

OE-3: 2016-06

August 2016

Frequent Hazardous Electrical Energy Related Events

PURPOSE

This Operating Experience Level 3 (OE-3) document provides information about a safety concern related to frequent hazardous electrical energy events during work at Department of Energy (DOE) facilities.

BACKGROUND

In the first 5 months of 2016, three dozen hazardous electrical energy events were reported to the Occurrence Reporting and Processing System (ORPS), with some sites indicating that additional hazardous electrical energy events were entered into site systems because they were considered "sub-ORPS." Most of the reports (32 of 36, or 88%) indicated that no corrective actions (CAs) had been assigned.

The potential danger of contact with electricity cannot be overstated. If CAs are not assigned every time a seemingly insignificant electrical event occurs, there is the real possibility that the next event may be fatal.

THE EVENTS

The events described below represent a few of the varied situations and causes reported in the 36 ORPS reports.

- 1) On June 2, 2016, at the Savannah River Site Salt Waste Processing Facility (SRS-SWPF), a Qualified Electrical Worker (QEW) was asked to review a draft (i.e., unapproved) work package, but he misunderstood the direction and instead went to the field and began to conduct the work. The work package (WP) for resetting overloads for pumps had been discussed at the Plan of the Day meeting, but since the WP was not complete, the work had not been authorized. (ORPS Report EM-SR--PSC-SWPF-2016-0004)
- 2) On May 13, 2016, at Fermi National Laboratory (Fermilab), a building manager removed a Lockout/Tagout (LOTO) lock improperly on a disconnect that fed a heater that had been removed approximately 2 years before. Removal of the LOTO lock (and replacement with a configuration control lock) had been assigned during an April 7, 2016, inspection of the area, with a due date of May 9. When the building manager's request to the system engineer and electrical task manager to remove the lock went unanswered, and the due date arrived, the manager used bolt cutters to remove the lock. (ORPS Report SC--FSO-FNAL-FERMILAB-2016-0004)
- 3) On May 5, 2016, a worker at Los Alamos National Laboratory (LANL) TA-53 saw an electrical arc when he placed an extension cord box onto metal flooring. He immediately secured the area and notified management. The extension cord had been fabricated in-house with UL-listed components and had been inspected and approved for use. A fact-finding was held and, upon further review, the event was upgraded to a near miss because of the potential exposure to dangerous voltage with the use of older, in-house-built, 480-volt extension cords. (ORPS Report NA--LASO-LANL-ACCCOMPLEX-2016-0002)
- 4) On April 20, 2016, an apprentice electrician at the Savannah River Site (SRS) was removing unused temporary power cables when he cut into a live cable he thought was dead and saw a spark. A group of approximately 15 cables that was bundled together, hanging 8 feet off the floor had been checked before the electrician started to cut. Work stopped. An hour later in another room of the facility, electricians were removing temporary cables; one fell and sparked when it hit the floor. The 480-volt breaker tripped and work immediately stopped. (ORPS Report EM-SR--PSC-SWPF-2016-0002)

- 5) On April 8, 2016, at LANL, an Electrical Safety Officer and a Person in Charge were scoping a job in TA-53 when they discovered a conduit containing wires had been cut, contrary to work requirements. The Integrated Work Document (IWD) required that wires be traced, zero-energy checked, and air gapped prior to removing them from the conduit and cutting them; however, they were left inside the conduit. There was no lock on the circuit and no evidence that a zero-energy check had been performed. (ORPS Report NA--LASO-LANL-ACCCOMPLEX-2016-0001)
- 6) On March 10, 2016, at the National Renewable Energy Laboratory (NREL), a subcontractor discovered unexpected electrical potential on a circuit due to legacy mis-wiring on an HVAC fan speed selector. He had completed scheduled upgrades to an existing system; when he turned the system on, the components failed and the equipment was damaged. (ORPS Report EE-GO--NREL-NREL-2016-0003)
- 7) On February 19, 2016, Fluor-BWXT management at Portsmouth D&D project (PORTS) defined a management concern that recurring LOTO issues demonstrated a weakened field implementation of the LOTO program. The Recurrence report was filed after four ORPS reports and eight internal issue reports with apparent similar and/or closely related issues were submitted over the 3-month period from December 2015 to February 2016. A formal root cause analysis was commissioned, and 20 issues were identified that fell into 3 primary error categories: Integrated Work Document/procedure execution errors; Inattention to detail or inadequate review; and Administrative violation of the LOTO procedure. (ORPS Report EM--PPPO-FBP-PORTSDD-2016-0005)

