LZ SURF Offsite Safety
Re-Assessment
September 10, 2018

Conducted *by the Lawrence Berkeley National Laboratory*
Physics and EHS Divisions

Report prepared by:

11/20/18

Ingrid B. Peterson, LZ Safety Officer Date:

Report reviewed and approved by:

11/20/2018

Natalie Roe, LBNL Physics Division Director Date:

Executive Summary:

An Offsite Assessment of the Sanford Underground Facility (SURF) was conducted in FY17 by the LBNL Physics Division, see Appendix A. This facility was ranked category 2; see description of rankings below.

1. DOE National Laboratories. These are institutions that follow ISM and have equivalent policies, processes and procedures to LBNL.
2. Institutions that LBNL has worked with for a long time and demonstrated to have equivalent policies, processes and procedures.
3. Institutions that are safe for the most part but have gaps in demonstrating equivalency to LBNL's policies, processes and procedures. The gaps require a mitigation plan.
4. Institutions where LBNL workers need to follow the LBNL safety program because the host safety program is not equivalent.

The LZ SURF Offsite Safety Re-Assessment was conducted in 2018 in response to the recommendation from the DOE Independent Project Review of Status of the LZ project which took place on January 9-11, 2018.

SURF was re-ranked as a category 3. LZ staff will be able to work at SURF under SURF's EHS program except for the areas where additional controls beyond those in SURF's EHS policies and procedures are implemented. The identified areas where SURF's EHS program was considered in need of additional strengthening were primarily in electrical safety with minor issues with Job Hazard Analysis and documentation. The controls in place are as follows:

- LBNL electrical equipment inspector to travel to SURF regularly to perform NRTL inspections
- LZ collaborators are restricted to perform electrical work and LOTO
- LBNL Subject Matter Experts (SMEs) will review JHAs for selected critical LZ activities

Background:

The rating system for offsite facilities where LBNL conducts research is listed above. It was developed in 2016 by the Nuclear Science and Physics Divisions as a follow up on the Physical Sciences EHS Assessment conducted between August 2014 – November 2015. This assessment was performed in response to off-site safety concerns which involve travel to and from work at institutions where there is safety program that is not under the control of LBNL and may be different from LBNL.

These documents can be found in Appendix A.

LZ SURF's Re-assessment 2018 Process:

In response to the recommendation from the DOE IPR in January 2018, a re-assessment of LZ SURF offsite safety was conducted.

The strategy for this re-assessment was presented to the Physics Division Safety Committee on 3/21/18 and it was agreed to move forward.

SMEs from the LBNL EHS Division (see list below) were asked to review selected elements of LZ/SURF's safety programs including electrical and high voltage safety, chemical safety, cryogen safety / oxygen deficiency hazard, pressure safety, and work planning and control.

Lock-out-tag-out (LOTO) was not included in the electrical program documents reviewed. Confined space was not reviewed except where it was referenced in ODH policy. The purpose of this review was to:

- Perform a comprehensive assessment of specific SURF/EHS program elements related to LZ work at SURF
- Determine if SURF policies are equivalent to LBNL ES&H requirements
- Determine if training adequately protects the LZ collaboration researchers from hazards while working at LZ/SURF
- Establish training equivalencies between LBNL and SURF to streamline training for individuals working in both locations

The following team of SMEs reviewed the documentation and provided the recommendations found in ***LBNL Subject Matter Expert Assessment Report for***

LZ-SURF Programs. This document can be found in Appendix B. It was sent to SURF's EHS Director on July 13, 2018 requesting SURF to provide a written response to each of the recommendations before the August 22, 2018.

Scott Robinson, CIH, CSP, FAIHA, LBNL EH&S Research Support Team Leader
Mark Scott, PE, LBNL Electrical Safety Officer
Evelyn Davies, Ph.D., LBNL Chemical Safety Specialist
Alyssa Brand, MS, LBNL Cryogens and ODH SME
Kurt Ettinger, CSP, LBNL Pressure Safety and Compressed Gas SME

In addition, a walkthrough of the LZ SURF Surface Lab and Underground areas was conducted on August 22, 2018 by the following committee

Ingrid B. Peterson, Ph.D., LBNL LZ Safety Officer
Scott Robinson, CIH, CSP, FAIHA, LBNL EH&S Research Support Team Leader
Frank O'Neil, CSP, MS, System Safety Engineer, SLAC
Stephanie L. Collins, CESCP, LBNL Deputy Electrical Safety Officer

Recommendations:
In total, there are 35 recommendations based on the Assessment and Walkthrough summarized in the Table below. The recommendations and response to the recommendations by SURF can be found in **The *LBNL Assessment and Walkthrough Report spreadsheet, LBNL SME Assessment and Walkthrough Status presentation***, Appendix C.

– Eight Electrical Safety • Four pending • One needs action	– Eight WPC, JHAs, SOPs • All closed/agree
– Five Chemical Safety • All closed/agree	– Six Waste Management • All closed/agree
– Seven Cryogens and Pressure Safety • All closed/agree	– One staffing • Closed

The identified areas where SURF's EHS program was considered in need of additional strengthening were primarily in electrical safety and Job Hazard

Analysis and documentation. Below is a summary of the recommendations and mitigations for gap closure.

SURF Electrical Safety Gap Closure Summary

- SURF to look at electrical safety policy NFPA 70E 2015 and 2018 and adopt the appropriate policy
- SURF to establish a process to train/validate their QEWs
- SURF's electrical safety program needs to incorporate best practices per 70E that are most suitable for the LZ work and be brought on par to a DOE Lab
- ARC Flash has to be completed for all electrical panels where work or switching is performed

SURF Electrical Safety Gap – LZ Mitigations

LZ staff will be able to work at SURF however, the controls listed below must be followed by the LZ collaboration staff.

LZ Equipment Inspections at SURF

- Sending equipment to LBNL to be NRTL inspected will cause delays
  - SURF to conditionally accept the equipment
- LBNL inspector (Ohmar Sowle or other designated by the LZ safety officer) to travel to SURF on a regular basis to perform equipment inspections

Limit Project LOTO's to be performed by LZ personnel that are LBNL trained

- Will Waldron and Ethan Bernard for cathode activities (both are LBNL QEW's)
- All other LOTO used to control hazardous electrical energy will be performed by SURF

Operation of all circuit breakers will be performed by SURF until Arc Flash labels are installed on panels for LZ project equipment. This is achange from the present *"reset one time if cause known"* SURF policy.

WPC, JHA, SOPs Gap Mitigation

It was also recommended that LBNL SMEs review the SURF's Job Hazard Analysis program and effectiveness to ensure consistency.

It was agreed that the appropriate LBNL SMEs would review the JHAs and other documentation and provide recommendations for the following critical LZ activities in the Table below:

Item	**When**	**Comments**
Trial lowering of acrylic vessel support frame with dummy load under cage to Davis	Oct 2018	Trial run
Long acrylic vessels going underground, into water tank	Oct 2018 Dec 2018	4 times. Under cage
First turn on of cryo/Xe full system underground with dummy cryostat	Early 2019	Non-SDSTA Xe used. Will be operations readiness review process
TPC in ICV going underground	June 2019	Under cage
Before committing SDSTA Xe at SLAC Kr removal	June 2019	Review at SLAC
Before committing SDSTA Xe post Kr removal underground	Fall 2019	Review at SURF
Before doing liquid scintillator fill of tanks	Late 2019	Review at SURF. Includes transport of LS underground

Table I: List of Critical LZ Activities Requiring LBNL SME JHA Review

In addition to reviewing the JHAs per Table I above, both LZ Safety Officer and LBNL SMEs will be on site at SURF during critical activities as specified per LZ and LBNL SMEs Events document.

Appendices

A: ***FY16 Multi Division Projects Assessment Report***
B: ***FY 17 Assessment Report, Appendices to FY17 Assessment Report, Letter to SURF EHS Director 2017***
C: ***LBNL Subject Matter Expert Assessment Report for LZ-SURF Programs***
D: ***LBNL SME Assessment and Walkthrough Status presentation***
E: **The *LBNL Assessment and Walkthrough Report spreadsheet***

Appendix A - *FY16 Multi Division Projects Assessment Report*

Physical Sciences Joint ESH Self-Assessment FY16

Integrated Safety Management in Physical Sciences Multi-Division Projects

Prepared by:

Marshall Granados, Engineering Safety Coordinator Date

Patricia Thomas, ATAP Safety Coordinator Date

Martha White, NSD & Physics Safety Coordinator Date

Reviewed & Approved by:

Barbara Jacak, Nuclear Sciences Division Director Date

Wim Leemans, ATAP Division Director Date

Natalie Roe, Physics Division Director Date

Henrik Von Der Lippe, Engineering Division Director Date

James Symons, Physical Sciences Associate Laboratory Director Date

Integrated Safety Management in Physical Sciences Multi-Division Projects

Executive summary:

The Physical Sciences (PS) divisions conducted a joint assessment of adverse environmental, health, and safety incidents that occurred in PS divisions between August 2014 - November 2015 and involved more than one division to see how to improve the controls and decrease the number of adverse incidents.

