Date: Fri, 30 May 1997 13:57:48 -0600
From: Meredith Brown <racer@lanl.gov>
Subject: Red Alert: Update on Electrician Injury at INEEL

Title: RED - **Electrician Injured While Working on Plant Air Compressor Electrical Potential Transformer** (Final Lessons Learned)

Executive Summary: This is the final Lessons Learned following a preliminary Lessons Learned issued August 24, 1996, addressing an electrical shock accident occurring August 13, 1996, at the Idaho National Environmental Engineering Laboratory (INEEL).

Keywords: electrical shock, compressor modifications, phase stab, VAC bus

Identifier: INEEL Lessons Learned #96379 Final
Date: May 22, 1997

Lessons Learned Statement(s):

1. Provide increased assurance that personnel exposed to high risk are fully informed of hazards through sufficient work control planning.

2. Provide assurance that workers are "qualified", as described in PRD-1, "Electrical Safety", and 29 CFR 1910, to all those involved in work package planning, approval, and execution, through a comprehensive program. To be qualified, a worker must be familiar with the equipment or system and aware of the hazards involved, including the ability to determine how to protect themselves from hazard. "Skill of the craft" expectations need to be clearly defined in both work control procedures and craft training. Job skills and knowledge that are beyond "skill of the craft" or job-related skills should be identified and addressed in work planning.

3. Expectations for zero-energy verifications should be formal, specific, clear , and site-wide. The emphasis should be on communicating zero-energy verification requirements to employees. Each time a new cubical or panel is opened and a live part is exposed, a zero energy check must be done to ensure the cubical or panel is safe to work in. If an exposed part has not been zero energy checked and proved to be de-energized, it must be treated as energized.

4. As-built drawings and vendor data for older equipment should not be accepted as current and correct. Compensatory requirements should be implemented to compensate for inaccurate information. If the work cannot be done as stated in the work package, stop work. It is the responsibility of everyone on the job to ensure that each job step in the work package is completed as instructed. If work must deviate from the work package, be sure to have changes made to the work package and that all the needed approvals have been obtained.

5. Program control documentation should accurately reflect and communicate the clearly defined roles and responsibilities of managers, supervisors, and workers. Management review and approval should be commensurate with possible risks involved in any work package . Work packages should have one manager with primary ownership, to ensure the job is done right and

safely. Responsible line managers must understand the work to be done and periodically visit the job site to ensure the job is being done according to the job plan. It is the responsibility of line management to ensure only qualified persons are assigned to do the work.

6. When deficiencies in work controls are identified, management needs to focus attention on correcting deficiencies. Achievable milestones should be established and completed on schedule, and completion should be verified.

7. Safety requirements should be integrated into work control documents and implemented in the field, through work controls, hazard evaluations, and work packages. Time should be taken to do a complete hazards analysis: 1) identify all of the job steps to be done; 2) determine the hazard involved with each job step; 3) implement steps to eliminate the identified hazards.

Discussion of Activities: On August 13, 1996, while working inside an electrical cubicle at Test Reactor Area (TRA) 609 which contains electrical wiring designed to carry voltages ranging from 120V to 2400V, an electrician received an electrical shock.

The electrician was on temporary duty from another facility, working with and under the direct supervision of a Leadman. Work was to be completed in three compressor drawers, M-6, M-7, and M-8. The VAC bus supplying energy to M-6 and M-8 had been tagged out earlier that day, and zero energy checks had been performed. The VAC bus supplying energy to M-7 had not been de-energized. Work on the M-7 drawer was to be through the tilt out drawer only, which would disconnect the potential transformers when tilted open. The electrician was tasked with the removal of 120V wiring on the secondary side of the potential transformers in back of the electrical cubicle in accordance with approved written instructions, nearby but not within direct sight of the Leadman. Access to the wires, though possible, was difficult through the M-7 tilt out drawer, so the electrician decided to access the wires through the top panel. The electrician did not understand the M-7 compressor bus configuration and had not been closely following conversations (noting that the M-7 2400 VAC bus would remain energized) between the Leadman and the Utility Area Controller that occurred at the beginning of the shift and during the morning. He believed that power for the M-7 compressor also came from the bus feeding M-6 and M-8, which were confirmed to be de-energized. The electrician climbed from a 6-foot fiberglass ladder onto the top of the cabinet frame and removed the M-7 top panel to gain improved access to the M-7 tilt out drawer, which exposed him to energized 2400 VAC bus components. No zero energy check was performed from this new access point.

