Operating Experience Summary

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Failures to Follow Prescribed Hazardous Electrical Energy Control Processes

Introduction

Hazardous energy control processes are designed to protect workers from exposure to hazardous energy, including electrical energy. Exposure to electrical energy can cause shocks, burns, electrocution, and injuries resulting from falls or being struck by objects. Arc flashes and arc blasts can cause severe injuries as well. Property damage may also occur when hazardous energy is not adequately controlled by strict adherence to processes created to protect workers and property.

Background

Department of Energy (DOE) Order (O) 232.2A, *Occurrence Reporting and Processing of Operations Information*, requires that failures to follow a prescribed hazardous energy control process be reported in the Occurrence Reporting and Processing System (ORPS). From 2012 until the first quarter of 2018, there were 390 reports of these occurrences throughout the DOE complex. They comprised between four and nine percent of the total ORPS reports, as shown in Figure 1, with the percentage of ORPS reports caused by failures to follow a prescribed hazardous energy control process increasing over the past four years. Some examples of these occurrences are summarized as follows.

Failure to Follow a Prescribed Hazardous Energy Control Process Results in Shock

On February 12, 2017, an electrician at the Waste Isolation Pilot Plant sustained a shock when attempting to attach a grounding cluster to the ground bus in a 13.8 kilovolt transformer. Incoming electrical power was removed, feeds to the transformer were properly locked and tagged out, and the absence-of-power checks were performed. Grounding sticks were then applied to each incoming power lead to discharge any residual electrical energy within the circuitry

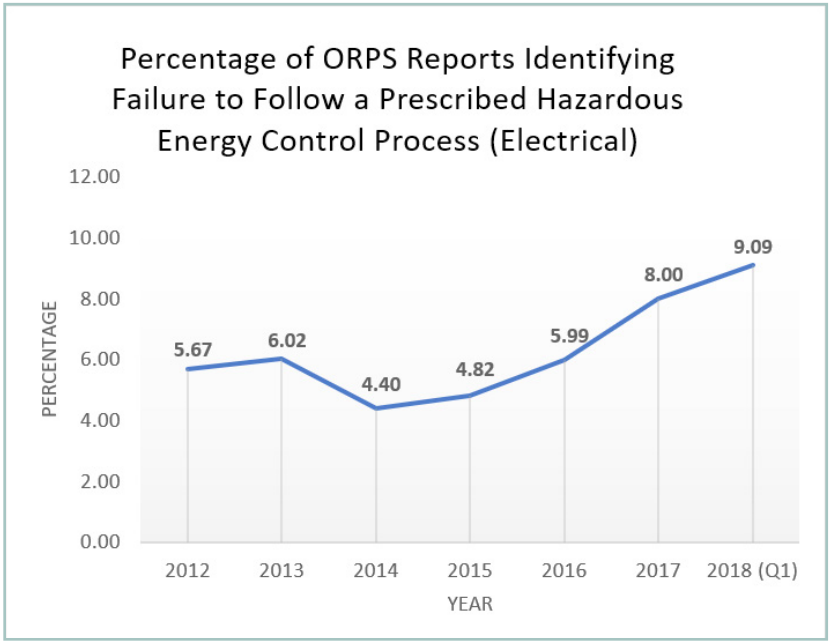

Figure 1. Percentage of ORPS reports identifying failure to follow a prescribed hazardous energy control process

and cabling. After these hazardous energy control processes were complete, the electrician removed his electrical Personal Protective Equipment (PPE) and donned leather gloves. When he attempted to attach the grounding cluster to the ground bus, he felt a shock in his thumb and dropped the grounding cluster. It was determined that the lockout/tagout and absence-of-power checks had been performed correctly, but procedures governing the use of grounding sticks and electrical PPE requirements were not followed. (ORPS Report EM-CBFO--NWP-WIPP-2017-0004)

Employee Experiences Contact with Hazardous Energy Source

On July 18, 2017, two workers at Argonne National Laboratory's Advanced Photon Source were testing capacitors (305uF/10 kilovolts each) for a beamline pulsed magnet power supply project in a high voltage test stand. They finished testing one capacitor and believed it to be in a safe state. As one worker began attaching a safety ground across the capacitor, an arc flash occurred while attaching the clip lead. The capacitor had not been safely discharged. A coworker approached and saw that one of the worker's hands was black. A 911 call was made and the Argonne Fire Department responded. According to the initial reports from the firemen, the employee was awake and alert, his electrocardiogram result was normal, and he had second degree burns on his fingertips. He was taken directly to the emergency room. The second employee was also taken to the emergency room as a precaution, after evaluation in the Argonne Medical Clinic. Both employees were released from the hospital the same day. (ORPS Report SC--ASO-ANLE-ANLEAPS-2017-0003)

