BERKELEY LAB

CHARLES V. SHANK
DIRECTOR

July 30, 2004

Milton D. Johnson
Chief Operating Officer
Department of Energy
Office of Science
Washington DC 20585

Dear Dr. Johnson: Milt

Attached is the Electrical Safety Action Plan asked for in your memo of May 24, 2004. BSO has reviewed and approved of this plan as you will see by the site manager's signature. Our program will be strengthened by recent improvements we have made and those we commit to within the plan.

We did find EH's Operating Experience and Lessons Learned Report on Electrical Safety helpful in developing new strategies as well as confirming the importance of existing program elements. It points to challenges Berkeley Lab and probably the other SC labs face – the quality of "as built" drawings, the lack of precision in devices used to locate underground utilities, and building designs from eras having different standards. You will see a picture in our plan of a successful excavation (done mainly by hand) through a concrete pad that illustrates these challenges.

We also look forward to hearing from your office about effective approaches other SC labs described in their plans. Berkeley Lab has already participated in a UC-led best practices workshop on sub-surface and behind-the-wall utility imaging and penetrations, but there is always more to learn. Perhaps the plans themselves could be posted or otherwise shared.

Please don't hesitate to contact our new EH&S Director, Phyllis Pei (510-486-5514), who will start on August 16, or the EH&S Division Deputy, Robin Wendt, should you have any questions.

Sincerely,

for CVS

Charles V. Shank

cc: Dick Nolan
Hattie Carwell
Jay Larson

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Electrical Safety Action Plan
Lawrence Berkeley National Laboratory (LBNL)

Aprrovals:

Robin Wendt, Acting EH&S Division Director, LBNL

Sally Benson, Deputy Director for Operations LBNL

Dick Nolan, Berkeley Site Office Manager

Introduction

The plan that follows describes both actions LBNL has taken and those to which we commit to strengthen our electrical safety program. In developing this plan, we have reviewed our own lessons learned and those described in the EH Electrical Safety Operating Experience and Lessons Learned Report. We've also closely evaluated the OSHA audit findings, both from 1999 and 2004, and implemented corrective action plans that will increase the safety and physical condition of the Lab.

Electrical safety at LBNL is implemented through the Lab's Integrated Safety Management Program. A key element of our ISM Program is the institutional Health and Safety Manual that describes line management's responsibilities for safety and, in particular Chapter 8 which describes our electrical safety program (http://www.lbl.gov/ehs/pub3000/CH08.html). Safety policy is developed by the LBNL Safety Review Committee (composed of representatives from all 16 divisions, both scientific and operations-related), and its Electrical Safety Review subcommittee. This subcommittee is composed of our site's Electrical Safety Engineer as well as other site experts in electrical instrumentation, testing, etc. The practice of and responsibility for electrical safety lies with the division management. The largest employee group exposed to potential electrical hazards are the electricians in the Facilities Division.

The following mechanisms are used to ensure compliance with LBNL electrical safety policies and procedures:

- Construction work is inspected by an EH&S construction safety inspector matrixed to the Facilities Division.
- Small projects and routine electrical work are governed by the electrical safety policies and procedures included in the LBNL Work Smart Standards which include the National Electrical Code, LBNL Facilities Standards and other recognized standards.
- Assurance under the ISM plan is provided by annual divisional self-assessments, triennial Management of Environment Safety and Health reviews of each division, and the triennial Integrated Functional Appraisal divisional reviews performed by subject matter experts from the Environment, Health & Safety Division.

LBNL has several communication tools (Lessons Learned Program, a daily e-newletter (Today At Berkeley Lab) electronic message boards, etc.) available to ensure timely and thorough distribution of information pertaining to electrical safety. Training in the area of electrical safety

Lessons Learned Applied to Operations

Advances in electrical safety practices come from many sources. DOE occurrence reports are reviewed on a daily basis, with referral of electrical safety incidents to the site Electrical Safety Engineer. LBNL also participates in the DOE Electrical Safety Working Group, and our Electrical Safety Engineer is currently participating in the revision of Chapter 10 of the DOE Electrical Safety Manual.

