PESDs IN DC APPLICATIONS

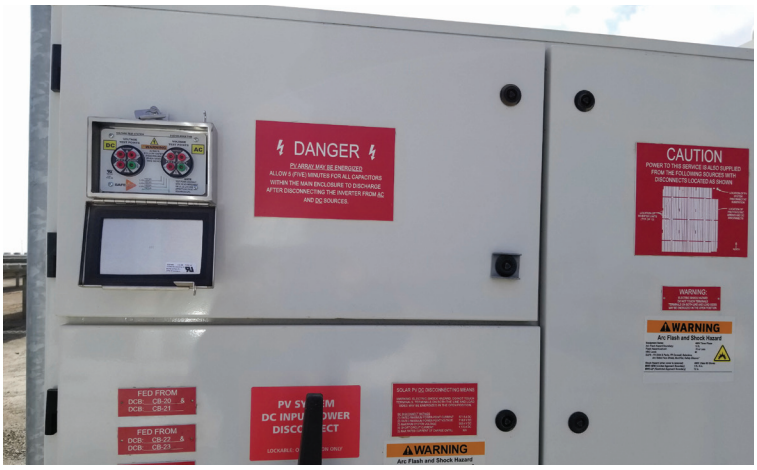
(RENEWABLE ENERGY SYSTEMS)

APPLICATION NOTE

Changes to NFPA 70E, 2018 edition recognized hazards involved with direct current (DC) systems as equally significant as AC systems and revised the shock protection approach boundaries from “less than 100 Volts” to “less than 50 Volts” for DC systems. Additionally, the increased use of renewable sources such as solar systems, wind turbines with utility-scale, solar plants, batteries and inverters in UPS systems for backup power in mission critical applications further intensified the requirements for DC systems. Article 320: safety requirements related to batteries and battery rooms further added energy threshold definitions to 70E, 2018 standards. On regulatory and enforcement side, OSHA requirements for Lockout/ Tagout (LOTO) under 29 CFR 1901.147 applies to both AC and DC systems.

In general, Electric Power Generation, Transmission and Distribution facilities are covered under OSHA’s 29 CFR 1910.269 standards. If the overall system is not part of the distribution system supplying power to two or more buildings or used in standby power application, renewable energy sources are covered under OSHA CFR 1910, Subpart S, Electrical. Workers performing servicing or maintenance of renewable energy systems such as solar panels, wind turbines, UPS system and fuel cells may be exposed to injuries from the electrical shock, arc flash hazards and unexpected energization or release of stored energy in the equipment which are covered under OSHA’s Green Job Hazards. Renewable energy employers are required to implement LOTO procedures outlined in OSHA standards at 29 CFR 1910.269(d) or at 29 CFR 1910.147.

In September 2015, OSHA’s ruling and interpretation on the guarding requirements for 50 Volts or more DC confirmed that 29 CFR 1910.303(g)(2)(i) applies to live parts of 50 Volts or more for both AC and DC voltages. Further, OSHA objectively made it clear through their interpretation that it considers all voltages of 50 volts or above to be hazardous, though some consensus standards consider them to be non-hazardous. It is critical to note that in the context of interpretation, OSHA also stated that the “Electric current, not voltage, passing through the human body causes injury, and the amount of current passing through an object depends on the resistance of the object. As explained in Appendix C to 29 CFR 1910.269, the internal resistance of the human body is 500 ohms, which is the minimum resistance of a worker with broken skin at the point of contact. The current through 500 ohms from a live part energized at 60 volts would be 120 milliamperes. This level of current, either AC or DC, is sufficient to cause serious injury.



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.

DC Voltage indicators significantly reduce the risk and enhance the overall safety while performing LOTO by verifying voltage presence and stored energy from 15 – 1000V DC in the system. Built-in with high impedance protected circuitry that limits current to 703 µA max @1000 Volts DC, and with redundant LED Indication, a task qualified person can safely verify the voltage presence from outside the cabinet.

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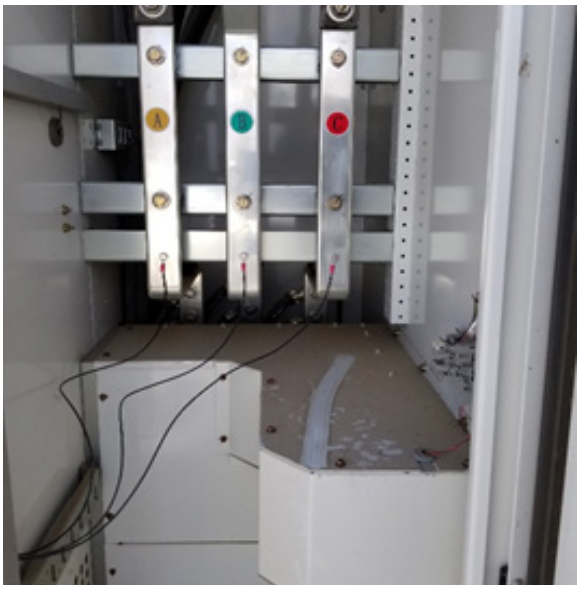
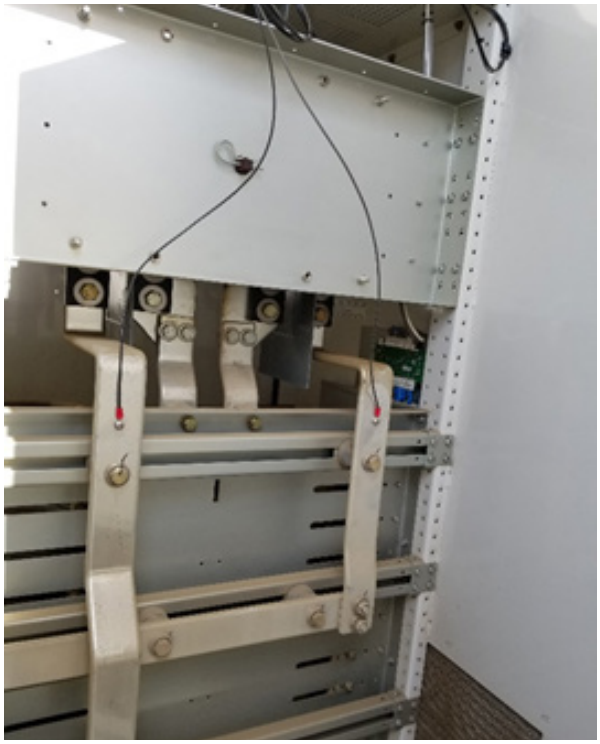
Absence of voltage testing during LOTO at solar combiner box that feeds main power to inverter, both line and load side connections of inverters, and disconnect switches. Having a DC Voltage indicator installed at the point-of-work greatly enables task qualified workers to verify the voltage presence and release of stored electrical energy from outside the cabinet that meets the requirements of Article 120.5 (4); use of Voltage Test Station (VTS) or Safe-Test Point™ assists qualified electrical worker to perform the absence of voltage test as defined in Article 120.5 (7), NFPA 70E, 2018, with a max fault current threshold of only 2.9mA @600 Volts Max.

Typical Application of DC Voltage Indicators and Safe-Test Points include:

a. PV String Solar Combiner box : a device that connects multiple strings of PV modules
b. DC/AC Power Disconnect Switches
c. Inverter Modules: Line & Load Side, DC max: 1000 Volts, AC max: 600 Volts
d. Step Up Transformer line side, Max 600 Volts AC
e. DC Car Charging Stations



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



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

DC Voltage Wiring Diagrams