Attachment 10 - Design and Installation Practices

Research Equipment Fabrication and Maintenance

- Design and construct equipment to protect personnel.
- First-line and backup safeguards should be provided to prevent personnel from accessing energized circuits operating over 50 volts and 5 milliamperes, or less than 50 volts and more than 1,000 watts.
- Establish periodic tests to verify that these protective systems are operative.
- Designs
    - Have designs reviewed: All systems and modifications to systems performing a safety function or controlling a potentially hazardous operation must be reviewed and approved by the Faculty Sponsor or project engineer.
    - Have designs and operation verified: All systems performing safety functions or controlling a potentially hazardous operation must be validated by actual test procedures before being placed in service, at least once a year (for on-going projects), and anytime the system is suspected of malfunction. Both the procedures and actual tests must be documented.
    - The Department responsible for the project and equipment must maintain all system and component documentation pertaining to the design safety features of the equipment, including any test data. This documentation must be available at any time to any safety inspector or EHS.
- Equipment Acceptability
    - Electrical equipment is considered safe only when it is used as specifically intended by its listing and design. Equipment must not be altered beyond the original design intent, and must not be used for any purpose other than that for which it was constructed.
    - Any equipment that is being re-commissioned must be examined and/or tested, as appropriate, to verify the status of all safety features and the integrity of construction.
    - Electrical equipment, and electrical components used in experimental apparatus, should be listed or labeled by a Nationally Recognized Testing Laboratory (NRTL).
    - The inspector or EHS may require that equipment that is not NRTL-listed undergo inspection and/or testing for conformance to standards. Such testing should be documented and submitted to EHS for approval. The inspection record must specify, at minimum:
        - Equipment identification;
        - Evaluator name, date, mailstop, and extension;
        - Standard to which equipment is being evaluated;
        - Specific tests, results, and areas of examination;
        - Any conditions of product acceptability or limitations of use.
        - Inspection records are kept at the site of the apparatus with copies in the experimental records.
- Equipment Safety Practices
    - Cable Clamping: A suitable mechanical-strain-relief device such as a cord grip, cable clamp, or plug must be used for any wire or cable penetrating an enclosure where external movement or force can exert stress on the internal connection.
    - Isolation: Isolate all sources of dangerous voltage and current with covers and enclosures. Access to lethal circuits (greater than 50V) must be either via screw-on panels (each containing no fewer than four screws or bolts) or via interlocked doors, panels, covers, etc. The frame or chassis of the conductive enclosure must be bonded to electrical ground with a conductor capable of handling any potential fault current.
    - Lighting: Provide adequate lighting for easy visual inspection.
    - Disconnecting Means and Overload Protection: Provide overload protection and well-marked disconnects. Local “off” controls must be provided on remote-controlled equipment.
    - All disconnects and breakers must be clearly labeled to identify the loads they control.
    - Power: All ac and dc power cabling to equipment not having a separate external ground but having line-to-line or line-to-ground voltage greater than 50V must have an equipment-grounding conductor unless cabling is inside an interlocked enclosure, rack, grounded wire

