

# Validation Appendices

for the  
Independent Oversight  
Inspection of Environment,  
Safety, and Health Programs at the



# Lawrence Berkeley National Laboratory

**April 2009**

---

Office of Environment, Safety and Health Evaluations  
Office of Independent Oversight  
Office of Health, Safety and Security  
Office of the Secretary of Energy





**VALIDATION APPENDICES  
FOR THE  
  
INDEPENDENT OVERSIGHT  
INSPECTION OF ENVIRONMENT,  
SAFETY, AND HEALTH PROGRAMS  
AT THE  
LAWRENCE BERKELEY  
NATIONAL LABORATORY**

**March 2009**

This page intentionally left blank.

**VALIDATION APPENDICES  
FOR THE  
INDEPENDENT OVERSIGHT  
INSPECTION OF ENVIRONMENT,  
SAFETY, AND HEALTH PROGRAMS  
AT THE  
LAWRENCE BERKELEY  
NATIONAL LABORATORY**

**Table of Contents**

Acronyms .....	iii
Foreword .....	v
Appendix C: Work Planning and Control .....	1
C.1 Introduction.....	1
C.2 Results.....	1
C.2.1 Advanced Light Source .....	6
C.2.2 Physical Biosciences Division.....	11
C.2.3 Chemical Sciences Division .....	18
C.2.4 Life Sciences Division.....	23
C.2.5 Maintenance and Fabrication.....	26
C.2.6 Construction .....	32
C.3 Opportunities for Improvement .....	36
Appendix D: Core Function #5 –Feedback and Continuous Improvement .....	44
D.1 Introduction .....	44
D.2 Results .....	44
D.2.1 Berkeley Site Office .....	44
D.2.2 Lawrence Berkeley National Laboratory Feedback and Improvement Systems.....	49
D.3 Opportunities for Improvement .....	62
Appendix E: Management of Selected Focus Areas .....	68
E.1 Introduction.....	68
E.2 Results .....	68
E.2.1 Chemical Management .....	68
E.2.2 Hazardous Waste Management .....	72
E.2.3 Worker Rights and Responsibilities .....	75
E.2.4 Occupational Injury and Illness Recording and Reporting .....	75
E.3 Opportunities for Improvement .....	77

This page intentionally left blank.

## Acronyms

AHD	Activity Hazard Document
AIHA	American Industrial Hygiene Association
ALS	Advanced Light Source
ANSI	American National Standards Institute
BSO	Berkeley Site Office
BUA	Biological Use Authorization
BUN	Biological Use Notification
CAIRS	Computerized Accident/Incident Reporting System
CAP	Corrective Action Plan
CAS	Contractor Assurance System
CATS	Corrective Action Tracking System
CFR	Code of Federal Regulations
CHSP	Chemical Hygiene and Safety Plan
CMS	Chemical Management System
CSD	LBNL Chemical Sciences Division
DOE	U.S. Department of Energy
DPO	Differing Professional Opinion
ECP	Employee Concerns Program
EH&S	LBNL Environment, Health, and Safety
ES&H	Environment, Safety, and Health
FEOSH	Federal Employee Occupational Safety and Health
FY	Fiscal Year
GERT	General Employee Radiological Training
HEPA	High Efficiency Particulate Air
HERL	Heavy Element Research Laboratory
HGV	Hazard Guide Value
HSS	DOE Office of Health, Safety and Security
HVAC	Heating, Ventilation, and Air Conditioning
HWHF	Hazardous Waste Handling Facility
ISC	Integrated Support Center
IH	Industrial Hygiene
ISM	Integrated Safety Management
ISMS	Integrated Safety Management System
JBEI	Joint BioEnergy Institute
JHA	Job Hazard Analysis
LAS	Low Activity Source
LBNL	Lawrence Berkeley National Laboratory
LSD	LBNL Life Sciences Division
MESH	Management of Environment, Safety, and Health
MSDS	Material Safety Data Sheet
NFPA	National Fire Protection Association
OHM	Occupational Health Medical
OHIR PM	Occupational Injury and Illness Process Manager
ORPS	Occurrence Reporting and Processing System
OSHA	Occupational Safety and Health Administration
PAAA	Price-Anderson Amendments Act
PBD	LBNL Physical Biosciences Division
PEMP	Performance Evaluation Measurement Plan
PPE	Personal Protective Equipment

QA	Quality Assurance
R&D	Research and Development
RIIO	Research and Institutional Integrity Office
RMA	Radiological Material Area
RPM	Regulations and Procedures Manual
RSA	Radiological Storage Area
RWA	Radiological Work Authorization
SAA	Satellite Accumulation Area
SAAR	Supervisor's Accident Analysis Report
SC	Office of Science
SCMS	Office of Science Management System
SME	Subject Matter Expert
SRC	Safety Review Committee
SWAMP	Shutdown Work and Maintenance Plan
TAP	Technical Assurance Program
TIG	Tungsten Inert Gas
TLV	Threshold Limit Value
TQP	Technical Qualification Program
TRC	Total Recordable Case
UC	University of California
UV	Ultraviolet
WAA	Waste Accumulation Area
WSHP	Worker Safety and Health Program



## **FOREWORD**

This validation appendix is provided to the Office of Science (SC), Berkeley Site Office (BSO), and Lawrence Berkeley National Laboratory (LBNL) site contractor – the University of California – to provide additional technical details regarding the January through February 2009 Independent Oversight inspection of the environment, safety, and health programs at LBNL by the U.S. Department of Energy (DOE) Office of Health, Safety and Security's Office of Enforcement and Oversight.

Three technical appendices (C through E) contain detailed results developed during the Independent Oversight inspection. Appendix C provides the results of the review of the application of the core functions of integrated safety management (ISM) for work activities. Appendix D presents the results of the review of DOE (SC and BSO) and LBNL feedback and continuous improvement processes and management systems. Appendix E presents the results of the review of safety management of the selected focus areas (i.e., chemical management, waste management, communication of worker rights, and injury and illness reporting). For each of these areas, the Independent Oversight team identified opportunities for improvement for consideration by SC, BSO, and LBNL. The opportunities for improvement are listed at the end of each appendix so they can be considered in the context of the status of the areas reviewed.

SC, BSO, and LBNL need to address the individual deficiencies and specific examples contained in these appendices in their corrective action plan for the findings identified in Appendix B of the inspection report. The individual deficiencies and specific examples in these appendices are referenced to the specific findings in Appendix B. The causal analyses, corrective actions, and recurrence controls developed in response to the findings in Appendix B need to fully consider the specific deficiencies and specific examples in these appendices.

This page intentionally left blank.

# **APPENDIX C**

## **Work Planning and Control**

### **C.1 INTRODUCTION**

The U.S. Department of Energy (DOE) Office of Independent Oversight evaluated work planning and control processes and implementation of the core functions of integrated safety management (ISM) at the Lawrence Berkeley National Laboratory (LBNL).

The Independent Oversight review of the ISM core functions focused on environment, safety, and health (ES&H) programs and work planning and control systems as applied to various LBNL organizations, including:

- Advanced Light Source (See Section C.2.1.)
- Physical Biosciences Division (See Section C.2.2.)
- Chemical Sciences Division (See Section C.2.3.)
- Life Sciences Division (See Section C.2.4.)
- Maintenance and Fabrication, performed by the Facilities Division and Engineering Division (See Section C.2.5.)
- Construction, managed by the Facilities Division (See Section C.2.6.)