All electrical incidents are investigated. Employees who receive an electrical shock must report to Health Services. LBNL's accident investigation process determines the cause and generates appropriate corrective actions. First aid and OSHA recordable injuries are investigated by line managers and EH&S liaisons who are trained in root cause analysis. Corrective actions developed from these investigations are managed through the Lab's Corrective Action Tracking System (LCATS). Construction accidents are reviewed by both the Construction Safety Inspector and the Electrical Safety Engineer.

Another source of program improvement is the review and implementation of the National Electrical Code, whose codes are reviewed on a three year cycle. For example, LBNL is reviewing the new electrical code's requirement for periodic recertification of arc blast protective clothing.

Recent lessons learned

- Lock out, tag out

A recent near miss at LBNL occurred during an electrical panel upgrade, when part of the panel was energized by the use of a backup generator, after the main supply to the panel had been turned off. This hazard was addressed by training the project management team in job hazard awareness, better coordination between in-house and contract electricians, and refresher training in lock-out, tag-out procedures. The new manager of the Facilities Division Design and Construction Department, is currently reviewing LBNL contracts to ensure that uniform language is included in future contracts that will require contractors to provide details in electrical safety as part of their safety plan.

- Underground utilities.

Like most laboratories, LBNL has had near-misses when digging for construction and/or environmental remediation purposes. LBNL uses a comprehensive permit system for both digging and wall penetrations, however occasionally subcontractors have violated the conditions of that permit and have used unauthorized methods. In response to this issue, Excavation/Penetration Permit Administration Awareness Training FAC0020 was conducted in June 2004. Seventy-two employees of the Facilities Division from both the Design and Construction and Plant Operations Departments attended. The 90-minute training provided a review of the two applicable Administrative and Operating procedures used to penetrate or excavate LBNL property: ADMN-053 and OPER–170.

Figure 1 – Conduit exposed during concrete removal to perform soil sampling. This illustrates the challenges in avoiding electrical conduit during surface penetration activities.

Administrative Procedure 053 applies document control to the Facilities Dig Permit process for all Facilities personnel and contractors responsible for reviewing, approving, or performing work that requires penetration or excavation deeper than 1-1/2 inches into any ground surface, concrete wall, column or slab. The purpose is to ensure that permits are tracked, approved and distributed according to standard Facilities document controls.

Operating Procedure 170 applies to locating and marking underground utility lines, reviewing dig permit parameters with applicable prints/maps of the area, preventing injury to workers and protecting known or unknown buried utility lines through appropriate work steps. Procedural changes have adopted best practices, including recent additional approvals from inspectors, hold points when metal is encountered, and the distribution of written copies of the procedures at the same time a dig permit is issued. LBNL has reviewed the state of the art in detection equipment, and has also implemented the use of automatic shut-off rotohammers, which stop automatically when in contact with underground metal.

- High voltage

High voltage switching is a significant hazard at LBNL. Following the reports of problems at other DOE labs, LBNL scheduled training in high-voltage switching. In May 2003 and again in June 2004, Associated Training Corporation was contracted by LBNL to give an Industrial Electrical Safety High Voltage certification (utility level) training to Facilities Division electricians and engineers.

Twenty-three laboratory employees including electricians, electrical supervisors, engineers, the chief electrical engineer, the chair of the LBNL Electrical Safety Committee, the Electrical Safety Engineer completed the training. Approximately 9 employees still required training (completion by 2nd Qtr FY05). This certification was designed specifically for LBNL. It was taught in nine modules over a three and one half day period (approximately 28 hours). The nine modules consisted of Electrical Hazards, Grounds and Fault Currents, Personal Protection and Personal Protective Equipment and Clothing, Energized Electrical Work, De-energized Electrical Work, Substation Grounds and Grounding, Hazard Recognition and Safety Considerations, Personal Protective Grounding, Managing and Planning Safety.

The purpose of this training was to provide an independent certification for those employees who work on equipment at the 12,000 volt and higher level. This certification has been identified as a requirement in addition to the LBNL "Qualified Worker" training program (see attachment 1) identified by the laboratory's job hazard assessment system.

