

### Regulatory Background

The 2018 edition of NFPA 70E recognized hazards in direct current (DC) systems as equally significant as those in AC systems. One major change was reducing the shock protection approach boundary from “less than 100 volts” to “less than 50 volts” for DC systems.

This update reflects the increased use of renewable energy sources — such as solar arrays, wind turbines, utility-scale solar plants, batteries, and UPS inverters — in mission-critical applications. NFPA 70E Article 320 (Batteries and Battery Rooms) also added detailed energy threshold definitions specific to DC systems.

On the enforcement side, OSHA’s Lockout/Tagout (LOTO) standard under 29 CFR 1910.147 applies to both AC and DC systems.

### OSHA Applicability

- Electric Power Generation, Transmission, and Distribution facilities are covered under 29 CFR 1910.269.
- If a renewable energy system is not part of a utility distribution network and is used for standby or backup power, it falls under OSHA 1910, Subpart S – Electrical.
- Workers servicing renewable systems (solar panels, wind turbines, UPS, fuel cells) may face hazards from electric shock, arc flash, and unexpected energization or stored energy release. OSHA’s Green Job Hazards initiative applies, requiring LOTO procedures per 1910.269(d) or 1910.147

### OSHA Guarding Requirements – 50 Volts or More

In September 2015, OSHA confirmed that 29 CFR 1910.303(g) (2)(i) applies to live parts operating at 50 volts or more, AC or DC.

OSHA clarified that electric current (not voltage) causes injury. The amount of current depends on the object’s resistance. The human body’s minimum resistance with broken skin is ~500 ohms. At 60 volts, current flow would be 120 mA, which is enough to cause serious injury or death, AC or DC.



*Two Safe-Test Points™ in Stainless Steel housing used to verify the absence of voltage on Line and Load side (DC/AC) of an inverter system in a PV solar application.*

### GracePESDs® for DC LOTO Safety

Permanent Electrical Safety Devices (PESDs) are permanently mounted on equipment to allow voltage detection or verification from outside the enclosure, reducing exposure to live parts during LOTO. DC Voltage Indicator PESDs improve safety during LOTO by verifying voltage presence and stored energy from 15–1000 VDC without opening the enclosure.

#### Key features:

- High-impedance protected circuitry limits current to 703  $\mu$ A @ 1000 VDC.
- Redundant LED indication allows task-qualified personnel to verify voltage presence safely from outside the cabinet.

### Absence of Voltage Testing

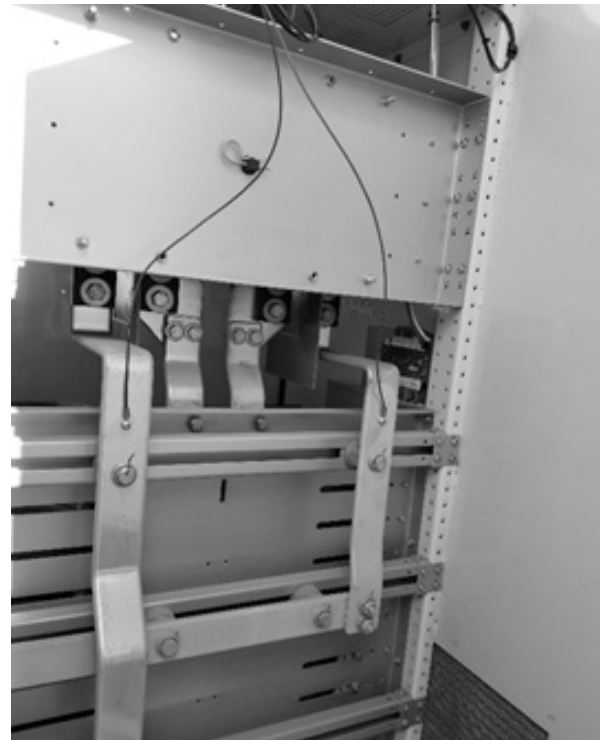
- Article 120.6(4), NFPA 70E – Requires verification of stored energy release.

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- Article 120.6(7), NFPA 70E – Requires an absence-of-voltage test before work begins.

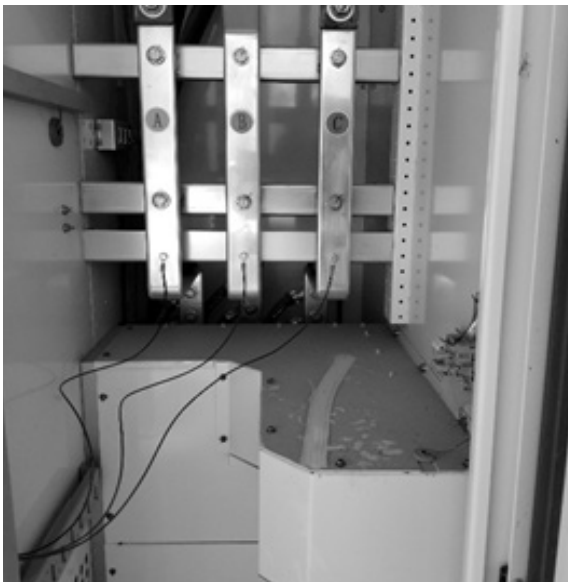
**Example:** At a solar combiner box feeding power to an inverter, DC Voltage Indicators can be installed at the point of work to verify voltage presence and stored energy release per NFPA 70E 120.6(4). For absence-of-voltage testing, a Voltage Test Station (VTS) or Safe-Test Point™ allows a qualified electrical worker to perform the test per 120.6(7), with a maximum fault current threshold of only 2.9 mA @ 600V.



Connections at the inverter show the termination of PESD to the 1000V DC Bus.

### Typical Applications

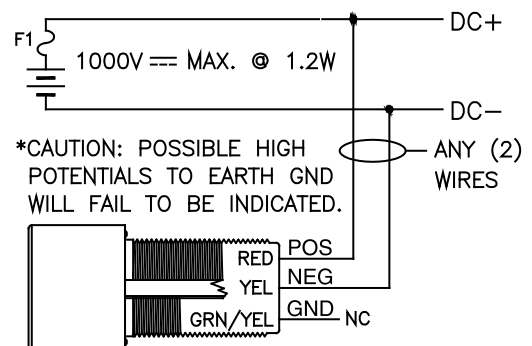
- PV String Solar Combiner Box – Connects multiple PV module strings.
- DC/AC Power Disconnect Switches.
- Inverter Modules – Line & load side, DC max: 1000V, AC max: 600V.
- Step-Up Transformer Line Side – Max 600V AC.
- DC Electric Vehicle Charging Stations.



Inverter terminations show the PESD leads connected at the Load side of the 480V AC Bus.

### DC Voltage Wiring Diagrams

DC SINGLE SOURCE, 2W ONLY  
NON-SAFETY APPLICATION



DC SINGLE SOURCE, 2W + GND  
SAFETY APPLICATION

