Special Operations Report
U.S. Department of Energy

Electrical Safety

DOE/EH-0703 2006-01 August 2006

***Special Operations Reports** are issued to initiate management actions in response to events whose subject matter represents significant Departmental safety concerns.*

***Environment, Safety and Health Alerts** are issued to initiate immediate action on potentially significant safety issues.*

***Environment, Safety and Health Bulletins** are issued to share information and recommend actions on potential safety issues.*

***Environment, Safety and Health Safety Advisories** are issued to provide information to the DOE Complex on potentially significant safety or health issues.*

PURPOSE

The Department of Energy (DOE) has issued this Special Operations Report (SOR) to inform DOE and contractor line management that there continues to be a significant concern regarding the safe performance of electrical work across the DOE complex.

BACKGROUND

The Department experienced an increased number of electrical safety events in 2004 that continued through 2005 and 2006. In response to this adverse trend, the Department took several actions in 2005. One of these was the Secretary's directive to DOE and contractor line management to demonstrate that performance expectations were adequate and that site managers were being held accountable for improved electrical safety performance.

More electrical safety events occurred in 2005 than 2004. What is most disturbing is the significant increase in the number of electrical lockout/tagout events and electrical shocks. More than a year after the October 2004 arc-flash event at the Stanford Linear Accelerator Center, which resulted in a Type A Accident Investigation, the Department experienced two arc-flash events during the month of December 2005 alone.

In order to achieve consistent improvement in electrical safety across the Complex and to ensure ownership for improvement, all electrical safety improvement activities are being integrated under the umbrella of the Energy Facility Contractors Group (EFCOG). In January 2006, DOE and EFCOG developed and approved an Electrical Safety Improvement Project Plan. All of the actions associated with this plan are expected to be completed by the end of calendar year 2006.

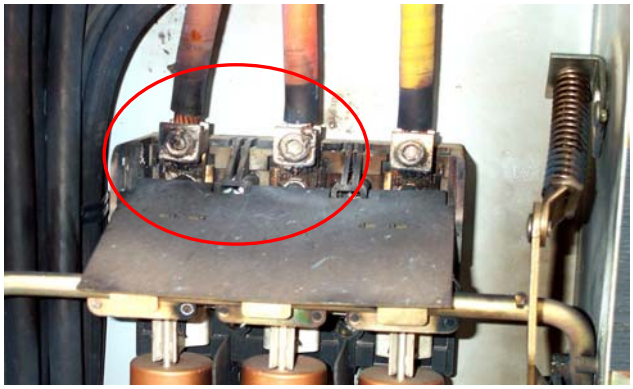
ANALYSIS

The risk of serious injury is always present when working with electrical systems. Electricity exists everywhere in the workplace and presents a hazard not only to electrical workers, but to anyone who could potentially come in contact with it. The amount of electrical current needed to cause a fatality is extremely small, and yet the energy released during an arc flash or arc blast can be tremendously large. Consequently, workers must possess an adequate knowledge of electricity's potential hazards in order to work smartly and safely.

As mentioned above, in the month of December 2005, two events occurred involving an electrical arc flash that could have had serious consequences.

- On December 10, at the Pantex Plant, electricians had removed ground sets from an automatic transfer switch in support of a short-circuit study and were re-installing fuses when an arc flash occurred. At the moment one of the electricians placed a fuse into a 480-volt fuse holder, a large arc flash occurred. The electrician, who was knocked to the ground, was wearing appropriately rated electrical personal protective equipment (PPE) and did not require medical attention. (ORPS Report NA--PS-BWXP-PANTEX-2005-0137)

- On December 6, at the Fernald Closure Project, electricians were attempting to verify voltage on the line side of a disconnect switch when an arc flash occurred. An electrician had just touched the two leads of his multimeter to the first and second phase lugs inside the switch panel when a loud bang was heard and the arc flashed from the panel, causing the electrician to fall backwards to the ground. The electrician had just turned his head to look at the meter being held by a coworker at the moment of the flash. The heat from the flash caused first-degree burns on the right side of his face and irritation in his right eye. Neither worker was wearing appropriate PPE. (ORPS Report EM-OH-FCP-FFI-FEMP-2005-0043)



Burned lugs in switch panel from arc flash at Fernald

These events underscore the importance of proper hazards identification during work planning, including safe approach distances and the required PPE for work on energized electrical systems.

