SUMMARY OF ELECTRICAL ARC FLASH INJURY AT THE STANFORD LINEAR ACCELERATOR CENTER

October 11, 2004

The following is a summary of information excerpted from the DOE TYPE A Accident Investigation Report that was released in December 2004. The full report can be read by accessing the following website:
https://reports.eh.doe.gov/csa/accidents/typea/Type_A_Electrical_Arc_SLAC_20041011.pdf

ACCIDENT SUMMARY

On October 11, 2004, at approximately 11:15 am, a subcontractor electrician working at the Stanford Linear Accelerator Center (SLAC) received serious burn injuries requiring hospitalization due to an electrical arc flash that occurred during the installation of a circuit breaker in an energized 480-Volt (V) electrical panel. The electrician was installing the circuit breaker in an energized electrical circuit breaker panel when the arc flash occurred, igniting his clothing. Another laborer, serving as the backup to the injured Electrician was standing two to three feet behind and the right of the electrician and was knocked down by the arc flash pressure burst. The electrician received second and third degree burns on his face, chest and legs and second degree burns on his arms, collectively involving approximately 50% of his body.

PHOTOGRAPHS OF THE SCENE

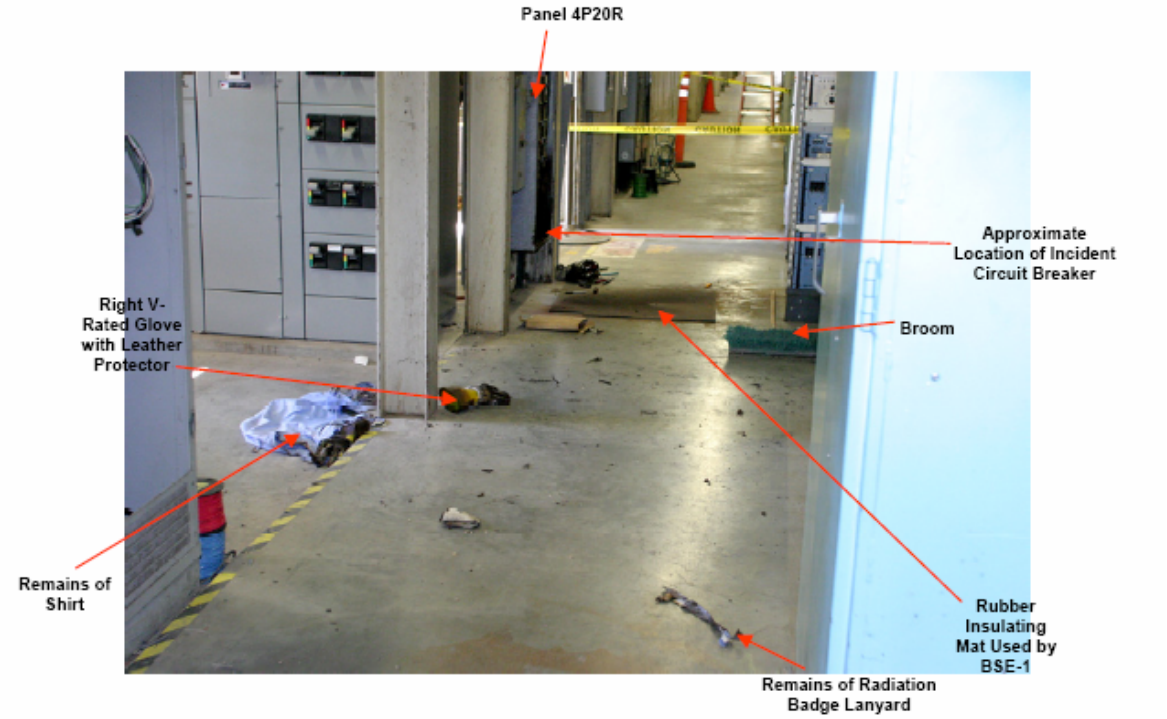

Figure 2-1. Scene immediately after the accident

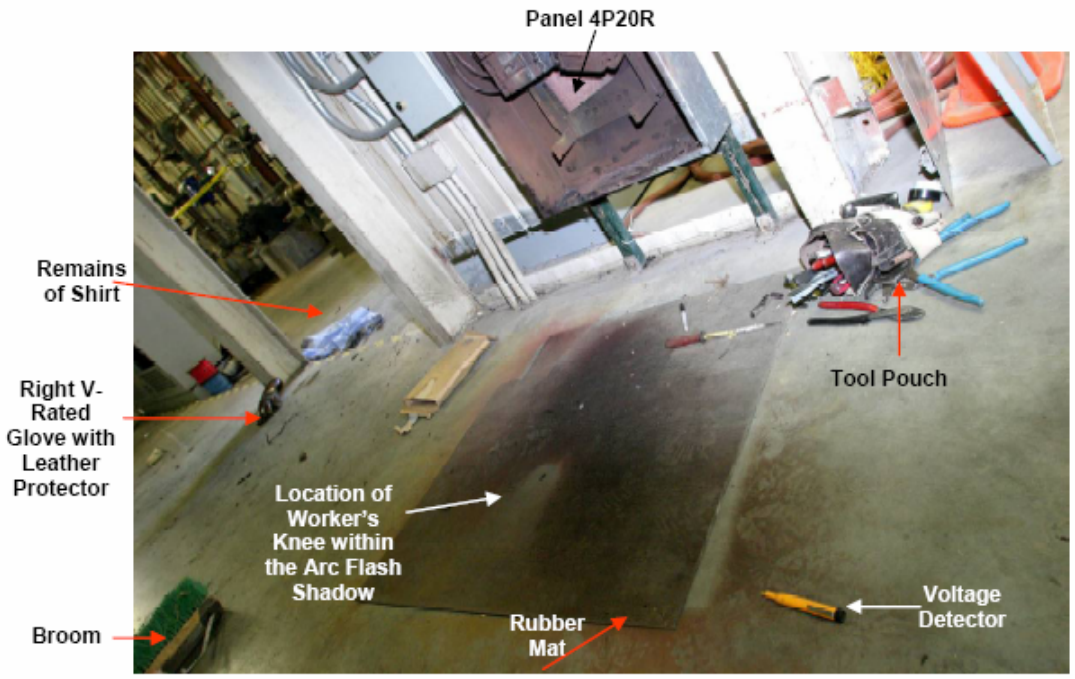

Figure 2-3. The insulating mat with the outline of BSE-1's knee in the arc flash shadow