way, or conduit, or feeds a commercial double-insulated or UL-listed ungrounded device. If the grounding of equipment introduces a greater hazard, the equipment must not be grounded.
    - Rating: Operate all conductors, switches, resistors, etc., within their design capabilities. Pulsed equipment must not exceed the average, the rms, or the peak rating of components. The equipment must be de-rated as necessary for the environment and the application of the components.
    - Safety Grounding of Capacitive Components: Use automatic-discharge devices on equipment with stored energy of 100J or more. Suitable and visible manual-grounding devices must also be provided to short-to-ground all dangerous equipment while work is being performed.
    - Electrical Enclosures and Equipment Rooms: Place an identifying label or sign on the door access panel when equipment that may require servicing, manipulation, or inspection is concealed in an enclosure, equipment closet or otherwise is obscured behind doors or panels.
    - Reuse of Circuit Breakers: Do not purchase used or reconditioned circuit breakers from vendors outside SCU. Reuse of SCU circuit breakers is permitted only after the circuit breaker has been tested by the SCU Electric Shop.
    - Only use circuit breakers designed to be installed in specific distribution boxes per manufacturer model number.
- Enclosures
    - The following specifications apply to circuits operating at greater than 50V, or storing more than 100J. An enclosure may be a room, a barricaded area, Faraday cage or an equipment cabinet:
    - Access: Interlock easily opened doors, hinged panels, etc., that allow ready access to exposed energized components so that the act of opening de-energizes the circuit. Automatic discharge of stored-energy devices must be provided.
    - Doors: Doors should be key-locked, and the same key should also be used for the locks in the control-circuit interlock chain, if applicable. This key must not be able to be removed from the door unless the door is closed and locked.
    - Heat: Mount heat-generating components, such as resistors, so that heat is safely dissipated and does not affect adjacent components.
    - Isolation: Ensure that the enclosure physically prevents contact with live circuits. The enclosure can be constructed of conductive or nonconductive material. If conductive, the material must be electrically bonded and connected to a good electrical ground. These connections must be adequate to carry all potential fault currents.
    - Seismic Safety: Secure all racks, cabinets, chassis, and auxiliary equipment against movement during earthquakes.
    - Strength: Ensure that enclosures are strong enough to contain flying debris caused by component failure.
    - Ventilation: Ensure that ventilation is adequate to prevent overheated equipment, and to purge toxic fumes produced by an equipment fault. Ventilation openings must not be obstructed.
    - Visibility: Ensure that enclosures large enough to be occupied by personnel allow exterior observation of equipment and personnel working inside the enclosure.

Cord and Plug Equipment (Testing and Maintenance)

An unqualified worker may remove covers and work on electrical equipment that has stored energy below 1000 joules and which is powered only through a 120 Volt Line-Cord that can be unplugged and positively controlled.

When electrical equipment has stored energy above 1000 joules and is only powered through a 120 Volt Line-Cord that can be unplugged and positively controlled then a qualified worker, wearing the PPE listed below must verify that all stored energy in the chassis has dissipated. Once the electrical safe condition is

verified requirements for PPE and worker qualification are no longer in effect until the chassis is reenergized.

PPE requirements for verifying the safe state of 120 Volt cord and plug equipment:

- Natural fiber long-sleeve shirt
- Natural Fiber long pants
- Natural Fiber Undergarments
- Non-conductive safety glasses
- Voltage rated gloves and leather protectors
- Voltage rated tools
- Category III or IV Multimeter
- Supervisor briefing or written procedure task specific to the equipment

Heating Tapes and Cords

Many experiments at SCU use heating tapes or cords, including many high vacuum apparatus. The heating tapes or cords pose an electrical shock hazard if not used properly. This section establishes requirements for the proper selection, care, and use of heating tapes and cords. These guidelines also apply to heating pads, wraps, or similar components intended to be applied directly to laboratory apparatus. Exemptions to the below requirements must be approved by EHS.

General Electrical Safety Requirements for Use of Heating Tape

- Read all of the manufacturer's instructions before using any heating device.
- Whenever possible, use heating tapes that bear a Listing mark by UL or another Nationally Recognized Testing Laboratory (NRTL).
- Use three-wire (grounded) heating tape and cord systems whenever practical. Two-wire heat tapes and cords, while allowed for use at SCU, are inherently less safe than three-wire systems.
- Inspect heating tapes and cords before use and discard any that display signs of excessive wear, fraying, or overheating. Do not repair damaged items.
- Properly ground all conductive equipment surfaces before heating tapes are powered.
- Equipment undergoing heating with a variable AC transformer controlled heat tape must be monitored on a regular basis to prevent overheating of either the chamber or the heating device.
- Heating tapes and cords with an AC plug that can be split into two pieces must have the plug replaced or glued together.
- Use heat tapes only on surfaces for which they are designed. Glas-Col® heating cords are an example of a cord that may not be used at SCU for any purpose but heating glassware and non-metallic apparatus.
- If you are unsure whether or not your heating tape or cord is approved for use at SCU, contact the EHS Safety Engineer.