The Causal Factors of 11 selected adverse incidents were correlated with the applicable Integrated Safety Management (ISM) Core Functions and Guiding Principles. Comparison of ISM weaknesses in PS multi-division incidents with the broader categories of all PS and LBNL Reportable (Recordable and First Aid) Injuries indicates:

- Incidents/injuries around the Lab generally fall into problems or weakness with **analyzing hazards** and **developing controls** for them. Incidents within multi-division projects generally show the same weakness in Core Functions (Analyzing Hazards and Developing Controls) but they differ greatly in Guiding Principles -- the PS multi-division incidents show additional weakness in **Line Management Responsibility** and **Clear Roles and Responsibilities**. In a normal single-division project, the hierarchy is evident by the respective organizational chart, but when multi-divisions are involved, there is no clear reporting structure.

Based on the preliminary conclusions, the following Line of Inquiries (LOIs) were developed:

- What are the current practices guiding the management of Physical Sciences multi-division projects?
- What are the characteristics of a successful project?
- What are the characteristics of an unsuccessful project?
- How can management of multi-division projects be improved?

The PS Division Safety Coordinators identified categories of workers and individuals within these categories who, based on their diverse experience, would be most likely to provide a representative sample of useful information regarding these LOIs. Group interviews were then conducted with staff members at the same responsibility levels.

From the interviews, these additional observations were noted:

- The supervisory chain is often sidestepped when PIs and their staff seek out technicians without coordinating those requests through a single point of contact.
- Lab managers are expected to oversee students that do not directly report to them and there is no associated funding stream to cover their efforts.
- Work Planning and Control (WPC) is poorly understood by many of the staff we interviewed. Staff often treat WPC like a Job Hazard Analysis tool and not a task-based hazard analysis tool.
- The past ten years has seen an increase in exodus of seasoned staff. Those who remain are left with expanded roles and responsibilities and less resources. The onboarding process has been abbreviated. There is no clear way to track the process within WPC. There is no Standard Operating Process (SOP) to provide a uniform and comprehensive introduction to LBNL shops, staff, and capabilities.

Integrated Safety Management in Physical Sciences Multi-Division Projects

Introduction:

The Physical Sciences divisions (Accelerator Technology and Applied Physics-ATAP, Engineering-EG, Nuclear Science-NSD, and Physics-PH) conducted a joint assessment of adverse environmental, health, and safety incidents which occurred in PS divisions between August 2014 - November 2015 and involved more than one division to see how to improve the controls and decrease the number of adverse incidents. Adverse incidents types were as follows:

- Reportable Occurrences as defined by DOE Order 232.2 and LBNL ES&H Manual Chapter 15 Occurrence Reporting,
- Recordable Injuries as defined by the Occupational Safety and Health Administration in 8 CFR 14300, and
- "Near misses" that could have resulted in Reportable Occurrences or Recordable Injuries if the events or consequences were slightly different.

These incidents were analyzed for weaknesses in implementation of ISM Principles and Core Functions. LBNL Environment, Health and Safety Division (EHS) performs a similar kind of analysis for Injury/Illness (I/I) at LBNL. The ISM weaknesses in the Physical Sciences incidents were compared to the ISM weaknesses most commonly identified in LBNL accident investigations.

The ISM Principles and Core Functions are as follows:

ISM Principles

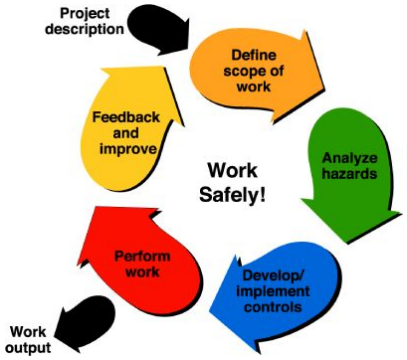
1. Line Management Responsibility for Safety
2. Clear Roles and Responsibilities
3. Competence Commensurate with Responsibilities
4. Balanced Priorities
5. Identification of Safety Standards and Requirements
6. Hazard Controls Tailored to Work Being Performed
7. Operations Authorization

ISM Core Functions

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

Integrated Safety Management in Physical Sciences Multi-Division Projects

Integrated Safety Management



Assessment Scope:

This joint self-assessment looked at 11 adverse incidents that took place at LBNL between August 2014 - November 2015 and involved personnel from at least one Physical Sciences division and at least one other division:

1. August 2014 -- Head injury from robotic tool changer shop equipment (ATAP, Engineering);
2. September 2014 -- Electric shock at the 88" Cyclotron (NSD, Engineering);
3. September 2014 -- Equipment damage during APEX carriage assembly (ATAP, Engineering);
4. July - October 2014 -- Non-compliant PCB waste storage at the 88" cyclotron (NSD, Facilities, EHS);
5. April 2015 (following 35 years exposure) -- Employee sustained hearing loss due to chronic noise exposure (ATAP, Engineering);
6. July 2015 -- Coil damage during LARP magnet assembly (ATAP, Engineering);
7. September 2015 -- Oily water discharge to sump (ATAP, Engineering);
8. October 2015 -- LOTO performed without current training (ATAP, ALS, Engineering);
9. August 2015 -- Technician sustained 120 VAC electrical shock to finger while working at Bldg. 6 computer rack (ATAP, Engineering, ALS).
10. August 2015 -- Neutron generator RWA violations (Physics, ATAP);
11. November 2015 -- Equipment damage during Lindberg oven operation (ATAP, Engineering).

Methodology /Assessment Timeline:

<u>Preparation</u>

January - February 2016: Gathering of information and selection of incidents for analysis

<u>Phase 1 Causal Factor Analysis</u>

March 2016: Analysis of Causal Factors in incidents using ISM Core Functions and Principles. (See Attachment a.)

The PS Division Safety Coordinators reviewed the Causal Factors of the 11 selected adverse incidents listed in Assessment Scope above. The Causal Factors were determined based on injury, occurrence, and incident causal analysis reports in addition to personal knowledge of the events. The Causal Factors were correlated with the applicable ISM Core Functions and Guiding Principles. In particular, the following questions were considered:

1. Was the work clearly authorized?
2. Was it clear who was in charge?
3. Was there a Memorandum of Understanding (MOU)?
4. Were all the ISM steps completed?

May 2016: Comparison of Causal Factors of selected Physical Sciences multi-division incidents with causes of LBNL Injury/Illness (I/I) cases. (See Attachments b, c, and d.)

The ISM weaknesses identified for the 11 selected adverse incidents were then compared to the ISM Causes of all PS Division I/I and all LBNL I/I cases which include recordable injuries and first aid cases from Aug 2013 to Jan 2016.

Phase 2 Interviews

June 2016: Development of Lines of Inquiry (LOI) and interview questionnaire, planning and conducting interviews. (See Attachment e.)

Based on the preliminary conclusions from Phase 1, the PS Division Safety Coordinators developed the following LOIs to explore further:

- What are the current practices guiding the management of Physical Sciences multi-division projects?
- What are the characteristics of a successful project?
- What are the characteristics of an unsuccessful project?
- How can management of multi-division projects be improved?

An Interview Questionnaire was developed with discussion points to collect and record responses to the LOIs.

PS Division Safety Coordinators identified categories of workers and individuals within these categories who, based on their diverse experience, would be most likely to provide a representative sample of useful information regarding these LOIs. Group interviews were then conducted with staff members at the same responsibility levels. The groups were all asked the same questions, using the Interview Questionnaire.

A total of 12 people were interviewed:
3 Program/Project leaders
2 Mechanical Engineering Supervisors
2 Mechanical Technicians
3 Electrical Engineering Supervisors
2 Electrical Engineering Technicians

People from all PS Divisions were included:
1 ATAP
2 Physics
1 Nuclear Science
8 Engineering Matrixed staff for all of the above

July – September 2016:

Development of observations and recommendations, drafting of report, report finalization.

Assessment Results:

Observations from analysis of Causal Factors of the 11 PS multi-division incidents by ISM Core Functions and Guiding Principles (see Attachment a):

- ISM Core Function 2-Analyse Hazards process was weak in 9/11 of the incidents.
- ISM Core Function 1-Define Work and Core Function 3-Develop Controls were both the secondary contributing area of weakness in 6/11 incidents.
- Guiding Principle 4-Balanced Priorities weakness of implementation showed in 8/11 incidents.
- Guiding Principle 1-Line Management Responsibility and Guiding Principle 2-Clear Roles and Responsibilities were identified as weakness in 7/11 incidents.
- Work was not formally authorized in 7/11 incidents.
- It was not clear who was "in charge" in 7/11 incidents.
- Memoranda of Understanding (MOU) between divisions were missing or expired in all cases, 11/11 incidents.
- One or more ISM steps were incomplete in all cases, 11/11 incidents.

Comparison of ISM Weaknesses in PS Multi-division Incidents with PS Reportable Injuries and LBNL Injuries indicates incidents/injuries around the lab generally fall into problems or weakness with analyzing hazards and developing controls for them. The incidents within multi-division projects generally show the same weakness in Core Functions (Analyzing Hazards and Developing Controls) but they differ greatly in Guiding Principles -- the PS multi-division incidents show additional weakness in Line Management Responsibility and Clear Roles and Responsibilities. (See Attachments b, c, and d.)