Other sites have also filed Recurrence reports, Brookhaven National Laboratory filed reports for both ORPS and non-ORPS events (ORPS Report SC--BHSO-BNL-BNL-2016-0006); and WIPP reported on a higher-than-expected number of events related to deficiencies in planning and implementing Hazard Energy Control (ORPS Report EM-CBFO--NWP-WIPP-2016-0004). In 2015, Idaho National Laboratory also filed a recurrence report, citing events that involved

injuries to linemen, premature removal of protective grounds, and an arc flash. The themes common to all events included inconsistent human performance, self-imposed pressure, overconfidence, and increased risk acceptance. (ORPS Report NE-ID--BEA-CFA-2015-0005).

If management reviewed near misses, tingles, open electrical cabinets, and failures to implement an effective Hazardous Energy Control program in their facilities and at their sites, the number of Recurrence reports would most likely increase. Near miss events are important indicators and should be reviewed, analyzed and corrected in order to prevent larger impact events from occurring.

DISCUSSION AND CORRECTIVE ACTIONS

- 1) In the SRS-SWPF event, the QEW donned appropriate personal protective equipment (PPE), then followed the steps in the unapproved WP, verifying the disconnect, opening the panel and performing a visual inspection. When he could not locate adjustment screws, he shut the panel and proceeded to the Compressor Building, where he checked the breaker pumps, then decided to return and consult his supervisor. On his way back, he talked about the work he had been doing to the Test Engineer, who asked him if the WP had been approved. When the QEW described the WP, it sounded as if it had been approved, and without asking to see the actual document, the Test Engineer accompanied the QEW back to the work area, where both of them donned PPE and commenced work on the panel. When the Test Engineer noticed that the WP for overload adjustment was not on the status board, the Work Authorization Authority told him the WP had not been authorized. When everyone involved realized no LOTO had been established, the work and related violations were reported and the area was secured.

In this event, missed/inadequate communication was the starting point for a series of steps/events that could have had severe, even fatal, results. Repeat back, closed loop, or parroting are terms that refer to a form of safety communication wherein the listener repeats what s/he believes was heard. If the QEW had restated what the Maintenance

Supervisor said, he would have reviewed the draft WP, or if he had said, "You want me to work this WP" the misunderstanding would have been corrected immediately. Another missed opportunity to correct the situation occurred when the QEW and Test Engineer talked about the WP, but the Test Engineer never asked to see the document, and so the chain of errors continued.

- 2) In the Fermilab event, the building manager had not received the electrical manager's response in a timely fashion. Since she believed the inspector had given her authorization to make the change when he assigned the CA, she removed the lock on the due date. It was later determined that the electrical task manager had been in the process of getting the electrician to remove the lock, but the electrician had been temporarily away on medical leave. One of the CAs directed inspectors to give adequate guidance in order to avoid such misunderstandings in the future. However, the building manager should not have performed any work associated with electrical energy, for any reason.
- 3) In the May 5, LANL event, the electrician used the extension cord because it was fabricated from UL-listed parts and had been inspected and approved for use. However, investigation after the event determined that the cord was more than 20 years old and its forensics were outdated to justify continued use. An extent of condition review was performed so that similar cords across the LANL site could be taken out of service and replaced.
- 4) At SRS, workers had not verified that all the cables had been disconnected from the power source(s) before pulling or cutting them. Instead, they made assumptions about the system configuration. In the first incident, the worker committed an error in letting past successful uses of a non-contact voltage detector overrule compliance with the work package instructions to verify that air gaps existed or lockouts were in place. His action was also in direct conflict with a warning in the detector manufacturer's instructions. Investigation of the second incident did not reveal sufficient information to determine the root cause of how the cable was cut and re-energized. However, a contributing cause involved management expectations not being well-defined and/or well understood and work planning that did not identify special circumstances and conditions. The resulting seven CAs included revising the work package to require two-person verification of LOTO and zero energy check and a Supervisor's or Foreman's second check; instituting a Senior Supervisory Watch; and updating training.
- 5) A fact-finding after the April 8 LANL event determined that the cut cables were de-energized only because the breaker had been switched off for other work, or the event might have ended badly. The event work was not performed in accordance with the IWD, there was no lock, and wires were not in an Electrically Safe Work Condition. In addition, the worker had not been wearing any dielectric or arc-rated personal protective equipment (PPE). Other groups in the area were informed of the lessons learned from this event. Lessons learned included that the mechanical technicians were new to both the work and the area, that D&D is an activity not routinely performed, that as-built wiring did not match drawings, that conduits in question could not easily be seen because pipes were in the way, and that the 10-inch reciprocating saw blade being used was too long for the 5.5-inch space and resulted in cutting more conduit than planned. CAs included developing an integrated plan for D&D, training on D&D hazards, and rewriting the IWD.
- 6) The work being performed at NREL was considered to be low-voltage (below 50V), so neither a LOTO nor electrical PPE was required during work. Nevertheless, as good safety practice, the subcontractor turned off the power at each of the control systems before conducting work. Because it is known that some causes stemmed from legacy mis-wiring, an extent of condition review was ordered. Reviewers determined that of the 81 analogous zone controls replaced in three NREL facilities, only this one was improperly wired; the transformer in this event was mounted in a different manner than all others; and no Work Orders show when the work was performed that resulted in the mis-wiring.
- 7) The Portsmouth D&D project identified a recurring weakness in field implementation of