Independent Oversight reviewed implementation of the core functions of ISM, observed ongoing operations, toured work areas, observed equipment operations, conducted technical discussions and interviews with managers and technical staff, reviewed interfaces with ES&H staff, and reviewed ES&H documentation (e.g., plant standards, permits, safety analyses). Work activities that were observed at LBNL included various research and development (R&D) experiments, laboratory operations, facility operations, maintenance work, machine shop operations, construction, maintenance, chemical management, and waste/environmental management activities. Based on the review of the six organizations, Independent Oversight also evaluated selected aspects of institutional programs.

### **C.2 RESULTS**

This 2009 Independent Oversight inspection determined that LBNL has made significant progress in improving its ISM program in the past two years. The improvement is a result of initiatives driven by BSO and LBNL senior management, which recognized that safety at LBNL relied too much on the expertise and diligence of individuals and that a significant effort was needed to improve the rigor and formality of the LBNL ISM program. As a result, BSO and LBNL management directed a number of actions to achieve the needed improvements. Specifically, LBNL senior management directed the development of a number of major improvement initiatives, including major efforts to develop and implement a job hazard analysis and work authorization process across the site, a program to reduce chemical hazards, an initiative to strengthen management of construction subcontractors, and efforts to improve the contractor assurance system (CAS). They also continued to focus on a systematic program to reduce ergonomic injuries. BSO has supported the LBNL initiatives and has taken proactive actions to enhance its oversight processes and to provide contractual incentives to LBNL to make the needed

improvements. Further, lower tiers of management, scientific staff, and workers demonstrated their support for safety and the value of making further improvements in safety management processes, indicating that BSO and LBNL senior management have had considerable success in communicating their expectations for effective safety management processes and continuous improvement in ES&H programs.

Notwithstanding the notable recent progress, many of the initiatives are in their early stages of implementation and much work remains to further improve the new processes. In addition to evaluating the selected six LBNL organizations/activities cited above, Independent Oversight also evaluated the collective results of the application of the core functions in these organizations to identify commonalities. As discussed below, the evaluation of the collective results provides perspectives on the site-wide ISM program and identified institutional findings in four areas (in addition to a chemical management institutional finding, discussed in Appendix E): (1) the LBNL hazard analysis process, (2) the exposure assessment program, (3) the radiation protection program, and (4) flow down of requirements. The institutional weaknesses in these areas can impact some or all organizations, facilities, and activities at LBNL and thus warrant management attention and corrective action at the institutional level.

**LBNL job hazard analysis (JHA) process.** The design and implementation of the LBNL JHA process does not sufficiently ensure that all hazards at the activity level are systematically identified, analyzed, and controlled. Although individual divisions have expended significant effort in developing and implementing the JHA process over the last year, process implementation has not been sufficiently effective in addressing an integrated hazard assessment at the job activity level. Most efforts to date have focused on putting JHAs in place, but JHA effectiveness has been limited because guidance on minimum content with respect to task-level work activities was not sufficient and the quality of new JHAs was not adequately monitored and reviewed. Further, individual divisions are moving forward with solutions that may or may not be compatible with the intent of the institutional process, in large part because few criteria or milestones related to quality of the JHAs have been established, and no system for real-time assistance or quality feedback has been implemented. Consequently, participants received minimal real-time feedback on the quality of their efforts. For example, expectations for tailoring task lists to definable work scopes were not well defined or communicated. In addition, the JHA template at the task level provides hazard-based tasks that, without tailoring to specific jobs, do not adequately convey specific job tasks. For example, the database generates generic tasks such as working with cryogenics or working with chemicals, which does not address activity level tasks such as operation of a specific liquid nitrogen system or synthesizing particular chemicals. In most JHAs that were reviewed, the task lists contained the generic task directly from the JHA template and did not provide such tailoring; consequently, the work was not sufficiently defined to be able to meet the 10 CFR 851 requirements to implement procedures that “perform routine job activity level hazard analyses.” As discussed in the subsections below, the weaknesses in the institutional program contributed to deficiencies in application of the ISM core functions in all six of the organizations/activities reviewed by Independent Oversight during this inspection. (See Finding #C-1.)

**Exposure assessment program.** The LBNL institutional non-radiological exposure assessment process is not sufficiently defined or implemented, and is described by LBNL as a “work in progress.” Significant work remains in the development of exposure assessment procedures and protocols, and in conducting qualitative and quantitative exposure assessments to meet the requirements of the LBNL Worker Safety and Health Plan. The LBNL exposure assessment program for assessing worker exposures to non-radiological workplace hazards (i.e., chemical, physical, biological, and ergonomic) is defined in PUB-3000, Chapter 32, Appendix E, of *Exposure Assessment*, and the *Medical Section* of the LBNL Chemical Hygiene and Safety Plan. The description of the exposure assessment program in Chapter 32 was updated in January 2009 to provide greater guidance to LBNL staff regarding when to initiate an exposure assessment, addressing low-risk exposures, and how to distinguish between a qualitative and quantitative exposure assessment. However, the program document lacks substance in a

number of areas such as clarifying the distinction between an exposure assessment and a hazard assessment, and establishing thresholds for initiating and conducting hazard and/or exposure assessments for exposures to hazards other than chemicals (e.g., noise, ergonomics, pressures, non-ionizing radiation, biohazards, etc.). In some instances, Appendix E of Chapter 32 is also misleading with respect to exposure assessments for chemicals. For example, if a “particularly hazardous substance” is used within a chemical fume hood, Appendix E of Chapter 32 infers that an exposure assessment may not be needed. However, for some of the “particularly hazardous substances” in use within some divisions, the primary exposure pathway is through the skin and not the respiratory tract. In the use of these chemicals, even within a chemical fume hood, worker exposure potential is not lessened. In addition, the LBNL exposure assessment process does not explain how the worker exposure assessment requirements of 10 CFR 851 and Section 7.2 *Worker Exposure Assessment* of the LBNL *Worker Safety and Health Program (WSHP)* are to be implemented. For example, 10 CFR 851, Appendix A.6.(a) requires that the contractor conduct “initial baseline surveys and periodic resurveys and/or exposure monitoring as appropriate of all work areas or operations to identify and evaluate potential health risks.” The current Chapter 32 does not address these requirements, and in each of the LBNL Divisions Independent Oversight observed examples in which these baselines and/or periodic resurveys had not been performed (see following sections of Appendix C for details). In addition, Section 7.3 of the WSHP requires that “assessments for chemical, physical, biological, and safety workplace hazards are documented following recognized exposure assessment and testing methodologies,” but the recognized exposure assessment methodologies are not identified nor explained. The LBNL Industrial Hygiene Group is in the process of developing an exposure assessment program guide that supplements the requirements provided in Chapter 32, and a working draft of this guide was provided to the Independent Oversight team. However, many challenges remain in completing the development of the exposure assessment process and in “conducting baseline assessments for representative LBNL workers” as noted in the draft LBNL document. A deficiency in the exposure assessment program was recognized by LBNL in mid-2008, and a corrective action was entered into the Corrective Action Tracking System (CATS). However, the deficiency documented in CATS stems from the 2008 Independent Oversight Nanomaterial Review, and is too limited in scope to address the programmatic deficiencies with the exposure assessment procedures and in implementing those procedures on a lab-wide basis(i.e., it addresses only the need for additional IH resources to conduct hazard evaluations stemming from the JHA process with respect to chemicals). (See Finding #C-2.)

