 70, *National Electrical Code (NEC)* ([NFPA 70](#))
- Underwriters Laboratories (UL) 817, “Cord Sets and Power-Supply Cords” ([UL 817](#))