Heating Tape Power Source Requirements

A Ground Fault Current Interrupter (GFCI) protected power source must be used. Portable GFCI adaptors are acceptable. Before use, the GFCI must be tested: depress the "TEST" button, verify that the "RESET" button pops out, and then depress the "RESET" button.
A maximum of 1920 Watts of heating capacity may be placed on a 20-amp circuit breaker.
A maximum of 1440 Watts heating capacity may be placed on any individual power cord, receptacle, or relocatable power tap (power strip).

Circuit Breaker Trip
If a circuit breaker trips during a heating operation, this is usually because the circuit is overloaded. Disconnect an appropriate number of the heat tapes and reset the breaker. If the breaker

trips again, call an SCU qualified electrical worker or EHS for help.

GFCI Trip
If a GFCI trips during the heating operation, it is permissible to reset the GFCI one time. Personnel must remain clear of equipment when the GFCI is reset. If the GFCI trips again, all of the heating tapes must be disconnected and thoroughly inspected for damage. If the problem persists, call a SCU qualified electrical worker or EHS.

Variable Transformer Issues
If the fuse blows in the device, replace the blown fuse only with a fuse rated for the device. Using a higher current fuse than rated for the device will allow overheating and may cause a fire. Variable transformers and other control devices for heat tape control should be periodically checked by a qualified electrical worker for receptacle tension and proper fusing.

Flexible Cords

Because cord and plug connections are generally well understood, this instruction does not cover portable hand-operated power tools, small kitchen appliances, office equipment, electronic instruments, personal computers, and other similar equipment.

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 that requires frequent interchange.
- Preventing transmission of noise or vibration.
- An appliance or equipment with fastenings and mechanical connections specifically designed to permit removal for maintenance and repair, and intended or identified for flexible cord connection.
- Power cables (ac) for data-processing equipment.
- Connecting moving parts.

When flexible cords and cables are used for lamps or appliances they must be equipped with an approved attachment plug and energized from a receptacle outlet. Only qualified persons may install cord caps, (the attachment plug), on 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.

Branch circuits that feed cord-and-plug connected equipment must be designed, have over current protection and be grounded in accordance with the CEC.

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 are allowed where the fastening means and mechanical connections are designed to permit removal for maintenance and repair, operates at 250V or less and has a maximum circuit rating of 30 A. Any equipment operating at higher voltages or currents should be permanently connected. (Exception; portable arc welders) "

Forbidden Uses of Flexible Cables:

- Substituted for the fixed wiring of a structure.
- Run through holes in walls, ceilings, or floors.
- Run through doorways, windows, or similar openings.
- Attached to building surfaces.
- Concealed behind building walls, ceilings, or floors.
- Installed in electrical raceways, unless specifically allowed by CEC provisions covering electrical raceways.

Except for the temporary wiring provisions of CEC, the CEC does not allow the cord-and-plug connection of equipment to be energized from extension cords. Extension cords are not legitimate 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.

Use of 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 used as temporary power sources. Extension cords are probably involved in more electrical-code and safety violations than any other device at SCU. They are stepped on, stretched, cut, overloaded, and, in general, used improperly.

Guidelines for the Safe Use of Extension Cords:

- Use only approved and properly maintained extension cords that have no exposed live parts, exposed ungrounded metal parts, damage, or splices and not home-made extensions.
- Use only heavy-duty or extra-heavy-duty rated cable.
- 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.
- Ensure that the extension cord is of sufficient current-carrying capacity to power the device. 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 it 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.
- Extension cords are for temporary use: In general, roll-up the cord at the end of the day. If an extension cord is required for the same work at the same location on a continual basis, you should call Facilities to install an additional receptacle where you actually need the power, or move the equipment. Do not daisy-chain extension cords. Check the cord for damage each time you use it. Electricians can repair damaged cords.

Avoiding Misuse of Extension Cords: Observe the following restrictions to avoid misuse of extension cords:

- Do not use extension cords in place of permanent facility wiring.
- 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.
- Removed immediately when no longer in use.
- Not a tripping hazard.

