



ACCELERATOR TECHNOLOGY & APPLIED PHYSICS

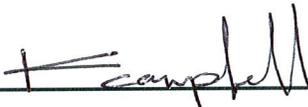
FY 15 ES&H FOCUS AREA SELF-ASSESSMENT REPORT

Lockout/Tagout of Hazardous Energy

January - August 2015

Signatures:

Approval:



Kerri Campbell, Team Leader

10/1/15

date signed



Patricia Thomas, Division Safety Coordinator

9/29/15

date signed

Accelerator Technology and Applied Physics Division



Wim Leemans, Director

9/29/15

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1.0 Executive Summary

The assessment focused on Lockout/Tagout (LOTO) program implementation at ATAP. This Focus Area was recommended by the ATAP ES&H Operations Committee and approved by the Division Director (Wim Leemans) because of potential impact on safety of personnel and to evaluate compliance with requirements. This assessment was coordinated with the March 2015 independent Lockout/Tagout Program Assessment and other Division Focus Area Self-Assessments to look at some common Lines of Inquiry and contribute to development of institutional findings, recommendations, and corrective actions.

ATAP Program Heads selected representatives to serve on the assessment team: Kerri Campbell (Team Leader -- Center for Beam Physics), Warren Byrne (Advanced Light Source Accelerator Physics), Jeroen van Tilborg (BELLA Center). EHS Subject Matter Expert Stephanie Collins was selected to provide advice because she joined LBNL after the LOTO program was revised in 2014. ATAP Electrical Safety Advocates Nathan Ybarrolaza performed LOTO procedure reviews and provided technical input to the team. Pat Thomas (ATAP ESH Coordinator), Tammy Welcome (Office of Contractor Assurance), and Andrew Peterson (EHS) provided guidance on the self-assessment process.

The ATAP assessment took place from January 2015 to August 2015:

- January 5 – Self-Assessment training provided by Office of Contractor Assurance. Team discussed assessment process, selected Team Leader
- March 5 – Discussion of new BELLA LOTO procedures
- March 9 – Supercon cabling machine LOTO discussion
- March 12 – Test Stand 6A LOTO review
- March 17 – Team discussed assessment status and planned additional activities.
- March 18 – Supercon cabling machine LOTO review.
- March 19 – Test Stand 12 LOTO discussion
- March 30 – Feedback from independent LBNL LOTO Program Assessment
- April 6 -- DD Neutron generator LOTO review
- April 10 – Team status & planning meeting
- April 16 – BELLA Capillary Discharge LOTO review
- April 17 – Quickbase LOTO Database workshop with EHS
- April 23 – BELLA Ekspla LOTO review
- April 28 and May 5 – Supercon Magnet Test LOTO discussion and review
- May 14 – Team status & planning meeting
- May 15 – NDCX-II LOTO review
- July 20 – Team meeting to begin developing report
- August 4 – Team review of draft report
- August 5-31 – Development of assessment report.

A **Noteworthy Practice** is a practice or condition that is recognized for its excellence and should be considered for Lab-wide application. There were 2 Noteworthy Practices:

- 1. We identified a working list of improvements to the Quickbase LOTO database.**
- 2. ATAP is developing a ground hook safety program.**

A **Finding** is a program or performance deficiency where there is noncompliance with established external or internal requirements. There were 3 Findings:

- 1. Line management kept poor accounting records regarding the number of times a procedure has been performed and did not retain hard copies of signed completed procedures.**
- 2. The Division did not have an accountability of all its LOTO activity and documentation of internal quality assurance audits to be done annually.**
- 3. There were deficiencies in configuration control.**

An **Observation** is a practice or condition that is not technically noncompliant with an external or internal regulation or requirement, but could lead to noncompliance if left unaddressed. There were 3 Observations:

- 1. There was a lack of continuity in LOTO procedure format.**
- 2. LBNL Standards for ground hooks were insufficient to assure safe use in LOTO procedures, and there were no additional ATAP standards.**
- 3. Researchers at some test stands have to repeat LOTO several times a day.**

The team recommends the following actions:

1. Develop standard format for ATAP LOTO procedures.
2. Transfer all ATAP LOTO procedures to the standard format.
3. Participate in development of LBNL ground hook standards.
4. Develop additional ATAP ground hook standards as needed.
5. PIs who need to repeat their LOTO procedures several times a day should work with the ATAP Electrical Safety Advocates to develop engineering solutions to reduce the need for repetitive LOTOs, where feasible.
6. Develop a checklist for each LOTO procedure and enter it in the Quickbase LOTO database to make compliance with recordkeeping requirements easier for Line Management.



7. Create a Google spreadsheet to collect current review and approval status information for each LOTO procedure.
8. Transfer current status information for each LOTO procedure to Quickbase LOTO database.
9. Require LOTO procedures to be specific to the work scope and configuration.
10. Require LOTO procedures to be amended and request re-approval when configuration or work scope changes.

2.0 Introduction

Accelerator Technology and Applied Physics Division's mission is to push the frontiers of accelerator, laser science, technology, and develop the next generation particle and light beams, as powerful tools for multi-scale science to serve the nation's needs. We carry out this mission with a deep commitment to training future researchers, and hold ourselves to the highest scientific, safety, and diversity standards. ATAP Division includes the following Programs: Advanced Light Source Accelerator Physics, Berkeley Electron Laser Accelerator (BELLA) Center, Center for Beam Physics, Fusion Science and Ion Beam Technology, and Superconducting Magnets.

The topic of this ATAP FY15 Focus Area Self-Assessment is Lockout/Tagout of hazardous energies. Lockout/Tagout is defined in the Environment, Safety and Health Manual, which adheres to LBNL's Requirements and Policy Manual. ATAP Division's Programs are affected by LOTO. ATAP Division and matrixed personnel often have the need to enter areas where the potential for exposure to high voltage exists to adjust experimental equipment, or to service or repair equipment or machinery that could cause injury if inadvertently powered up during servicing or repair. In these situations, equipment or machinery are de-energized and locked out under Lockout/Tagout (LOTO) procedures. The procedures, across all the groups, are written by the most knowledgeable persons involved with the LOTO work.