**Radiation protection program.** A variety of work control deficiencies were observed in the Chemical Sciences Division and the Physical Biosciences Division that illustrate weaknesses in institutional radiation protection programs and procedures. Walkthroughs, work observations, and document reviews identified problems with radiological work authorizations, contamination control methods, radiological postings and boundary control, technical basis documentation, and training. While LBNL has several health physics program plans and implementing procedures, the content and technical basis is insufficient in many areas to ensure adequate radiological safety. The areas of concern have resulted largely from inadequate specification and flow down of radiation protection requirements from the institutional level, as discussed below and in sections C.2.1 through C.2.6. (See Finding #C-3.)

First, radiological work authorizations (RWAs) are intended to specify radiological control measures needed for adequate radiological safety at the task level. However, the procedure governing development of RWAs does not provide adequate expectations to ensure their quality, such as minimum radiological control content that must be specified in each RWA (e.g., expected radiological conditions, suspension limits, personnel frisking requirements such as the need to frisk hands, feet, arms and torso when leaving the work area of a potentially contaminated hood, etc.). As a result, RWAs governing work observed in the field lacked adequate radiological control measures, resulting in the deficiencies discussed elsewhere in this Report. (See Finding #C-3.)

There are also institutional weaknesses in methods for analyzing airborne radiation hazards and in assigning hazard levels and associated control requirements to RWAs. Specifically, the Radiation Protection Group lacks sufficient technical bases to guide radiological air monitoring, to justify hazard classes assigned to RWAs using calculated hazard guide values, and to justify criteria allowing use of low activity source (LAS) authorizations. First, the existing LBNL air-monitoring procedure is written to implement air monitoring requirements of 10 CFR 835, but does not contain sufficiently detailed instruction or bases on essential elements of an air monitoring program that are needed to establish appropriate monitoring requirements at facility and job activity levels. This includes expectations for determining use, type, selection, placement, and operation of air monitoring and sampling equipment across LBNL facilities that have potential for airborne exposures. LBNL also lacks a documented technical basis for its hazard guide value (HGV) calculations (calculated numerical values associated with radionuclide quantities), which are used as a basis for assigning one of three hazard categories to RWAs to govern the resulting hierarchy of required controls. The source and justification for the current method of calculation and associated basis for specified controls is not documented and may result in insufficient controls. Lastly, radiological hazard analyses associated with LAS authorizations and associated institutional control requirements were not sufficient to ensure adequate radiological safety and training requirements for personnel. Specific examples of concerns in this area are presented in following subsections. (See Finding #C-3.)

In the area of radiological contamination control, requirements and practices at LBNL did not have sufficient rigor and definition to ensure early detection of contamination and appropriate radiological posting to prevent the inadvertent spread of contamination to clean areas. Specifically, current institutional survey and posting requirements do not ensure that all areas used for dispersible radioactive materials work are routinely evaluated against 10 CFR 835 contamination levels and/or are properly posted based on actual or potential contamination levels. The existing procedure for posting is not internally consistent with regard to the need to post localized areas used for radioactive materials work such as hoods, bench tops, and glove boxes. In addition, the definitions for areas that must be posted in the existing procedure conflict with definitions provided in 10 CFR 835. For work in such areas, neither the radiological survey nor radiological work authorization procedures ensure the performance of documented radiological surveys by the Radiation Protection Group or users following dispersible radioactive material work to verify control measures and demonstrate that contamination has not been inadvertently spread to clean areas, as required by 10 CFR 835. (See Finding #C-3.)

Lastly, in the area of radiological training, training materials and requirements at LBNL are not sufficiently designed or implemented to ensure all radiation workers are adequately trained and qualified in a manner consistent with DOE requirements. For example, most laboratory radiological workers receive appropriate theoretical training; however, workers who handle dispersible radioactive materials are not subject to sufficient practical factors demonstrations and examination in the areas of contamination control techniques or response to abnormal radiological events as needed to demonstrate proficiency and compliance with 10 CFR 835 for unescorted work in radiological areas. Existing practical factors for these workers is limited to use of radiological survey equipment provided in the laboratories. In addition, some categories of workers at LBNL, specifically those who work only under an LAS authorization, are only required to take LBNL general employee radiological training (GERT). GERT is intended to provide awareness training for workers who may enter controlled areas at LBNL. However, these workers are being permitted to handle and process dispersible radioactive materials of sufficient quantity to present contamination concerns and create regulatory contamination areas. As such, these individuals qualify as radiological workers under 10 CFR 835 and therefore must be trained as radiation workers, including performance demonstrations as required by 10 CFR 835. (See Finding #C-3.)

**Requirements flow down.** A variety of LBNL documents detail and flow down the requirements for implementing integrated safety management and for performing work safely and in compliance with regulations and DOE contract requirements. These documents include the Regulations and Procedures Manual (RPM), the University of California (UC) Assurance Plan (PUB-5520), the Operating and Quality Management Plan (PUB-3111), the Integrated Environment, Health, and Safety Management (EH&S) Plan (PUB-3140) and other implementing plans, manuals, and other documents. The Integrated EH&S Plan contains a description of the processes for managing changes to requirements. However, requirements management process and procedural deficiencies and weaknesses pose challenges to successful implementation of ISM at LBNL.

Weaknesses in LBNL flow down of requirements include processes and procedures that do not always distinguish between requirements and guidance, redundant and conflicting institutional documents, documents for which the authority is not well defined, and some confusing and inconsistent format in instructions to workers. Many EH&S manual chapters do not sufficiently detail roles and responsibilities or requirements. For example, the institutional requirements for ground and concrete surface penetration are contained in a Facilities Division document rather than an institutional document such as the EH&S manual, although such work can be performed by personnel and subcontractors outside of the Facilities Division, and some aspects of the requirements in this document are incomplete or inconsistent (e.g., electrical safety requirements for wall penetrations). The Health Services Department in EH&S has issued an internal document (formally approved internally and numbered/dated) that promulgates an institutional policy on the placement and use of first aid kits and prompt/self-treatment of injuries, rather than publishing these requirements as part of an institutional document. There is no formal institutional procedure detailing the requirements for reporting occupational injury and illness information to the DOE Computerized Accident /Incident Reporting System (CAIRS) database. As described Appendices D and E, there are no formal institutional procedures detailing the requirements for the conduct of the management of ES&H assessments by the Safety Review Committee or for reporting of occupational injury and illness information to CAIRS. The Independent Oversight team identified several instances in which redundant document types detail institutional processes and requirements, sometimes with conflicting information. As discussed in Appendix D, the lessons learned program processes and requirements are detailed in both a program manual and an EH&S manual chapter and four different documents detail processes and requirements for occurrence reporting, including two sections of the EH&S manual. In addition, as discussed in Appendix D, the institutional authority, organizational ownership, and location of Core Function 5 documents and several functional areas are not communicated appropriately. None of the cited institutional assurance documents (i.e., manuals containing implementing procedures) are reflected on the RPM or ISM plan flowcharts of ISM documents. (See Finding #C-4.)

