

	PRINCETON PLASMA PHYSICS LABORATORY ES&H DIRECTIVES		
	ES&HD 5008 SECTION 2, CHAPTER 15 Live-Line Tools and Temporary Grounding Devices		
Approved	Date: 07/07/05	Revision 6	Page 1 of 5

Chapter 15 **LIVE-LINE TOOLS AND TEMPORARY GROUNDING DEVICES**

Work on outside overhead electrical lines and indoor high voltage electrical components may require the use of safety apparatus and equipment including live-line tools and temporary grounding devices. Some of these tools and devices are used at PPPL to provide temporary energy barriers between potentially energized conductors and personnel. This section defines the safety requirements for such tools and devices.

15.1 DESCRIPTION

The basic component of many live-line tools is the hot-stick, which consists of one or more sections of a fiberglass-reinforced plastic (FRP) pole with a universal mounting head at one end and an end cap at the other. The user can attach a variety of special tools on the head to perform a wide range of functions from a safe operating distance. For example:

- A. When various adapters are attached to the universal mounting head of a hot-stick, it can be used to open and close disconnects, switches, and cutouts, and to manipulate fallen wires.

- B. When a hot-stick is fitted with a suitable clamping head and grounding cable, it is used as a grounding-stick (sometimes referred to as a low-impedance grounding-stick) to short-circuit and ground power-circuit conductors and other potentially live parts of electrical equipment.

- C. Grounding hooks bent in the shape of a shepherd's staff may be used on conductors to drain absorption and capacitive currents to ground. When used, it shall not be subject to power supply fault currents in excess of its rated current.

- D. When an appropriately sized set of discharge resistors is connected between the head and the grounding conductor, the assembly functions as a high-impedance device that is suitable for discharging stored-energy apparatus such as capacitors and inductors.

- E. Grounding sticks used to short and ground a de-energized power-circuit conductor may clutter access aisles or work area or the grounding sticks may be needed elsewhere. To avoid these problems, grounding sticks may be replaced with temporary grounding jumpers each consisting of an un-spliced length of clear insulated extra-flexible grounding conductor having suitable grounding clamps and cable ferrules at each end.

F. The term “portable” is used in conjunction with almost all temporary grounding devices. However, where one end of the grounding conductor is welded to a ground bus, the portability of the grounding device is determined by the length of the cable.

15.2 DESIGN AND CONSTRUCTION CRITERIA

A. Temporary grounding devices used for personnel safety to short and ground power circuits shall have a minimum withstand rating equal to the maximum short-circuit and ground-fault current available at the intended point of connection to the system as determined by the cognizant personnel. Multiple grounds of identical configuration may be used to achieve adequate withstand capacity if they are installed under one safety tag and at one location in a circuit.

B. Temporary grounding devices shall have components that comply with the requirements of NEC Article 250-8 and shall be furnished with clear, insulated, extra-flexible, stranded-copper, grounding conductors, except when the grounding cable is required to be No.2 AWG or larger; then the components of the device shall comply with ASTM Specification F855.

C. Temporary grounding hooks shall be equal to the electrostatic-grounding set as manufactured by A. B. Chance Co., Centralia, Missouri 65240.

D. Insulated collars shall be used on hot-sticks and grounding-sticks to indicate the handling limit. The collars shall be made of rubber or equivalent shatter-resistant material and equivalent to the A. B. Chance M3002 -1. Plastic collars may split on sudden impact and, therefore, they are not recommended for use at PPPL.

E. Discharge cable, connected between the head of a high-impedance grounding-stick and the discharge resistor(s), shall be rated and tested to withstand the available discharge current including the high frequency currents of pulsed circuits.

F. Grounding cable discussed herein shall be continuous throughout its length. The conductor shall be extra-flexible uncoated, stranded copper having transparent thermoplastic, 600 V rated covering to provide mechanical protection for the cable and to permit inspection for possible strand breakage. Grounding cable shall be terminated in listed compression fittings and connected together with other grounding conductors using approved clamps.

G. Grounding jumpers, which depend on compressed springs to maintain mechanical pressure at their contact points, shall not be used in circuits where they are subject to short-circuit or ground-fault currents in excess of their calculated withstand rating.

15.3 OPERATING CRITERIA

A. Only Qualified Personnel trained in the application of temporary grounding devices and hot-sticks shall be permitted to install or use them.

B. Before installing temporary grounding devices, perform the following:

1. Visually check the entire length of the grounding conductor for continuity and for mechanically adequate bonding to the nearest equipment grounding conductor having sufficient size. Note: See Warning in C(3) below prior to applying grounds.
2. Check the integrity of user rubber gloves before use by performing both an air-leakage test and visual inspection to detect pin-holes or cracks. Test-date stamped on the gloves must be within the last six months.
3. Verify that the distance measured from the cuff of the rubber glove, back to the end of the protector cuff, is adequate. Both Class 0 and Class 1 gloves shall have one inch separation. Class 2, Class 3, and Class 4 gloves shall have two, three, or four inches separation, respectively. The user may then wear the rubber gloves and protectors.
4. The user shall also wear safety glasses FR clothing, and a non-conducting hard hat.
5. Verify that hot-sticks are test-certified. Ground sticks shall be inspected prior to use and if defects are found they shall be repaired and tested-certified before use (see paragraph 15.3.E & 15.3.F for test-certification requirements).