The LBNL Facilities Electric Shop has also provided two High-Voltage training courses, one in 2003 and the latest in 2004. The Electric Shop is responsible for maintenance and switching of the 12-KV and 115-KV equipment at the site. To date, 12 Electricians, 2 Supervisors and 4 Engineers have attended the training. The training was conducted by an instructor having specific experience and knowledge of High-Voltage equipment, hazards, and the appropriate personal protective equipment and practices that are to be followed when working with and around this type of equipment. New electricians assigned to perform high voltage tasks will be required to take this training as well.

- Imported electrical hazards.

Frequently, research equipment manufactured elsewhere is brought into the laboratory for experimental use by researchers. This is most common at the Advanced Light Source and the 88-inch Cyclotron. In these cases, local technical safety reviews including consultation with the Electrical Safety Review Committee are conducted prior to experimentation. Once electrical hazards or wiring incompatibilities are identified, the Electrical Safety Engineer is once again consulted. One recent problem identified in this area was the use of consumer-quality voltage converters that do not meet US commercial standards. Laboratory policy requires review of all non commercially manufactured equipment not rated by a National Recognized Testing Laboratory. (see attached course syllabus for EH&S 249 – Electrical Safety for Design and Fabrication of Experimental Apparatus (for qualified workers).

Improving the Physical Condition

Prevention and detecting the creation of electrical hazards

Electrical hazards can be prevented at the design, build and inspection steps of construction. Large projects at LBNL go through a design review process, and in-house design is done to the specifications of the building code. We are currently examining the flow of projects, large and small, through the Lab to insert OSHA compliance control points where appropriate for the scope of the project.

Training

LBNL recognizes the need for ongoing training to keep current in electrical safety issues. As noted above, when specific needs are identified, specialized training is offered, such as the high-voltage switching training. Ground and wall penetration training is a required part of the permit process.

NFPA 70E Implementation

Currently we are studying the new NFPA 70E standard: "Electrical Safety Requirements for Employee Workplaces". This national standard has new recommendations on periodic recertification of high voltage personal protective equipment. LBNL is analyzing the future cost impact of recertifying personal protective equipment, anticipating a phased approach in implementing NFPA 70E within

- facilities engineering
- maintenance
- construction

The engineering scope includes calculation of the maximum release of the electrical energy in Calorie/cm^2 at each significant installation of electrical equipment and analyzing flash/arc hazards, and labeling electrical equipment with the level of the hazards and the type of personnel protective equipment required. The scheduled date for its completion is fiscal year FY2005.

OSHA Audit Response

In FY04, LBNL submitted funding requests in eight project areas to rectify issues from previous OSHA audit findings. We received funding for three projects in April and one additional project in July. These projects were created by combining similar types of violations and applying the DOE risk-scoring system to prioritize them. Funding amounts were $830,000 initially, and an additional $100,000 was later allocated. It is important to note that, due to LBNL being one of the last laboratories inspected and delays in receiving the OSHA report, our submission was based on the 1999 OSHA pilot survey findings which resulted from only a sampling of site buildings, not a wall to wall survey.

The first project funded related to emergency eyewash and shower (EEWS) problems. These problems in part related to the EEWS's proximity to electrical hazards. The project is now 70% complete. LBNL has developed a new policy on the collocation of eyewashes and safety showers, specifying minimum distances to avoid creating an electrical shock hazards (see attachment 3).

Electrical safety upgrades was a separate project. Our initial reviews found most improper uses of Relocatable Power Taps (our most frequent finding) have been addressed without adverse programmatic impact. In some experimental areas we identified the need for permanent wiring and new breakers, conduit and outlets. An electrical engineer is being hired to draw up plans for these installations. The OSHA audit identified a total of 742 electrical related deficiencies of which 155 were determined to be no cost/low costs fixes and are nearly all corrected. The remainder is being addressed with the $215k that was received from DOE for Health and Safety related improvements. To date, 90 of the 587 deficiencies which require funding have been rectified and $61k has been spent. We anticipate that all of the findings will be addressed by the end of 2004.

