



Near-Miss Electrical Accident at DOE Headquarters

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HS-32

October 5, 2009



What Happened?



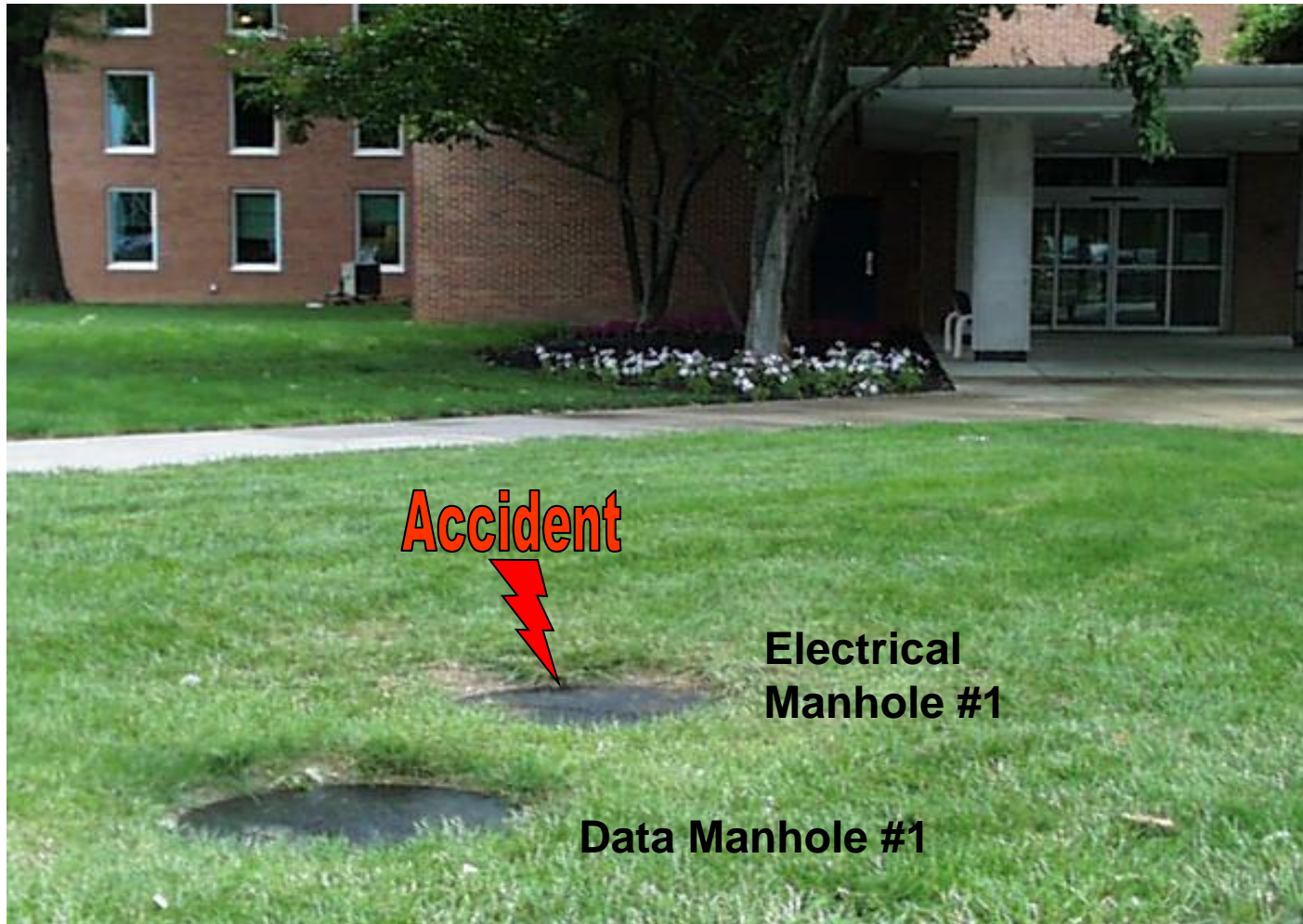
On June 9, 2009, an Integrated Security Technologies (IST) alarm maintenance technician, under contract to the Office of Health, Safety and Security (HSS), received an electrical shock while performing work in a manhole located near the south entrance to the Germantown facility.