Observations from interviews:

Mechanical Engineering (ME) Supervisors:

- Project management is fragmented and diffuse.
- Missing is the lead or project engineer.
- Some projects don't have design engineers assigned, so the ME Supervisors often take on the design work and ask for feedback from an engineer when needed.
- Highest risk is when the PIs want to do the work themselves.
- WPC is not well utilized or understood at this time, especially with multi-division projects where fast changes occur.
- Using the WPC takes longer. It's harder to check the training. ME Supervisors ask people whether they have had the required training and sometimes people are not aware that their training has expired (example: crane training).
- ME Supervisors don't know how to determine if the work scope is authorized:

- The assignments are presented in a vague manner…diffused approach. The design engineers interact more with the PIs than with the mechanical technicians.
- The ME Supervisors don't get enough information about the full scope of the project, and this would be helpful.
- When people don't understand the need for safety requirements (example: penetration permits) they are more likely to skip them when they need to cut costs.
- A successful project is well-funded, well-staffed, and designed by Engineers.
- An unsuccessful project is characterized by not enough detailed instruction, lack of communication, and lack of engineering design reviews.
- There needs to be a buffer position between PIs and the actual work. There should be Engineering oversight to serve as the go between for divisions.
- We need a formal process for documentation for work authorization requirements. PIs/Researchers need to understand the big picture so they can understand why not pulling a permit is a risk even though it takes more time.
- Students often approach mech techs directly, bypassing their line management and the shop leads. They often request work without the necessary charge number or a clear description of what needs to be done.

Electrical Engineering (EE) Supervisors

- The biggest risk is the lack of supervision for students. Students are assigned supervisors but those same supervisors don't oversee daily work. Students need guidance and get it from their local lab manager. Virtually all of the students are listed under one PI but not all the work they perform is for that same PI. The details of the students' assignments are not shared with lab managers. Lab managers' position descriptions do not include overseeing the student staff presently in their labs.
- Division policy states "no working alone" for students, but they are often found working without direct supervision. It's unclear who is in charge of them.
- Students arrive working on different project, using the lab's resources but they do not bring charge accounts to support that work. Funding streams are missing for overhead activities for the lab unless there are direct projects. Projects need to be expanded to cover overhead work within the lab space.
- Scope and budgets affect the work schedule and quality. **There is a lot of rushing when money or time runs out. We try to help out another person/project as much as we can but that gets to be an effort.** Some scientific measurements don't get done due to many demands on reduced staff or those with enough expertise not being available and as a result, rework has to happen adding even more time delays and cost.
- **ALS seems to have enough people to do work in a comfortable way. We do not have dedicated coordinators like the ALS and there is nobody to think about extra stuff surrounding the projects.**

Mechanical Technicians

- Staff attending conferences along with turnover of PIs pushes timetables, which creates additional pressure on technicians. This often results in inefficient schedule planning.

- Some PI's do not take charge and when this happens, lower level staff are coerced to fill the void and make decisions that are outside of their position description.
- While management structure is clear, there are too many not within those management lines asking for our help. Who is in charge of what project is hazy at best. Researchers short-circuit the system by going directly to individual workers, effectively bypassing management.
- The project leadership is often unavailable, and there are no project coordinators.
- The researchers/PIs often exploit new employees in an effort to get things done faster. New employees want to make a favorable impression but lack an understanding of the Lab's requirements. New employees are not onboarded effectively.
- Technicians have little input on experimental setup planning even though they are the ones with the most experience in assembly operations. Technicians are expected to organize the workflow around the PIs plans regardless of the workflow efficiencies. Work teams used to have meetings every week but now that is frowned on due to budget restrictions (pre-job briefings are not standard operating procedure).
- "We used to have supervisor-led safety meetings when we had an assigned supervisor for the entire shop"
- The staff was more static in the past - "we knew everybody and who to go to"- and now that we are in expansion mode, we are seeing weaknesses in management. We are having problems with chain of command and communication.

Project Leads

- WPC has blurred who works for whom - supervisor vs. Activity Lead. Roles and Responsibilities need to be defined within the Activities. The reporting chain between the Activity Lead and their respective supervisor needs to be strengthened. The thing that would have to come out of WPC is having everyone recognize that they report to at least two different people, their respective supervisor and the Activity Lead.
- We take the least expensive path if no project is funding the hire. If there is no money trail to follow, then we assign a less expensive employee/student who may not be the best suited for the role.
- "On-the-Job Training is the only real safety training." Every Activity should have On-the-Job Training (OJT) delivered by the Activity Lead and record it. The important parts of safety, walkthroughs and OJT, are not documented well in WPC.

EE Group Leads

- New hazards and new people are gradually introduced to labs over time. Those new co-located hazards and training status of new personnel are not well communicated to others sharing the same space. This creates uncertainty about the safety of the lab. I see people handling fiber optics but don't know if they are doing it properly. If it feels off, there is no clear way to see if they are doing it safe. I could issue a stop work order but wouldn't it be better to be informed?
- It is unclear who to talk to in multi-division projects or shared spaces. What is the structure to let you know who is in charge or to find out what's going on with the

Activity next to you? How do you look at the training of those around you to see if they have been trained? How do you know who are the other Activity Leads ?

- "I noticed with the WPC, it's a new era, but there are folks that just fill it in to get through it… not taking it seriously. They don't treat the safety with integrity." And even suggested was an ISM app to guide the user through the WPC/ISM process and its steps i.e. define work…hazard analysis? Like a questionnaire.
- With the current electrical safety advocate (ESA) role, there is confusion as to who takes the lead where division spaces are shared. No formal documentation exists to define the current role of the ESA when divisions differ over interpretations.
- Location is critical. As the distance increases between project members, the quality of the communication decreases.
- There is underutilization of Subject Matter Experts (SMEs) by projects because there are fewer of them, and finding one available is so onerous, it's not worth it. We can't afford the schedule delays.
- A successful project has detailed task lists, due dates with dynamic updates, SME involvement and the right people.
- An unsuccessful project often has less-experienced people, moving too fast.

Conclusions:

- In a normal single-division project, the hierarchy is evident from the respective organizational chart, but when multi-divisions are involved, there is no clear reporting structure.
- Multi-division projects have similar weaknesses to all LBNL incidents, however, prominent weaknesses with communication and confusion surrounding their roles and responsibilities distinguishes the multi-division projects.
- The supervisory chain is sidestepped when PIs and their staff seek out technicians without coordinating those requests through a single point of contact. This forces lower level staff to make decisions that are outside of their position description. This creates an unbalanced workload on certain very competent staff without their respective management knowing about it.
- Management of students is not aligned with their respective project funding. Lab managers are expected to shepherd students that do not directly report to them and there is no associated funding stream to cover their efforts.
- WPC is poorly understood by many of the staff we interviewed. WPC is under constant change and not being well communicated.
    - The training function of the Job Hazard Analysis has been moved to the Berkeley Lab Training database. This change appears to have caused confusion to many of the supervisors with whom we spoke.
    - Co-located hazards remain an unknown due to their inconsistent identification. Staff have concerns they are working in environments with other Activities but cannot easily access the hazards and their respective controls information.
    - Staff often treat WPC like a JHA tool and not a task-based hazard analysis tool.

- The past ten years has seen an increase of exodus of seasoned staff. Recruiting by local companies, and the end of the expectation of spending an entire career with one employer has left us hemorrhaging process knowledge with every coming June. Those that remain are left with expanded roles and responsibilities and less resources.
- The onboarding process has been abbreviated. There is no clear way to track the onboarding process within WPC. There is no Standard Operating Process (SOP) to provide a uniform and comprehensive introduction to LBNL shops, staff, and capabilities.

Recommended Corrective Actions:

1. Physical Sciences Division Safety Coordinators will draft updated MOU's aligned with WPC by end of 1st QT of FY17.
2. Update RPM Matrix Worker policy E subpart D using the Requirements Management Committee (RMC) (RI-Heather Madison. DSCs will draft proposed changes and submit to H. Madison (EHS) by end of FY16.
3. The Project Lead of all multi-division projects must assign a designee in WPC to serve as project coordinator for all Activity Lead(s). The primary purpose is to be the **single point of contact** for the project/activity(ies). This is an ongoing update as Activities are renewed/created.
4. Allocate a funding stream for compensating existing lab managers for outside scope work. Division Directors to review all lab shared spaces to identify those labs. Target completion FY17.
5. Request EHS updates on WPC changes. PS DSCs will advocate for these regular system updates.
6. Tutorials need updating to show how the training records are connected to the new WPC, where to put OJT and how it's used. DSCs will request from EHS. PS DSCs will advocate for training updates.
7. PS DSC's will work with EHS to strengthen the co-located hazards tool within WPC. Target FY18.
8. **Onboarding** of new personnel needs a SOP. It should include how to direct request for assistance from mech techs and E-techs. HR and EG Supervisors to develop the onboarding steps.