Timeline for Continued Improvement

November 2004 - We continue to progress on the OSHA improvements. With regard to the electrical safety project, we have reviewed the majority of areas identified by the OSHA inspectors, and expect to finish this project by the end of November.

February or March, 2005 – Finish High Voltage Switching training for remainder of electrical qualified personnel.

FY2005 – Implement NFPA 70E recertification of electrical personal protective equipment.

LBNL is most appreciative for the funding to upgrade our facilities and solve these safety problems. We continue to progress on the OSHA improvements

Attachments:
1) Course Syllabus EH&S 250, Electrical Safety for Qualified Facilities Workers
2) Course Syllabus EH&S 249, Electrical Safety for Design and Fabrication of Experimental Apparatur
3) LBNL Policy – Eyewash/Shower Collocation with Electrical Panels and Switches, Minimum Clearances
4) LBNL Policy on Relocatable Power Taps

LBNL EH&S 250
Electrical Safety for Qualified Facilities Workers
Course Syllabus

Subject Category	Electrical Safety
Course Length	2 hours
Schedule	Annually or by request
Location/Time	Varies
Prerequisite	EH&S 260
Medical Approval	None

Course Purpose: This course is designed for employees and guests who are hired by facilities to construct and maintain the electrical distribution and all site buildings and structures. It is also available to any other qualified individuals and groups who are can demonstrate a need acceptable to this laboratory.

Course Objectives:

- To define and explain the hazards associated with high voltage / high power Systems.
- To teach hazard analysis and mitigation techniques for high voltage electrical safety.
- To define the working rules and practices for high voltage electrical safety.
- To define the acceptable use and requirements of personal protection equipment (PPE).
- To introduce the National Fire Protection Association (NFPA) 70E (National Electrical Safety Code).

Course Instructional Materials:

- Overhead projector and PowerPoint presentation
- Excerpts from NFPA 70 and NFPA 70E
- IEEE standards
- 40 cal/cm2 FA approved flash suit

Instructor: Tom Caronna

Training Compliance Requirements: 29CFR 1926; NFPA 70E; and Pub-3000, Chapter 8

Course hand-outs: Student manual

Participation Evaluation: written evaluations regarding the effectiveness of the trainer, the training, and the visual aids.

Written test: Yes
Practical Exam: No
Retraining/ Recertification: No
Web Resource: Pub-3000, Chapter 8

LBNL Course EH&S 249
Electrical Safety for Design and Fabrication of Experimental Apparatus
Course Syllabus

Subject Category	Electrical Safety
Course Length	2 hours
Schedule	Annually or by request
Location/time	Varies
Prerequisite	EH&S 260
Medical Approval	None

Course Purpose: This course is designed for employees and guests who are hired by the lab to design and fabricate experimental apparatus. It is designed to teach the theory, acceptable practices, and approved techniques for electrical safety with respect to experimental apparatus.

Course Objectives:

- To define and explain the hazards associated with:
  High voltage electrical equipment.
  Stored energy (capacitive or inductive) reactive power systems
  Acceptable practices for safety with respect to ungrounded equipment.
- To teach hazard analysis, approved testing practices, and mitigation techniques for experimental apparatus.
- To define working rules and accepted practices for testing and Maintainance of experimental apparatus.
- To define the acceptable use and requirements of personal protection equipment (PPE).
- To introduce applicable National Fire Protection Association (NFPA 70E) and Occupational Health and Safety Administration documents (OSHA).
- Rated tested tools, equipment and components

Course Instructional Materials:

- Overhead projector and PowerPoint presentation
- Excerpts from appropriate documents (NFPA, OSHA, and IEEE standards)
- Personal protection equipment (PPE) – clothing and tools

Instructor: Tom Caronna

Training Compliance Requirements:

- OSHA, NFPA, and IEEE standards.
- Pub-3000, chapter 8

Course hand-outs: Student manual

Participation Evaluation: Written evaluations regarding the effectiveness of trainer, the training, and the visual aids.