C. When applying temporary grounding jumpers: Establish a flash protection boundary until system is verified to de-energized, Locked and Tagged out.

1. The ground-bus connection must be first on and last off. The equipment or device connection should be last on and first off.
2. Take care to keep clear of the grounding cable, since its covering is provided to protect the conductors from mechanical damage and has no appreciable voltage rating.
3. Obtain a voltage detector and confirm that its range and rating exceeds the maximum operating voltage of the system to be tested. In systems operated over 600 volts, use a voltage-detector hot-stick.

WARNING

Before applying grounds, use an appropriate Voltage-detector to verify that each Ungrounded conductor is de-energized. Verify that the voltage-detector is Operational before and after each use.

4. Apply the grounding-clamp head with a smooth, continuous motion until firm contact has been made.
5. Hold the connection together for one or two seconds, then tighten the grounding clamp around the conductor to form a captive connection.

D. When replacing a captive grounding-stick with a temporary grounding jumper, install the jumper before the captive grounding-stick is removed. Later, when removing the jumper, the grounding-stick may need to be reinstalled before the jumper is removed.

E. Purchase requisitions for hot-sticks and temporary grounding devices shall be reviewed and approved by the Head of ES&H or designee before a purchase order is issued. Each hot-stick shall have a serial number assigned by the ES & H Division and shall be tested in accordance with ES&H Division specification and statement of work.

F. All sticks, ground wires and connectors shall be visually inspected for defects prior to use and as a minimum every two years as required by 29CFR 1910.269(J). All sticks with defects shall be repaired and the sticks test-certified prior to being used. Frequencies of the test-certifications shall be:

1. Sticks that are used often or have hard usage(outdoor switchyard usage, capacitor yards, etc.) shall be test-certified with-in twelve months.
2. All other sticks shall be test-certified every two years as a minimum. The ES& H Division shall coordinate all testing by sending out testing notifications to stick custodians. Stick custodians shall deliver sticks to the designated testing area and pickup the sticks after testing-certification.

EXCEPTION: Sticks that are in-use (safing a power system) shall be exempt from the above 2 year requirements until the stick is removed. At the time of removal the user shall notify the ES & H Division to have the stick test certified. A "Warning" tag shall be placed on these stick stating that they are to be tested after removal and not to be reused.

3. All sticks shall have an in service test per ASTM F-711.
4. The maximum usage voltage for live line tools with fiberglass handles is 93kv per foot of length, phase to phase or phase to ground per DOE 1092-98. Wooden handle live line tools are not to be used at PPPL.

15.4 HOT-STICK AND GROUNDING-STICK LENGTHS

Table 15.4 shows the minimum and recommended hot-stick and grounding-stick lengths for the indicated voltage groups. Overall lengths may be adjusted to suit the intended application, but the minimum collar-to-head lengths must be maintained (see Table/Figure 15.4).

Table 15.4 - Hot-Stick and Grounding Stick Lengths

MAX. VOLTAGE (KV)		HOT-STICK AND GROUNDING-STICK LENGTHS		
AC RMS (Ø-Ø)	DC	MINIMUM COLLAR-TO-HEAD (FT.-IN.)	RECOMMENDED HANDLE-TO-COLLAR (FT.-IN.)	OVERALL (FT.-IN.)
2.0	3	1-10	0-8	2-6
15.0	21	2-0	1-0	3-0
35.0	50	2-4	1-8	4-0
46.0	65	2-6	2-0	4-6
72.5	103	3-0	2-0	5-0
121.0	171	3-4	2-2	5-6
145.0	205	3-6	2-6	6-0
169.0	239	3-8	2-10	6-6
242.0	342	5-0	3-0	8-0

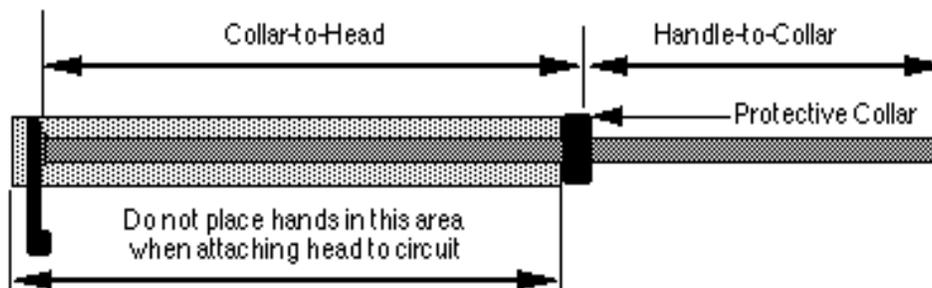


Figure 15.4 - Hot-Stick or Grounding-Stick Configurations