Near Miss: Vendor Trips Breaker while Performing Testing and Diagnostic Activities

On June 7, 2017, a vendor at the National Renewable Energy Laboratory was performing testing and diagnostic activities associated with a warranty repair on a dielectric discharge breakdown voltage tester. The vendor initially replaced a part in the controller for the voltage tester; however, when the replacement did not repair the issue, the vendor and the Qualified Electrical Worker (QEW) performed additional troubleshooting. Only component replacement on the deactivated instrument was expected to be performed before the visit; live work, such as troubleshooting, had not been

Photo 1. An electrician tests control panel switches in Hanford's Analytical Laboratory.

anticipated. The area of the equipment in which they were working contained the 110 Volt (V) alternating current (AC) and 208 V AC power supply terminals and capacitors. While the QEW did initially apply locks to the cord for the equipment, the vendor did not perform zero-energy verification using a multi-meter and only used the vendor-supplied grounding stick. The grounding stick was originally installed for use operating the instrument. During troubleshooting, the vendor inadvertently contacted the terminals of the power supply with the grounding stick, tripping the breaker. The QEW then contacted Operations to request that the breaker be reset. At that point, it was noted that the work performed by the vendor had not been vetted through the internal processes and procedures. (ORPS Report EE-GO--NREL-NREL-2017-0013)

Regulations

Per requirements in DOE O 440.1B Chg 2 (AdminChg), *Worker Protection Program for DOE (Including the National Nuclear Security Administration) Federal Employees*, and 10 Code of Federal Regulations (CFR) Part 851, *Worker Safety and Health Program*, DOE employees and contractors must follow electrical energy control processes prescribed by 29 CFR Part 1910, *Occupational Safety and Health Standards*, and 29 CFR 1926, *Safety and Health Regulations for Construction*, as well as National Fire Protection Association (NFPA) 70E, *Standard for Electrical Safety in the Workplace*, as applicable to electrical hazards in the workplace.

OSHA Regulations

29 CFR 1910.147 (1910.147) defines the requirements for an employer to have a written energy control program, which utilizes lockout procedures, unless the employer can demonstrate that tagout provides full employee protection. It requires employers to develop lockout and tagout procedures, and defines the requirements of the same, including group lockout or tagout and how to handle shift or personnel changes. Such procedures have detailed requirements, must be performed in the following order, and are summarized as follows:

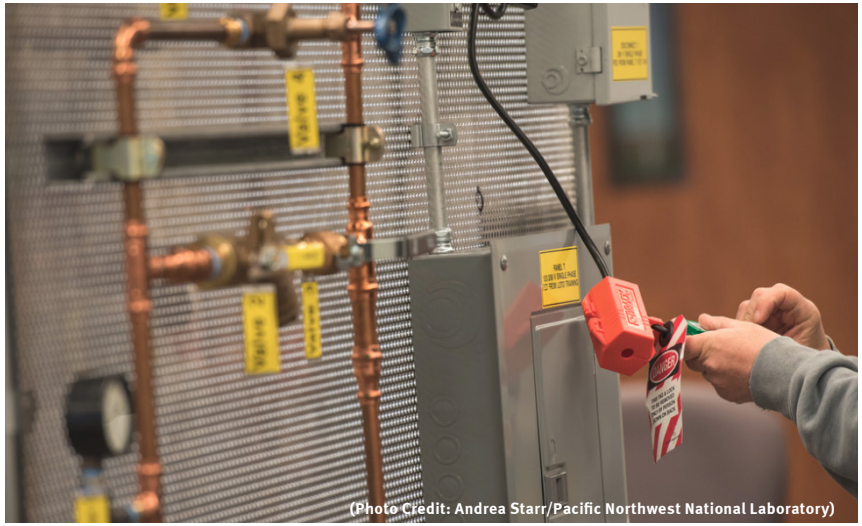

Photo 2. "Lockout/tagout" refers to specific practices and procedures to safeguard employees from the unexpected energization or startup of machinery and equipment, or the release of hazardous energy during service or maintenance activities.

1. Prepare for shutdown
2. Shut down machine or equipment
3. Isolate machine or equipment
4. Apply lockout or tagout device
5. Render safe due to stored energy (relieve, disconnect, restrain, etc.)
6. Verify isolation

There are specific procedures defined for release from lockout or tagout state. 29 CFR 1910.147 also specifies employers' responsibilities to conduct inspections, and to provide training and communication to employees on the lockout/tagout program. Finally, 29 CFR 1910.147 defines requirements for lockout and tagout devices; i.e., they must be durable, standardized, substantial, and identifiable. 29 CFR 1910.269 covers the operation and maintenance of electric power generation, control, transformation, transmission, and distribution lines and equipment, and therefore, focuses on protection from exposure to high voltage electrical energy.