Figure 2-4. Warning label on Panel 4P20R

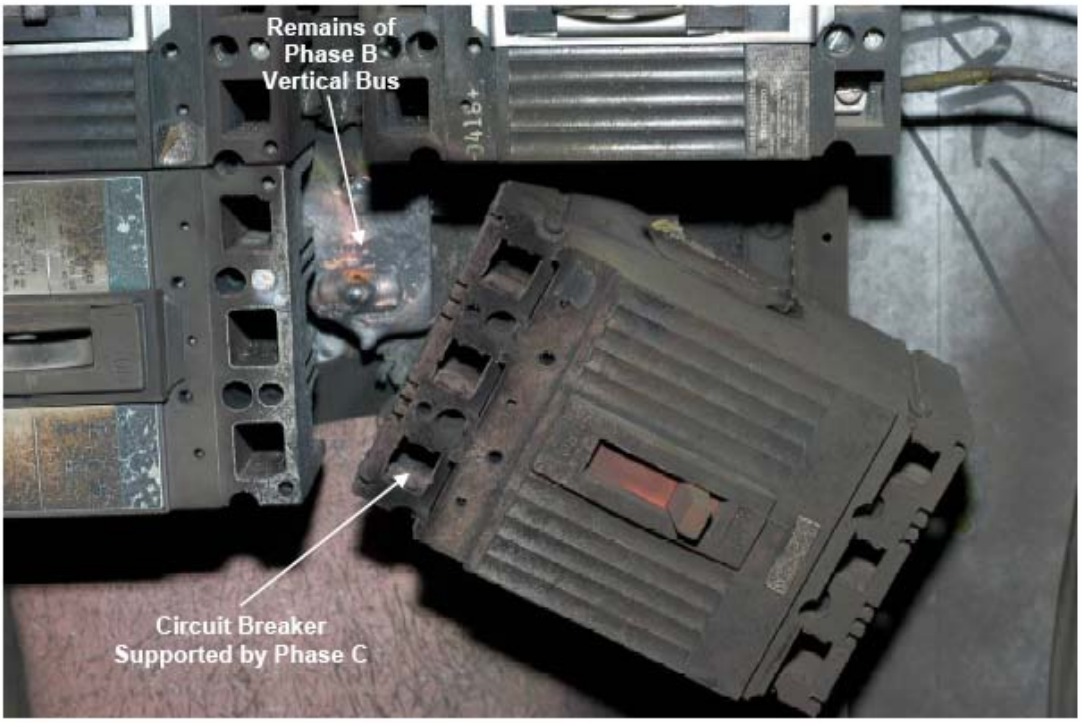

Figure 2-10. Closeup 1 of the damaged circuit breaker panel

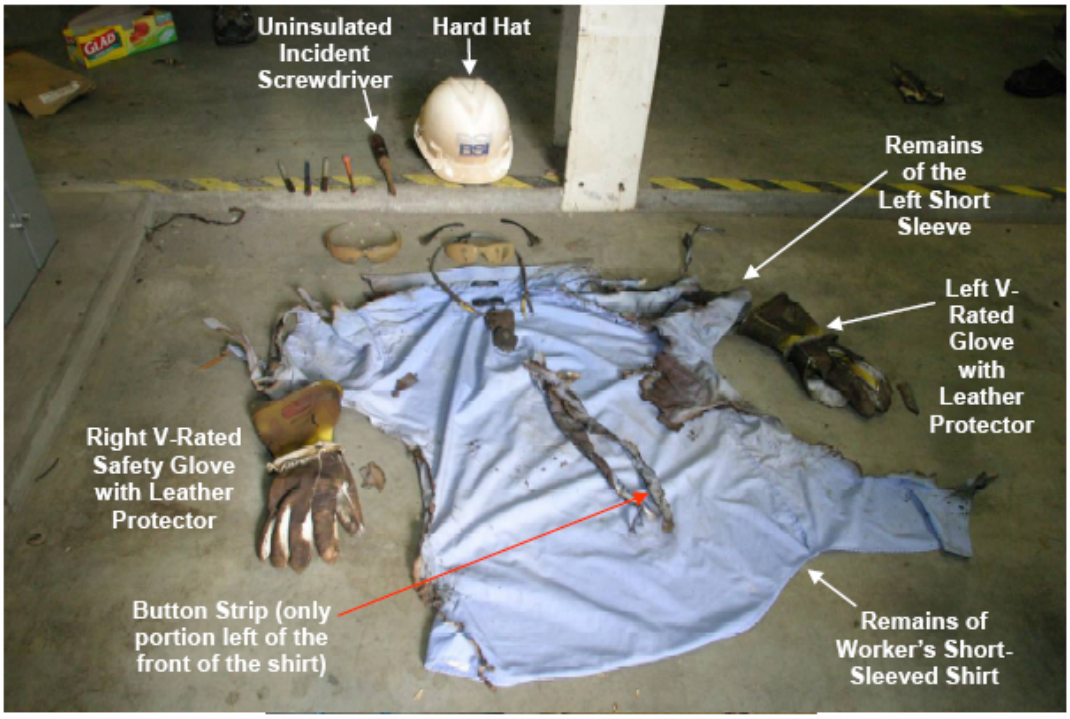

Figure 2-6. BSE-1's burned shirt and his flash-damaged PPE and tools

Figure 3-4. Worker wearing the correct protective clothing and PPE

Figure 3-5. Worker wearing the eye and hearing protection to be worn under the double-layer switching hood

ANALYSIS

The accident resulted from deficiencies in SLAC's work control planning and implementation processes. The SLAC Site Engineering and Maintenance Department (SE&M) exhibits a culture where safety is often secondary to operations. Deficiencies were identified in the line management organizations of the DOE Stanford Site Office (SSO), SLAC, and "Bay Span, Inc"

(Bay Span), the electrical subcontractor performing the work. The events leading up to and during the installation of the circuit breaker and the resultant arc flash are characteristic of an unstructured and largely undocumented approach to work that did not ensure the safety and health of workers at SLAC.

Managers, supervisors, and support staff do not take action to enforce compliance with the safety requirements for this very dangerous task. For the circuit breaker replacement, the Board identified the following key deficiencies:

- A "Pre-Work Hazard Analysis" (PWHA) form was not completed.
- There was no approved electrical hot work permit.
- The workers were not wearing the appropriate Flame Resistant (FR) clothing and all the required Personal Protective Equipment (PPE).
- The Bay Span Laborer (BSL) was not trained to be backup for an electrician.
- No one in the SLAC management chain had been informed of the decision by the SLAC Field Supervisor to install the circuit breaker in an energized panel.