- Do not daisy chain extension cords (i.e., plug one extension cord into another extension cord).
- Do not overload extension cords. Make sure that the wire size is sufficient for the current required.
- Do not cut off the ground pin of an extension cord or compromise the ground protection in any way.
- Do not use extension cords with a ground conductor that has less current-carrying capacity than the other conductors.
- Do not use frayed or damaged extension cords.
- Never splice extension cords, even for a repair. If an extension cord is damaged, it may be made into two cords, provided the proper connectors are used in a proper manner. Only qualified personnel may install cord caps for use with potentials greater than 50V.
- Only qualified personnel may make repairs of extension cords.

Acceptable Combination (for Office Only)

- One single extension cord (single outlet) to a power strip (with over current protection) to a computer system is not recommended, but will be accepted to provide power to personal computer systems and peripherals only when there is no other reasonable way to do so. This is an interim solution, limited to 600 watts total load. For long-term installation a premises wiring outlet at the computer system will be required.
- Relocatable Power Strips/Power Taps (for Office and Lab Bench Tops Only)
- 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.

Additional considerations are:

- Relocatable power taps are not rated for heaters, refrigerators, toaster ovens, or other high power devices. They may be used only for office and laboratory 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.
- 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.

Portable Workbenches

This section covers laboratory and shop workbenches that can be moved by sliding, rolling, etc. It does not cover built-in workbench assemblies that are permanently attached to structure surfaces. Such built-in assemblies must use appropriate fixed-wiring methods to provide power for receptacles, lighting fixtures, ventilation fans, etc., in accordance with the CEC.

Flexible cord and plug assemblies may be used to provide ac power to portable workbenches only when:

- The branch circuit voltage supplying the workbench is 150V or less.
- The over current protection device rating on the branch circuit supplying the workbench is 20A or less.
- The flexible cord is no longer than 4.5 m (15 ft), is attached to the workbench with an approved tapered rubber-bushing cord-grip fitting, is no smaller than #14 AWG, is type-listed under the CEC as “Extra Hard Usage” (Type SO, G, W, etc.), is protected from physical damage, is routed to prevent tripping hazards, and is terminated in a listed attachment plug and mating receptacle interface that has the proper voltage and current rating for the branch circuit feeding the workbench.

- Each workbench has its own cord, attachment plug, and branch circuit receptacle. Workbenches must not be parallel fed or daisy chained by plugging their power cords into a receptacle located on another workbench.
- Each workbench wiring system has equipment-grounding protection that consists of a correctly sized and identified equipment-grounding conductor. This grounding conductor must be an integral part of the flexible cord. Grounding circuit continuity must be provided by the branch circuit wiring feeding the workbench, and at the interface between attachment plug and receptacle.
- All metal surfaces of the workbench assembly that are likely to become energized by an electrical fault are properly bonded to the equipment grounding conductor in accordance with the CEC.
- The number of workbench receptacle outlets is limited to no more than 10 duplex receptacles or 3 linear meters (10 linear ft) of wire-mold plug strip on a 15A branch circuit, or 13 duplex receptacles or 4 linear meters (13 linear ft) of an approved multi-outlet assembly on a 20A branch circuit. In any case, the continuous load fed by the workbench outlet receptacles must not exceed 80% of the rating of the branch circuit that feeds the workbench.
- Each workbench has proper seismic anchoring or other restraint against unintentional movement so that the cord-and-plug AC input power assembly is protected from damage resulting from tension, pinching, crushing, etc.
- If the bench is fitted with a metallic or otherwise conductive work surface, the workbench wiring system is protected by an approved GFCI.

Power Supplies

Primary Disconnect
Provide a lockable means of positively disconnecting the input on large power supplies. This disconnect must be clearly marked and accessible.

If provided with a built-in lock that is part of an interlock chain, the key must not be removable unless the switch or breaker is in the “off” position.

Overload Protection
Overload protection must be provided on the input and should be provided on the output.

Floating Power Supplies
Some research equipment (e.g., electrophoresis devices, x-ray tubes, and ion-bombardment power supplies) employ ungrounded (floating) power supplies. This equipment may operate in voltages ranging from 50V to kilovolts, with output capacities in excess of 50mA, and must be considered a lethal electrical hazard. Users of such equipment must take special precautions to minimize electrical hazards. Follow all manufacturers’ instructions for equipment use, testing, and training.