Integrated Safety Management in Physical Sciences Multi-Division Projects

Attachments:

a. Spreadsheet- ISM Weaknesses in PS Multi-division Incidents
b. Comparison of ISM Weaknesses in PS Multi-division Incidents with LBNL Injuries.
c. Lab-Wide ISM causes
d. Physical Sciences ISM Causes
e. Interview Questionnaire template
f. Current Requirements:
   LBNL ES&H Manual (Pub 3000),
   http://www2.lbl.gov/ehs/pub3000/pub3000c.html
   Chapter 1, General ES&H Requirements, Responsibilities and Work Practices;
   Chapter 6, Work Planning and Control

   LBNL Requirements and Policies Manual, section 07.01.008.000 Matrixed Employee Work Authorization

   ISM plans:
   LBNL Integrated Environment, Safety , and Health Management Plan
   ATAP ISM Plan, particularly Section 2.13 Matrixed Personnel and Shared Spaces
   Engineering Division ISM Plan
   Nuclear Science Division ISM Plan
   Physics Division ISM Plan

   DOE Guide 450.4-1C
   OSHA Recordkeeping Handbook 3245-09R

Appendix B - *FY 17 Assessment Report, Appendices to FY17 Assessment Report, Letter to SURF EHS Director 2017*

Report of Physics Division
Self-Assessment Report on Off-Site Safety at SURF and Kitt Peak

Prepared by: Marty White 6/29/17

Martha White, Physics Safety Coordinator **Date**

Approved by: Natalie Roe 6/29/17

Natalie Roe, Division Director **Date**

Report on Off-Site Safety at SURF and Kitt Peak
June, 2017

Executive Summary

The Self-Assessment for Physics for FY17 was an implementation of the rating system developed in FY16 for off-site facilities with their own safety program where Physics work. Off-site safety has been a concern for Physics for a long time, and LBL has not had a way to address these safety concerns. Physics looked at the LBL requirements last year and developed a rating system and a checklist to help evaluate off-site safety.

For this year, Physics implemented this program by including the discussion of off-site safety in the Physics ISM Plan, and evaluating both Sanford Underground Research Facility (SURF) and Kitt Peak Observatory using the checklist. Both of these facilities were rated at a level 2, which means that Physics feels the safety program at these institutions is essentially equivalent in policy and philosophy to ISM, and Physics will not require a WPC activity for Physics staff to work at either place.

Background

In FY16, the Physics Division Self-Assessment devised a method to categorize safety at off-site institutions with their own safety programs. For FY17, Physics used the rating system to evaluate and document the ratings of two recent collaborators where Physics staff will be spending increasing amounts of time: SURF and Kitt Peak Mayall Observatory where the DESI instrument will operated.

Current Requirements

The Physics ISM Plan includes the report completed last year, and a list of off-site instutions with their own safety programs where Physics staff work. The institutions that could be rated have been rated, mainly DOE Labs and long-time collaborators like CERN. The check list which was developed last year and is included in the ISM plan was used to rate SURF and Kitt Peak this

year. After the SURF check list was completed, Marty White, the Physics Safety Coordinator, Natalie Roe, the Physics Division Director, and Gil Gilchriese, the LZ Program Director determined a consnsus rating for SURF. Using the check list for Kitt Peak, Marty, Natalie and Michael Levi, the DESI Program Director determined a consensus rating for Kitt Peak.

Discussion

The check list, which is included in the Physics ISM plan, does not include questions about every aspect of the safety program. It was developed to assess the philosophy of the safety program and make sure that staff who work at off-site facilities have a way to resolve safety issues which arise there. Since LBL uses Integrated Safety Management (ISM),the division wants to make sure that LBL staff will be able to continue using ISM in their off-site work. If the facility does not use ISM questions are designed to make sure that their safety program has similar elements, including defining the scope of the work, identifying and controlling hazards before work starts, and stop work policy.

SURF was rated first, due in part to the urging of the EHS Director at SURF to complete the assessment. The SURF EHS Director was sent a copy of FY16 report and was very enthusiastic about the process. He completed the check list for SURF and sent it back to LBL (Appendix A). After receipt of the completed check list, the Physics Safety Coordinator and an LBL EHS employee familiar with SURF talked with SURF about their program. Per the Physics ISM Plan, a consensus rating was determined for the facility by the Division Director, Safety Coordinator, and LZ Program Director. SURF was rated at a 2. This means that Physics believes their staff will be safe at the facility without imposing any additional controls. SURF was informed of this rating (Appendix A).

Kitt Peak Observatory was rated next. The process was explained to the Safety Manager at the Mayall Telescope where the DESI instrument will reside, and the checklist was discussed, answering all relevant questions (Appendix B). Per the Physics ISM Plan, a consensus rating was determined for the facility by the Division Director, Safety Coordinator, and DESI Program Director. Before a consensus could be reached, several questions raised by the DESI Program Director about the program needed to be answered:

- **Will DESI workers get an orientation training?** Yes, there will be an orientation training similar to the Docent training. (Appendix B)
- **Can the Program Director see the training records for the DESI workers?** It is not kept online but will be made available to the Program Director for his review on a periodic basis.

- **What training will be required by Kitt Peak for DESI workers?** Anyone who wants to work in the dome should take cryogen safety training and fall protection training for working at height. These courses need to be taken from the home institution as Kitt Peak will not offer them. DESI workers need to send proof of their training to the Safety Manager at Kitt Peak.

Kitt Peak was rated at a 2. This means that Physics believes their staff will be safe at the facility without imposing any additional controls. The Safety Manager has been informed of this rating.

Conclusions

The Self-Assessment for Physics for FY17 was an implementation of the rating system developed in FY16 for off-site facilities with their own safety program where Physics work. Off-site safety has been a concern for Physics for a long time, and LBL has not had a way to address these safety concerns. Physics looked at the LBL requirements last year and developed a rating system and a checklist to help evaluate off-site safety.

For this year, Physics implemented this program by including the discussion of off-site safety in the Physics ISM Plan, and evaluating both SURF and Kitt Peak using the checklist. Both of these facilities were rated at a level 2, which means that Physics feels the safety program at these institutions is essentially equivalent in policy and philosophy to ISM, and Physics will not require a WPC activity for Physics staff to work at either place.

Appendix A - Completed checklist and letter to EHS director for SURF

SURF

Attachment A - Off-Site Safety Assessment Checklist

Collaboration member: **Y/N/NA** **Comments**

Questions:

Is there an explicit ISM program? Y
If no, is scope of work defined before it is started? How?
Are hazards identified? How? daily weekly walkdowns
Are controls established? How? yes
Is PPE provided by the facility? Replaced by the facility? yes & personnel
How is it verified that work is performed within controls? mgt walk downs
Is there feedback & improvement? yes QA program being developed
Is there a stop work policy? Y
How is work authorized? JHC new process per ESH&C 12-16
What are the major hazards at this facility (examples: electrical, oxygen deficiency, working at height, heavy machinery, radiation)?
How is the safety program communicated? ongoing and initial site training
Does the safety program get reviewed? every 6 mos
Are there safety inspections? Y → ES&H & const. mgmt
Are subcontractors protected? What are the requirements? Y
Is there quick access to medical aid? yes - kits, EKT, local med. services (Hosp.)
Is the injury rate calculated? Y
If yes, what is it?
Are leading causes of incidents identified? yes
Are near hits, accidents and dangerous occurrences investigated? (near misses) yes all/cop investigated
Is safety on performance reviews for everyone, including management? yes

For specific hazard situations as needed:

For underground work:
- Are oxygen monitors available? Y
- Is there a communication system with above ground personnel? ye - min 2 teams
- Are there AEDs? Y
- Are workers trained in CPR and First Aid? Y
- Is there an on-site Emergency Rescue Team? Y
- Are there Rescue Boxes with food and water? Y
- Are workers equipped with self-rescuers? Y
- Is worker underground entry & exit monitored? Y
- What PPE is required to access the underground? list

what do you mean?
- sources?
- any work
- can reset breakers

For electrical work:
- Is there a LOTO program? Y
- What is the de minimus level for electrical work?
- Explain controls for electrical work. list policy

For ODH work:
- Are oxygen level calculations done for cryogen work? Y
- Are there oxygen monitors available? Y
- Explain controls for ODH work. list

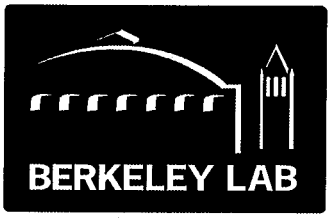
For working at heights:
- Do workers have PPE equipment that keeps them from falling? Y
- Explain controls for working at heights. list

For working with heavy machinery:
- Are crane operators certified? Y — task specific trained
- Is there a work alone prohibition? Y - ?
- Are fork lift operators certified? ye — task specific trained

lift plans

For radioactive material work:
- Is there a rad worker authorization program? Y
- Explain controls for radioactive material work. list

contractors
- circle yes
- fax yes



Lawrence Berkeley National Laboratory

PHYSICS DIVISION

April 11, 2017

Noel Schroeder
Sanford Underground Research Facility
630 East Summit St
Lead, SD 57754

Dear Noel,

Thank you for participating in the recent Physics Division evaluation of the SURF EHS program. I am pleased to inform you that as a result of the evaluation, SURF will be granted a rating of 2, which means that the SURF program is essentially equivalent to the LBNL EHS program in policy and philosophy.