The technician was exiting an 11-foot-deep manhole on an 8-foot all-aluminum ladder when he received the shock.

The technician sustained a minor burn to his left hand. He was transported to a hospital for evaluation and released later that day. He was placed on leave for two days after experiencing soreness in his joints, arms, and shoulder.



Manholes at South Entrance



Accident

**Electrical
Manhole #1**

Data Manhole #1



What was the Job Task?



- On February 23, 2009, while the Info IST construction group was upgrading the CCTV system at the baseball field, they discovered a break in the fiber-optic cable. The IST project manager tasked the IST maintenance group with replacing the cable.
- On June 9, 2009, a crew of four IST alarm maintenance technicians, one of whom was the supervisor, were tasked with pulling a length of fiber-optic cable from Electrical Manhole/Vault 2 (Manhole #2), which is located across the south parking lot of the Germantown facility at the baseball field, to Electrical Manhole/Vault 1 (Manhole #1).



Diagram of the Accident Site





Electrical Manhole #1





What Electrical Hazards Were Present?

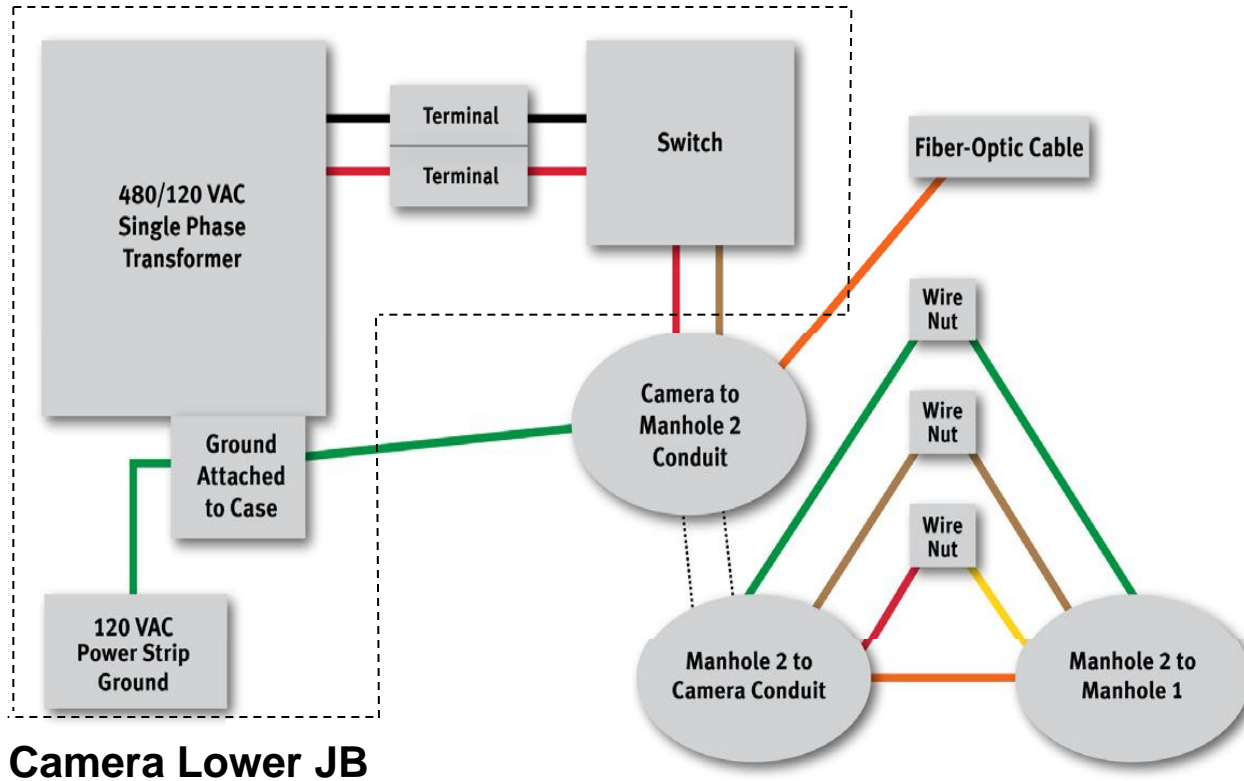


- The fiber-optic cable being replaced was located in the same conduit as the 480-volt electric cable that supplies power to the camera transformer.
- A separate, 480-volt, 3 phase, electrical service for the radio building was in the bottom of the manhole.
- The lower electrical junction box at Camera 126 contained exposed energized electrical terminals with 480 volts electrical phase-to-phase potential.

NFPA 70 E, Article 110.8, "Working On or Near Electrical Conductors or Circuit Parts"



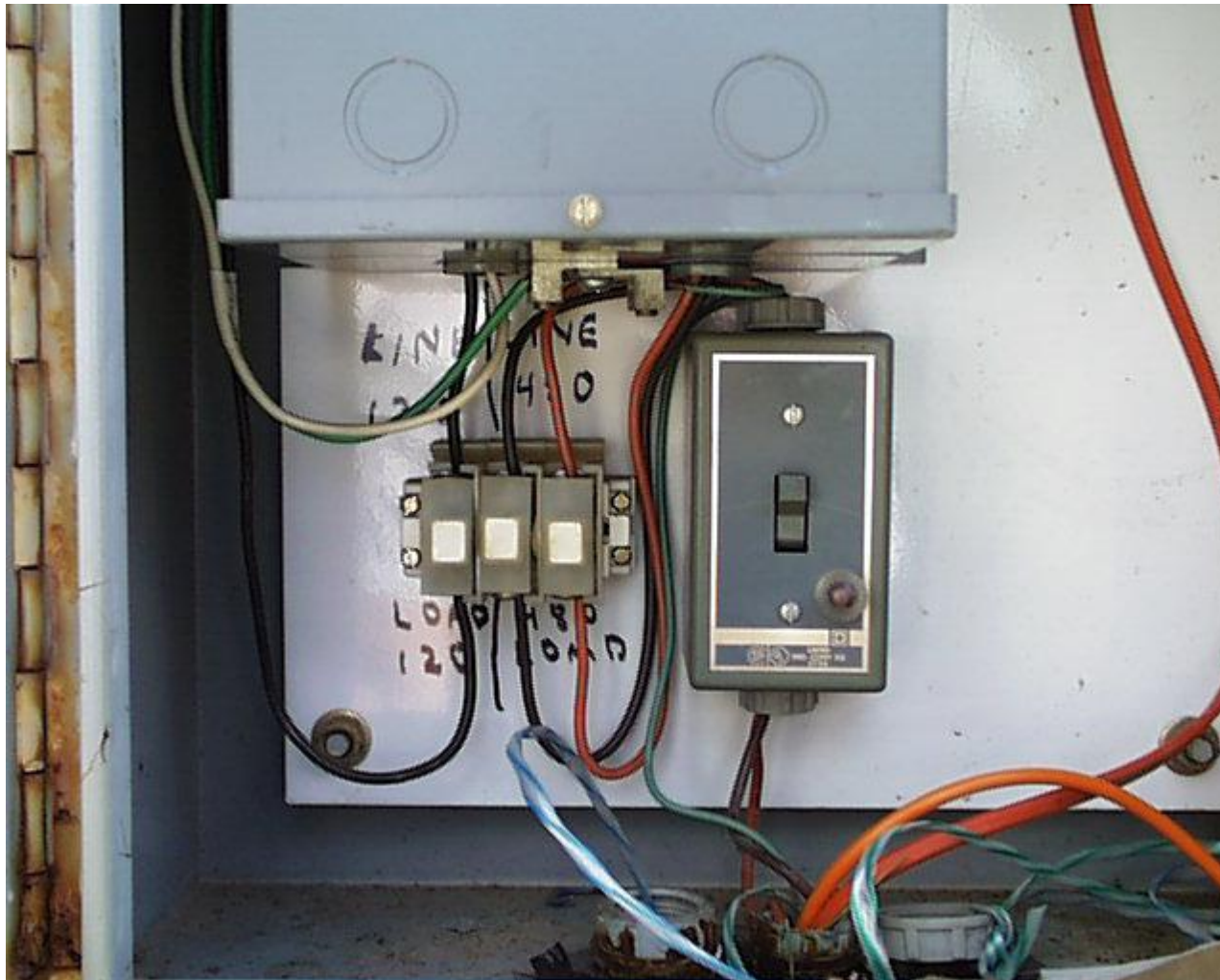
Conceptual Electrical Cable Wiring Diagram