The EH&S manual lacks sufficient detail regarding requirements and guidance for many other functional areas. For example, Chapter 17 of the manual states that LBNL has a policy that “states that those individuals without a prior medical clearance **should** not lift loads that weigh more than 50 pounds” (emphasis added). The JHA tool question regarding lifting results in a requirement for lifting training at a threshold of 20 lbs, but nothing related to training requirements is in the EH&S manual. The EH&S manual does not specify requirements for pre-use damage inspection of slings and other rigging gear and provides only a “typical” crane pre-use inspection tag rather than a specific listing of inspection criteria. The manual chapter on powered industrial trucks specifies that they must be routinely maintained by LBNL’s maintenance contractor, but does not specify any details as to scope, frequency, or documentation. The EH&S manual section on lead exposure consists of two sentences identifying the work at LBNL in which there is the potential for exposure to lead and a reference and link to the Lead Program description document. This program document inappropriately uses the term “should” repeatedly in addressing expectations for topics such as surface contamination surveys and limits, EH&S review of lead abatement work, housekeeping and decontamination, use of construction material

containing lead, and training requirements. As discussed above, requirements regarding the radiation protection program, exposure monitoring, and ventilation hoods are not adequately detailed. (See Finding #C-4.)

Some of the requirements management deficiencies are attributed to the fact that LBNL has not adequately established a defined and structured hierarchy of documents (e.g., policies, plans, procedures, instructions, and manuals), an associated identification/number scheme, and configuration control mechanisms for effectively communicating management expectations and requirements. Various aspects of an effective requirements management system and document hierarchy have not been established. LBNL has not sufficiently detailed safety and ISM requirements in implementing documents that effectively communicate management expectations and DOE and regulatory requirements down to the task level. LBNL has not established published definitions for the content and purpose for various document types published at LBNL that specify safety requirements (i.e., PUB, ES&H implementation plans, program manuals, "Admin"). Requirements for creating (e.g., format and content), reviewing, and approving institutional requirements documents and for change management have not been adequately established. The Operating and Quality Management Plan specifies basic content requirements for formal procedures used to accomplish LBNL organization operational objectives but there are no implementing instructions. LBNL requirements documents contain numerous inconsistencies and internal conflicts including documents that are referenced but do not exist or that are not issued as requirements documents. (See Finding #C-4.)

Deficiencies in the ISM documentation were identified in a 2006 LBNL ISM evaluation that identified that "institutional command media are not clear regarding the hierarchy and relationship between documents" and recommended clarification of the hierarchy of institutional documents (specific examples included the RPM, PUB-3000, quality assurance (QA) plan, and contractor assurance plans). However, the corrective action for this issue, to "restructure and refine institutional EHS/ISMS documents," specified in the corrective action plan and cited in the current ISM Improvement Project plan as complete was insufficiently detailed and did not address the deficiencies cited in the evaluation. (See Finding #D-2.)

### **C.2.1 Advanced Light Source**

The Advanced Light Source (ALS) user facility generates synchrotron radiation, which is a name given to x-rays or light (photons) produced by electrons circulating in a storage ring at nearly the speed of light. These extremely bright x-rays can be used to investigate various forms of matter ranging from objects of subatomic size to man-made materials with unusual properties. The ALS facility is comprised of the injector complex (consisting of a linear accelerator and a booster synchrotron), an electron storage ring, photon beam lines from insertion-device and bend-magnet sources, and associated experimental facilities. In addition, the facility has several areas such as machine shops, laser development areas, and chemical laboratories. LBNL's ALS Division operates the ALS facility.

The Independent Oversight team observed several work activities performed by the ALS Division including outage work, accelerator operations activities, experimental activities at the beam lines, chemical laboratory work, and machine shop work. Observed outage work activities included installation of new components for an operational upgrade, safety system interlock tests, installation of storage ring tunnel cover blocks, laser alignment of new beam line components, and power supply maintenance. Operations activities observed included equipment checks and search and sweep of areas prior to operation, normal control room activities, and beam line disabling and enabling. Experimental activities observed included sample preparation, operation of beam line end stations, and laser hutch activities. Other work activities included laboratory chemical cabinet clean-out and machine shop parts fabrication. Associated hazards and hazardous materials included high voltage, lasers, hazardous chemicals,



asphyxiant gases, cryogenics, forklift operations, and other industrial hazards such as activities at elevated heights requiring fall protection. In addition to work activities, the Independent Oversight team reviewed the ALS facility experiment review process, including implementation of the experiment safety sheet process; walked down chemical laboratories, shops, material storage areas, and waste storage areas; and observed ALS user training.

### ***Core Function 1: Define the Work***

ALS work activities were generally well defined and appropriately scheduled. Long-term schedules for accelerator operations were detailed, up to date, and readily available to facility staff and users. Schedules for outage work were effective in ensuring appropriate coordination of planning activities. For example, the one-day Shutdown Work and Maintenance plan (SWAMP) was well developed and broken out into reasonable tasks. Each of those tasks was addressed as a separate item on the SWAMP such that appropriate hazard identification and analysis could be made on a task-specific basis.

The scopes of work for equipment maintenance or experimental setup in areas requiring access to beam lines or radiological interlock protected areas are generally defined in approved work documents (such as work permits and procedures) containing a description of the work sufficient to identify the most significant hazards. For example, configuration control requirements for protection systems generally require specific scope of work descriptions in work documents such as the ALS facility Beam Line Shielding Change Form.

The scopes of work for experimental activities are extensively defined. Experiment proposals are required for staff scientists as well as visiting researchers (users). The proposals adequately describe the experiments, and materials and the overall experimental approach in sufficient detail to permit effective hazard identification and analysis. The proposal review process requires experiment proposals to include potentially hazardous materials, processes, and equipment, thereby providing advance notice of potential hazards. The experiment safety sheets provide a more succinct, user-friendly scope of work to ensure users operate under the limitations of the allowed scope of work. For certain high hazard activities such as laser operations, the activity hazard document (AHD) adequately describes the scope of work. For example, an AHD for a class 4 laser setup at a reviewed beam line described the layout and intended functions and actions of the laser in sufficient detail to enable effective hazard assessment.

ALS uses a facility-specific work permit process for more complex and non-routine work and all vendor work that provides an effective process for defining the scope of work. The scopes of work defined in ALS work permits were comprehensive and provided the information necessary to perform an adequate hazard analysis.

Most operations work activities were well defined in the associated operations procedures. Although the requirements section of DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*, is not included in the LBNL contract, ALS has chosen to follow the Order guidelines and uses an extensive set of operations procedures to formally describe and direct accelerator operations.

Scopes of work for many observed routine activities are adequately described in personnel JHA forms. Although not always tailored to specific activities, the combination of JHAs and individual scope of work descriptions and the JHA task descriptions for observed personnel described most work in sufficient detail to support effective hazard analysis. However, similar to other divisions, many of the ALS facility personal JHA scopes of work and task descriptions for some jobs were too broad to provide the necessary information to analyze fall hazards and implement the controls. For example, ALS workers were assisting Facility Division workers in storage ring cover removal and installation. The ALS facility workers were within a few feet of an unprotected edge with the potential of a fall of greater than six feet

and were not wearing fall protection. The only task description related to height in one worker's JHA was "working near exposed roof edges," but the opening in the storage ring cover may not have been considered a roof edge. The other worker's (a supervisor) personal JHA had no reference to working in conditions in which falls might be a concern. In another example, an operator performed an equipment check without fall protection outside of a steel cable barrier and near an unprotected edge with the potential of a fall of greater than six feet. This operator's JHA and any of the other sampled operator JHAs reflected a scope of work that required working near unprotected edges. The LBNL EH&S manual requires fall protection when working at elevated surfaces that are unprotected by railings. (See Finding #C-1.)