Written test: Yes
Practical Exam: No
Retraining/Recertification: No
Web Resource: Pub-3000, chapter 8

LBNL Policy
Eyewash/Shower Collocation with Electrical Panels and Switches – Minimum Clearances

All eyewash and safety showers should be located a minimum of 3 feet from electrical panels and disconnects. This is the policy agreed upon by the Electrical Safety Review Committee (ESRC) in 2001. We arrived at this agreement by applying the National Electrical Code (NEC) requirement for 6 foot separation (finger tip to fingertip of outstretched arms) of electrical equipment in residential and commercial bathrooms. We then applied this logic to safety showers using center of the users head to fingertip and agreed to a 3 foot rule. As a committee we also agreed to very strongly recommend that all new installations of these utility apparatus use the 6 foot clearance rule for panels and disconnects.

In addition the ESRC looked at the "wet touch" hazard and recommended barriers be installed to mitigate this hazard. In those instances where the panel / disconnect share the same plane (the shower is to the side of the panel / disconnect) and the clearance from the proximal edge of the shower head to the panel is 3 to 4 feet, a barrier should be installed on the wall and project out a minimum of 11 inches from the wall. These barriers should also extend a minimum of 4 inches top and bottom of the electrical panel. These barriers should not in any way impede access to the panel or interfere with normal operation of the door. In those instances where the emergency shower is in front of the panel / disconnects and less than 4 feet of clearance exists, the shower or the electrical equipment needs to be moved. The reasoning is that a splashed panel and a wet person create a potentially extreme safety issue. This distance can be reduced to 3 feet for eyewashes for 120/208 volt panels / disconnects and 42 inches for 480 volt panels / disconnects. The ESRC also agreed that all 120 volt receptacles in this safety zone be of the ground fault interrupter (GFCI) type.

Other voltage receptacles need to be addressed individually. All switches and other devices (over 50 volts) need to be enclosed in weather tight (waterproof) plastic covers that allow full use and operation. Carlon is the only manufacturer that I know of that makes these devices. The lab stocks these covers at stores building 78. Alternatively we can order these covers from Alameda Electrical Distributors Inc. Contact Tom Anderson (373-1410) or Aaron Brackin (373-1411). Another potential solution for this issue is the installation of weatherproof panels (NEMA 4) and disconnects. The NEC also requires a clear space of 30 inches by 36 inches from the floor to 10 feet above the panel or the ceiling for 120/208 volt panels. This clearance changes to 30 inches by 42 inches for 480 volt panels. Any barriers that are installed may not violate this required clearance.

LBNL Policy

Relocatable Power Taps

Relocatable Power Taps, also called RPTs, multiple outlet strips, plug strips, surge suppression strips, etc., are electrical devices consisting of Several receptacles (outlets), an On/Off power switch, overcurrent protection (circuit breaker), and a cord. They Were originally designed and listed for use with computers, associated hardware components and peripherals. Computer-related equipment often requires up to 6 outlets and typically draws low total current (3 to 5 amperes). Although the circuit breaker in a RPT is often rated at up to 15 amps, no single load should exceed 5 amperes or 600 watts and the total load should not exceed 12 amperes or 1440 watts.

LBNL Policy is that Relocatable Power Taps may not be used to supply power to high current equipment. Examples of high current equipment that may not be connected to Relocatable Power Taps include, but are not limited to:

- Portable space heaters
- Office fans or any other single load exceeding 600 watts
- Copy machines that are not computer printers
- Coffee pots
- Microwave ovens
- Toasters and toaster ovens
- Refrigerators

High current equipment must be plugged directly into wall outlets. If additional outlets are required please contact Facilities.

Relocatable Power Taps must be plugged directly into a permanently mounted outlet, such as a wall outlet. DO NOT plug an RPT into an extension cord.

Acceptable uses of Relocatable Power Taps include:

- Personal computer and associated peripherals
- Multiple low-current laboratory measurement equipment
- Radios
- Fluorescent desk lamps
- Other low-current (less than 600 watts), non-motor powered electrical loads

One of the hazards associated with Relocatable Power Taps is failure of the internal circuit breaker. If the circuit breaker trips more than once for a given load, the RPT should be evaluated by an electrical technician or other qualified employee.

Please address any questions to:

Tom Caronna
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