

California Institute of Technology

ELECTRICAL SAFETY AWARENESS PROGRAM



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PURPOSE

The purpose of the Electrical Safety Awareness Program is to provide information about electrical hazards to Caltech faculty, researchers, students, and employees to prevent exposure to and injury from electrical hazards. This Program is designed to comply with the California Occupational Safety and Health's (Cal/OSHA's) Electrical Safety Orders. In addition, elements of this Program follow the intent of the National Fire Protection Association (NFPA) 70E and NFPA 70B.

SCOPE

The Program applies to all trades' people, grounds and custodians' employees, researchers and office employees who need to have an awareness level of electrical safety but are not expected to perform work directly on electrical equipment and that would require them to operate as a "qualified electrical person."

This Program does NOT apply to Caltech employees who have the potential to work near or on exposed, energized electrical equipment 50 volts or greater or contains a burn (arc flash hazard) greater than 1.2 calories/cm² incident energy. For these activities, please refer to the [Caltech Electrical Maintenance and Construction Safety Program](#).

ROLES AND RESPONSIBILITIES

ENVIRONMENTAL HEALTH AND SAFETY OFFICE (EH&S)

EH&S is responsible for:

- Periodically performing a review of the Cal/OSHA electrical safety requirements for general awareness and consulting with experts to identify regulatory changes and update the Electrical Safety Awareness Program accordingly.
- Identifying and/or developing and administering Electrical Safety Awareness training for students and staff.
- Including electrical safety items (such as use of electrical extension cords, blocked electrical panels, etc.) in periodically conducted safety inspections (labs and facilities).

FACULTY AND SUPERVISORS

Faculty and Supervisors are responsible for:

- Ensuring the procurement of safe electrical equipment in the workplace (laboratories and offices).
- Ensuring that students and employees' projects and tasks do not pose significant electrical risk, and work with EH&S for projects where higher electrical risks are identified.
- Establishing, implementing, and maintaining procedures and/or work practices that ensure safe work conditions as outlined in this Program.
- Reporting incidents, near-misses or potentially hazardous operation or conditions to EH&S.
- Taking corrective action to control any potentially hazardous operation or conditions.
- Completing the required training per the requirements of this Program.
- Maintaining training documentation when applicable.

STUDENTS AND STAFF (UNQUALIFIED ELECTRIC PERSON)

Students and staff, including trades people who are not specifically identified and trained to be Qualified Electrical Workers are considered an "Unqualified Electric Person", and each are:

- Responsible for completing required electrical safety awareness training when assigned ([see training matrix](#)).
- Responsible for recognizing electrical hazards as described in this Program.

- Prohibited from performing energized electrical work or working near exposed energized conductors.
- If working with or near a Qualified Electrical Person performing electrical work, following all their instructions such as, but not limited to, refraining from crossing a Limited Approach Boundary.

CAMPUS GENERAL ELECTRICAL SAFETY AWARENESS PROGRAM ELEMENTS

Electrical current is measured in *amperes*. The higher the current, the greater the damage. The table below shows the general relationship between the level of current exposure to a person and the reaction they may experience when current flows from one of their hands to a foot for just 1 second.

REACTION OF THE HUMAN BODY TO ELECTRICAL CURRENT	
Effect of AC current (95% of Young Adults Average weight = 115-150 lbs.)	
Perception Threshold - tingling sensation	0.7-1 mA
Slight Shock (not painful) - no loss of muscle control	1.2-1.8 mA
Shock (painful) - no loss of muscle control	6-9 mA
Shock (severe) - muscle control loss, breathing difficulty, onset of <i>let go</i> threshold	15-23 mA
Possible ventricular fibrillation - 3 send shock	0.1 A
Possible ventricular fibrillation - 1 send shock	0.2 A
Heart muscle activity ceases	0.5 A
Tissue and organ burn	1.5 A

Source: *Electrical Safety in the Workplace* Ray and Jane Jones - Jones & Bartlett Learning; 1st edition (January 1, 2000)

PROCUREMENT OF OFFICE/LABORATORY EQUIPMENT

All electrical equipment whether used in a laboratory or office should be UL/NRTL ([Nationally Recognized Testing Laboratory Program](#))-listed and in good condition.

- Always purchase equipment that is compatible with US electrical standards.
- Always use equipment in accordance with Manufacturer's instructions.
- Examine all electrical equipment and cords prior to use for loose connections, frayed wiring, and for cut or damaged insulation.
- Keep electrical equipment and power cords away from heat, water, and oil.