A review of electrical safety events in 2005 and 2006 indicates that the following recurring process area issues need to be addressed by site managers and electrical safety personnel in the near term.

- **Inadequate work planning and hazards identification:** failure to understand the scope of work, failure to adequately review drawings and walk down the job, failure to consult with subject matter experts (SMEs), failure to evaluate potential hazards and identify adequate barriers, failure to prescribe appropriate PPE, and failure to stop work when unanticipated conditions are encountered.
- **Hazardous electrical energy control:** failure to follow lockout/tagout procedures, failure to properly install a lockout/tagout, and failure to perform independent verification.

An electrical worker checks an energized panel while wearing appropriately rated flash PPE for 240v or less

- **Electrical safety compliance:** failure to properly perform zero-energy verification, failure to wear properly rated PPE, failure to use electrically rated tools, and working on energized lines or equipment without sufficient justification.

ACTIONS

To realize near-term and lasting improvement in our electrical safety performance, DOE Program Secretarial Officers will be issuing direction to field office managers. At a minimum, action will need to be taken to ensure that the three critical areas noted above as underlying causes of poor performance are being addressed.

The Department's senior management expects each organization to use the following Lines of Inquiry (LOIs) to assess its electrical safety program in response to Special Operations Report (SOR) 2006-01. The purpose of this assessment is to determine the extent to which facility procedures address electrical safety and whether or not those procedures are being implemented in the field. Although these LOIs do not address all aspects of electrical safety programs, they include those that are necessary for evaluating contractor performance in process areas that the Department determined were the chief causes of poor electrical safety performance.

INSTRUCTIONS

Each contractor will use this form to document assessment results. These results are to be submitted to the respective DOE Field or Operations Office for review. The collective results from each Field or Operations Office will then be summarized and submitted to the Program Secretarial Office (PSO) on this form. Each PSO is to review the Field or Operations Office results, compile them, and submit them through the Department's Chief Safety Officer (EH-1) to the Deputy Secretary. Each DOE Field and Operations Office should keep copies of the individual contractor facility assessments. PSO submissions should reach EH-1 by October 30, 2006.

"Contractor" means any entity contracted directly to DOE for a scope of work within a facility. "Subcontractors" are the entities under contractual agreement with the contractor that perform contractor-assigned work.

In those instances where a "YES" is indicated for a Line of Inquiry, the responder should provide a summary of the methodology that resulted in the "YES" response. If a response is "NO," the responder should provide, in addition to the methodology, corrective actions along with a due date for completion.

Additional LOIs may be added to address adverse electrical safety performance trends specific to a PSO, Site, or contractor.

Site Name: _____ **Contractor Name**: _____

1. Electrical Work Planning Process

1.1 Procedures: The contractor must have electrical safety procedures that incorporate the necessary safety provisions into work planning and hazards analysis processes. These procedures must be maintained under revision control and readily accessible to task planners and electrical workers. Electrical safety procedures should assist the work package planner to properly identify hazards, identify proper mitigation steps, and determine the necessary personal protective equipment (PPE).

1.1	LINES OF INQUIRY	YES	NO	SUMMARY RESULTS OF ASSESSMENT AND CORRECTIVE ACTIONS
1.1.1	Are electrical safety procedures incorporated into work planning and hazards analysis processes?	☐	☐	
1.1.2	Are these procedures kept up to date?	☐	☐	
1.1.3	Are work planners using the latest revision?	☐	☐	

1.2 Training: The contractor must provide training classes in work planning and hazards analysis that include electrical safety procedures and keep records of employees' mandatory attendance. All subcontractors performing work within the boundaries of DOE contracts are required to either have equivalent procedures and training for electrical work planning or take the contractor-provided training.

1.2	LINES OF INQUIRY	YES	NO	SUMMARY RESULTS OF ASSESSMENT AND CORRECTIVE ACTIONS
1.2.1	Does the training provided on work planning address electrical safety procedures?	☐	☐	
1.2.2	Are training records maintained and up to date?	☐	☐	
1.2.3	Are attendance records maintained and up to date?	☐	☐	
1.2.4	Do subcontractors attend the site training?	☐	☐	
1.2.5	Does the subcontractor provide equivalent training?	☐	☐	

1.3 Implementation: The contractor should implement an electrical safety program as part of its work planning and hazards analysis processes in the areas of research and development, production and maintenance, design and construction, or deactivation and demolition, including subcontracted work. The contractor shall ensure that its subcontractors have implemented procedures for effective electrical hazards analysis, walkdowns, PPE requirements, and worker or supervisor qualification. Work planning and hazards analysis processes should be reviewed and checked by an engineer or subject matter expert (SME).