Note: This figure is conceptual and may not represent the actual wiring configuration.



Camera Lower Junction Box





Manhole #2

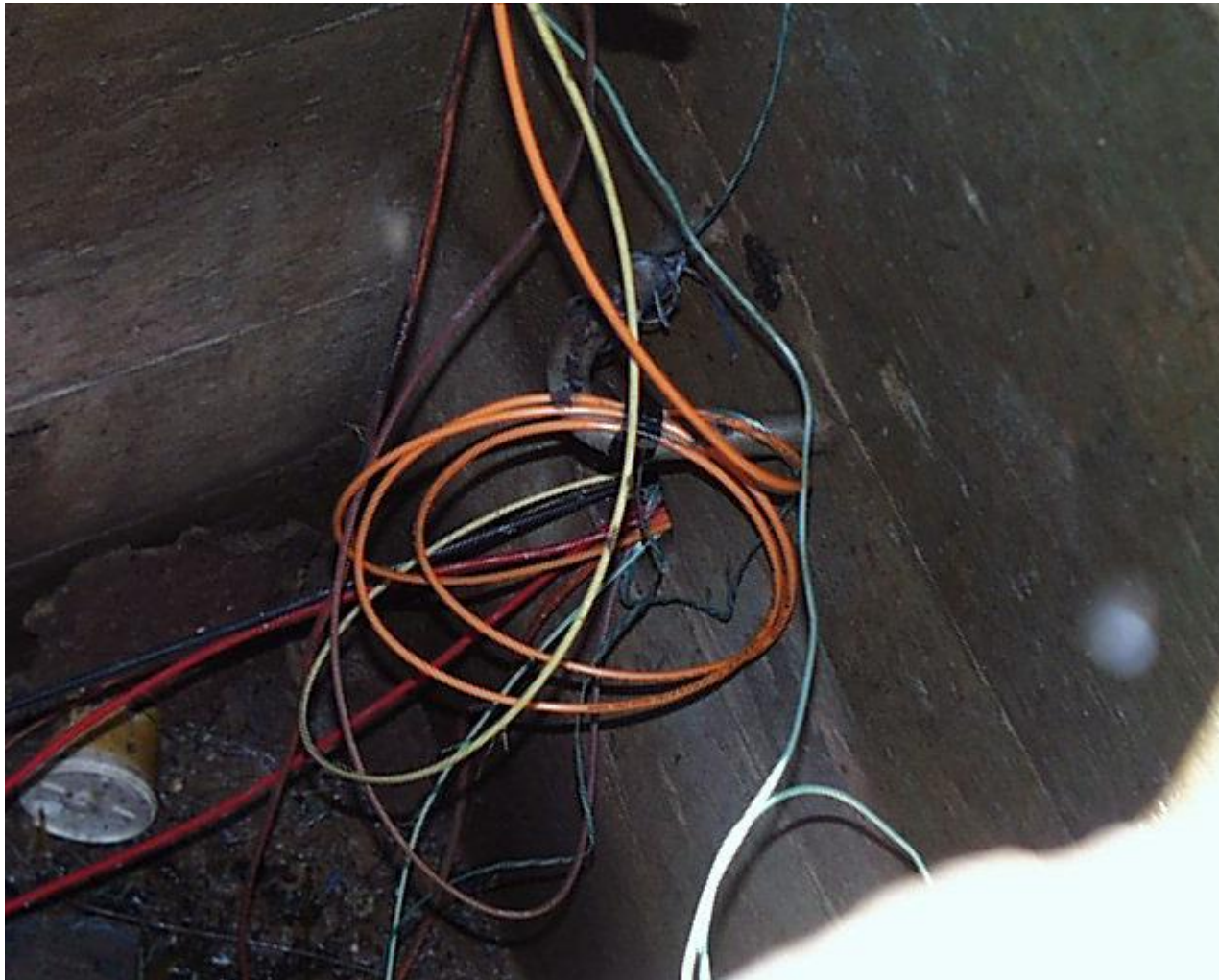
Conduit to Camera





Manhole #2

Conduit to Manhole #1





Manhole #1

Wiring and Cables





What were the Confined Space Issues?



- There were no danger signs or alternative measures that identified the two manholes as permit-required confined spaces. There was no air monitoring of the spaces.
- There was no rescue equipment at the job site. In many cases, a co-worker has been injured or killed while attempting a confined space rescue without proper equipment.
- The only method of egress (ladder) was moved between manholes leaving workers without a method to escape.

29 CFR 1910.146 Permit-Required Confined Spaces



What were the Work Execution Issues?



- There are major gaps in how work is routinely executed as compared with how work is required to be executed at DOE HQ facilities.
- HSS line management did not ensure that effective Integrated Safety Management Systems were in place for this work or that IST was in compliance with Title 10 of the Code of Federal Regulations Part 851 (10 CFR 851), *Worker Safety and Health Program*.
- IST did not have an effective Worker Safety and Health Program in place and their existing Worker Health and Safety Plans (HASP) were not followed.



What were the Work Coordination Issues?



- There are gaps in coordination of work at DOE HQ facilities. Construction and maintenance work may occur without coordination with the Office of Management (MA), which creates the potential for putting other support service contractors at risk.
- There is no over-arching agreement or work control process at DOE HQ facilities to ensure that work is adequately reviewed, approved, coordinated, and overseen.



How was the Job Performed?



- Initially, the technicians used the old fiber-optic cable to pull the new cable between the two manholes.
- Then the old fiber-optic cable broke.
- The technicians then disconnected an electrical cable ground wire and used it as a “pull string” to install the new fiber-optic cable.
