

INDUSTRY WIDE LABOR-MANAGEMENT SAFETY COMMITTEE

SAFETY BULLETIN #23

GUIDELINES FOR WORKING WITH LIGHTING SYSTEMS AND OTHER ELECTRICAL EQUIPMENT

All electrical systems and electrically energized equipment are potentially hazardous whether AC or DC: whether 50 volts, 120 volts or higher.

Only employees authorized by the employer to do so should connect, disconnect, or operate electrical systems or equipment.

This Safety Bulletin is intended to warn of potential hazards and to recommend safe practices for trained personnel. This Safety Bulletin is not intended as a design specification nor an instruction manual for untrained persons.

The City of Los Angeles Department of Building and Safety has published **BASIC ELECTRICAL SAFETY AND INSPECTION GUIDELINES FOR MOTION PICTURE AND TELEVISION OFF STUDIO LOT PRODUCTION LOCATIONS**. Those Guidelines are included with this Safety Bulletin for your information.

GENERAL SAFETY MEASURES

PLUGGING AND UNPLUGGING ELECTRICAL EQUIPMENT

Visually inspect the condition of the plug, cable, and equipment for any signs of excess wear, frayed cables or exposed current-carrying parts. **DO NOT USE** any equipment in this condition. Return this equipment for repair.

All grounded equipment should be tested for continuity between the ground pin on the plug and the metal parts of the lighting equipment before it is put into service.

Turn off power whenever possible. Be sure that all equipment that is being plugged and unplugged is in the off position to avoid creating an arc at the receptacle. Wear protective gloves to avoid getting burned from a flash created by short-circuit in the equipment.

Do not pull on the cord when unplugging equipment. This can cause the ground wire to pull out of its termination in the plug. Always grasp the plug firmly to unplug.

Check to be **certain** that you are not plugging Alternating Current (AC) to Direct Current (DC).

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REPLACING FUSES AND CIRCUIT BREAKERS

Over-current protection is one of the most vital parts of the electrical circuit since improper protection leads to fire and/or damage to equipment.

When replacing a blown fuse, be sure to select a fuse of proper voltage, interrupting capacity, and amperage for the application. Fuses come in a wide variety (*i.e.*, one-time, time delay, slo-blow, dual element, etc.), and you should obtain fuse catalogs to become familiar with the different types.

Over-current protection must be sized according to the ampacity of the conductors and equipment served. Use table 310-16 of the National Electrical Code for selecting the proper size for interior permanent wiring. Use table 400-5A or B for flexible cords and cables.

If a circuit keeps tripping or blowing fuses, then you have an overload or equipment failure. You must correct the problem by adding more circuits, balancing the load, or repairing the equipment. NEVER use oversized fuses or circuit breakers or use a copper slug or tubing to replace fuses.

Proper over-current protection must be used whenever there is a change in wire or cable size or receptacle rating in the distribution system. Adapters that reduce the receptacle rating from the plug that feeds them, such as a 100 amp "Bates" to 5-20 amp "Bates", must contain a 20 amp fuse or circuit breaker for each of the 20 amp receptacles.

There is one exception to this rule which allows the over-current device to be located 25 feet after a change in cable size. This rule is commonly referred to as the "25 foot tap rule". (See Sections 240-21, 210-19(a), and 520-69 of the NEC)

POWER TOOLS

Power tools are dangerous unless they are handled with care and respect. If a power tool is treated roughly, dropped, banged around, or gets wet, the insulation may weaken and present the possibility of a shock hazard. If the operator is standing on a wet conductive surface, the shock can be fatal. Secondary wounds can occur even during mild shocks if the operator loses control of his tool.

Power tools should never be carried by their cords and they should never be shut off by yanking the cord from the receptacle. This puts too much stress on the cord and other connections. Insulating platforms, rubber gloves, and rubber mats provide an additional safety factor when working with electrically powered tools in damp locations.

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Regular inspection and maintenance is important. Check the tool over before using it. Is it clean? Is it grounded? The answer to both these questions should be "yes." Make sure the cord is in good condition. Check the trigger. Make sure it works easily, that it doesn't stick, and that the power goes off quickly when the trigger is released.

When using power tools during construction, Ground Fault Circuit-Interrupter (GFI) protection is required. Test the GFI device to see if it is functioning properly. Portable GFI devices are available and should be used when operating tools while standing on an outdoor grade or damp concrete.