### ***Core Function 2: Analyze the Hazards***

Facility level modifications to the beam lines or the light-generating machine itself receive extensive hazard analysis. For example, modifications to change the method of operation to a nearly constant electron level in the storage ring (known as "top-off" mode) received extensive hazards review, including analysis of failure modes, potential accidents, and detailed calculations of consequences. Evaluation of potential accident scenarios involved coordinated reviews between LBNL groups and also involved revision of the current Accelerator Safety Assessment Document.

At the activity level, ALS uses several hazard analysis mechanisms. For example, ALS has a formal, documented, stringent proposal review process for experiments that effectively integrates safety throughout the process. The process applies to all users of the beam and is documented in a suite of procedures available online for users and based on the particular type of beam line requested and the identified potential hazards. The experiment proposals effectively define the scope of the experiments and the process requires users to include descriptions of all hazardous materials, equipment, or processes being proposed. The ALS facility experiment safety sheets are used to ensure all safety reviews are performed for the experiments and substitute for the JHA process to analyze the hazards and to develop and approve appropriate hazard controls. For certain high-hazard activities such as laser operations, the AHD provides an effective hazard analysis. For example, an AHD for a class 4 laser setup at a reviewed beam line described hazards of the laser, including laser power and wavelengths, in sufficient detail to enable effective development of controls. For more complex and non-routine work and all vendor work, ALS uses a facility-specific work permit process that provides an effective process for analyzing hazards resulting from complexity. The ALS facility work permit process includes a team approach to ensure activities involving multiple higher hazards (i.e., multiple AHDs or permits) and/or multiple work groups are analyzed as a single activity although multiple hazard documents and JHAs are involved.

For lower risk or routine work, ALS uses the personal JHA process to identify and analyze activity/task level hazards associated with ALS staff activities and operations. Although many JHAs at ALS share the same lack of tailoring to specific jobs as other divisions, the processes are adequate in most instances for the limited activities at ALS that are not otherwise covered by the other hazard analysis processes discussed above.

Although most hazards are adequately analyzed, two types of hazards were not sufficiently analyzed (see Finding #C-2):

- ALS does not have a baseline hazard survey and/or an exposure assessment for the work in the dome area that reflects the potential exposure to lead paint chips. The inside dome of the ALS facility has large areas of peeling paint known to contain lead. Although housekeeping is generally excellent in this area, floor and work areas directly below the peeling paint areas showed signs of recently fallen paint chips, including small white chips on a desk used for maintaining lockout/tagout logs, and areas on concrete floors below the peeling area of what appears to be chips that are in some instances

ground into a powder. The industrial hygiene (IH) organization has performed some limited inhalation exposure surveys and has analyzed some bulk samples of paint chips to verify the paint is lead based, but has not performed baseline hazard surveys and/or exposure assessments as required by 10 CFR 851 and the LBNL Worker Health and Safety plan, including the potential for the ingestion pathway or the potential for carrying lead contamination home. Additionally, there is no evidence that housekeeping in the area is treating floor sweepings as potential hazardous waste or that an exposure assessment has been conducted for the custodial staff to address the potential lead hazard. After notification, facility management requested an exposure assessment from IH.

- ALS had not identified the environmental hazards associated with use of lead based solder, which is used by multiple workers and at multiple locations throughout the ALS facility. Although workers were aware of the hazards of lead ingestion, the hazard to the environment had not been adequately analyzed, workers did not recognize that waste solder may be hazardous waste, and consequently, the practice was to dispose of lead solder as ordinary waste. A contributing cause may be that lead based solder has not been entered into the chemical management database. After pointing this out, ALS immediately took actions to properly manage this material.

LBNL's lack of baseline hazard surveys is an underlying cause for the two instances of insufficient hazard analysis. For most ALS work areas, LBNL does not meet the 10 CFR 851 requirements for initial or baseline hazard surveys; 10 CFR 851, Appendix A, Section 6(a) requires that initial or baseline hazard surveys be performed for all work areas or operations to identify and evaluate potential worker health risks. The LBNL Worker Safety and Health plan states that assessments for chemical, physical, biological, and safety workplace hazards are documented following recognized exposure assessment and testing methodologies. Although inhalation exposure assessments have been performed and documented for a few discrete activities when requested by ALS, baseline hazard surveys for all work areas have not been performed. (See Finding #C-2.)

### ***Core Function 3: Develop and Implement Controls***

ALS makes extensive and effective use of engineering controls to mitigate the potential for exposure to high-risk hazards such as radiation, high voltage, and laser light. Shielding, alarm systems, and interlock systems are extensively used throughout ALS to warn workers of hazards and provide passive or active protection from hazards. For example, radiological hazards are extensively controlled through engineered components and systems such as shield walls and interlock systems. To ensure the engineering controls remain valid, administrative controls such as beam line shielding change forms, periodic interlock check procedures, and beam line authorizations verify appropriate configuration control of the engineered safety systems. For users, safety checklists are developed to ensure appropriate controls are implemented.

Where hazards were adequately identified and analyzed, associated task-specific controls were appropriately described in JHAs, AHDs, work permits, procedures, postings, and other related controls. For example, the procedure system at ALS is formal, rigorous, and developed in accordance with DOE Order 5480.19 guidelines, even though this Order is not in the LBNL contract. In another example, controls for vendors in work permits were generally comprehensive, involved facility work coordinator review of the controls with the vendors prior to approval of the permit, and addressed the appropriate controls for the jobs.

ALS Division management and staff displayed their commitment to teamwork and safety. Managers and staff were open to involving all disciplines in problem solving. The team concept was demonstrated in facility-specific administrative processes, such as the requirement for team analysis of work permits. In addition, the ALS facility management organization structure and safety culture facilitates interactions

among engineering and safety functions and research and operations functions. Day-to-day work involving informal problem activities demonstrated that teamwork is normal for the staff.

In general, ALS staff are experienced, well trained, and knowledgeable of ALS systems and hazard controls. Staff ES&H training requirements were appropriate for observed work activities, and workers had completed required training. Workers were knowledgeable of the systems, activities, and associated requirements. For example, beam line scientists were extremely knowledgeable of the design, operation, and associated hazards and controls of their assigned beam lines, including engineered interlock systems.

ALS provides an extensive training program to ensure outside users are adequately trained on facility hazards. The training was comprehensive and covered emergency actions and activities, responsible site contacts, facilities orientation, facilities hazards and controls overview, and beam-specific training, including training on interlocks authorized to be operated by users (e.g., hutch interlocks, etc.). The user training provides a comprehensive review of the safety controls at ALS.