No additional LBNL training or controls will be required for LBNL Physics employees unless required by the collaboration the employee is working under.

Sincerely,

Natalie Roe
Physics Division Director
Lawrence Berkeley National Laboratory

cc. Murdock Gilchriese
Marty White

Ernest Orlando Lawrence Berkeley National Laboratory
One Cyclotron Road | MS 50-4049| Berkeley, California 94720-8153
Tel: 510-486-6380 | FAX: 510-486-6003
Email: naroe@lbl.gov

Appendix B – Completed checklist and Docent training for Kitt Peak

K. P.

Attachment A - Off-Site Safety Assessment Checklist

Collaboration member:	**Y/N/N A**	**Comments**
Questions:		
Is there an explicit ISM program?	NO	
If no, is scope of work defined before it is started? How?		yes - JHA
Are hazards identified? How?		" "
Are controls established? How?		" "
Is PPE provided by the facility? Replaced by the facility?		" yes
How is it verified that work is performed within controls?		observation, discussions
Is there feedback & improvement?		crews review SOPs, JHA
Is there a stop work policy?	yes	
How is work authorized?		supervisor assigns worker
What are the major hazards at this facility (examples: electrical, oxygen deficiency, working at height, heavy machinery, radiation)?		lifts of heavy items, telescopic movement
How is the safety program communicated?		training, safety mtgs
Does the safety program get reviewed?		Fac. Man, Mtn fac. manager, workers + outside reviews
Are there safety inspections?		yes (Tammie - once a week)
Are subcontractors protected? What are the requirements?		
Is there quick access to medical aid?		EMT, 45 min for ambulance
Is the injury rate calculated?	yes	work safety plans ahead of time
If yes, what is it?	0 ~~3~~	last year 15 first aid
Are leading causes of incidents identified?		STF
Are near hits, accidents and dangerous occurrences investigated?		yes
Is safety on performance reviews for everyone, including management?		no, but under discussion

For specific hazard situations as needed:

For underground work:
- Are oxygen monitors available?
- Is there a communication system with above ground personnel?
- Are there AEDs?
- Are workers trained in CPR and First Aid?
- Is there an on-site Emergency Rescue Team?
- Are there Rescue Boxes with food and water?
- Are workers equipped with self-rescuers?
- Is worker underground entry & exit monitored?
- What PPE is required to access the underground?

For electrical work:
- Is there a LOTO program?
- What is the de minimus level for electrical work?
- Explain controls for electrical work.

For ODH work:
- Are oxygen level calculations done for cryogen work?
- Are there oxygen monitors available?
- Explain controls for ODH work.

✓ For working at heights:
- Do workers have PPE equipment that keeps them from falling? yes, training, harnessed, lanyards
- Explain controls for working with heavy machinery:

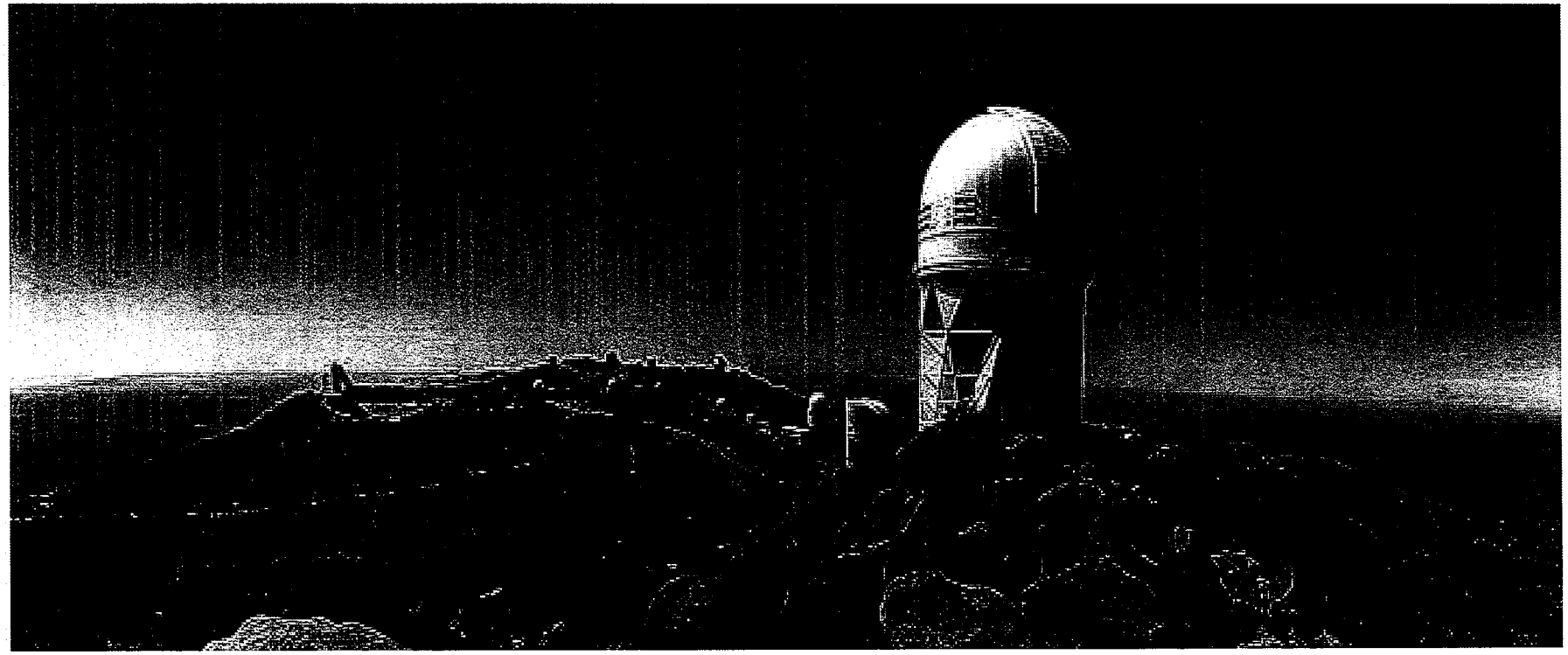
✓ For working with heavy machinery:
- Are crane operators certified? yes, inspected cranes
- Is there a work alone prohibition? yes
- Are fork lift operators certified? yes

none For radioactive material work:
- Is there a rad worker authorization program?
- Explain controls for radioactive material work.

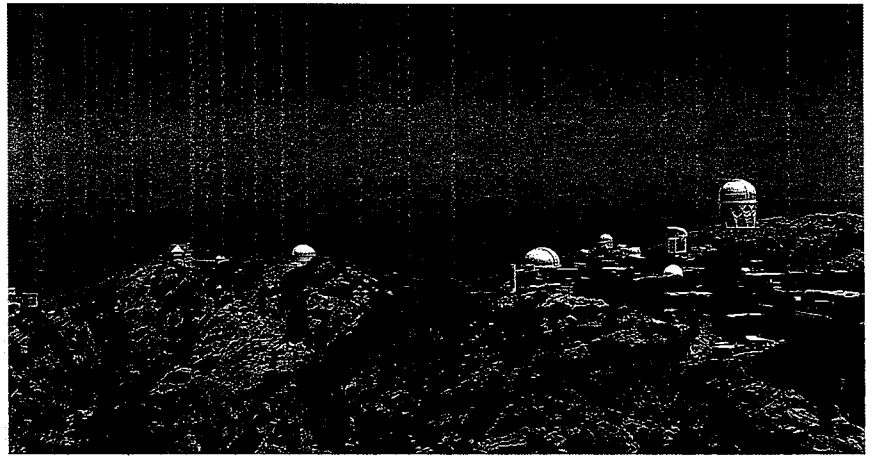
DOCENT
Kitt Peak Emergency Manual & Safety Review

Tammie Lavoie-Safety Mgr. & Amanda Head-EMT

October 23 ,2015



Overview



- Why are we here?
- Review Kitt Peak Emergency Manual
- Required Equipment
- Services provided
- Emergency phone numbers

So, Why are we here?

Does everyone know how to respond to possible emergencies at Kitt Peak?

- Fire – building/wildfire
- Medical – twisted ankle, broken bones, heart attack, bee stings, etc.
- Animal/Reptile bites
- Weather-thunderstorms, blizzards
- Falling Rocks

Visitor Center

- Other concerns or issues:
  - ✓ Walking around in the dark to telescopes
  - ✓Covering running lights on vehicles
  - ✓Walking to/from restrooms
  - ✓Emergency exits, Fire Extinguishers, Evacuation locations
  - ✓Can't contact anyone on the mountain??
  - ✓More Training?? CPR, AED, Fire Extinguisher

General Safety Items

- **<u>Driving Hazards on Kitt Peak</u>**
  - Animals – deer, mountain lion, cattle, bobcat
  - Rocks/gravel in the road
  - Covering of running lights at night
  - No headlights at top of mountain

- **<u>Remember</u> you are responsible for visitor safety too!**

Kitt Peak Emergency Manual

- Available on the NOAO intranet and the Kitt Peak Website
- What it Covers: Emergency Procedures, Fire Procedures, Weather Hazards, Wildlife Encounters , Power Outages and more!
- Step-by- Step directions on what to do and say in an emergency.
- Emergency numbers and Emergency Staff available.