1.3	REQUIRED ASSESSMENT	YES	NO	SUMMARY RESULTS OF ASSESSMENT AND CORRECTIVE ACTIONS
1.3.1	Do subcontracts mandate compliance with the site electrical safety program and require that work planning processes are consistent with site procedures?	☐	☐	
1.3.2	Do contractor records demonstrate that the appropriate actions were taken for inadequate or improper electrical safety work plans, including disciplinary actions where appropriate?	☐	☐	
1.3.3	Have subcontractors effectively implemented their electrical safety programs, and do they prepare effective work packages for electrical work?	☐	☐	

1.4 Verification: The contractor must verify that its electrical safety program is rigorously applied in the work planning process. Periodic internal audits or assessments should check the quality of work planning sessions and approved work packages. Managers, safety engineers, or SMEs should periodically conduct walkthroughs or field checks to 1) document worker qualifications (including subcontractors), procedure compliance, PPE use; and 2) verify that corrective actions are taken to address deficiencies and tracked to completion. Safety engineers or SMEs are to review work packages before they are issued. Workers understand their responsibility to stop work whenever they encounter unanticipated conditions.

1.4	LINES OF INQUIRY	YES	NO	SUMMARY RESULTS OF ASSESSMENT AND CORRECTIVE ACTIONS
1.4.1	Have work planning process records been internally audited for frequency, rigor, and corrective action monitoring?	☐	☐	
1.4.2	Are managers, safety engineers, and SMEs responsible for conducting walkthroughs, and has the frequency of these walkthroughs been determined?	☐	☐	
1.4.3	Have work planning documents been reviewed by engineering or SMEs for configuration conditions and proper isolation points?	☐	☐	

2. Lockout/Tagout (LOTO) Process

2.1 Procedures: The contractor must have LOTO procedures that are maintained under revision control and readily accessible to task planners and electrical workers.

2.1	LINES OF INQUIRY	YES	NO	SUMMARY RESULTS OF ASSESSMENT AND CORRECTIVE ACTIONS
2.1.1	Do comprehensive LOTO procedures exist?	☐	☐	
2.1.2	Are these procedures maintained up to date?	☐	☐	
2.1.3	Are work planners using the latest revision?	☐	☐	

2.2 Training: The contractor must provide training on LOTO procedures and keep records of employees' mandatory attendance. All subcontractors performing work within the boundaries of DOE contracts must either have the equivalent procedures and training for LOTO or take contractor-provided training.

2.2	LINES OF INQUIRY	YES	NO	SUMMARY RESULTS OF ASSESSMENT AND CORRECTIVE ACTIONS
2.2.1	Is training provided on the LOTO program and procedures?	☐	☐	
2.2.2	Are training records maintained up to date?	☐	☐	
2.2.3	Are attendance records maintained up to date?	☐	☐	
2.2.4	Do subcontractors attend LOTO training?	☐	☐	
2.2.5	Do subcontractors provide equivalent LOTO training?	☐	☐	

2.3 Implementation: The contractor must implement its LOTO program in all work, including that performed by subcontractors. The contractor must ensure that its subcontractors implement equivalent LOTO procedures. Work planning and hazards analysis processes should be reviewed and approved by an engineer or SME. The procedure should call for technical field support by an engineer or SME when unclear or unanticipated conditions arise during work execution.

2.3	LINES OF INQUIRY	YES	NO	SUMMARY RESULTS OF ASSESSMENT AND CORRECTIVE ACTIONS
2.3.1	Are subcontractors required to comply with site LOTO procedures?	☐	☐	
2.3.2	Do records demonstrate that necessary actions were taken for procedure noncompliance, including disciplinary actions where appropriate?	☐	☐	
2.3.3	Do subcontractors effectively implement LOTO procedures?	☐	☐	
2.3.4	Are SMEs, electrical engineers, or managers involved in task walkdowns, task planning, and field support when unexpected conditions arise?	☐	☐	

2.4 Verification: The contractor must ensure that its LOTO program is followed through a rigorous verification process. Periodic internal audits or assessments confirm training quality, training records management, and procedure maintenance and distribution. Periodic walkthroughs or field checks by managers, safety engineers, or SMEs record field execution compliance and corrective actions taken. Work packages should be reviewed by engineering or SMEs.