The following general guidelines also apply:

- Locate equipment away from water and large metal areas.
- Do not use connectors and jack fittings that allow accidental skin contact with energized parts.
- Interlock readily accessible enclosures.
- Use nonmetallic secondary containment if liquids or gels are involved.
- Verify that the power supply is floating when commissioning and recommissioning the equipment and at least once a year.

Capacitors

This section describes some key practices for both high and low voltage capacitors. For further details the CEC and CalOSHA should be consulted.

Low voltage (<600v) capacitor safety practices:

- Capacitors containing more than 3 gallons of flammable liquid are enclosed in vaults or outdoor fenced enclosures.
- Capacitors are enclosed, located, or guarded so that persons cannot come into accidental contact or bring conducting materials into accidental contact with exposed energized parts, terminals, or buses associated with them.
- Capacitors are provided with a disconnecting and automatic means of draining the stored charge to 50 volts or less within one minute after the capacitor is disconnected from the source of supply.

High voltage (>600v) capacitor safety practices:

- Capacitors shall be provided with a permanent nameplate giving the makers name, rated voltage, frequency, kvar or amperes, number of phases, and the amount of liquid identified as flammable, if such is the case.
- Capacitors containing more than 3 gallons of flammable liquid are enclosed in vaults or outdoor fenced enclosures.
- Capacitors are enclosed, located, or guarded so that persons cannot come into accidental contact or bring conducting materials into accidental contact with exposed energized parts, terminals, or buses associated with them.
- Capacitors are provided with a disconnecting and automatic means of draining the stored charge to 50 volts or less within five minutes after the capacitor is disconnected from the source of supply.
- A means shall be provided to detect and interrupt fault current liable to cause dangerous pressure within an individual capacitor.
- Single pole individually operated or multiple pole group operated switches used for capacitor switching shall be capable of carrying continuously not less than 135 percent of the rated current of the capacitor installation.
- Care shall be exercised in handling and disposing of failed capacitors because of possible internal pressure and residual energy.

Inductor and Magnets

This section describes some hazards peculiar to inductors and magnets that can store more than 100J of energy or that operate at 50V or more. For further details the CEC and CalOSHA should be consulted.

- The ability of an inductor to release stored energy at a much higher voltage than used to charge it.
- Stray magnetic fields that attract magnetic materials.
- Time-varying stray fields that induce eddy currents in conductive material, thereby causing heating and mechanical stress.
- Time-varying magnetic fields that may induce unwanted voltages at inductor or magnet terminals.

Safety Practices:

- Energy Control. Know and use the SCU LOTO program and policies.
- Automatic Discharge. Use freewheeling diodes, varistors, thyrites, or other automatic shorting devices to provide a current path when excitation is interrupted.
- Connections. Pay particular attention to connections in the current path of inductive circuits. Poor connections may cause destructive arcing.
- Cooling. Many inductors and magnets are liquid-cooled. The unit should be protected by thermal interlocks on the outlet of each parallel coolant path, and a flow interlock should be included for each device.
- Eddy Currents. Units with pulsed or varying fields must have a minimum of eddy-current circuits. If large eddy-current circuits are unavoidable, they should be mechanically secure and able to safely dissipate any heat produced.
- Grounding. Ground the frames and cores of magnets, transformers, and inductors.

- Rotating Electrical Machinery. Beware of the hazards of residual voltages that exist until rotating electrical equipment comes to a full stop. If needed block rotating electrical machinery so that mechanical rotation cannot occur prior to working on it.

Control and Instrumentation Design

Proper philosophy is vital to the safe design of most control applications. The following checklist should be used as a guide.