- The technicians did not de-energize the electrical cable to the camera before disconnecting the ground wire and using it to pull the new cable through the conduit.
- After completing the pull, the ground wire was reattached, the ladder was returned to manhole #1, and the technician attempted to egress. That’s when he felt the shock.



What Was the Source of the Electrical Shock?



The direct source of the electrical current that resulted in the electrical shock to the technician may have come from one of the following:

- ⚡ Contact with an exposed energized conductor; either one of the three-phase (480-volt) electrical cables or the single-phase (480-volt) electrical cables located in the manhole.
- ⚡ Damage to the single-phase 480-volt cable by the ground wire.
- ⚡ Disconnecting the ground wire.

A more definitive determination of the direct cause is not possible at this time because the manhole is not safe to enter. The manhole has been secured to prevent unauthorized entry until the electrical hazard can be abated.



What Went Wrong?



Everything!

BARRIER ANALYSIS

Hazard: Dangerous Electrical Energy and Confined Spaces		Target: IST Technician	
What were the barriers?	How did each barrier perform?	Why did the barrier fail?	How did the barrier affect the accident?
Work Plan/Job Safety Hazard Analysis	Failed	Not Used	Supervision and workers were not aware of the hazards and proper controls.
HSS Contract Award Process: Review and Approval for IST Contract	Failed	HSS did not review Health and Safety Plan (HASP) submitted by IST per 10 CFR 851 requirements.	Allowed IST to conduct work using inadequate work controls and procedures relating to work performed at DOE Germantown facility.
Work Planning and Controls	Failed	Non-existent	Lack of IST work planning resulted in failure to recognize hazards and controls. IST failed to fully interface with DOE MA facilities management.
Lock and Tag Out	Failed	Not Used	Allowed dangerous electrical current to flow to IST Worker causing electrical shock.