USE OF PERSONAL ELECTRICAL SPACE HEATER

The use of a personal space heater in an office or laboratory is not allowed at Caltech. If experiencing indoor temperature issues, please contact the Facilities Service Center at ext. 4717 or open a [Facilities Service Request](#). If Facilities cannot resolve the issue in a timely fashion, a **temporary** personal space heater or cooler can be considered upon assessment of the space and equipment by EH&S. Please contact safety@caltech.edu for more information.

USE OF EXTENSION CORDS (OFFICE AND LABORATORY)

Extension cords provide a convenient method of bringing AC power to a device that is not located near a power source. **They are used as temporary power sources.** They should not be stepped on, tripped over, stretched, cut, overloaded, and, in general, used improperly.

Extension cords are for temporary use: In general, roll up the cord at the end of the day or when the task is completed (whichever comes first). If an extension cord is required for the same work at the same location on a continual basis, contact the Facilities Service Center to request installation of an additional receptacle where the power is needed, or move the equipment to the nearest wall receptacle.

- Do not “daisy-chain” or interconnect extension cords or power strips.
- Check cords and power strips for damage each time you use them.
- Do not use extension cords in place of permanent facility wiring.
- Use only approved and properly maintained extension cords that have no exposed live parts, exposed ungrounded metal parts, are damaged, or have been spliced.
- Use only extension cords that are listed and labeled in accordance with UL817.
- Use extension cords that are protected by a ground fault circuit interrupter (GFCI) around construction sites, in damp areas, or in an area where a person may be in direct contact with a solidly grounded conductive object (e.g. working in a vacuum tank).
 - The GFCI can consist of a special circuit breaker, a GFCI outlet, or an extension cord with a built-in GFCI as an extra layer of safety.
- Ensure that the extension cord is of sufficient current-carrying capacity to power the device in use.
 - Use of an undersized cord results in an overheated cord and insufficient voltage delivered to the device, thus causing device or cord failure and a fire hazard. Undersized cords also constitute a serious shock hazard as they may not allow the breaker feeding it to trip.
- Always use three-conductor (grounded) extension cords, even if the device has a two-conductor cord. **Never use two-conductor extension cords.**
- If extension cords cross foot-traffic aisles, use cord protectors of a bright color, preferably orange or yellow, to highlight the cord and protect it against impact.
- If extension cords cross vehicle traffic aisles or roadways, use cord protectors strong enough to prevent vehicle contact with the cord.
- Avoid running extension cords through doors, ceilings, windows, or holes in the walls. If it is necessary to run a cord through a doorway for short term use, ensure that the cord is protected from damage and removed immediately when no longer in use.
- Make sure extension cords are not a tripping hazard.

USE OF POWER STRIPS (OFFICE AND LABORATORY)

A relocatable power tap (also referred to as a *Power Strip*) is a variation of an extension cord where the cord terminates in a row or grouping of receptacles. Relocatable power taps are commonly used in offices to provide multiple receptacles to office equipment. In general, all rules pertaining to extension cords also apply to relocatable power taps.

Relocatable power taps are not rated for heaters, refrigerators, toaster ovens, or other high-power, high-current drawing devices. They may be used only for office equipment such as computers, printers, etc.

- The total load on the relocatable power tap must not exceed 1440 watts or 12 amperes. Any single load (single receptacle) must not exceed 600 watts (5 amperes).
- Do not permanently mount relocatable power taps to any facility surface.
- **Relocatable power taps are classified as temporary devices.** It is acceptable to hang them from screws or hooks if they are manufactured with slots or keyholes specifically designed for this use.
- In equipment racks, the preferred method of supplying 120/208V utility power to rack mounted instruments is via a special relocatable power tap specifically designed to be rack installed.
- Relocatable Power taps must be listed in accordance with UL1363.

FLEXIBLE CORDS

Flexible cords are those cords that are exposed, flexible, unsecured, and more susceptible to damage than fixed wiring. Flexible cords and cables may be used for:

- Pendants, Wiring of fixtures, Connections of portable lamps or appliances.

- Elevator cables.
- Crane and hoist wiring.
- Connecting stationary equipment which requires frequent interchange.
- Power cables (AC) for data-processing equipment.

When flexible cords and cables are used for lamps or appliances, they must be equipped with an approved attachment plug and energized directly from a receptacle outlet.