- Checkout. Check interlocks for proper operation after installation, after any modification, and during periodic routine testing.
- Fail-safe design. Design all control circuits to be "fail-safe." Starting with a breaker or fuse, the circuit should go through all the interlocks in series to momentary on-off switches that energize and "seal in" a control relay. Any open circuit or short circuit will de-energize the control circuit and must be reset by overt act.
- Interlock Bypass Safeguards. Establish a systematic procedure for temporarily bypassing interlocks. Follow-up procedure should be included to ensure removal of the bypass as soon as possible. When many control-circuit points are available at one location, the bypassing should be made through the normally open contacts of relays provided for this purpose. In an emergency, these relays can be opened from a remote control area.
- Isolation. Isolate control power from higher-power circuits by transformers, contactors, or other means. Control power should be not more than 120V, ac or dc. All circuits should use the same phase or polarity so that no hazardous additive voltages are present between control circuits or in any interconnect system. Control-circuit currents should not exceed 5A.
- Lockout. Use a keyed switch in interlock chains to provide positive control of circuit use. To ensure power removal before anyone enters the enclosure, this same key should also be used to gain access to the controlled equipment.
- Motor Control Circuits. Motor circuits must have a positive disconnect within view of the motor or, if this is not practical a disconnect that can be locked open by the person working on these motor circuits.
- Overvoltage Protection. Control and instrumentation circuits used with high-voltage equipment must have provision for shorting fault-induced high voltages to ground. High-voltage fuses with a high-current, low-voltage spark gap downstream from the high-voltage source are recommended. This also applies to all circuits penetrating high-voltage enclosures.
- Voltage Divider Protection. The output of voltage dividers used with high voltages must be protected from overvoltage-to-ground within the high-voltage area by spark gaps, neon bulbs, or other appropriate means.
- Current Monitors. Measure currents with a shunt that has one side grounded, or with current transformers that must be either loaded or shorted at all times.
- Instrument Accuracy. Check instrumentation for function and calibration on a routine basis.

Ground Fault Circuit Interrupters (GFCIs)

GFCI's are designed to protect a person from electric shock when he or she simultaneously contacts a "live" (usually 120V) wire or part and a grounded object. The GFCI works by sensing a difference between the supply and return currents. When the difference exceeds 5mA—indicating that current is flowing to ground (through the person)—the device switches off.

Although the GFCI is an effective safety device, it is not a guarantee against shock in every situation. The GFCI does not protect against a line-to-neutral or a line-to-line shock. Also, if GFCI-protected equipment contains transformers, a ground fault (shock) on the secondary side of the transformer may not trip the GFCI.

GFCI's are normally installed as either circuit breakers or receptacles. In either case, the GFCI may be wired to protect multiple receptacles. Individual GFCI plug-in adapters are also available.

GFCI protection is required for the following conditions:

- Any 120V convenience outlet located within 2 m (6 ft) of an open water source. This does not include emergency eyewash showers or fire sprinklers.
- Any 120V convenience outlet located outdoors.
- Any 120V convenience outlet located within 2 m (6 ft) of a “massive ground.” (A massive ground is a large area of metal, wet earth, or other highly conductive surface that enhances the conductivity to ground of the person touching it.)
- Any extension cord providing power for construction activities.
- Any resistance heating equipment not having a metal covering, such as heating tapes.

The GFCI requirements in conditions 1, 2, and 3 above are being implemented on a phase-in basis. Any new or remodel construction will include the GFCI’s as specified. Existing locations should be prioritized for retrofitting according to relative risk. For example, locations near sinks with heavy electrical use should be retrofitted immediately with GFCI protection.

GFCI’s must be tested before each use, but at least at 30-day intervals. Push the “test” button and observe if the “reset” button pops out and the receptacle turns off. If this does not happen, the GFCI is not functional and must be replaced.

CAUTION: Testing of a GFCI will disconnect all receptacles protected by the GFCI. Before testing, determine which receptacles are protected. Verify that the interruption of power will not adversely affect other activities.

Nationally Recognized Testing Laboratories (NRTL’s)

Whenever possible electrical equipment or electronic components used at SCU should bear the mark of a NRTL. The enhanced safety and reliability of using equipment so tested and certified is considered added component or equipment value.

