Office of Environment, Health, Safety and Security
Operating Experience Level 3

OE-3: 2015-03

September 2015

Electrical Safety: Shocks

Purpose

This Operating Experience Level 3 (OE-3) document provides information about a safety concern related to electric shocks workers have received while performing work at Department of Energy (DOE) facilities.

Background

From January 1, 2012 through May 1, 2015, 249 reports were filed in the Occurrence Reporting and Processing System (ORPS) with Keyword 12C, *Electrical Safety*.

Ninety-nine of those 249 events (39%) involved shocks to personnel, and one event was fatal (described below). Other events reported under 12C involved lockout/tagout (LOTO) deficiencies, equipment malfunctions/short circuits, damage to energized lines, and unexpected discoveries of electrical energy. The three electrical safety event summaries provided in this document are good examples of the types of events reported in ORPS, and their final reports provide a thorough description of corrective actions.

On September 22, 2014, at the National Renewable Energy Laboratory (NREL), subcontractors installing data cables in a floor box moved the floor box ring and lifted out an energized electrical receptacle (120-volt), exposing the live, energized parts of the receptacle. They did not use a LOTO. They had not followed the NREL requirements for work control and planning; work was stopped. An electrician responded and restored the box to a safe condition. (ORPS Report EE-GO--NREL-NREL-2014-0038)

On June 24, 2014, at Sandia National Laboratory, an employee received a cross-body shock while performing a test on a Capacitor Discharge Unit. The worker was using his right hand to position the resistor and his left hand to attach a connector, when his left hand brushed a low-voltage input and he felt current flow through his body between his right and left hands. He was released to work after medical evaluation. (ORPS Report EM-SR-PSC-SWPF-2014-0005)

The most serious electrical event occurred on July 30, 2013, when a Wilson Construction Company Crew Foreman (CF) received a fatal shock while preparing to remove a jumper from a sectionalizing disconnect switch on a 115-kilovolt line. He was employed on a construction project for the Bonneville Power Administration's (BPA) Bandon-Rogue line in Oregon. The pre-job briefing emphasized the importance of doing three things in order to avoid a fatal shock: establish and install a three-phase ground set; establish an equipotential zone (EPZ) to protect the workers from shock caused by differences in electric potential; and take a step-and-touch voltage measurement. The CF disagreed with the way the grounding was to proceed. Although he argued with another CF, he did not raise his difference of opinion to the appropriate authority. As a result, he did not instruct his crew to take a step-and-touch voltage measurement or establish an EPZ. When he positioned himself to assist in the work, he received a fatal electric shock. (BPA Level 1 Accident Investigation Report, September 2013)

Discussion

Neither of the first two events described above resulted in serious injuries. However, workers

could have received fatal shocks in all of these scenarios where work on live electrical equipment was being performed and safe work practices were not being used.

All electrical shocks are hazardous. The severity of health effects depends on the amperage of the current through the body, the duration of the shock, and the pathway the current takes through the body. Low voltage encounters are not necessarily low hazard. Resulting muscular contractions can result in a person becoming "frozen" to the source, increasing the time that current flows through the body. Excitation of extensor muscles can result in a worker being thrown from the source, which can lead to other injuries from striking objects or falling from heights. Other environmental (e.g., moisture presence) and health conditions (e.g., heart rhythm at time of shock) can increase the possibility of electrocution, even from low voltage power sources. An electrical current pathway from hand to hand through the body, as experienced by the worker at Sandia, travels through the chest cavity and can cause cardiac arrest, arrhythmia, or lung damage. Contact with high voltage energy exposes workers to greater flows of current through their bodies by quickly breaking down the resistance provided by intact skin.

All of these hazards can be reduced or eliminated by performing a thorough hazard analysis prior to the start of any work, training workers on safe work practices, and supervising the implementation of those practices during the performance of work that involves potential encounters with electrical hazards. "Dead" work (i.e., work performed on non-energized lines or equipment) should be performed whenever possible. "Live" work (i.e., work performed on energized lines or equipment) should be conducted with continual awareness of the serious hazards presented by electrical currents and by strict adherence to procedures designed to protect workers from those hazards, such as LOTO.

Corrective Actions

Sites that filed ORPS reports cited in this OE-3 took the corrective actions (CA) described below.

- All parties issued Stop Work orders upon discovery of an unmitigated hazard.
- Supervisors or workers removed the equipment from service or disconnected power supplies to mitigate the hazards.

Conclusion

These occurrences serve as reminders of the need for thorough job hazard analyses, strict procedural compliance, and a cautious, questioning approach when dealing with any electrical situation.

References

- ORPS Report EE-GO--NREL-NREL-2014-0038
- ORPS Report EM-SR-PSC-SWPF-2014-0005
- BPA Level 1 Accident Investigation Report, September 2013
- Training materials available at the Energy Facility Contractors Group (EFCOG) portal: http://www.efcog.org/wg/esh_es/

Questions regarding this OE-3 document can be directed to Ashley Ruocco at 301-903-7010 or ashley.ruocco@hq.doe.gov.

This OE-3 document requires no follow-up report or written response.

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