EMERGENCY PHONE NUMBERS

BY Phone – 8777

- Dialing this number rings a sequence of extensions starting at the reception desk until a responsible person can be reached

BY Phone to Radio System – 8721

- After one or two beeps, state the emergency and location. This is a two-way radio phone patch. After you're done Hit the # key to disconnect.

BY Radio – Channel 1 and state your Emergency

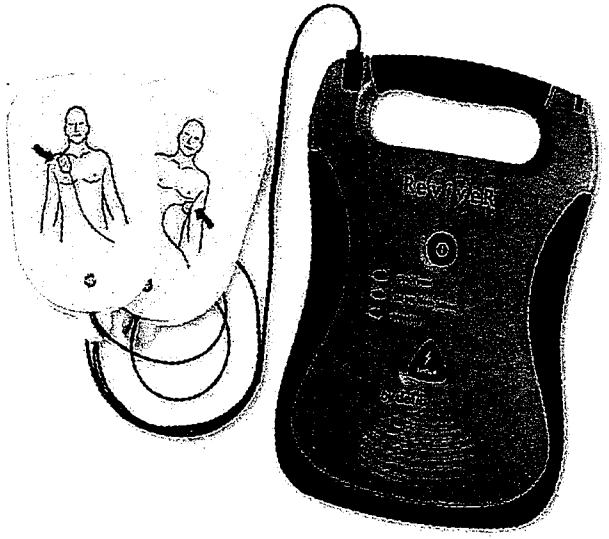
DIAL 9-911 or 911 on any phone at Kitt Peak and follow the Emergency Call Procedures.

What Do I Say?

- I Have an Emergency
- What Type? (Shortness of breath, snake bite, passed out....)
- Your Name and phone number
- The Exact Location of the Emergency
- If Assistance is needed(EMT, Fire Dept., etc.)
- Number of injured People
- Any Hazardous conditions
- Who is at the scene
- Wait for instructions before hanging up!!

AEDs Available

- AEDs located ??
- There are 2:
  - Visitors Center
  - Mountain Ambulance
- Very Simple to Use
- Training Available

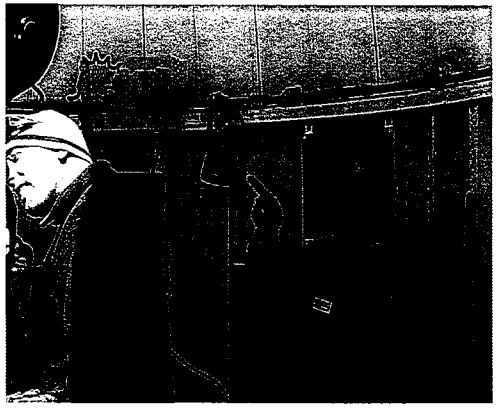


EMERGENCY STAFF

- Kitt Peak has EMT's available every day shift 7/days per week.
- Amanda Head and Stacy Taghon
- At Night, the Observing Technician(s) are able to take the 8777 calls and help assist you.
- Call on Radio for help

Docent Responsibilities

- At All Times have **Radio** and **Flashlight** with you.
- Know the **Emergency Numbers** to Call for Emergency Response
- Know the **Emergency Exits** in the areas you have visitors
- Know the location of **Fire Extinguishers** in your area
- Report **Fires** – Either Structural or Wildfire
- Warn visitors of **Weather Conditions**
- Keep **Control** of group-no wanderers

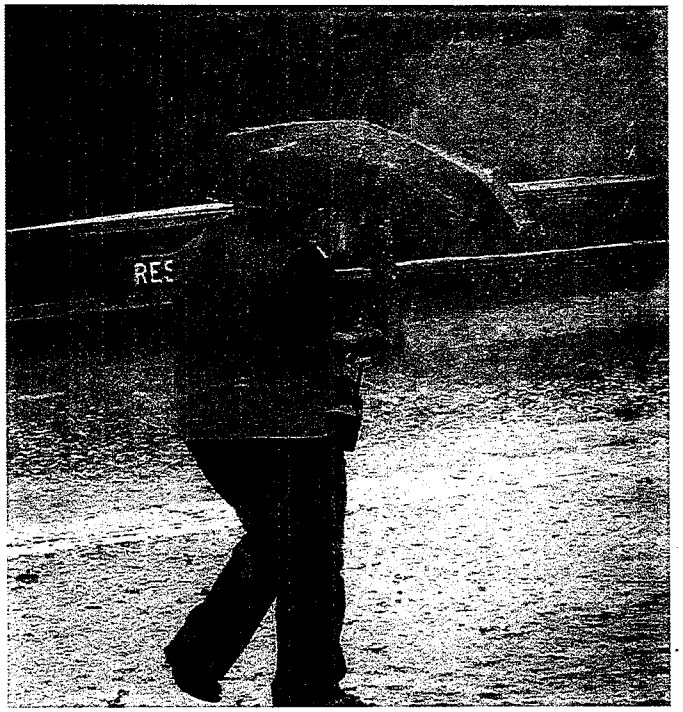


Two-Way RADIOS

- Does everyone have one while at Kitt Peak?
- Are they charged and/or do you have spare batteries?
- Always on Channel 1 to communicate with Kitt Peak
- Push button to talk and then release button to hear response
- Make sure two-way radio in car is turned on while driving up or down the mountain.

Weather Conditions

- Be alert and responsive to thunder and lightening storms
  - http://www.lightningsafety.com/nlsi_pls
- Where do you go?
- What if you get caught outside?
- High Wind precautions
- Heat Stress
- Hypothermia
- Falling Ice from buildings



Wildlife Encounters

*Snakes *Bees

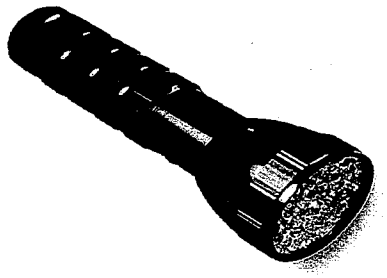
*Bobcats * Javelina

*Mountain Lion *Deer

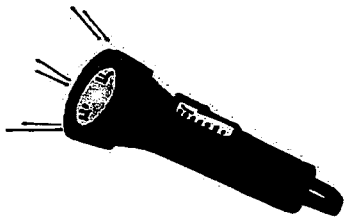
-Do Not Harass, Confront, or Annoy any wildlife you see.

-Do Not attempt to feed them.

Power Failure



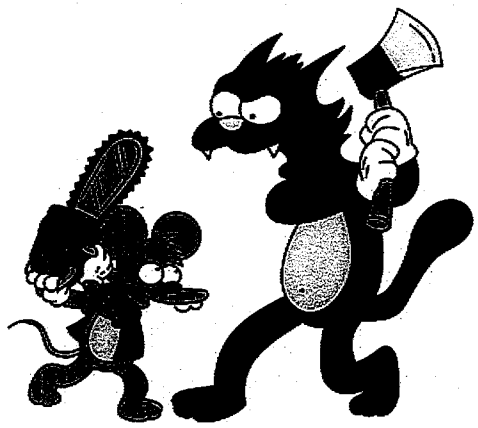
- Have your flashlight with you at all times
- Generator will automatically come on within 30 seconds of power outage
- Elevators – if stops what do you do?
- Find out what caused the power outage to see if an evacuation is necessary.



Violence

- If you find yourself in a situation that a person or property is threatened, DIAL 911 and follow Emergency Call Procedures

- Use Radio to Notify First Response Team of an issue/concern



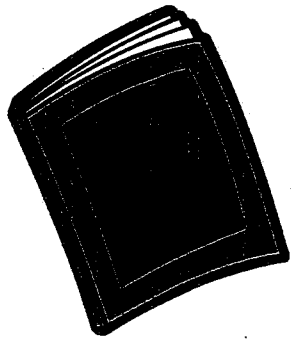
Training Available

- Throughout the year – CPR/First Aid/AED classes will be available.
- Amanda Head will notify when and where classes will be held.
- Please take advantage of these classes

Kitt Peak Emergency Manual (more stuff)

- Many more topics in the manual that you can review.
- Telephone numbers listed in the back of the manual.
- Never hesitate to call for assistance from Kitt Peak staff if you are unsure.
- Feel Free to contact the Safety Manager: Tammie Lavoie – 8211

  tlavoie@noao.edu



Appendix C - *LBNL Subject Matter Expert Assessment Report for LZ-SURF Programs*

LBNL Subject Matter Expert Assessment Report for LZ-SURF Programs

Electrical Safety, Chemical Safety, Cryogen Safety / Oxygen Deficiency Hazard, Pressure Safety and Work Planning and Control

Prepared by:

Scott Robinson, CIH, CSP, FAIHA, H&S Research Support Team Leader	Date 7/11/18
Mark Scott, PE, LBNL Electrical Safety Officer	Date 7/16/18
Evelyn Davies, Ph.D., Chemical Safety Specialist	Date 7/11/18
Alyssa Brand, Cryogens and ODH SME, Laboratory Safety Specialist	Date 7/11/2018
Kurt Ettinger, CSP, Pressure Safety and Compressed Gas SME	Date 7-11-18

Executive Summary:

Lux-Zeplin (LZ), a merger of two dark matter detection experiments, is a collaborative effort involving scientists and subject matter experts (SMEs) across 36 institutions. This project is currently in a phase involving assembly and installation of scientific equipment at the Sanford Underground Research Facility (SURF) in Lead, South Dakota. Lawrence Berkeley National Laboratory (LBNL), as the lead laboratory for the LZ/SURF collaboration, is committed to ensuring excellent performance for all aspects of LZ/SURF Environment Health and Safety (EHS) programs throughout the lifetime of this experiment.