Although effective in most instances, the Independent Oversight team observed a few deficiencies in hazard controls. In one instance, a boom attachment was marked as being suitable for a particular forklift used in ALS, but the attachment had not been approved by the forklift manufacturer as required by the ES&H manual and the Occupational Safety and Health Administration (OSHA). In another instance, ALS did not implement an administrative control for tracking flammable gases at the beam lines as specifically described in the ALS facility Accelerator Safety Assessment Document. Although the total amount of flammable gases in the building is tracked to ensure the total quantity is below the allowable limit, the subset of flammable gases specifically at the beam lines is not tracked. In a third instance, ALS postings for appropriate protective eyewear at some laser hutches did not specifically match the allowed manufacturer list in the applicable laser AHDs. While the beam line scientists verify that new eyewear provides equivalent protection for the applicable wavelengths, the newer protective eyewear has not been reviewed and approved by those involved with the initial approval of the AHD. In all three instances, facility management promptly initiated actions to address the deficiencies, including initiating actions to perform an un-reviewed safety issue on specifically tracking flammable gases at the beam lines.

#### ***Core Function 4: Perform Work Safely Within Controls***

ALS has implemented adequate systems to ensure appropriate hazard controls are in place before work authorization. For example, readiness and authorization to perform experiments by visiting users is rigorously controlled using the experiment safety sheet and associated approval processes. Final readiness to perform the experiment includes verification of required safety training for users, and final formal authorization by the lead beam line scientist after verifying the controls on the experiment safety sheet have been completed and beam line-specific training and orientation is complete. For work permits, ALS adequately implements the standards based management system work control authorization process. Work permits must receive approval from a work permit review group, be coordinated through the ALS facility work coordinator, and the workers must participate in a pre-job briefing prior to proceeding with the work.

In general, ALS workers performed work in accordance with established controls. For most observed work, workers followed JHA, AHD, and other provided controls and used the correct personal protective equipment (PPE). Activities such as operator performance of search and sweep procedures, technician performance of interlock checks, beam line scientist access to a laser hutch, and user activities to load proton crystallography samples into the end station were performed in accordance with appropriate procedures and controls. Management has established expectations to operate the ALS facility in accordance with DOE Order 5480.19 guidelines even though this Order is not in the LBNL contract; and a sampling of operations activities indicated that accelerator field and control room conduct of operations

were rigorous and in accordance with the guidelines of DOE Order 5480.19. Logbooks were legible and appropriate, equipment status boards were current and accurate, radio communications were clear and concise, and shift turnover activities were appropriate and in accordance with procedurally established shift turnover checklists. Operator assignments were formal and met minimum requirements. Appropriate use of shield change forms, startup checklists, and administrative follow-up of lockout/tagouts in preparation for startup demonstrated effective configuration control.

A few minor deficiencies were noted in performance of work. For example, in one instance a vendor was not wearing a lab coat as required by the work permit and did not remember that the lab coat was a requirement in the permit. When questioned, the vendor immediately donned a lab coat. In another example, a few compressed gas cylinders were improperly stored on the storage ring cover, which is normally only accessed by ALS facility personnel, not users. When pointed out, facility management initiated actions to correct the improper storage conditions.

To further reduce chemical risks, ALS is proactively reducing the amount of hazardous chemicals in the facility. A contract industrial hygienist is being used to clean out chemical storage cabinets. During cabinet cleanouts, the industrial hygienist sorts chemicals, identifies and isolates any noncompatible chemicals, disposes of expired or suspect chemicals as hazardous waste, barcodes any chemicals not already identified, and organizes the cabinets.

### **C.2.2 Physical Biosciences Division**

The mission of the Physical Biosciences Division (PBD) is to integrate techniques and concepts of the physical and engineering sciences into the investigation of biological systems, and to use this information to solve some of society's greatest challenges in the areas of medical diagnostics, renewable energy, and biofuels research. The Division employs approximately 500 staff, half of whom are guest researchers. PBD research is conducted in LBNL Buildings 64 and 66, the Donner lab located on the University of California Berkeley Campus, the ALS facility, and the Joint BioEnergy Institute (JBEI), housed in a leased space offsite in Emeryville, California. At JBEI, six national labs conduct groundbreaking biofuels research, with LBNL providing ES&H support to all of the partners.

The Independent Oversight team observed 12 varied research experiments being performed within these facilities in the areas of molecular and structural systems biology, cell imaging, chemical extractions from organic materials, fuels synthesis research, photochemical experiments and characterization, propagation of mammalian cell cultures, protein crystallography, and enzyme and metabolic engineering. The hazards within these diversified PBD research activities include radiological, cryogenic, electrical, ergonomics, pressure, thermal, robotics, nanoparticles, non-ionizing radiation (i.e., lasers, ultraviolet radiation, and magnets) and biological hazards (i.e., risk group level 1 and 2 biological agents). In addition to observation of research experiments, the Independent Oversight team reviewed the PBD research work control process including the use of authorization work documents (e.g., biological use authorizations, radiological work authorizations, and activity hazard documents); walked down most of the PBD laboratory work spaces, including chemical, radiological, and biological laboratories, material storage areas, and waste storage areas; participated in a PBD Director's management walk down; and observed PBD research scientists mentoring graduate and undergraduate students.

#### ***Core Function 1: Define the Work***

At the research program level, research work scopes are defined through research grant documents, proposals, and technical publications. In some instances, the details of such programmatic documents, such as research proposals, have been sufficient to provide a description of work at the activity level such that types of hazards may be identified. For example, the research proposal associated with the Time

Resolved FT-IR and Synthesis Research Project that is in the initial planning stages in Building 66, Room 310, is sufficiently defined in the research proposal, which is updated on an annual basis such that the overall work scope can be identified. At this level, there is an inherent need to describe the research activity in sufficient detail and clarity such that funding organizations can appropriate the necessary resources.

At the bench scale research experiment level, those research activities that have well defined protocols and safe work authorizations have sufficient work scope definition such that hazards can be identified. Within PBD, safe work authorizations consist of RWAs when using radioactive materials in JBEI, AHDs for lasers and acutely toxic gases, and biological use authorizations (BUAs) when working with risk group level 1 and 2 biological agents. For example, research experiments performed within the JBEI radiation room requires that work scope be defined through detailed protocols that require supervisor approval before work is authorized. The RWA for this room provides another mechanism in which work scope is broadly defined. In another example, research experiments involving the plasmid purification and analysis conducted in JBEI 978-440 follow a detailed step-by-step protocol for this activity. In addition, the biological work associated with this activity is described in the biological use notification (BUN).

At the work activity or experiment level, a few PBD research work scopes are not sufficiently documented such that hazards can be identified and activity-level hazard controls can be documented and linked to the hazards in the experiment. Furthermore, the use and control of lab notebooks and laboratory protocols as the means for defining work at the experiment level such that the hazards can be identified is not defined in LBNL and/or PBD research work practices. (See Finding #C-1.)

Individual baseline JHAs have been prepared for each PBD research staff member. The individual JHA, as applied to PBD research, typically does not provide sufficient detail about research work at the experiment level such that experiment level hazards and controls can be identified. For example, the individual JHA for one researcher conducting plasmid preparations in JBEI identifies his scope of work within JBEI as “all laboratory work at the Joint BioEnergy Institute at Emery Station East,” but provides no further scope breakdown. The task-based JHA, as described in PUB-3000, Chapter 32, *Job Hazard Analysis* (or equivalent), is not used within PBD to supplement the individual baseline JHA, although some individual JHAs are being modified to be more activity specific. PUB-3000, Chapter 32, does not provide sufficient guidance on the level of detail expected in a JHA for individual research activity work scopes. LBNL is currently updating the JHA process such that more detailed work scopes can be documented. (See Finding #C-1.)