Across these programmatic and matrixed areas, new accountability and ownership of the ATAP LOTO program has been established by appointment of an Electrical Safety Advocate by Division Director Wim Leemans. ATAP's LOTO Program has emerged out of the programmatic groups individual LOTO needs. The Focus Area team inventoried all submitted LOTO procedures

The Focus Area assessment examined the actual LOTO practices of divisional and matrixed staff finding that LOTO is practiced and follows the guidelines of ES&H Manual Chapter 18. The Assessment Team over several weeks reviewed training, LOTO procedures, interviewed personnel and observed LOTO work. The team also setup workshops on the use and adoption of the LOTO Quickbase application as a Division wide practice for Complex LOTO Procedures.

The LOTO reviewers and Assessment team visited ATAP labs and shops in Buildings 58/58A, 71, 77A and 88 where ATAP LOTO is being performed. LOTO equipment was identified and inspected. Staff explained their understanding of the procedure and hazards. Staff was able to demonstrate the Complex LOTO sequence and release of the LOTO adequately meeting all proficiencies required.

The team reviewed completion of required LOTO training because Environmental Health & Safety LOTO training paired with OJT (On the Job Training) alongside a discrete understanding of the equipment and machinery is the core of ATAP's LOTO program.

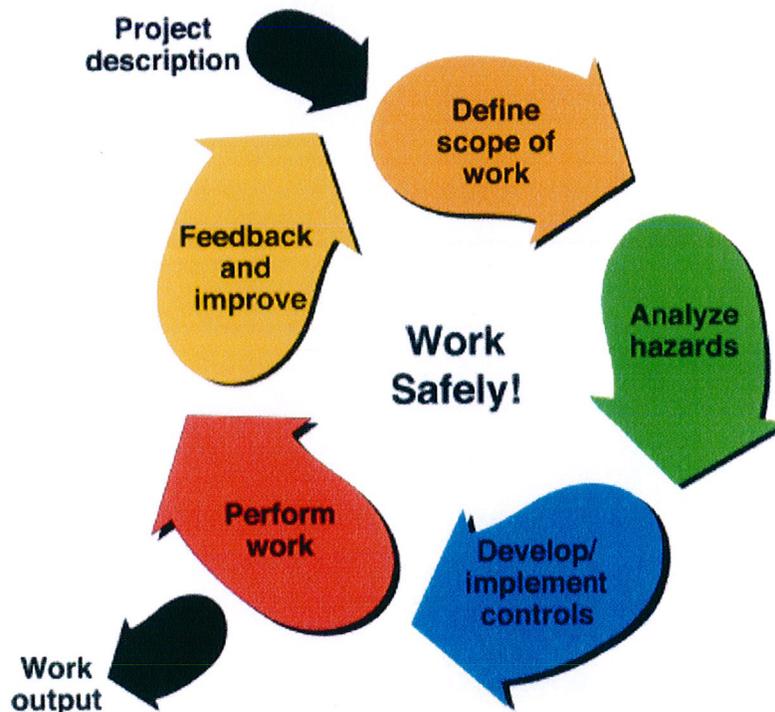
3.0 Current Requirements

Integrated Safety Management

Safety embodies our work practice and is a culture here at LBNL. LOTO by LBNL staff is active policy demonstrating Integrated Safety Management. The Integrated Safety Management System identifies the core requirements that provide work planning, creating a safe work condition, and feedback with a narrative of continuous improvement.

DOE's Five Core Functions:

1. Define the Scope of Work
2. Analyze the Hazards (including environmental impacts)
3. Develop and Implement Hazard Controls (including environmental controls)
4. Perform Work within Controls
5. Provide Feedback and Continuous Improvement



“Berkeley Lab policy requires all work to be performed safely with full regard to the well-being of workers, affiliates, the public, and the environment.”(ISM plan for Berkeley Lab rev.8)

The Core Functions require that work be planned prior to starting work, including steps that define the work scope, identify and analyze associated hazards, and develop specific controls that mitigate hazards.

This assessment focused on the 3rd Core Function of Integrated Safety Management, Development and Implementation of Controls. The LOTO assessment reviewed requirements and processes that provide essential conditions, content, format, and other specifics for these documented controls.

This examination of the 3rd Core Function shaped the Lines of Inquiry and Methodology. The assessment explored:

- Are LOTO procedures properly reviewed?
- Do LOTO procedures meet requirements?
- Are persons who perform LOTO knowledgeable of their procedures, as demonstrated through their activity?
- Are RI's (Responsible Individuals) trained and knowledgeable of their role as leaders of complex/group LOTOs?

EH&S Requirements

ATAP's LOTO program is extensively in accordance to ES&H Manual. The program hinges on an Integrated Safety Management structure. ATAP's compliance with institutional requirements includes:

1. ES&H Manual, Chapter 6, Safe Work Authorization;
2. ES&H Manual, Chapter 18, Lockout Tag out Program;
3. LBNL Requirements and Policies Manual, Hazard Analysis & Work Authorization Policy and Overview;
4. LBNL Requirements and Policies Manual, Lockout-Tag out Program;
5. LBNL Pub-3140, Integrated Environment, Safety, & Health Management Plan, Integrated Safety Management (ISM) System

Roles and Responsibilities

Our roles and responsibilities for LOTO are defined in ES&H Manual Chapter 18: “This program is required for all Berkeley Lab employees, affiliates, students, visitors, and subcontractors who may be exposed to hazardous energy while performing any construction, service, maintenance, modification, or demolition activity.”

Role	Responsibilities
Environment/Health/Safety (EHS) Division	<ul style="list-style-type: none"> • Maintain, administer, and revise the LOTO Program as needed • Ensure that LOTO equipment is available and consistent with Berkeley Lab standards • Develop and implement the Lockout/Tagout training courses • Periodically audit LOTO compliance
Qualified Persons	<ul style="list-style-type: none"> • Wear all required PPE and follow all required safe work practices while performing the necessary operations and verifying the zero-energy state of equipment to support the LOTO process
LOTO Affected Persons	<ul style="list-style-type: none"> • Follow all LOTO and safety requirements • Recognize when LOTO is being used, the general reasons for LOTO, and the importance of not tampering with or removing a lock and tag
LOTO Authorized Persons	<ul style="list-style-type: none"> • Recognize the conditions of work that require LOTO, assess all hazardous energy sources, and use correct procedures and materials to implement LOTO • Maintain control over the keys to their personal LOTO locks • Apply his or her own personal LOTO lock and tag when performing servicing, maintenance, or modification work • Must NEVER apply a LOTO lock for anyone else