Applied Research Laboratories, Inc. (ARL)

Communication Certification Laboratory, Inc. (CCL)

FM Global Technologies LLC (FM) Also known as FM Approvals and formerly Factory Mutual Research Corporation

Canadian Standards Association (CSA)

NRTL NRTL/C US C US

Used for products meeting only U.S. standards

Used for products meeting both U.S. and Canadian standards

Curtis-Straus LLC (CSL)

Electrical Reliability Services, Inc. (ERS). Also known as eti Conformity Services and formerly Electro-Test, Inc. (ETI))

Intertek Testing Services NA, Inc. (ITSNA) Formerly ETL Testing Laboratories, Inc.

Warnock Hersey

Entela, Inc. (ENT)

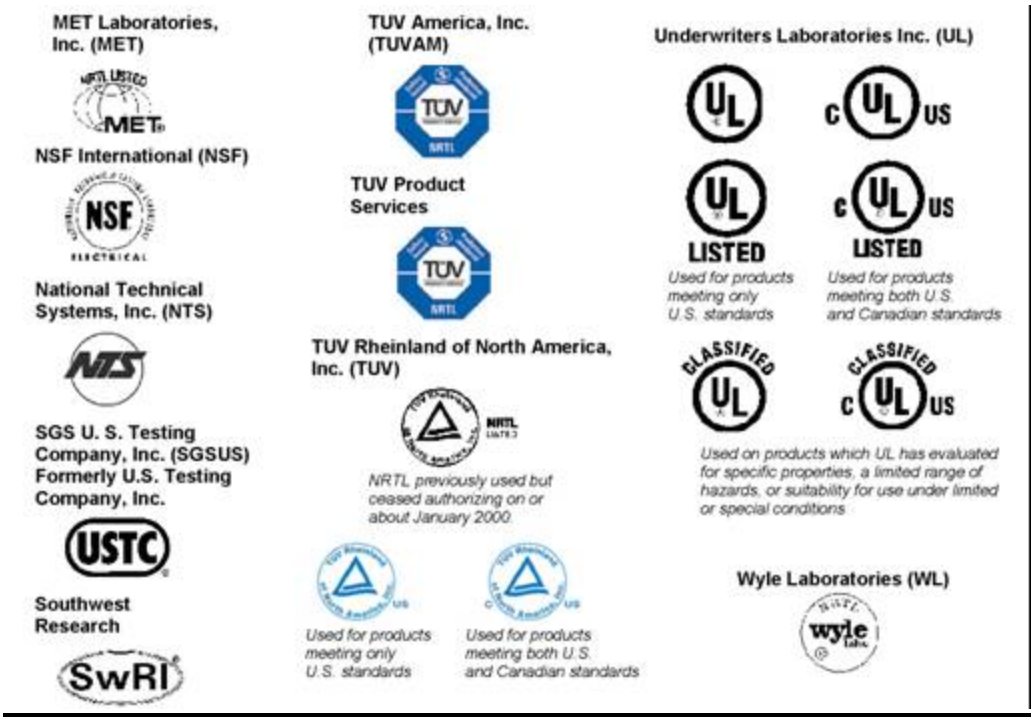
Used for gas-fueled products meeting U.S. standards

Used for products meeting only U.S. standards

Used for products meeting both U.S. and Canadian standards

Used for products meeting only U.S. standards

Used for products meeting both U.S. and Canadian standards


MET Laboratories, Inc. (MET)
NSF International (NSF)
National Technical Systems, Inc. (NTS)
SGS U. S. Testing Company, Inc. (SGSUS) Formerly U.S. Testing Company, Inc.
Southwest Research
TUV America, Inc. (TUVAM)
TUV Product Services
TUV Rheinland of North America, Inc. (TUV)
NRTL previously used but ceased authorizing on or about January 2000
Used for products meeting only U.S. standards
Used for products meeting both U.S. and Canadian standards
Underwriters Laboratories Inc. (UL)
LISTED
Used for products meeting only U.S. standards
LISTED
Used for products meeting both U.S. and Canadian standards
CLASSIFIED
CLASSIFIED
Used on products which UL has evaluated for specific properties, a limited range of hazards, or suitability for use under limited or special conditions
Wyle Laboratories (WL)