### ***Core Function 2: Analyze Hazards***

For the wide variety of observed PBD research activities, the senior research staff are knowledgeable of the hazards involved with their activities. For example, the principal investigator for the research being conducted in the JBEI chemistry lab has significant education and experience in the research that is being conducted in this lab. In another example, the principal investigator responsible for the metal synthesis research and instrumentation development being conducted in Building 66, Room 310, was well aware of the potential hazards associated with his research. All of the PBD research staff members interviewed had completed an individual JHA to document the classes of hazards to which they are likely to be exposed (e.g., chemicals, pressures, electrical).

PBD has been proactive in the identification and reduction of a number of health hazards and risks. For example, ergonomic hazards within PBD laboratories and offices have been rigorously identified, analyzed, and documented. In addition to the computer-use ergonomic hazards, ergonomic lab hazards (such as the use of microscopes) and ergonomic hazards in the JBEI robotic lab have been well identified

through self-assessments, have been analyzed, and engineering controls have been developed and implemented. PBD has also expended considerable focus on the reduction of hazardous chemicals in laboratories and whenever possible implement the substitution of less hazardous chemicals. Examples include the replacement of ethidium bromide with a less hazardous chemical, the increased usage of chemical buffer kits to minimize the exposure of PBD staff who previously prepared such buffer solutions, and the use of the chemical management system (CMS) database to identify and evaluate chemical bottles at risk for peroxide formation and the identification of elemental bromine in the PBD laboratories.

The hazards associated with research conducted within PBD laboratories have been globally identified in researchers' individual JHAs. However, these global hazards often lack sufficient detail for a specific PBD experiment. Individual JHAs in use within PBD are typically not tailored to identify hazards for specific research experiments. For example, many of the PBD research staff interviewed who worked with hazardous chemicals identified "working with or around hazardous chemicals" on their individual JHAs. Similarly, all of the research staff listed on their JHAs the same chemical hazard, specifically "exposure (inhalation, skin or eye contact) or other hazards due to the use of or proximity to hazardous chemicals." However, at the bench scale experiment, there was seldom an identification of hazards of specific chemicals in use and/or identification of the most hazardous chemicals in use for the experiment and the minimum controls required when using those chemicals. PUB-3000, Chapter 32, does not provide sufficient guidance on the level of detail of hazard identification expected in a JHA. In addition, Chapter 32 does not provide adequate guidance on hazard thresholds or the application of a risk-based approach to developing and approving JHAs. In addition, Chapter 32 does not provide guidance on "risk thresholds" for when a JHA may no longer be adequate as a result of introducing a greater hazard or risk to workers. As a result, for an individual JHA that lists "working with or around hazardous chemicals" as the hazard, unless the chemical is a toxic gas with acute hazards that would require an AHD, the individual is authorized to work with all other hazardous chemicals, including chemicals that may be procured in the near future and regardless of potential risk, including those chemicals that may pose significant health, flammability, or explosive hazards. The observed hazard analysis practices do not meet the requirement of 10 CFR 851.21(a)(6) requiring that DOE contractors "perform routine job activity level hazard analysis." (See Findings #C-1 and #C-4.)

Hazard analysis for most PBD research activities is an ongoing collaborative activity, but is typically performed informally and seldom documented. Discussions with research staff (i.e., principal investigators and research associates) concerning the hazards associated with the newly emerging research in synthesis of inorganic materials indicated that the staff was knowledgeable of the potential hazards of their research activities. However, in most PBD research activities, hazard analysis at the experiment level is not well documented. On occasion, some hazards are documented in various locations in a researcher's lab notebook or as notes in draft protocols. For example, with respect to research involving synthesis of a hydrous Cu(I) oxide nanocluster in Building 66, Room 310, some hazards were identified within a researcher's lab notebook. However, a number of the identified hazards for this experiment (pressure, chemical, and thermal hazards) were not documented or described at the experiment level in the researcher's individual JHAs. Similarly, for the research apparatus or equipment that was developed by the research staff in support of this experiment, there was no operating manual, instructions, or written document to describe the potential hazards and hazard controls for the apparatus, and the hazards associated with operating the equipment were not identified in their individual JHAs. Even for those experiments with developed protocols or technical publications, the protocols and publications typically do not identify and describe the analysis of the hazards associated with the research experiment. (See Finding #C-1.)

Although most individual JHAs are sufficiently broad to envelope the hazards to which a researcher may be exposed, in a few instances some research hazards were not identified in the individual's JHA. For

example, for the research staff working in the JBEI robotics lab, the hazards associated with robotic work (e.g., pinch points, moving objects, etc.) were not identified on their JHAs. In another example associated with the growth of mouse embryo cells in Building 80, the ultraviolet (UV) light hazard from the biological safety cabinets and the cryogen hazards were not identified in a researcher's JHA. Once identified, the researcher revised his or her individual JHA to include these hazards, and the researcher had previously completed the required cryogen training. In another example, the pressure hazards for the operation of a French press in Building 64, Room 142, were not identified on the researcher's JHA, and oxygen deficiency calculations had not been performed in one of the PBD labs which housed two 160 liter liquid nitrogen dewars.

The LBNL institutional industrial hygiene exposure assessment process is not sufficiently defined or implemented, and is described by LBNL as a "work in progress." A number of PBD research activities requiring an exposure assessment either through controls identified in JHAs or requirements within PUB-3000, Chapter 32, have yet to be conducted. During the past 10 years, 27 exposure assessment surveys and 21 hazard assessment surveys have been conducted within PBD, although the distinction between a hazard assessment and an exposure assessment is not defined. Of the 27 exposure assessments performed to date, only three were performed during the past four years. Furthermore, many of these exposure assessment surveys performed during the past 10 years were not associated with research experiments but were performed in response to off-normal events (e.g., spills) or to support asbestos projects (e.g., inspections and abatement projects) or evaluations of the use of respirators. For many of the PBD research activities, including most of the observed PBD research experiments during this inspection, there is no documented exposure assessment or documented hazard assessment. There are few documented exposure assessments for using hazardous chemicals or for other PBD research hazards such as dermal hazards from researchers working in chemical fume hoods, pressure and laser hazards, heat/cold exposure hazards from cryogen and furnace use, etc. In some instances, individual JHAs, such as those for the research staff in JBEI Room 978-4440 (fuels synthesis research), require the "performance of an exposure assessment" when working with or around hazardous chemicals. However, the PBD research staff and LBNL ES&H have not conducted an exposure assessment for this activity. The recently revised ES&H manual Chapter 32, Section E.2, *Low-Risk Exposures*, indicates that the conclusions and prescribed controls from the assessment of any common or low-risk exposure activities at LBNL should be "documented on the JHA or other work documentation." Although several of the observed PBD research experiments may fall within the low-risk exposure category, documentation to justify a low-risk category as not been included on the individual JHAs or in other work documentation (e.g., protocols, lab notebooks). One exception is the research conducted in a walk-in chemical fume hood in the JBEI chemistry lab for which a respirator evaluation and a hazard assessment has been performed. LBNL IH is currently in the process of conducting an exposure assessment for those experiments that will be performed in this fume hood. (See Finding #C-2.)