<p>LOTO Responsible Individuals (RIs)</p>	<ul style="list-style-type: none"> • Accountable for the safe execution of a complex or group LOTO • Conduct the LOTO briefing • Supervise the Qualified Person(s) in the execution of the LOTO procedure • Manage all changes to the scope of work • Ensure all personnel performing work under the LOTO are LOTO Authorized Persons and are personally locked out for their tasks
<p>LOTO Procedure Evaluators</p>	<ul style="list-style-type: none"> • Observe the performance of LOTO procedures for the purpose of periodic quality assurance (QA) inspection • Verify that the LOTO procedures are adequate, are understood, and are being followed by persons participating in the LOTO • Document the completion of the LOTO procedure inspections in the EHS database
<p>LOTO Approvers</p>	<ul style="list-style-type: none"> • Review submitted LOTO procedures for completeness and accuracy • Verify that the scope of work is clearly defined, is described in the LOTO procedure, and that the LOTO Safe Zone established in the LOTO procedures fully encompasses the scope of work • Approve LOTO procedures that meet all requirements in Work Process N. LOTO Procedures
<p>LOTO Coordinators</p>	<ul style="list-style-type: none"> • Maintain overall control of a set of LOTOs established during a large project • Provide overall coordination with the project schedule • Resolve scheduling conflicts between different LOTOs and other scheduled work • Ensure the various Responsible Individuals (RIs) are properly informed of any changes that will impact their respective LOTO procedures

Line management (including supervisors, managers, and work leads)

- Prohibits employees from working on equipment requiring LOTO until the worker is trained and authorized to perform LOTO
- Generates and maintains written LOTO procedures where required, and audits these LOTO procedures at least annually
- Assigns and documents employee LOTO authorization, including:
 - Designating specific equipment or categories of equipment to be controlled
 - Verifying that workers are qualified to perform the necessary LOTO procedures
- Determines the appropriate levels of training required for each employee
- Ensures consistent policy implementation and reinforcing LOTO rules
- Removes LOTO devices in case of a person's absence ([Work Process O. Special Condition LOTO Lock Removal](#))
- Ensures that necessary LOTO hardware is available
- Ensures that all outside contractors operating under the supervision of the division are informed of and adhere to the Berkeley Lab LOTO Program ([Work Process I. Subcontractor LOTO Permit](#))
- Ensures that periodic quality assurance (QA) inspections of LOTO procedures are conducted ([Work Process P. Periodic Quality Assurance Inspections of LOTO Procedures](#))

4.0 Assessment Scope and Methodology

Assessment Team

The Assessment Team included:

- Kerri Campbell, Team Lead – Selected by Center for Beam Physics
- Warren Byrne – Selected by ALS Accelerator Physics Division
- Jeroen van Tilborg – Selected by BELLA Center

The assessment was facilitated by Patricia Thomas, ATAP Division Safety Coordinator. Technical advice was provided by Stephanie Collins, EHS Division Electrical Safety Officer, and Nathan Ybarrolaza, ATAP Electrical Safety Advocate.

Scope

The scope was defined as an accounting of ATAP LOTO practice in the following areas:

- a. Locations where ATAP LOTO work takes place;
- b. ATAP employees, affiliates, and matrixed personnel that perform LOTO; and
- c. Lockout/Tagout procedures performed by ATAP or matrixed personnel.

ATAP LOTO work is diverse and specialized for each activity. The LOTO work being performed is hill-wide. The assessment team visited locations with the LOTO reviewers to observe LOTO work practiced.

Lines of Inquiry

1. Do ATAP LOTO procedures meet requirements of the ES&H Manual?
2. Are ATAP LOTO procedures properly reviewed?
3. Are people knowledgeable of the requirements of the LOTO procedures they are implementing?
4. For procedures that require a Responsible Individual, are the RI's properly trained and knowledgeable of their responsibilities?
5. Do people who perform LOTO procedures know how to provide feedback if they see a need for improving the procedure?
6. Do people who perform Simple LOTO know how to perform it correctly?
7. Do researchers/technicians, who are *not* LOTO trained, but work around equipment with LOTO procedures, understand when LOTO is required and the limits to their scope of work?

Methodology

The assessment included assessment of written procedures, observations of performance of procedures by authorized personnel during LOTO procedure reviews, and a review of training records.

Assessment of Procedures

Complex LOTO Procedures by Program:

<u>Program</u>	<u>LOTO Procedures</u>
<ul style="list-style-type: none"> • Fusion Science & Ion Beam Technology <ul style="list-style-type: none"> ○ CLP-28 Test Stand 6A ○ CLP-57 Neutron Generator ○ CLP-63 NDCX-II Solenoid Pulser ○ CLP-64 NDCX-II Compression Pulser ○ CLP-92 NDCX-II Diagnostics End Station ○ CLP-93 NDCX-II Blumleins and Switch Chassis ○ CLP-94 NDCX-II Injector ○ CLP-101 NDCX-II Kaeser Air System ○ (new draft) Chamber 1 Plasma Diagnostics and Deposition ○ (new draft) Test Stand 12A – Source End ○ (new draft) Test Stand 12A- Cube End 	11
<ul style="list-style-type: none"> • BELLA Center <ul style="list-style-type: none"> ○ CLP-87 Spectra-Physics GCR350/170 Laser System ○ CLP-88 Capillary Discharge Pulser ○ CLP-89 Ekspla Power Supplies for Gaia Laser 	3
<ul style="list-style-type: none"> • Superconducting Magnets <ul style="list-style-type: none"> ○ CLP-62 Cabling Machine ○ CLP-81 Magnet Power Supply ○ CLP-96 Magnet Test 	3

At the time of the assessment, ATAP had 17 Complex LOTO Procedure's total. Four of the 17 procedures were not yet entered into the database. During this assessment, some drafts were finalized and approved. ATAP's self-assessment triggered documentation to be added to the Complex LOTO Database in the form of new procedures, updated uniformly formatted procedures, and added/updated photos.

Observations of LOTO Procedure Performance

The Assessment team observed 7 LOTO reviews:

- Fusion Science & Ion Beam Technology 3
- BELLA 2
- Superconducting Magnets. 2

Fusion Science and Ion Beam Technology

Procedure CLP-28 Test stand 6a in 88-071 was observed on March 12, 2015.