- Do not modify or install cord caps (the attachment plug) on cords.
- Flexible cord and cable, attachment plugs, and receptacles must be of the proper type, size, voltage and current rating for the intended application.
- Branch circuits that feed cord-and-plug connected equipment must be designed, have over-current protection, and be grounded in accordance with the National Electrical Code.
- All cord-and-plug-connected equipment must be grounded with a correctly sized and identified equipment-grounding conductor that is an integral part of the ac power cord or cable. Exception: Listed equipment that is protected by a double insulation system or its equivalent.
- Cord-and-plug connection of equipment that operates at 250V or less and has a maximum circuit rating of 30A is allowed. Any equipment operating at higher voltages or currents should be permanently connected. Exception: portable arc welders, portable equipment, movable equipment.

Flexible cords must NOT:

- Be substituted for the fixed wiring of a structure.
- Run through holes or be concealed in walls, ceilings, or floors.
- Run through doorways, windows, or similar openings.
- Be attached to building surfaces.
- Installed in electrical raceways, unless specifically allowed by NEC provisions covering electrical raceways.
- Installed outdoors for more than 1 week except for construction project sites where temporary power may be needed for longer periods of time.
- Except for the temporary wiring provisions of the NEC, the NEC does not allow the cord-and-plug connection of equipment to be energized from extension cords. Extension cords are not acceptable substitutes for the fixed wiring of a structure such as a receptacle outlet.
- In industrial locations, such as shops, a suitable guard or cover must protect the interface between attachment plug and receptacle from intrusion of process waste or other foreign material, such as cutting oils and machining chips.
- When using power strippers (spiders), one must pay attention to not overloading the amperage capacity of the main power flexible cord.

This guidance does not cover portable hand-operated power tools, small kitchen appliances, office equipment, electronic instruments, personal computers, and other similar equipment.

SPECIAL PRECAUTIONS FOR OUTDOORS AND WET/DAMP LOCATIONS

- When using portable tools within six feet of a water source, or while working in damp locations or outdoors, use a ground fault circuit interrupter (GFCI) unit. The GFCI may be part of a fixed outlet, part of an in-line extension cord, or a separate unit (e.g., a multiple outlet GFCI-protected spider box).
- When removing standing water, observe the following precautions:
 - In general, remove standing water with power disconnected.
 - Ensure that electrical equipment used to remove water is rated for wet work and is connected to a GFCI-equipped power source.
 - Ensure that extension cords have molded end caps free of defects in their insulation.

ELECTRICAL EQUIPMENT IN RESEARCH LABORATORIES

RESEARCH INVOLVING FABRICATING OR MAINTANING ELECTRICAL EQUIPMENT

Faculty requiring the use, maintenance, or engineering of high voltage equipment for their research projects must have safe procedures and PPE in place. Contact EH&S for assistance in performing a risk assessment on their operation, projects, instruments or engineering plans posing electrical hazards to them or other laboratory personnel.

POWER SUPPLIES USED IN HUMAN SUBJECTS EXPERIMENTS

All research involving power-supplied research apparatus / equipment intimately in contact with human subjects must have fail-safe monitoring of output power circuits. Such power supplies must be able to detect any ground fault or phase-to-phase fault on the output of the power supply and immediately (within three-cycles) shut-down the output of the power supply to the research apparatus. Such power supplies must be manufactured, tested, and approved by an NRTL to be failsafe for use on Human Subjects Experiments.

QUALIFICATION LEVELS AND REQUIRED TRAINING

GENERAL ELECTRICAL AWARENESS LEVEL

Caltech students and staff are introduced to general electrical safety awareness topics during their onboarding at Caltech. Topics presented include:

- Understanding of electrical hazards and effects
- Appropriate use of power cords, power strips, and other safe practices.
- Recognition of defective wiring.
- Emergency procedures.

EMERGENCY RESPONSE

In case of an Emergency: Call Caltech Security at ext. x5000 or 626-395-5000

Key Caltech personnel have been trained in First Aid, Cardiopulmonary Resuscitation (CPR), and automated external defibrillation (AED) techniques.

Outside Medical Response: Caltech relies on the support of the City of Pasadena Fire Department Emergency Responders who are located adjacent to campus to provide outside medical response in the event an emergency occurs.

RECORDKEEPING

All documentation related to the Caltech Electrical Safety Awareness Program will be kept in accordance with Caltech's Retention Policy.