the LOTO program. In each event, work was being performed in a safe manner; however, inadequate compliance with work documents, inadequate reviews, improper form completion, and administrative violations such as incorrect lock usage were apparent. The large number of errors was determined to be a Conduct of Operations issue; the root cause was identified as *management expectations not clearly defined, understood, or enforced*. Forty CAs were assigned that included holding meetings to stress compliance, stop work, and accountability; simplifying the LOTO process where possible; assigning a LOTO Committee; conducting LOTO error lab training; revising the LOTO permit-generating software; and performing a CA effectiveness review.

CONCLUSION

These events illustrate the importance of proper hazards identification and the use of physical barriers such as LOTO to prevent electrical shock, injury, or death. Work procedures for maintenance activities should include standardized LOTO and zero-energy checks, and workers need to understand the potentially life-saving importance of compliance. All work in and around electrical components must be authorized, and workers need to ensure that they understand what they are doing before they start. Stopping to ask for clarification is the smart, safe thing to do. These events also reinforce the importance of CAs in order to mitigate or eliminate more significant electrical events in the future.

REFERENCES

EM-SR--PSC-SWPF-2016-0004, *De-Energized Electrical Panel Entered without an Authorized Work Package*

SC--FSO-FNAL-FERMILAB-2016-0004, *Lab C LOTO Lock Removal Procedural Violation*

NA--LASO-LANL-ACCCOMPLEX-2016-0002, *NM Potential Exposure to Employee from Old In-House-Built 480V Extension Cord*

EM-SR--PSC-SWPF-2016-0003, *Electrical Panel Entered Without a LOTO in Place*

NA--LASO-LANL-ACCCOMPLEX-2016-0001, *Near Miss: Potential Unexpected Hazardous Electrical Energy Discovered when Appropriate Tool Was Not Used*

EE-GO--NREL-NREL-2016-0003, *Near Miss Resulting from Mis-Wired Equipment in the IBRF*

EM--PPPO-FBP-PORTSDD-2016-0005, *Recurring LOTO Execution and Administration Issues*

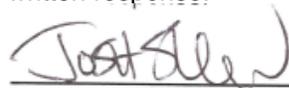
SC--BHSO-BNL-BNL-2016-0006, *Recurring LOTO and Electrical Events/Issues*

EM-CBFO--NWP-WIPP-2016-0004, *Recurring Failures to Follow a Prescribed Hazardous energy Control Process*

NE-ID--BEA-CFA-2015-0005, *Identification of Recurring Theme within the INL Power Management Group*

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



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COMMUNICATING FOR SAFETY

- Focus attention on the message.
- Listen, and also look for unspoken cues the speaker may be sending.
- Keep an open mind; do not judge.
- Verify what was heard. Do not assume that what you heard was the speaker's intent.
- Repeat what you believe were the instructions.

Remember: Simply acknowledging a message indicates that you heard it. Repeating the message (parroting) indicates that you understand it and creates an opportunity for clarification.