LOTO was performed by an Authorized LOTO person on the activity. LOTO Equipment was identified and inspected. Staff explained their understanding of the procedure and its electrical hazards. Staff was able to perform the Complex LOTO sequence and release of the LOTO adequately, meeting all proficiencies required. Isolation equipment was visually inspected. They have a designated area labeled for the LOTO hardware and procedures. Grounding hooks were used on the floating source.

New procedure in development Test stand 12a source and cube in 88-071 was observed on March 19, 2015.

LOTO was performed by an Authorized LOTO person on the activity. The researcher is building the draft LOTO procedure for the beam test stand. This experiment is a migrated set up from Building 16. Observing the Limited approach boundary when establishing LOTO is in question and barriers and signage was suggested. Observation of the LOTO revealed corrections to the sequence to be made. Steps were re-arranged such as "Challenge should be done before verification". Also changing the release sequence so, "removing ground pins first then putting covers in place". The Electrical Safety Advocate and additional reviewers discussed dissipating the Einzel lens energy using an alternative method to the grounding hook by creating a plunge tube design that allows easier dissipation verification without the mechanical dis-assembly of the protective covers that are the High Voltage barrier. Note: The researcher is leaving LBNL in August 2015. The experiment and draft procedure are on hold pending future need for development and use.

Procedure CLP-57 Neutron Generator in 58A-002 was observed on April 6, 2015.

LOTO was performed by a Staff Scientist, and Authorized LOTO person on the activity. This procedure is designed to create safe entrance to room 058-002b for allowing configuration changes to the test stand. To create a LOTO safe zone, power supplies and microwave generators are shut down, and then locked out at the isolation point, the PDU main circuit breaker. There is a visual inspection component of verifying the safety drop switch for the hutch door has landed before entry. With this confirmation, the room is entered so grounding hooks may be put in place.

We observed the back panel of the rack housing for power supplies and microwave generators was accessible, allowing a scenario where these units could be reconfigured to different power sources, invalidating or bypassing the LOTO. It was recommended that a non-LOTO lock be administered to rack access panel door controlling the configuration.

Arising from the inquiry an understanding of the potential for high volume repetitive use of the LOTO procedure when the experiment was not producing desired results was noted. It is not ideal for LOTO to be used in a repetitive way. ATAP's Electrical Safety Advocate will investigate alternate engineering controls.

BELLA Center

Procedure CLP-88 Capillary Discharge Pulser in 71 was observed on April 16, 2015. LOTO was performed by a QEW and Authorized LOTO person on the activity. During a planning meeting on March 5, LOTO sequence identified to be blocked in Row/Column Table format achieving Itemized check listing. Expanded and or amended section sequence to be added and include making safe for removing from service. Add itemized checklist of LOTO Verification kit specific to this LOTO Procedure. Once these changes were made, on April 16 the Assessment team observed the LOTO being performed and found it established a safe work zone and met requirements.

Procedure CLP-89 Ekspla power supplies in 71 was observed on April 23, 2015. LOTO was performed by a QEW who is an Authorized LOTO person on the activity. There was a draft review on March 5 that identified the procedure and scope to be used for several system models. The reviewer recommended;

- Adding list of system models to the document.
- Blocking the LOTO sequence in row/column table format to create an itemized checklist.
- Expanding engineering controls to supersede grounding hooks with a dummy load device and divider for verification.

Once these changes were made, on April 23 the Assessment team observed the LOTO being performed and found it established a safe work zone and met requirements.

Superconducting Magnet Program

Procedure CLP-62 Cabling Machine in 77A-0103 was observed on March 9, 2015.

LOTO was performed by an Authorized LOTO person on the activity. We observed they have an existing complex procedure, LOTO equipment, and station, with trained staff knowledgeable of the procedure. The General LOTO was to stop accidental startup. The Cabling Machine operation is LOTO'd at the knife throw switch isolating the machine from its electrical source. The second issue is rotation hazard when loading and configuring the Fly Wheel spooler. Blocking is used to prevent movement of the Fly Wheel. The ATAP Electrical Safety Advocate took concern with the brake on/off switch being used as the sole isolation point for this process because the switch did not have an engineered control designed for Lockout. Investigation into the documentation of the circuitry controlling the cabling machine found it was incomplete and is to be further looked into and made whole. This will confirm whether the switch has full control of the wheel brake and no other circuitry is in its place. The EH&S Electrical Safety Officer and Electronics Supervisor were notified and made aware that a verification of the system was being planned.

By the second meeting on March 18, the Supercon group created a LOTO control to secure the on/off switch for the brake. The LOTO reviewer had issue with whether the circuit is a "AND" or an "OR" gate. If the controlling circuit was "AND" it would invalidate the LOTO. The circuitry documentation was incomplete. Contact was established with the electrician who installed the circuit to request his knowledge of the legacy equipment. There is one hand drawing of the timer relay system. SuperCon met the initial requirement of being able to LOTO the "On/Off air brake switch" by means of engineered control enabling the User to LOTO the switch in an off position. After further review by the Electrical Safety Advocate, it was found that the Air Brake switch was an inadequate isolation point. The LOTO procedure was changed to lock out the quick release hose that feeds the Air Brake. This quick release hose is now listed as the energy dissipation device for the rotational hazard on this LOTO.

CLP-96 Magnet Test Facility in Bldg. 58-0101 was observed on April 28, 2015.

LOTO was performed by an Authorized LOTO person on the activity. The procedure was invalid as of the first step because it required a prerequisite of the 25kV power supply to be LOTOed (CLP-81). This is a separate procedure that must be done first. It was recommended to separate the procedures and make CLP-81 the prerequisite.

The QEW/LOTO reviewer performed the final LOTO review on May 5. Corrective actions were taken by SuperCon Group. One corrective action of significant importance was step 5.5 of establishing the LOTO. This step measures voltage at the EES door test point. This measurement of the Cap bank for Zero energy was changed from SHV connector terminations - to standoff test points with a clear guard creating an electrical shield. This engineering control allows for unambiguity of probe contact and voltage verification.