ELECTRICAL SYSTEMS SAFETY MEASURES

RIGGING A SYSTEM

Use proper lifting techniques when lifting or moving heavy objects such as cable or lighting equipment. Do not step directly on equipment such as cable. It can roll underfoot and cause a slip or fall.

When rigging the power distribution equipment, do so with all power off whenever possible. Start at the point furthest from the power source and work your way back. Ring out the system with a continuity tester to check for short circuits or crossed wires before tying on to the power source.

CONNECTING ORDER OF SINGLE CONDUCTORS

All single conductor connections shall be made in the following order:

- 1st - Grounds (all AC, and on DC where used)
- 2nd - Neutrals
- 3rd - Hots

Disconnect in the reverse order:

- 1st - Hots
- 2nd - Neutrals
- 3rd - Grounds (all AC, and on DC where used)

All multi-pole connectors used on AC shall provide for "first make, last break" of the ground pole.

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COLOR CODING

Portable cables and conductors should be color coded in such a way that the equipment cannot be improperly connected.

Neutral conductors shall be permitted to be identified by marking at least the first 6 inches from both ends of each length of conductor with white or natural gray. Grounding conductors shall be permitted to be identified by marking at least the first 6 inches from both ends of each length of conductor with green or green with yellow stripes.

Phase conductors (hots) shall be permitted to be identified by marking at least the first 6 inches from both ends of each length of conductor with any color other than green, green with yellow stripes, white, or natural gray.

Where more than one nominal voltage exists within the same premises, each ungrounded system conductor shall be identified by system. This can be done by separate color coding, marking tape, tagging, or other equally effective means.

Where color coding is used to distinguish between different lengths or owners of cable, it must be done so that there is no confusion created.

Yellow should not be used, as it appears white under sodium lighting.

DEVICES AND CABLES

Cables and devices must be protected from foot and automobile traffic.

All electrical distribution systems should be elevated in such a manner that they will not come in contact with running or standing water.

When it is necessary to have electrical distribution systems which come into contact with water, such systems shall be designed and approved for use in water.

Alligator clips or clamps shall not be used in conjunction with any electrical system or equipment.

2-wire, non-polarized DC plugging boxes, paddle plugs, and porcelain boxes are not permitted on AC systems. This applies even with the use of an external ground.

All gang boxes that are supplied by a connector plug that is rated higher in ampacity than the receptacles in the gang box shall contain fuses sized according to the ampacity of those receptacles.

All AC multi-pole connectors shall be grounded and polarized.

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All cable shall be listed by an approved testing laboratory. Only types "G", "W", or Entertainment Industry Stage Lighting Cable (EISL, SC, SCE) is acceptable for single conductor feeder cables. Welding cable can be used only for equipment grounding conductors.

Single conductor connectors used on "hots" and "neutrals" shall be connected to the conductors by means of solder, set-screw, or crimping. Some methods of preventing pull on a cable from being transmitted to joints or terminals are: (1) winding with tape, (2) applying heavy-duty heat shrink, or (3) fittings designed for the purpose.

Equipment Grounding conductor connection devices or fittings that depend solely on solder shall not be used.

GUARDING OF LIVE PARTS

Any part that is live or non-insulated must be covered with appropriate insulation material or protected or barricaded to protect it from any possible contact by person or objects to a point of danger.

When branching off a system that is tied in, shut off the power if possible, and lock-out and/or tag-out all switches that may energize the circuit that you are working on.

Appropriate precautions shall be taken when tying on to an energized system. Be sure that all equipment being hooked up is in the "off" position. Be sure to tie on in the same order as shown above. Wear safety glasses and gloves, and use insulated "T" wrenches and tools. Have someone at the main switch standing by in case of an emergency when doing the actual hook-up.

PORTABLE AND VEHICLE MOUNTED GENERATORS

Read thoroughly any operational manuals provided with the generator. If you do not understand any of the instructions, do not attempt to operate the generator. Only a qualified operator shall operate a generator with amperage rating in excess of 200 amps. Contact your supervisor. The generator should have as much open space as possible on all sides to allow maximum ventilation and minimum interference. It is important that all generating sets be protected from the elements and from unauthorized access.

Extra precaution must be taken when re-fueling the generator. Use U.L. listed fuel nozzles to prevent the build-up of static electricity, which could create a spark and explosion. Make sure that all exhaust fumes are ventilated away from closed areas, personnel, and air conditioning intake ducts. Be aware of hot surfaces and moving parts when servicing the generator.