- SLAC safety officials were not involved (only notified after such work occurred).

All SLAC management officials above the SLAC Field Supervisor stated that it was unnecessary for the circuit breaker installation to be done with the panel energized, and they would not have approved working on an energized circuit breaker panel. The events that occurred on October 11, 2004, violated all of the Integrated Safety Management (ISM) Guiding Principles and Core Functions. As recently as July 23, 2004, SLAC management prepared a report to the DOE Office of Science in which work on energized electrical equipment performed at SLAC was reviewed. On June 24, 2004, the SLAC Director formed an Electrical Safety Review Team to focus on areas of concern identified by DOE: (1) personnel errors, (2) work control problems, (3) configuration management weaknesses, (4) electrical intrusion events, and (5) vehicles. The review team's report analyzed 31 SLAC electrical hot work permits from February 25, 2004, through May 25, 2004, and found that 23 did not have the necessary justification for the work to be conducted while systems were energized. Nineteen of the hot work permits were missing some of the required information. This report also notes significant deficiencies in each area reviewed. As significant as the findings were, the review team, SLAC management, and SSO did not demonstrate a sense of urgency in implementing the recommendations that resulted from the review. The significant breakdown in the enforcement of health and safety requirements is indicative of a work environment where occupational safety and health policies, programs, and procedures for worker protection are not fully implemented. The SE&M, in particular, has not balanced the priorities of accelerator operations and worker protection.