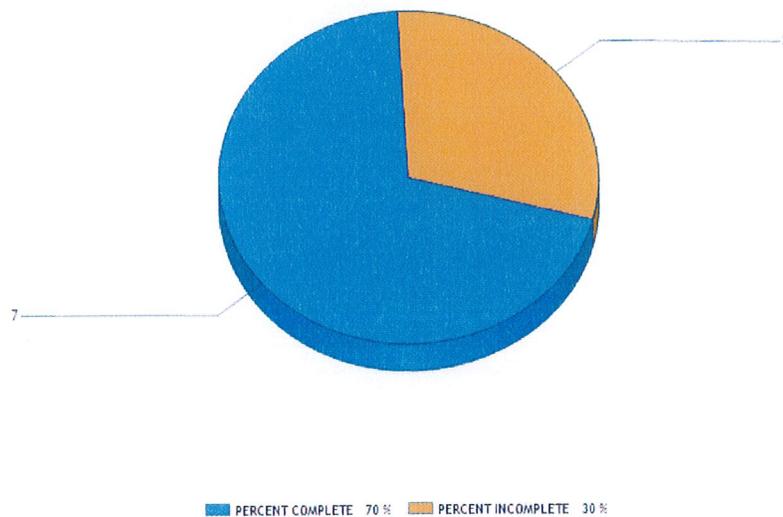
Review of Training Records

There are 3 required training courses for LOTO:

EHS0370 Lockout/Tagout for Authorized Persons – designed for employees and affiliates who work on or near equipment with exposed hazardous energy above human vulnerability limits. This includes all maintenance, modification, calibration, and repair functions. The course is designed to provide participants with training on Lockout/Tagout responsibilities, acceptable practices, and procedures with respect to safety and compliance. This course stressed specific approved techniques, tools, equipment, and line management and supervision responsibilities.

Search Criteria: Division = Accelerator Tech-Applied Phys, Course = EHS0370

Required Training

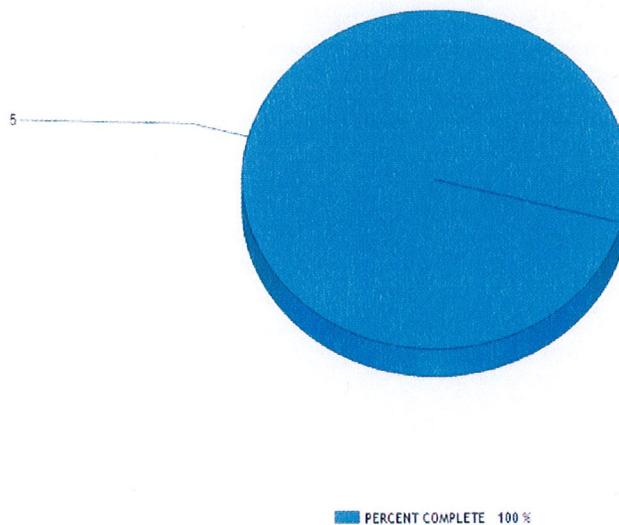


On August 1, there were 10 ATAP people listed in the training database who were required to complete EHS0370. Of these, 7 (70%) had completed the requirement and 3 (30%) had not. A closer look at the records revealed that two of the people who needed the training had previous training that had just expired on August 1, and one of them is scheduled to leave LBNL in August and will not be performing LOTO before he leaves. The third person who needed training was a student assistant who joined the group in June, was not yet performing LOTO, and was enrolled to take the class on August 18.

EHS0372 Lockout/Tagout Awareness for Line Managers – This course is for Line Management who oversee individuals who perform Lockout/Tagout. This training provides an awareness of the LOTO process and the different roles and responsibilities associated with LOTO so that line managers can discuss LOTO with their staff. This does not qualify anyone to perform LOTO.

Search Criteria: Division = Accelerator Tech-Applied Phys, Course = EHS0372

Required Training



On August 7, there were 5 ATAP people who were required to take EHS0372, and all had completed the training.

EHS0373 Lockout/Tagout for Responsible Individuals – This course is designed for employees and affiliates who supervise the execution of LOTO as a Responsible Individual (RI) or approve, inspect, or coordinate multiple complex LOTO procedures for a specific Division.

On August 7, there were no ATAP people who were required to take EHS0372.

5.0 Results

Answers to Lines of Inquiry

1. Do ATAP LOTO procedures meet requirements of the ES&H Manual?

Yes, the focus was on Work Process E. Complex LOTO by a LOTO Authorized Person. This was the concern of the focus group accounting. Other processes were addressed through interviews and reviews. Reviewing all submitted LOTO procedures the assessment team found all met safe work practice with some needing amendments for hazardous energy analysis and energy isolation points in table format to be stated in the document and clarity of steps to perform the task.

2. Are ATAP LOTO procedures properly reviewed?

ATAP Electrical Safety Advocate and associated RI's are now conducting the reviews on behalf of the division. Preceding reviews were done internally by others with intimate knowledge of the task but not involved with the work. Mark Scott, Electrical Safety Officer of EH&S Division, was the approver and reviewer for some of the complex LOTO procedures. The review process consists of periodic document review, interviews, and witnessing LOTO practice.

Procedure Inspection Criteria:

- Each equipment-specific written energy control procedure must be inspected by an Authorized Employee on an annual basis.
- The procedure shall be demonstrated by (a) LOTO-Authorized Person(s) who uses the procedure.
- The Authorized Employee performing the inspection must be familiar with the LOTO procedures utilized as well as with the equipment's energy types and methods of controlling them.
- The inspector must not be a person who is involved in the actual use of the procedure on the equipment or apparatus.
- If the inspection scope was limited by operational demands, describe in Comments.

The Inspection report has 5 sections with stipulated questioning:

- I. Written Equipment-Specific LOTO procedure
- II. Authorized Employee Knowledge
- III. LOTO Devices
- IV. LOTO Practices
- V. Effectiveness

Archiving of the records has been fragmented. Consolidation into Google documents is the current adoption of the assessment team with further review into a permanent repository, the ATAP CLP database.

3. Are people knowledgeable of the requirements of the LOTO procedures they are implementing?

A search for Divisional units not having procedures found that the groups observed at minimum had a draft of LOTO procedures for all projected task with a majority having clear work processes meeting rigorous uniformity and compliance. The format and content of the procedures establish clear guidelines. It documents the scope of work permitted under the LOTO. It documents the specific isolation's established by the LOTO. It serves as the primary communication document for all parties involved in the LOTO. Policy of briefing, checklist style procedures, and logging of the LOTO create an environment for feedback built in to the document inviting continuous improvement. After participating in multiple LOTO reviews, we were convinced that LOTO was safety empowerment not just policy.

4. For procedures that require a Responsible Individual, are the RI's properly trained and knowledgeable of their responsibilities?