CHANGE ANALYSIS

Accident Situation	Prior, Ideal, or Accident-Free Situation	Difference	Evaluation of Effect
<p><i>Inaccurate Mental Model</i> Workers did not recognize the dangers of the confined space and the electrical hazards.</p>	<p>IST reported to LSI Investigators that they entered Manhole 1 and 2 previously, approximately seven times, without incident.</p>	<p>None. Workers did not expect or anticipate changes in hazards.</p>	<p>Worker received an electrical shock.</p>
<p><i>Change of Work Scope</i> Workers failed to stop work until impact of the change of work scope was evaluated.</p>	<p>The potential for contact with hazardous electrical energy would be identified and protective measures taken by IST.</p>	<p>After the old fiber-optic cable broke, the IST workers decided to disconnect the electrical ground wire from the CCTV transformer and use it as a pull string.</p>	<p>Removing the electrical ground from the 480-volt transformer created an electrical hazard that was unrecognized by the IST workers.</p>
<p><i>Lockout/Tagout</i> Workers disconnected the ground wire from the energized 480-volt camera transformer. Workers failed to lockout/tagout 480-volt power to camera.</p>	<p>Power source to the transformer would have been locked out/tagged out before cutting the green wire. IST would have had a lockout/ tagout program and would have coordinated lockout/tagout with MA.</p>	<p>If lockout/tagout procedure had been followed, green wire would not have been compromised and energized.</p>	<p>Worker received an electrical shock.</p>
<p><i>Confined Space</i> Danger of confined space is not identified before the accident and permits are not implemented.</p>	<p>MA would have implemented a uniform confined space program for Headquarters.</p>	<p>If IST had recognized the confined space permit entry, they would have coordinated with MA and may have controlled the hazards.</p>	<p>Worker received an electrical shock.</p>
<p><i>Work Planning, Job Safety Analysis (JSA), and Configuration Management</i> Work planning and JSA were not performed; unstructured and inadequate to identify hazards.</p>	<p>Work planning and JSA would have identified the electrical hazards. Would have identified appropriate controls/PPE. If as-built drawings were available, workers would have known of the existence of hazards associated with the 480-volt cables.</p>	<p>Failure to do adequate work planning and specify controls resulted in proper controls or PPE not being implemented. (non-conductive ladder, insulating gloves).</p>	<p>Worker received an electrical shock.</p>





Define the Scope of the Work



- IST did not adequately define the scope of the work associated with replacing the old fiber-optic cable with new fiber-optic cable.

Effective work execution begins with a well-defined scope of work that translates the mission and requirements of the work into terms that those who are to accomplish the work can clearly understand.

- IST did not effectively communicate the scope of the work to the MA facilities maintenance organization. IAW the contract, corrective maintenance is to be initiated by a DOE Security Corrective Maintenance Request.



Define the Scope of the Work (Cont.)



- IST did not adequately determine the method, techniques, and safety aspects associated with performing the task.
- The IST project manager assigned the task to the IST maintenance crew orally, not in writing. The IST supervisor was aware of the electrical hazards but did not know the manholes were designated as confined spaces.



Analyze the Hazards



- The IST HASP includes a Confined Space Entry Program that sets the practices and procedures to protect employees from the hazards of entry into permit-required confined spaces. **IST did not implement this.**
- The IST HASP states: “Employees will not work near live parts of electrical circuits, unless the employees are protected by: De-energizing and grounding the parts; Guarding the part by insulation; or Visual airgap.” **IST did not implement this.**
- The IST HASP states: “Only non-metallic, approved ladders will be used on IST projects. The Site Safety Coordinator will coordinate the approval of ladders with the site manager.” **This was not done.**



Analyze the Hazards (Cont.)