2.4	LINES OF INQUIRY	YES	NO	SUMMARY RESULTS OF ASSESSMENT AND CORRECTIVE ACTIONS
2.4.1	Are LOTO process records internally audited for frequency, rigor, and corrective action monitoring?	☐	☐	
2.4.2	Do managers, safety engineers, or SMEs conduct field walkthroughs and has the frequency of these walkthroughs been determined?	☐	☐	
2.4.3	Are work planning documents reviewed by engineering or SMEs for configuration conditions and proper isolation points?	☐	☐	

3. Zero-Energy Check and Energized Work Process

3.1 Procedures: The contractor must have procedures for performing zero-energy checks and energized work in compliance with NFPA 70E. These procedures must be maintained under revision control and readily accessible to task planners and electrical workers. These procedures should discourage energized work except under the most critical need.

3.1	LINES OF INQUIRY	YES	NO	SUMMARY RESULTS OF ASSESSMENT AND CORRECTIVE ACTIONS
3.1.1	Do comprehensive procedures for performing zero-energy checks and energized work exist?	☐	☐	
3.1.2	Are these procedures kept up to date?	☐	☐	
3.1.3	Are work planners, supervisors, and workers using the latest revision?	☐	☐	
3.1.4	Are decisions to work on energized lines documented and authorized at the appropriate management level? Are electrical safety SMEs involved in decisions to work on energized lines or equipment?	☐	☐	

3.2 Training: The contractor must provide training on energized work procedures, including proper energized/de-energized practices, high-energy tools, and PPE requirements. The contractor must maintain records of employees' mandatory attendance. All subcontractors performing work within the boundaries of DOE contracts must have the equivalent procedures and training or take the contractor-provided training.

3.2	LINES OF INQUIRY	YES	NO	SUMMARY RESULTS OF ASSESSMENT AND CORRECTIVE ACTIONS
3.2.1	Does training on energized work procedures address proper energized/de-energized practices, high-energy tools, and PPE?	☐	☐	
3.2.2	Are training records maintained up to date?	☐	☐	
3.2.3	Are attendance records maintained up to date?	☐	☐	
3.2.4	Do subcontractors attend the training?	☐	☐	
3.2.5	Do subcontractors provide equivalent training?	☐	☐	

3.3 Implementation: The contractor must implement procedures for performing zero-energy checks and energized work for all work performed on site, including subcontracted work. The contractor shall ensure that subcontractors properly implement zero-energy checks and energized work procedures. Work planning and hazards analysis processes should be reviewed and checked by an engineer or SME. The procedure should call for technical field support by an engineer or SME when unclear or unanticipated conditions occur.

3.3	LINES OF INQUIRY	YES	NO	SUMMARY RESULTS OF ASSESSMENT AND CORRECTIVE ACTIONS
3.3.1	Do subcontracts require compliance with site procedures governing zero-energy checks and energized work?	☐	☐	
3.3.2	Do records demonstrate that appropriate actions were taken for procedure noncompliance, including disciplinary actions?	☐	☐	
3.3.3	Do subcontractors effectively implement zero-energy checks and energized work procedures?	☐	☐	
3.3.4	Are SMEs, electrical engineers, or supervisors involved in task walkdowns, task planning, and checking or overseeing energized work?	☐	☐	

3.4 Verification: The contractor should ensure that zero-energy checks and energized work procedures are followed through a rigorous verification process. Periodic internal audits or assessments confirm training quality, training records management, and procedure maintenance and distribution. Periodic walkthroughs by managers, safety engineers, or SMEs verify and document that energized work takes place only under a strict approval and oversight process and monitor corrective actions taken. Engineers or SMEs review the work packages prior to issuance.

3.4	LINES OF INQUIRY	YES	NO	SUMMARY RESULTS OF ASSESSMENT AND CORRECTIVE ACTIONS
3.4.1	Are records of zero-energy check and energized work processes internally audited and evaluated for frequency, rigor, and corrective action monitoring?	☐	☐	
3.4.2	Are managers, safety engineers, or SMEs responsible for conducting periodic walkthroughs and has the frequency of these walkthroughs been determined?	☐	☐	
3.4.3	Have work planning documents for energized work been reviewed by engineering or SMEs and justifications properly validated?	☐	☐	