Currently no active regular CLP are default Work Process F. Complex LOTO Requiring a Responsible Individual. The Division staff and matrixed RI's have completed EH&S classroom training and have been vetted through the QEW application process. These skilled and trained individuals can assume the RI role and administer a Group LOTO and have been trained to properly execute and manage LOTO procedures of a more complex nature than those allowed under Work Process E. Complex LOTO by a LOTO Authorized Person.

5. Do people who perform LOTO procedures know how to provide feedback if they see a need for improving the procedure?

The team discussed recommending a uniform feedback section for procedures; however, after an informal polling we discovered a majority of users stated they would prefer to initiate suggestions and corrections through email. The assessment team conducted interviews with technical staff. The response's given show awareness of availability to improve or amend the processes by contacting the owner of the equipment.

"Yes, if a step needs to be changed contact ownership of equipment, Supervisor and /or EHS Mark Scott, "Said a QEW at the BELLA Facility.

Ownership of the equipment and contact information is the first and foremost section of the LOTO Procedure. This same question was asked of an ATAP Laser Technician who has applied for QEW consideration and has completed RI training.

"Send an E-mail to LOTO coordinators." He said, "I can find their names on the LBNL website."

We found the annual review process was an extremely productive platform. With each review, Affected and Authorized users had input on not only the effectiveness of the Procedure, but also the advantage of it being the primary form of communication for the hazards.

6. Do people who perform Simple LOTO know how to perform it correctly?

Simple LOTO practice was discernable and understood that one user, one source, and one cord control was safe practice. Interview responses to question 8:

- “Yes, one energy source, and exclusive control of cord.”
- “Simply LOTO for One person, single energy source (no capacitors). Doesn't have to be limited to electricity as energy source (could be pressure for example). It is pretty easy.”

7. Do researchers/technicians, who are not LOTO trained, but work around equipment with LOTO procedures, understand when LOTO is required and the limits to their scope of work?

Affected users not authorized to perform LOTO are expected to have OJT, be able to recognize LOTO lock and tags, and understand how to contact someone about the LOTO.

This above question was asked of LOTO trained technical staff.

“Hard to judge, but it seems safe. People in general know how to find the appropriate electrical support.” Statement made by a BELLA Laser technician.

An Electronics Technologist QEWR/RI at the BELLA center gave this response.

“Yes, we LOTO-brief (conduct briefings on procedures before performing them), but barriers keep people from entering approach boundary/LOTO safe zone.”

Name and phone number is the minimum information that can be on a LOTO tag creating assurance of immediate point of contact. Technicians are using barriers, warning tape and signage to create additional awareness of LOTO safe zones and approach boundaries.

Summary of Noteworthy Practices, Findings and Observations

Noteworthy Practices

A **Noteworthy Practice** is a practice or condition that is recognized for its excellence and should be considered for Lab-wide application.

1. **We identified a working list of improvements to the Quickbase LOTO database.** This was a direct result from user feedback and evaluation of the database by the assessment team. EHS is in process of cloning the database and working with ATAP to add specific improvements targeted for ATAP divisional needs. Some of the identified improvements in progress include incorporating a checklist to be used during performance of complex LOTO, adapting the Glove and Equipment inspection database for use in recording grounding hook inspections, and linking information from the grounding hook inspections to the LOTO procedures.
2. **ATAP is developing a ground hook safety program.** Ground hooks are an important component of many ATAP LOTO procedures. The ATAP Electrical Safety Advocate is participating on an LBNL Electrical Safety Committee subcommittee to develop grounding hook standards for the Lab. In addition, he is working with EHS Electrical Safety to develop a more detailed implementation program for ATAP, which includes inventory, inspection/testing, and approval of ground hooks for specific uses. A recordkeeping system is being developed through the Quickbase database. (See Supporting Documentation.)

Findings

A **Finding** is a program or performance deficiency where there is noncompliance with established external or internal requirements.

1. **Line management kept poor accounting records regarding the number of times a procedure has been performed and did not retain hard copies of signed completed procedures.** The authorized persons we observed performing LOTO were unable to provide documentation that they had reviewed and signed the applicable LOTO procedure each time it was used.

ES&H Manual Chapter 18, Work Process E Complex LOTO by a LOTO Authorized Person requires:

Section 5.a.i. **Print out and review the LOTO procedure.** Verify that the scope of work to be performed is described in the LOTO procedure, and that the LOTO Safe Zone is adequate for all planned work.

And

Section 7.e. **Sign off the LOTO procedure to indicate that the complex LOTO has been cleared. Place the completed LOTO procedure in a location for safekeeping.**

3. **The Division did not have an accountability of all its LOTO activity and documentation of internal quality assurance audits to be done annually.** The list of LOTO activity was derived from a combination of procedures entered into the Quickbase database and procedures provided to the Division ESH Coordinator by research groups. There were some additional procedures that were being used by research groups but had not been submitted for review.

ES&H Manual Chapter 18, Work Process P Periodic Quality Assurance Inspections of LOTO Procedures requires:

Section 4. All LOTO procedures at the Berkeley Lab are subject to periodic QA inspection. The EHS Division will coordinate the Laboratory-wide LOTO Procedure QA Inspection Program and certify that the inspections have been completed. To meet this requirement, each division is responsible for conducting QA inspections of its LOTO procedures and submitting the results to the Electrical Safety Group for record keeping.

And

Section 6. **During the FY14–FY15 implementation period, the following sampling schedule is the minimum QA inspection requirement:**

- a. All LOTO procedures embedded in an Activity Hazard Document must be inspected annually.
- b. Subcontractor LOTO permits will be sampled at three permits per month for a total of 36 permits annually.
- c. Divisions with a large number (100 or more) of equipment-specific LOTO procedures must inspect at a rate of 10% of active procedures, or a minimum of 36 procedures, whichever is greater.
- d. **Divisions with a small number (10 to 99) of equipment-specific LOTO procedures must inspect at a rate of 33% of active procedures, or a minimum of 10 procedures, whichever is greater.**
- e. Divisions with less than 10 equipment-specific LOTO procedures must inspect all active LOTO procedures.
- f. Inactive procedures (LOTO procedures that have not been used in over 12 months) must be flagged by the division for either re-approval or certification at the next use.

While the minimum standards of Section 6 for FY15 were met, ATAP will not be able to comply with the requirements of Section 4 going forward without a complete and accurate record of LOTO procedures and their inspections.