NFPA 70E

NFPA 70E details methods by which organizations can comply with the regulations above and protect workers from exposures to hazardous electrical energy by establishing an electrically safe work condition. It defines procedural elements for planning, including locating sources, identifying potentially exposed persons and required PPE, identifying a person-in-charge and defining their responsibility, and differentiating between a simple and a complex lockout/tagout. It defines elements of control that must be included in hazardous energy control procedures, such as de-energizing equipment, releasing stored energy, disconnecting, verifying disconnection, testing, and grounding. It also defines requirements to account for personnel, handle shift changes, and identify where lockout and tagout applies. Finally, it states that procedures shall identify removal authorities, release for equipment to return to service, and temporary release for testing. NFPA 70E is a necessary resource for all personnel involved with hazardous electrical energy at the DOE Complex.

Discussion/Recommendations

The events above describe breakdowns in the overall hazardous energy control process that resulted or could have resulted in exposure to electrical energy. Additionally, they each represent an overall breakdown in the integrated safety management process. In order for the control of hazardous electrical energy process to be successful, proper planning must be performed, and workers must adhere to the plan. If unexpected situations arise during work performance, additional planning is necessary to account for the changes and ensure that they do not present additional exposures to hazardous electrical energy or reduce the effectiveness of exposure controls. The planning process must include the following elements:

1. The plan must be completed by a qualified person.
2. There must be a clear scope for the tasks, and all of the electrical hazards must be identified.
3. A shock and arc flash risk assessment must be performed for the tasks identified in the scope.
4. Work procedures for safe execution must be defined and must include any special precautions, the energy control procedure, and required personal protective equipment.
5. Once the plan is complete, all personnel involved in the work must be part of the job briefing, and the briefing must be repeated if the scope changes or additional personnel get involved.

The upfront planning is crucial to ensure that the work is performed safely and without exposure to hazardous energy. These examples and many other recent events across the DOE complex could have been prevented with proper planning and risk assessments, and adherence to the hazardous energy control processes.

Conclusion

Adherence to hazardous energy control processes is necessary to protect workers from the hazards of exposure to electrical energy such as shock, electrocution, arc flash, arc blast, or fire, which could result in worker injury or death and/or property damage. This *Operating Experience Summary* is part of an ongoing effort to highlight the hazards and controls associated with electrical work. Previous Operating Experience documents related to this topic include:

- External Operating Experience Update presentation, *Arc Flash Safety*; December 2017;
- OE-3: 2017-07, *Contact with Underground Utility Lines*;
- Operating Experience Committee presentation, *Control of Hazardous Energy: Lockout/Tagout*; June 2017;
- OE-3: 2016-06, *Frequent Hazardous Electrical Events*; and,
- OE-3: 2015-03, *Electrical Safety: Shocks.*

AU plans to issue additional Operating Experience documents to support Departmental elements with reducing the number and severity of electrical incidents within DOE. Protecting workers from exposure to hazardous energy requires an ongoing, concerted effort to ensure effective behaviors are put into practice on every task, every time.

References

29 CFR 1910.147, *The Control of Hazardous Energy (Lockout/Tagout)*

29 CFR 1910.269, *Electric Power Generation, Transmission, and Distribution*

29 CFR 1926, Subpart K, *Safety and Health Regulations for Construction- Electrical*

DOE Order 422.1, Chg 2 (Admin Chg), *Conduct of Operations*

DOE-STD-1030-96, *Guide to Good Practices for Lockouts and Tagouts*

NFPA 70E: *Standard for Electrical Safety in the Workplace*

The Office of Environment, Health, Safety and Security (AU), Office of ES&H Reporting and Analysis publishes the *Operating Experience Summary* to promote safety throughout the Department of Energy (DOE) Complex by encouraging the exchange of lessons-learned information among DOE facilities.

To issue the Summary in a timely manner, AU relies on preliminary information such as daily operations reports, notification reports, and conversations with cognizant facility or DOE field office staff. If you have additional pertinent information or identify inaccurate statements in the Summary, please bring this to the attention of Mr. Ross Natoli, (202) 586-1336, or e-mail address ross.natoli@hq.doe.gov, so we may issue a correction. We would like to hear from you regarding how we can make our products better and more useful. Please send any comments to Mr. Natoli at the e-mail address above.