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One of the most obvious and serious dangers associated with electrical generating equipment is the potential for electric shock. Even a small current can produce severe shock or can prove fatal. There should be suitable barriers between buss-bars, and a substantial mat of non-conductive material or cover over the completed connections to prevent accidental contact.

When tying on to a portable AC generator, the non-current carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles shall be bonded to the generator frame. The Neutral conductor shall be bonded to the frame, and if the generator is mounted on a vehicle, the frame of the generator shall be bonded to the frame of the vehicle.

Generators mounted on trucks or trailers shall be completely insulated from earth by means of rubber tires, rubber mats around metal stairways and rubber mats under any type of lift gate or jacking device. Metal supports for trailers shall be insulated by means of wooden blocks. Safety tow chains shall be secured so as to not touch the ground. If complete insulation is not possible, a grounding electrode system shall be installed per the California Electrical Code, Article 250-83(c) or (d).

Generator Grounding Connections (When Required)

- Interior water pipes, interior metal fixtures, metal frames of buildings, and the building grounding electrode system **SHALL NOT BE USED** as a grounding connection for mobile generators supplying power **EXCLUSIVELY** to location production systems.
- When mobile generators supply power to location production systems **IN ADDITION** to the building's electrical system, the generator's grounding connection **SHALL BE BONDED TO THE MAIN BUILDING GROUNDING ELECTRODE SYSTEM AT THE SERVICE.**
- Multiple generators shall have their grounding connections bonded to each other when located within 20 feet of each other or when one supplies equipment which might possibly come within 20 feet of equipment supplied by the other(s).
- Bonding connectors shall be sized per the California Electrical Code, Article 250-96.

As the generator operator, you are responsible to ensure that all personnel are clear of the equipment before the distribution system is energized.

GROUNDING DIRECT CURRENT/DC SYSTEMS AND EQUIPMENT

Direct current supplied equipment, operating at not over 150 volts between the hot and neutral does not have to be grounded, although it is not prohibited. Care should be

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taken to provide a barrier, either of material or space, between grounded and non-grounded devices.

It is recommended that direct current supplied HMI ballasts be bonded together if they are operated within 10 feet of each other.

If you are using 2-wire, ungrounded equipment on DC, be sure that when you rig a set that you do not unintentionally ground any metal surface such as hanging green beds from water pipes, etc. This can be tested by checking continuity between a "known" ground and any metal surfaces that you are likely to come into contact with during normal working duties. A "no continuity" reading on the meter indicates that there is no ground to that piece of equipment.

GROUNDING ALTERNATING CURRENT/AC SYSTEMS AND EQUIPMENT

All AC systems used by the motion picture and television industry shall be grounded. This generally means that the neutral conductors of the various systems shall be the conductor that is permanently grounded.

All AC supplied equipment shall have all non-current carrying metal parts grounded by a continuously connected equipment grounding conductor, back to the source of power. This conductor shall be sized according to Table 250-95 of the National Electrical Code.

When tying onto house power, the grounding conductor must originate from the ground bus in the same panel board or switchboard that you tied in to for power.

CONNECTING TO PREMISES/HOUSE ELECTRICAL POWER SOURCE

Connecting (tying onto) a premises/house electrical power source such as a panel board or switchboard can create the risk of a serious or fatal accident. Such connections should only be made by a qualified person specifically authorized to do so.

In most cases, an electrical permit must be obtained before such work is done. If the building employs a house electrician, the connection should be done by or under the direction of that electrician.

First, you must calculate the existing demand on the electric panel and determine if there is sufficient capacity left for your equipment. This will prevent over-loading the panel, tripping the main, and shutting down the building.

Use a spare circuit breaker or disconnect switch whenever possible. Use only approved lugs or devices when tying on to the panel bus. "Alligator" clamps are not an acceptable device for this work. NEVER tie on ahead of the main circuit breaker, fuse box, or meter.

Remember, when removing a panel cover, there will be exposed, live parts. Use

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suitable matting of non-conductive material and barriers to protect against accidental contact.

Attach the cables in the proper order: GROUND, first; NEUTRAL, second; LINE or HOT, last. Disconnect in the reverse order.

Be sure that your portable distribution system has a sufficient interrupting rating in the event of a short circuit. Fault currents due to ground faults or short circuits from premises/house power can be at extremely high levels. Be certain your distribution equipment, including the overload protection, is sufficient to handle such high currents.

After you have finished with the house power and you have disconnected your cables, put back all covers and screws that you removed.