SMEs from the LBNL EHS Division were asked to review select elements of LZ/SURF's safety programs including electrical safety, chemical safety, cryogen safety / oxygen deficiency hazard, pressure safety, and work planning and control. Lock-out-tag-out (LOTO) was not included in the electrical program documents reviewed. Confined space was not reviewed except where it was referenced in ODH policy. The purpose of this review was to:

- Perform a comprehensive assessment of specific SURF/EHS program elements related to LZ work at SURF
- Determine if SURF policies are equivalent to LBNL ES&H requirements
- Determine if training adequately protects researchers from hazards while working at LZ/SURF
- Establish training equivalencies between LBNL and SURF to streamline training for individuals working in both locations

Based on this assessment, several areas were identified that warrant further attention to ensure equivalency with LBNL EHS requirements. At a high level, these areas shared common themes, summarized by:

- Ownership, management, and additional development of written policies/programs
- Training requirements and assurance
- Implementation of work planning and control (WPC)

High priority areas warranting further attention include:

- Updates to existing written programs
- Development of written programs that are not available but may be required to adequately protect workers
- Electrical safety program elements
- Hazardous waste accumulation area practices, training, and management
- Cryogen handling outside of enclosed systems and cryogenic systems policy

Recommendations are included in Sections V and VI.

I. Introduction

LBNL work authorization has two distinct components: (1) the work itself must be planned, reviewed, and authorized before it may proceed, and (2) individual workers must be trained and authorized to perform the work before they can proceed. Formal WPC processes are primarily managed in Activity Manager, in addition to construction job hazard analysis, subcontractor job hazard analysis, among others. All work is authorized by line management. A risk-based approach is taken where high hazard work requires concurrence of the EHS Division in addition to line management. All operations follow an integrated safety management (ISM) process. More details on WPC and ISM principles at LBNL can be referenced in the Environment Safety and Health Manual (PUB-3000) Chapter 6 and the Integrated Environment, Safety, and Health Management Plan PUB-3140.

Due to the unique nature of the LZ/SURF collaboration, policies and procedures are generally tailored to suit specific requirements found in this work environment. SURF also takes a risk-based approach for WPC, while documenting formal reviews and work authorization on either a job hazard analysis (JHA) or standard operating procedure (SOP) template. The latter is designated for tasks that are routinely performed, and may be reused when needed. Line management authorizes work, although roles and responsibilities differ from those at LBNL.

II. Assessment Scope

This review was limited in scope to documents in specific program elements provided to the Review Panel by the LZ Project Safety Officer. These documents included:

Electrical Safety:

- Electrical Safety, Document 73376 V2, revised 3/31/15
- Electrical Safety: Energized Electrical Work Planning Guidance, EHS-7004-L3-01 V1, revised 7/13/10
- Electrical Safety App C: Safe Electrical Working Procedure, EHS-7004-L2-01 V1, revised 7/12/10

- Energized Electrical Work Permit (EEWP), dated 10/15/15

Chemical Safety:

- SURF EHS Waste Management Plan (WMP), EHS-4000-L1-02, Version 1, revised 8/23/10
- LZ Chemical/Waste Management Plan (brief), dated 1/2016
- LZ Chemical Inventory Sheet, last update 6/4/17
- SURF sample standard operating procedure (SOP) #0056, from 10/22/12
- SURF EHS Hazard Communications, EHS-4000-L1-01, Version 1, revised 8/20/10

Cryogen Safety and Oxygen Deficiency Hazard:

- SURF EHS Oxygen Deficiency Hazard, EHS-8000-L1-02, Version 3, revised 12/17/13
- SURF EHS Cryogenic System Review, EHS-8000-L1-01, Version 1, revised 8/4/10
- Oxygen Deficiency and Cryogen Hazards at SURF, slides for presentation by Chuck Lichtenwalner, dated 11/11/2013
- Oxygen Deficiency & Cryogen Hazards at Sanford Lab Module Quiz
- Training Program Cryogen and Oxygen Deficiency Hazards at SURF Course Syllabus
- Training Agenda for Oxygen Deficiency and Cryogen Hazards, dated 3/18/14

Compressed Gases:

- EHS Compressed Gases, EHS-7009-L1-03, Version 1, 8/16/10

Work Planning Control (WPC), Job Hazards Analysis (JHA) and Standard Operating Procedures (SOP):

- SURF Environment, Safety and Health Work Planning and Control, Document-73320, Version 4, last revised 3/9/18
- SURF Formal JHA Guideline, Document-101874, revised 1/20/15
- Job Hazard Analysis Form, JHA # LUX-0017, dated 11/1/16

LBNL policy documents referenced in this analysis are detailed below. SURF also uses a number of online training courses developed by LBNL in their programs.

Relevant LBNL policies:

- Environment Safety and Health Manual (ES&H Manual, PUB-3000), Chapter 20: Waste Management, revised 9/15, Section 20.5, 20.6, and Work Process C; Chapter 45: Chemical Hygiene and Safety Plan, revised 3/18, Work Process X, Y, and Z; Chapter 51: Environmental Releases, revised 3/13; Chapter 56: Spill Prevention, Control, and Countermeasures, revised 4/13, Work Process A
- Environment Health and Safety Waste Management Generator Guidelines (PUB-3092), revised 10/19/2016, Section 1.3 and 1.5
- LBNL Chemical Management System (CMS), chemical inventory database
- ES&H Manual Chapter 29: Safe Handling of Cryogenic Liquids, Work Processes A-E and G- I
- ES&H Manual Chapter 13: Gas Safety
- ES&H Manual Chapter 8: Electrical Safety
- Electrical Safety Manual (ESM), revised January, 2017, Section 3: Hazard Classification System and Section 6.7: Energized Repair Work

- ES&H Manual Chapter 6: Work Planning and Control

Relevant LBNL training courses:

- Chemical Hygiene, EHS-0348
- Cryogen Safety Course, EHS-0170
- Pressure Safety Course, EHS-0171
- Electrical Safety Course, EHS-0260

III. Assessment Results:

Observations from analysis of the listed documents:

- Numerous written programs are overdue for revisions and/or contain outdated policy
- Training in reviewed areas is generally provided as a combination of online courses from LBNL, site-specific SURF courses, and on the job training (OJT), with an emphasis on site-specific work steps
- WPC at SURF uses a combination of JHAs and SOPs to manage high hazard work review and authorization; distinction between these two document formats depends on the frequency of work, with SOPs designated for routine/repetitive work

Note: The terms "Findings" and "Observations/Comments" are used liberally in this document. The term "Finding" may -- but does not necessarily -- connote a deficiency versus a regulatory requirement.

Findings from this review, in order of decreasing priority, by program area follow.

Electrical Safety

Findings:

1) The SURF electrical safety document references NFPA 70E for details, but provides no specifics. Details from this standard may be needed for an effective electrical safety policy document.
2) Electrical Safety: Energized Electrical Work Planning Guidance uses an older hazard classification system, which has since been superseded. LBNL has adopted the hazard classification system from the DOE Electrical Safety Handbook, 2013.
3) Electrical Safety App C: Safe Electrical Working Procedure is a list of basic principles for safe work. Insufficient detail is provided. This document is too generic to provide adequate guidance.
4) LBNL EEWP requires a detailed step-by-step Electrical Safe Work Procedure in accordance with ESM Section 6.8. This incorporates multiple best practices of IEEE 3007.3. The SURF EEWP is not equivalent to LBNL.

Chemical Safety

Findings:

1) SURF WMP has not been maintained by the owner. It contains editing notes, bookmark errors, and typos.

2) SURF WMP states there are no limits on storage time for each satellite accumulation container so long as the container is not full. This is inconsistent with LBNL policies, which limits storage time to 275 days from initial start date. There is also concern that this is not acceptable practice regarding Resource Conservation Recovery Act (RCRA) guidelines.
3) SURF Hazard Communications ("HazCom") needs updating. It does not address the Globally Harmonized System of Classification and Labeling of Chemicals (GHS), which OSHA's HazCom standard has ruled to align with since 2009. The National Fire Protection Association (NFPA) hazard identification is referenced exclusively in the policy, which may present confusion for employees encountering both NFPA and GHS classification.