At approximately 12:49 PM, the electrician reached into the top of the enclosure to clip some small wires, touching his right forearm, near the wrist, to a phase stab on the energized 2400 VAC bus. A calculated 1385 V shock traveled through his arm and was primarily grounded through his right elbow to the cabinet frame. The effects of the electrical shock caused him to fall off the switchgear cabinet, 5 1/2 feet to the concrete below. As a resultof this fall, he suffered a laceration to the back of the head, a concussion, and a temporary loss of consciousness, in addition to the shock and electrical burns.

Analysis: DOE convened a Type A Accident Investigation Board. The following analysis information is summarized from the final report.

Root causes of the accident were: (1) an effective management control system was not in place to develop and implement adequate work controls; (2) the responsibilities inherent in line supervision were not made clear; and (3) the electrician did not understand that there were energized components in the enclosure.

Direct cause of the accident was: the lack of effective work control.

Contributing causes for the accident were: (1) configuration control weaknesses were not mitigated with good work planning; (2) some managers do not understand their roles, responsibilities, and authority in electrical safety; (3) corrective actions were not incorporated in a timely manner; and (4) the "skill of the craft" was used as a substitute for explicit safety requirements in Safe Work Release (SWR).

Recommended Actions: Emergency Medical Technicians arrived within 4 minutes. LMITCO Security, appropriate TRA line management, and safety personnel were notified and immediately responded to the scene. The accident scene was secured, following the evacuation of the electrician. Detailed photographs were taken and a video of the accident scene was made. The LMITCO Deputy Operations Manager from the Advanced Test Reactor took charge of the accident scene to establish a clear line of accident scene management.

All equipment in use by the electrician at the time of the accident were collected as evidence. Emergency Control Center logs, Central Facilities Area Fire Department logs, and a list of all personnel notifications were collected. Written statements of all personnel present in the immediate area were completed quickly.

A critique was held immediately after the accident, to review known facts and determine causes of the accident. Line management directed an electrical stand-down of other electrical work in progress at TRA until the cause of the accident had been determined.

Department of Energy Idaho Operations Office established a Type A Accident Investigation board on August 14, 1996, in accordance with DOE 225.1, Accident Investigations.

An initial briefing was provided by LMITCO management on August 16, 1996, after all of the members of the Board had assembled. The Board was presented with all physical evidence collected at the scene and the photographs, and then elected to have additional detailed photographs taken.

Corrective actions were initiated, which include:

a) complete a site-wide enhanced work control improvement effort

b) conduct work standards and management expectation training

c) correction of work package review and approval weaknesses

d) implementation of streamlined work control field changes

e) clarify management and supervisory expectations

f) strengthen documentation requirements for pre-job attendance accountability and confirmation of understanding

g) clarify safety requirements for working within the vicinity of energized equipment and train personnel in those requirements

h) implement procedures for control of individuals not normally assigned to the work area

i) issue plan to measure success of work control improvement and completion of corrective actions

The Type A Accident Investigation was completed in September, 1996. The final Occurrence Report was released and approved April 22, 1997.

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Type A Accident Investigation Board Report, August 13, 1996, Electrical Shock at TRA-609, Test Reactor Area, Idaho National Engineering Laboratory, by the Idaho Operations Office, September 1996

INEL Lessons Learned #96379, preliminary, 8/24/96, interim update, 8/30/96

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