The initial response was consolidation of procedures and inspection records on Google docs. This created a place for list of LOTO users, LOTO drafts not yet ready for submission, and LOTO training and documenting aids. The second step (in progress) is transferring the LOTO procedures and inspection records into the Quickbase LOTO database.

3. There were deficiencies in configuration control. Researchers often need to try different equipment configurations to achieve desired test results. There has been a cultural practice of creating vague and general descriptions of work in LOTO procedures to avoid the effort of updating procedures and re-submitting them for review when configurations change. This practice can result in inadvertent introductions of unrecognized electrical hazards.

EHS Manual Chapter 18 requires LOTO procedures to be specific to the work. Work Practice E Complex LOTO by a LOTO Authorized Person, requires:

Section 3. Every complex LOTO shall have an approved written LOTO procedure that meets the requirements of [Work Process N](#).

- a. The LOTO procedure is a formal written document, **approved by a LOTO Approver, which details the scope of work performed under the LOTO and the energy isolations to be established.**
- b. The LOTO procedure also **details, where required, the method of stored energy dissipation and any specific sequence required for the shutdown.**

Work Practice N, LOTO Procedures, requires:

Section 1. A LOTO procedure is a formal document **detailing all the steps required to establish the lockout. It is specific both to the equipment or system and to the scope of work.** A LOTO procedure is required for all complex LOTOs.

Section 2. The LOTO procedure fulfills the following purposes:

- a. It documents **the scope of work permitted** under the LOTO.
- b. It documents **the specific isolations** established by the LOTO.

And

Section 13. Grouping of LOTO Procedures

- a. Grouping of LOTO procedures is not authorized, except for the purpose of periodic inspection in [Work Process P](#). **LOTO procedures must not describe multiple “scenarios” where energy isolations are selected based on different scopes of work. Instead, the LOTO procedure must establish only one LOTO Safe Zone, where all energy isolations are performed. Multiple scenarios may only be addressed by creating separate LOTO procedures.**

- b. Multiple scopes of work may be performed under the same LOTO procedure, provided that **each scope is described on the LOTO procedure** and that the LOTO Safe Zone is adequate.

Observations

An **Observation** is a practice or condition that is not technically noncompliant with an external or internal regulation or requirement, but could lead to noncompliance if left unaddressed.

1. **There was a lack of continuity in LOTO procedure format.** Feedback from the users and the assessment team found a discontinuity between template formats. Adjustments noted for consolidation; procedures did not have a LOTO description # and name identifier; approach boundary to be added to the scope of work, also itemized as a LOTO Sequence step; identify Energy Dissipation Devices as Hazards.

ES&H Manual Chapter 18, Work Process N Procedures Section 11 Write the LOTO Procedure says:

- a. All Berkeley Lab LOTO procedures must follow the standard format included in [the Lockout/Tagout \(LOTO\) Procedure Template](#).
 - i. Implementation Period: Existing LOTO procedures are acceptable until FY16, after which they must be converted to the standard format in [the Lockout/Tagout \(LOTO\) Procedure Template](#)<http://www2.lbl.gov/ehs/pub3000/CH18/CH18.html> - appb.
- b. Alternative formats specific to divisions or user facilities may be used, provided that they contain the elements described in [Appendix B](#).

All the groups amended the templates and procedures during the individual LOTO reviews this year. This action has now unified the Division's LOTO procedures to the document standard.

The now-standardized LOTO procedure document is a formal hazardous energy analysis. The table format with individual steps provides not only action items for the user to follow but also the energy analysis giving the user full knowledge of the hazards, energy isolation, approach boundaries, required PPE, and test and measurement equipment needed.

2. LBNL Standards for ground hooks were insufficient to assure safe use in LOTO procedures, and there were no additional ATAP standards.

LBNL Electrical Safety Manual Section 15.7 says:

The following need to be considered:

15.7.1 Conductor terminations should be soldered or terminated in an approved crimped lug. All conductor terminations should be strain relieved within 15 cm.

15.7.2 The resistance from the tip of the ground hook to ground should be less than 0.1 ohm.

15.7.3 The cable conductor should be clearly visible through its insulation.

15.7.4 A cable conductor size of at least #2 AWG should be used, with the conductor sized to be capable of carrying the available fault current of the system. The available fault current should be calculated from $V_{peak}/0.1$ ohm, including the stored energy.

15.7.5 A sufficient number of ground hooks should be used to adequately ground all designated points.

15.7.6 If they are permanently installed, ground hooks should be permanently grounded and stored in a manner to ensure that they are used.

15.7.7 Ground hooks should be designed so that equipment cannot be energized with the hook across the capacitor

The use of ground hooks is an essential component of many ATAP LOTO procedures. There are no specific requirements for inspection or testing of ground hooks to ensure they are appropriate for the specific use and will function as intended. There is no ATAP program in place for tracking the status of grounding hooks.

In response to the identification of this need, the Electrical Safety Committee has formed a subcommittee to develop LBNL standards for grounding hooks. The ATAP Electrical Safety Advocate is on this committee. The ATAP Electrical Safety Advocate is also in the process of developing an ATAP ground hook program to implement the anticipated requirements, and is working with EHS to adapt the Quickbase Glove database to track ground hook inspection records.

3. Researchers at some test stands have to repeat LOTO several times a day.

While this practice is compliant with LOTO requirements, repetitive use of LOTO could discourage careful practice of the procedure each time with proper recordkeeping. When the activity frequency is too high an engineering solution needs to be considered.

Improving the LOTO to include a trapped key interlock system would keep configuration control and effectively reduce the number of steps in the LOTO procedure.

LBNL ES&H Manual PUB-3000 Section 18.7 Work Process R. Interlock Systems says:

3. Trapped Key Interlock Systems

C. A trapped key interlock system may be used in conjunction with the Berkeley Lab LOTO Program, but by itself does not meet the requirement for personal LOTO. To use the system with LOTO, there must be at least one token key that can be kept on a person or locked in a lockbox. Ways to incorporate trapped key interlocks and also meet the requirements of the LOTO program include:

- i. Limiting the number of LOTO Authorized Persons to the number of token keys available. Each person accessing the controlled area must keep the token key on his or her person while in the area.
- ii. Place at least one token key in a lockbox, then use the group LOTO procedure.

D. A properly designed trapped key interlock system can significantly strengthen a LOTO procedure by making it physically impossible to violate key steps in the required sequence.

E. Trapped key interlock systems where the last key is held captive in a lock do not meet the requirement for LOTO but can still be used to enforce the required sequence. In this case the LOTO process simply overlaps the trapped key interlock system.