Observations/Comments:

4) Laboratory Waste Manager (LWM) responsibilities for SURF are not equivalent to those for a Waste Generator Assistant (WGA) at LBNL. At LBNL, a WGA has additional responsibilities that should be considered for application at SURF.
5) SURF may classify some types of waste differently than LBNL due to Federal Regulations vs. California Code of Regulations, for example empty containers or other non-RCRA hazardous waste. This appears acceptable given LZ/SURFs geographical location, but further review is recommended.
6) Spill response is covered in the WMP, however, guidance on spill prevention does not appear to be sufficient.
7) Several waste categories are not consistent with LBNL including aerosol cans, empty containers, and used oil.
8) Chemical inventory does not appear to be tracked by barcode, although manufacturer, location, owner, quantity, and container are specified.

Cryogen and ODH Safety

Findings:

1) LZ/SURF lacks explicit policy on the handling of cryogenic liquids outside of closed systems. Although training covers personal protective equipment and controls for preventing frostbite, thermal burns, asphyxiation, *etc.* there does not appear to be documentation that these policies are in force at LZ/SURF.
2) Cryogenic system review is thorough; however, the specific requirements for cryogenic systems (*i.e.*, pressure relief and materials of construction) do not appear adequately documented or enumerated in the policy.
3) Passive boil-off of cryogenic liquids as an ODH issue is not addressed, nor is the ODH that could result during the first "charging" or cooldown of the system.
4) No guidance on damaged cryogenic liquid cylinders or information on who owns cylinders (LZ/SURF or vendor-supplied)

Observations/Comments:

5) ODH determination used by LZ/SURF is the same method used by LBNL; controls are also equivalent.

6) The cryogenic systems review at LZ/SURF uses a more comprehensive analysis than that used by LBNL, and as such, is believed to be equivalent or superior.
7) Training, which uses LBNL's online cryogen safety training EHS 0170 in addition to site-specific training and other additional information, is believed to be at least equivalent to LBNL training.

Pressure Safety

Findings:

1) There does not appear to be SURF policy similar to LBNL's Pressure Safety Chapter 7, although the Cryogenic System Review policy addresses some aspects of pressure hazards in a "how to review" format.
2) SURF may not have equivalent web-based trainings courses (or live courses) for pressure safety. Workers take LBNL course EHS 0171 "Pressure Safety Awareness for Research", however, LBNL has separated this course into two components. EHS 0171 still covers pressure. It needs to be determined if the new course, EHS 0103 "Working Safety with Compressed Gases", is relevant to LZ/SURF work and should be included in training.

Observations/Comments:

3) SURF Compressed Gas Policy has similar components to LBNL's Gas Chapter 13, although more tailored to SURF-specific gas requirements.

Work Planning & Control, Job Hazards Assessment, and Standard Operating Procedures

Findings:

1) Use of JHA/SOP to manage WPC at LZ/SURF may cause confusion for LBNL workers who use Activity Manager. Training requirements for work authorization on JHAs and SOPs are not clearly defined. Hazards and controls are difficult to track. JHA/SOPs are a process-focused list of steps. While SURF's methods may meet their needs, they are not equivalent Activity Manager used at LBNL.
2) Focus of training is "training to the steps", not an emphasis on training for exposure to a particular hazard (example: electrical safety).
3) Different templates are used for JHA and SOPs, which may present confusion. The SOP template appears less rigorous, which is not the intention based on the WPC policy definition of a Formal Hazard Analysis. Both include a permit/authorization section. The SOP template includes a section for special training or forms, but not all training requirements.
4) Roles and responsibilities for WPC policy may not be adequately defined. Only two roles are defined, supervisor or researcher/worker. Other roles included in LBNL WPC may be applicable.
5) Some definitions in WPC policy are not equivalent to LBNL. Some important definitions are not included. JHA and WPC definitions do not reference training requirements. Control (as in hazard and control) and exposure assessment are not defined.

Observations/Comments:

6) LBNL typically does not consider construction and other subcontractors within the scope of WPC and alternatively uses a Subcontractor Job Hazards Analysis, where SURF includes these work types under JHA/SOP authorization.
7) All hazardous chemicals, cryogen use, electrical work, and waste generation at SURF is fully reviewed with SME and EHS involvement as needed. Change in work scope is reviewed critically, ISM principles are employed, and work authorization includes line management.

IV. General Conclusions

This review identified some equivalencies between LZ/SURF and LBNL policy in the reviewed areas, and there is overlap in training as LBNL courses are used. Areas of concern where LZ/SURF policies and procedures may not be equivalent to LBNL have been noted. The findings summarized above include specific examples where workers may not be adequately protected from hazards such as electrical and cryogens. Recommendations for addressing these findings follow.

V. Recommendations

Electrical Safety

1) Evaluate detail regarding NFPA 70E in the SURF electrical safety document. Some of the key items missing include: practical certification test for Qualified Electrical Workers (annual), how to perform hazard analysis (shock and arc flash) with demonstration of absence of voltage verification (ZVV), ZVV requirements, requirements for electrical PPE and tools, specific requirements for capacitors, inductors, UPS systems, *etc.*, alerting techniques, lookalike equipment, and breaker rackout requirements.
2) Update document EHS-7004-L3-01 V1 using the DOE Electrical Safety Handbook 2013 hazard classification system.
3) Improve level of detail and guidance provided in document EHS-7004-L2-01 V1. The document should focus on specific procedures that are relevant to the work.
4) Provide a detailed step-by-step Electrical Safe Work Procedure in the EEWP document. LBNL ESM Section 6.8, which incorporates multiple best practices of IEEE 3007.3, may provide guidance.

Chemical Safety

5) Designate owner(s) to update and maintain SURF WMP and HazCom policies.
6) Determine if current SAA labeling practice is acceptable. It is advised that the date be added to a hazardous waste label when first waste is added, and policy should be revised accordingly. Waste should not be stored longer than permitted based on generator status, regardless of how full the container is.
7) Incorporate GHS into SURF HazCom policy and training. NFPA hazard identification is acceptable for labeling as long as all workers in the area understand the notation.
8) Assure chemical inventory tracking methods are sufficient to meet the needs of LZ/SURF. Particular attention should be paid to instances of multiple containers in one location, ability to locate a chemical, and unambiguous removal of consumed materials from the hazardous material inventory.
9) Confirm that workers have ready access to Safety Data Sheets and understand the content.

Cryogen/ODH Safety

10) Develop and incorporate LZ/SURF policy on the handling of cryogenic liquids outside of closed systems.
11) Evaluate policy pertaining to specific requirements for cryogenic systems. For example, ensure pressure relief on all isolatable parts of the cryogen system and ensure pressure relief on evacuated insulation areas.
12) Evaluate ODH for passive boil-off of cryogenic liquids and during the first "charging" of the system and include these scenarios as part of routine ODH assessment.
13) Incorporate guidance on damaged cryogenic liquid cylinders into SURF Cryogen Policy.
14) Define in policy who is responsible for ownership, maintenance, *etc.*, of cryogenic cylinders at LZ/SURF.

Pressure Safety

15) Evaluate LBNL's Pressure Safety Chapter 7 and determine if additional pressure hazard policy is relevant to LZ/SURF.
16) Determine if LBNLs EHS 0103 and/or EHS 0171 are relevant to LZ/SURF work with compressed gas and pressure safety. Include with training as needed.

Work Planning & Control, Job Hazards Assessment, and Standard Operating Procedures

17) Include section to define all training requirements on WPC forms. Improve focus of training for specific hazards, rather than training to specific steps, to ensure workers have adequate knowledge to perform a task safely.
18) Consider revising JHA and SOP designation to avoid confusion. Both are essentially equivalent and distinction unnecessary.
19) Evaluate templates used for JHA and SOP and update as necessary to ensure the goals of WPC are met. Training requirements and work authorization should be clear. Consider using one template for both, and referring to all activities under one classification, *i.e.* JHA.
20) Evaluate roles and responsibilities of all parties involved in WPC. Supervisor may not be an adequate category. Consider who can add workers to a JHA, who can authorize work, *etc.* LBNL roles and responsibilities for Activity Lead and Activity Lead Designee may be relevant.
21) Include statement referencing training requirements for JHA and WPC definitions. Define control. Define exposure assessment and provide guidelines for when they are needed. Refer to LBNL ES&H Manual Chapter 6 for guidance.

VI. Other Recommendations

1) Include additional LWM responsibilities equivalent to a WGA at LBNL.
2) Define empty container policy in the WMP.
3) Provide better guidance on spill prevention in the WMP. In particular, explicitly state the requirement of secondary containment for all liquids, use of drain covers, *etc.*
4) Critically evaluate other implications of Federal Regulation guidelines on policy.

VII. Additional Recommended Training Courses

- EHS 0103, if relevant