- The IST HASP states: “The path to ground from circuits, equipment, and enclosures will be permanent and continuous.” The same section states that electrical safety-related work practices cover both qualified persons and unqualified persons.

The IST alarm maintenance technicians were not trained or certified electricians, yet they worked in an energized 480-volt panel around exposed energized parts.

- IST did not adequately perform a hazards analysis as required by 10 CFR 851, 29 CFR 1910, NFPA 70E, and the IST HASP.

A hazards analysis develops a clear understanding of the task-specific hazards that may affect the worker, the public, or the environment. Hazard identification and analysis occur in preparation for a specific task and continue throughout performance of the task as conditions change.



Develop, Implement, and Perform Work within Controls



- IST did not develop a job-specific hazards analysis; therefore, they could not develop and implement adequate controls.

Hazard controls must be properly implemented, and personnel performing work must be fully apprised of the hazards and associated controls before work can be safely performed.

- Authorization to perform the work was informal and consisted of a telephone call from the IST project manager to the IST maintenance crew.

Authorization to commence work must be explicit, and associated limits under which work is to be performed should be specific.



Develop, Implement, and Perform Work within Controls (Cont.)



- No formal work documentation (site-specific JSA, work “ticket,” or work control document) was developed or used to authorize and control the work.
- The original scope of work consisted of installing new fiber-optic cable between Camera 126 and the Germantown Main Building using the old fiber-optic cable as the method for pulling the new fiber-optic cable. *However:*
- The original scope of work changed when the IST maintenance technicians determined it would be necessary to use an existing ground wire to install the new cable when the old cable broke.

Deviations to the planned and authorized scope of work are to be analyzed, and appropriate modifications to existing controls implemented before executing a scope change.



Feedback and Improvement



In 2005, the Office of Security Operations (SO) and IST were the subject of a LSI concerning multiple events at Germantown involving vehicle barrier malfunctions. The JONS included:

- SO - Develop and implement a formal process to ensure essential safety requirements are identified and incorporated into contractor documents for implementation.
- SO - Develop a formal process to ensure that IST and other contractors have established roles and responsibilities for effective hazard evaluation and identification and implementation of hazard controls for SO projects.
- SO - Develop and implement a formal process for systematically conducting surveillances, inspections, or assessments of all pertinent contractor and subcontractor activities.



Feedback and Improvement (Cont.)



- IST (and other contractors) - Formally institutionalize a process for identifying, capturing, evaluating, and translating essential safety requirements into SO project activities.
- IST (and other contractors) - Develop and implement a formal process to define roles and responsibilities for evaluation of hazards, identification and implementation of hazard controls, and the incorporation of any modifications associated with SO projects.

Neither SO or IST had a formal feedback and improvement process so the management system weaknesses identified in 2005 were not corrected and became precursors to the 2009 accident.



Recent Electrical Event in a Confined Space



- On August 24, 2009, in Washington, DC, two Pepco contract workers were injured while pulling cable in manhole. One of the workers received an electrical shock when he touched an energized wire, which then touched another wire causing an arc flash and fire that was described as an explosion.
- The worker, who was shocked, also received severe burns to his face and upper extremities. He was hospitalized in critical condition. The other worker suffered from smoke inhalation.
- The utility company (Pepco) said the vault contained various high-voltage feeds.



In Conclusion



These types of events underscore the importance of:

- Having a clear and concise work scope,
- Recognizing hazards, performing hazards analysis, and implementing hazardous energy controls,
- Coordinating work activities with authorities having jurisdiction,
- Stopping work to reanalyze changed conditions, and
- Conducting safety oversight of contractor work.

The Limited Scope Investigation Report, which contains the causal analysis and Judgments of Need on this accident, can be found at:

http://www.hss.energy.gov/csa/csp/aip/specialreviews/LSI_GTN_Electrical_Incident_Final.pdf