6.0 Recommended Corrective Actions

Observations	Recommended Corrective Action (Status)
1. There was a lack of continuity in LOTO procedure format.	Develop standard format for ATAP LOTO procedures (completed) and transfer all ATAP LOTO procedures to this format (in progress).
2. LBNL Standards for ground hooks were insufficient to assure safe use in LOTO procedures, and there were no additional ATAP standards.	Participate in development of LBNL ground hook standards (in progress). Develop additional ATAP standards as needed (in progress).
3. Researchers at some test stands have to repeat LOTO several times a day.	Affected PIs should work with ATAP Electrical Safety Advocates to develop engineering solutions to reduce the need for repetitive LOTOs, where feasible (in progress).
Findings	Recommended Corrective Action & Status
1. Line management kept poor accounting records regarding the number of times a procedure has been performed and did not retain hard copies of signed completed procedures.	Develop checklist for each LOTO procedure and enter it in Quickbase LOTO database to make compliance with recordkeeping requirements easier for Line Management (in progress).
2. The Division did not have an accountability of all its LOTO activity and documentation of internal quality assurance audits to be done annually.	Create a Google spreadsheet to collect current review and approval status information for each LOTO procedure (completed) Transfer LOTO procedure status information to Quickbase LOTO database (in progress).
3. There were deficiencies in configuration control.	Require LOTO procedures to be specific to the work scope and configuration (in progress). Require procedures to be amended and request re-approval when configuration or work scope changes.



7.0 Supporting Documentation

LOTO ASSESSMENT INTERVIEW

Employee Name:		LOTO:	
Title:			
Supervisor:		ATAP:	
Title			

<p>1. ARE YOU A QEW? DO YOU FEEL EMPOWERED TO STOP WORK IF YOU DO NOT UNDERSTAND OR AGREE WITH THE LOTO PROCEDURE?</p>
<p>2. CAN YOU PROVIDE DOCUMENTATION OF OJT TRAINING AND WAS A DISCUSSION OF HAZARDS FOR THE LOTO INCLUDED?</p>
<p>3. CAN YOU EXPLAIN WHAT A LIMITED APPROACH BOUNDARY IS?</p>
<p>4. CAN ANY LOCK BE USED FOR LOTO?</p>
<p>5. WHAT IS THE MINIMUM INFORMATION THAT CAN BE ON A LOTO TAG?</p>
<p>6. CAN YOU LOAN SOMEONE YOUR KEY?</p>

EMPLOYEE SIGNATURE	INTERVIEWER SIGNATURE
Date	Date



LOTO ASSESSMENT INTERVIEW

Employee Name:		LOTO:	
Title:			
Supervisor:		ATAP:	
Title			

<p>7. DO PEOPLE WHO PERFORM LOTO PROCEDURES KNOW HOW TO PROVIDE FEEDBACK IF THEY SEE A NEED FOR IMPROVING THE PROCEDURE?</p>
<p>8. CAN YOU EXPLAIN THE REQUIREMENTS OF SIMPLE LOTO? DO PEOPLE WHO PERFORM SIMPLE LOTO KNOW HOW TO PERFORM IT CORRECTLY?</p>
<p>9. DO RESEARCHERS/TECHNICIANS WHO ARE NOT LOTO TRAINED, BUT WORK AROUND EQUIPMENT WITH LOTO PROCEDURES, UNDERSTAND WHEN LOTO IS REQUIRED AND THE LIMITS TO THEIR SCOPE OF WORK?</p>
<p>10. EXPLAIN WHAT "CHALLENGE MEANS REGARDING LOTO?</p>
<p>11. EXPLAIN WHAT "ZERO ENERGY" MEANS REGARDING LOTO?</p>

EMPLOYEE SIGNATURE	INTERVIEWER SIGNATURE
Date	Date

EXAMPLE OF GROUND HOOK INVENTORY RECORD

 Blankets and Sticks > Blanket/Stick #6
[REPORTS & CHARTS](#)

Description Grounding hook for 58-002B DD Neutron generator test stand. This permanent hook grounds and discharges the output and output capacitor of power connects to the test stand at the drop switch on the back wall of the room.

Date Tested 08-18-2015

Date Due 08-18-2016

ID Number ATAP-GH-001

Class 120kV

Attachment [Ground Hook Annual Inspection ATAP-GH-001.docx](#)

Created on Aug. 18 at 1:19 PM (PDT). Owned by [Ybarrolaza, Nathan](#).

EXAMPLE OF GROUND HOOK INSPECTION RECORD

Hook Location Details

Ground Hook Number	ATAP-GH-001
Building	058
Room Number	002B (Test stand)
Further Location Details	DNN test stand
Hook Hazard Description (purpose)	Grounding neutron generator source power supply
New Hook?	No
Sticker Present?	No
Hook first in service	?
New users?	Qing Ji
Removed users?	

Hook Physical Inspection

Item	Comment/Check	Photo
Commercial Hook?	Yes	
Make	Hastings	
Model Number	CTO2676	
Serial Number		
Manufacture Date	9-2010	
Date of Last Commercial Inspection		

Hook meets requirements (corrosion free, conductor exposed, hook fasteners to handle tight, if chain style or other style than standard hook is used, parts are in good repair?)	Everything is bolted together well. Hook work well with mount point. Hook and cable lug seem to fasten using same fastener, which may be a problem. Fastener was tight. No noticeable locking washer.	
Hook handle meets requirements (no damage or undue wear, no cracks, correct material type, length is consistent with hazard?). Adheres to ASTM F-711?	The handle length is 36". The material is rated for at least 50kV per foot. Last 6" are for the hand so the handle will do 125kV. There is also a blocking ring on the handle to keep the hand and the proper distance. The material is of type and is tested according to ASTM F-711	
Hook lead meets requirements (correct insulator and no insulator damage, conductor size, lead is correctly affixed to hook device with tight fastener, lug and or other electrical connection?)	The hook lead looks to be of 2/O Ga wire and insulated with a yellow insulation. The lugs on both ends of the hook are fastened to the lead securely.	
Hook Storage/Hanger meets requirements?	Yes	

Ground System Physical Inspection

Item	Comment/Check	Photo
Hook Connection	The hook connection to the ground system is to ground bus 1 on the experimental bench. The connection is in good shape with a well torqued 5/16" bolt with lock washer.	