Direct Cause

The direct cause of the accident was the electricians attempt to install a circuit breaker in an energized Panel. Violations of OSHA, DOE, SLAC, and Bay Span electrical safe work practices increased both the probability that an arc flash could occur and the severity of the resulting consequences.

Root Cause

Neither SLAC nor Bay Span fulfilled their responsibilities under OSHA and DOE's ISM policies and procedures to provide the electricians and the laborer with a workplace free of recognized electrical hazards, such as arc flash.

Contributing Causes

1. The Electrician worked on an energized circuit breaker panel without sufficient justification for exposure to the arc flash hazard. The Electrician did not exercise the stop work authority granted him by the DOE, SLAC, and Bay Span policies and procedures.

2. A second electrician working nearby did not exercise his stop work authority when he observed the Electrician working on an energized circuit breaker without FR clothing and appropriate PPE.

3. The SLAC Field Supervisor directed the Electrician to install a circuit breaker in an energized panel without ensuring that the Electrician understood the hazard and appropriate controls. The SLAC Field Supervisor did not provide sufficient justification for exposure to the arc flash hazard. The SLAC Field Supervisor did not direct the Electrician to lock and tag out Panel 4P20R. The SLAC Field Supervisor did not advise the Electrician that his clothing was not appropriate for electricians or that additional FR clothing and PPE were required for electrical hot work.

4. Bay Span's oversight failed to identify their electricians' deviation from the safety and health terms and conditions in their contract with SLAC.

5. SLAC's policy on worker protection did not ensure that Bay Span's employees received the same protection against electrical hazards that SLAC employees were provided. SLAC's policy violated OSHA standards and interpretations on worker protection in multiemployer workplaces.

6. SLAC's electrical safety oversight failed to detect and correct SE&M's and Bay Span's deviation from established electrical safe work practices.

7. The DOE SSO's electrical safety oversight failed to detect and correct SLAC's violation of OSHA standards and interpretations on worker protection in multiemployer workplaces.

8. SSO and SLAC failed to ensure that lessons learned from numerous potential sources (e.g., the ISMS Phase II Verification Report, the URS independent study, the 2003 Type B Accident Investigation report, et al.) led to continuous improvement of electrical safe work practices.

9. SSO did not direct SLAC to take immediate, effective corrective actions in response to the Electrical Safety Action Plan, Stanford Linear Accelerator Center submitted in July 2004.

CONCLUSION

The Independent Accident Review Board concluded that this accident was preventable. The direct cause of the injury was an explosive release of energy resulting from an arc flash that occurred during the installation of a circuit breaker in a 480V energized panel. The circuit breaker installation on an energized panel was not justified. If proper permitting procedures

had been followed, the work would not have been performed. The severity of the injuries could have been significantly reduced or eliminated had the worker been wearing the appropriate FR clothing and using the correct PPE. There were at least three people directly involved in the task with sufficient direct interaction and safety knowledge who could have exercised stop work authority because of the unsafe working conditions, yet no one took action. The SLAC managers above the SLAC Field Supervisor (the SE&M line managers responsible for the work in the area where the accident occurred) were not involved in work planning, task monitoring, or follow-up to ensure that the principles of ISM were applied. The SLAC Field Supervisor stated that assignments associated with this work were verbal and that such informality was characteristic of the SE&M's work practices. SE&M management assigned the SLAC Field Supervisor to function as a University Technical Representative (UTR), although he has not received the required training. UTRs manage the subcontractor. The SLAC Field Supervisor was not in the immediate area when the arc flash occurred; there was no site supervision by SLAC over this hazardous job. Personnel from the Environment, Safety, and Health (ES&H) Division were not present, as this organization monitors work on a random basis. Consequently, there was no SLAC safety professional involvement with this event. Interviews with other SLAC employees and managers indicated that this approach to work is prevalent in the SE&M. Bay Span, the subcontractor, provided no oversight. The injured Bay Span foreman was not wearing clothing or PPE appropriate for electrical work at the time of the accident. The DOE SSO put safety and health performance criteria in the SLAC contract in response to previous safety problems. The thrust of the performance criteria is the full implementation of the ISM System. This investigation determined that violations of all seven ISM Guiding Principles and all five ISM Core Functions led to this accident.