### ***Core Function 3: Identify and Implement Controls***

In most instances, engineering controls within PBD research labs are extensive, well maintained, and routinely used by the research staff. For example, access to JBEI labs, which are located in an offsite leased facility, is well controlled though key card access to the elevators. Safety interlocks for those PBD labs with class 3 and 4 lasers were appropriate and operational. Laboratories that contained higher hazards, such as radioactive material, were cipher locked and could only be entered providing the researcher had completed the required training. In addition, engineering controls on robotic devices (e.g., light curtains) within the JBEI robotic lab were effective in preventing operators from coming into contact with moving parts.

Many administrative controls observed within the PBD laboratories were effective in communication and controlled the potential hazards. Hazard postings on facilities and equipment were consistent with LBNL



requirements. PBD lab doors are posted with hazard warning signs that accurately reflected the classification of hazards within the lab (e.g., toxins, compressed gases). The pinch and contact hazards for the robots in the JBEI robotic lab were well marked on the equipment.

At the institutional level, safety and health training has been developed to address the typical hazards encountered by the PBD research staff. LBNL institutional training requirements are sufficiently identified on an individual's JHA, and for observed activities PBD research staff was current with respect to meeting training requirements. At JBEI, the research staff is also required to complete some training that is beyond the LBNL minimum expectations. For example, everyone in JBEI must successfully complete fire extinguisher and first aid training. As an administrative control, all LBNL and JBEI staff must complete GERT training.

Mentoring is routinely performed as the mechanism for instructing new PBD research staff and/or students. For higher hazards, such as working with lasers, documented on-the-job training is required. The Independent Oversight team observed senior PBD research staff mentoring graduate and undergraduate students in the performance of research experiments. In each observation, senior staff were knowledgeable and professional in their mentoring activities. Although mentoring and on-the-job training are important controls, they lack formality and rigor. At present, there is no format, minimum content, or requirements for approval of mentoring within the PBD, and the only requirement for on-the-job training is that completion be documented with a signature.

General laboratory hazard controls are documented within the individual PBD JHAs. For example, when the task description in an individual's JHA includes "general safety," "laboratory safety," or "chemical handling," the list of controls such as "wear safety glasses and appropriate clothing when handling chemicals" is a useful reminder. However, an individual's JHA within PBD rarely identifies a specific hazard control for an activity or experimental based hazard (e.g., wearing nitrile gloves for incidental contact with chemical solvents when cleaning chemical ovens). At the activity level, hazard controls for individual research experiments are seldom documented in individual JHAs, are often lacking from activity level work documents (e.g., experiment protocols, lab notebooks, technical publications), and are seldom linked to the hazards for which they were intended to mitigate. The identification and assessment of hazard controls at the experiment level is typically determined by the researcher in consultation with the principal investigator, but the agreed upon controls are seldom documented. Although research protocols have been developed for a number of PBD research activities, as discussed previously, guidance is lacking at the institution and division level on format, content, and use of research protocols, and particularly whether and how protocols should address hazards and hazard controls. Although PUB-3000, Chapter 32, Appendix A, provides an option for a JHA equivalent, the PBD work documents reviewed (e.g., research protocols) would not currently meet such requirements. (See Finding #C-1.)

As discussed above, institutional weaknesses in radiation protection programs have resulted in radiological control deficiencies for work observed in PBD in such areas as contamination control, radiological postings and boundary control, radiological surveys, and training. In the JBEI radiation room, for example, some fume hoods and bench tops used for processing of dispersible radioactive materials are posted with "radiological work in progress" signs as required. However, potential contamination boundaries are not marked for individual research experiments and these areas are not being evaluated for posting as "contamination areas" in accordance with 10 CFR 835 criteria or alternately being surveyed and released as clean areas following each use. A radiological liquid waste container in the JBEI radiation room was not labeled to indicate the presence of radioactive material within the waste container, although once identified, the appropriate label was attached to the container. RWAs for the JBEI radiological room do not require the performance of quantitative radiological surveys at the completion of radiological evolutions to verify that contamination controls have been effective and contamination has not been inadvertently spread to clean areas, as required by 10 CFR 835. In the JBEI

radiation room, observers in the radiological material area (RMA) were permitted to exit the room without frisking their shoes, although when papers were dropped on the floor the papers were assumed to be contaminated. In these work observations, the JBEI researcher followed the RWA requirements, but the RWA lacked sufficient detail with respect to hazard controls including expected frisking practices and marking of work area contamination boundaries. (See Finding #C-3.)

In a different area of JBEI, an LAS authorization permits the staff to use low activity liquid sources of C-14 and H-3 in their research experiments outside of the JBEI radiation room and within the larger JBEI MoBio 2 lab that is routinely occupied by a number of molecular biologists. This LAS permits working with dispersible radiological materials of sufficient quantity to create contamination areas in any location within the JBEI MoBio 2 lab, without marking the boundaries of work areas, posting work areas as potentially contaminated, or quantitatively surveying work areas following use of materials to ensure the area has been maintained free of radiological contamination. (See Finding #C-3.)

There are no radiological protocols associated with contamination control requirements in the LAS and area surveying is not conducted by the research staff. The documented survey frequency of this area (i.e., MoBio 2 Lab) is annual and a radiation survey for this facility has yet to be documented. However, the survey will be difficult to perform because all the locations in which these radioactive sources were used during the past 12 months may not be known. Lastly, the use of an LAS work authorization only requires GERT training, which is not a sufficient level of radiological training for hands-on work with radioactive material that has the potential to create contamination concerns. Because the staff that conducts research under the LAS authorization also conducts research in the JBEI radiation room, which requires more significant radiation training, researchers have received the prescribed level of radiological training. However, as discussed previously, this training also lacks sufficient practical factors demonstration and verification. (See Findings #C-3 and #C-4.)

Throughout the PBD laboratories, there is widespread use and storage of hazardous chemicals. The current CMS listing of hazardous chemicals within the division is over 180 pages in length and reflects more than 9,000 chemical entries. In 2008, a PBD self-assessment identified concerns with respect to the labeling and bar coding of chemicals. In autumn 2008, protocols were developed to reconcile the actual PBD inventory with the CMS database on an annual basis. Although progress in chemical reconciliation and bar coding is evident, some examples of chemicals without the appropriate bar codes were identified during this Independent Oversight inspection. (See Appendix E for discussion of CMS across LBNL.)

One particular challenge with PBD is the tracking of small chemical containers that had originally been included within buffer kits or chemical kits that were pre-packaged by the chemical supplier. Often, these kits, which are in widespread use throughout PBD laboratories, are entered into the CMS as kits, but without acknowledgement of the individual chemical containers within the kits. A number of these chemical containers were identified within JBEI chemical shelves apart from their kits, and without the appropriate chemical labeling and/or CMS barcodes. In some instances, CMS bar codes were not provided on the intact kits. A second challenge within PBD with regards to hazardous chemicals is providing adequate labeling on secondary chemical containers (e.g., cans, squeeze bottles, and other containers to which hazardous materials are transferred by an employee). The Chemical Hygiene and Safety plan (CHSP) requires secondary containers to be marked or labeled with the name of the chemical(s) and hazard warnings. A number of secondary containers were observed in PBD labs without hazard warnings, and some lacked sufficient identification of the names of the chemicals such that workers in the vicinity of the chemical, who may have been unfamiliar with the chemical, could identify both its chemical constituents and hazards. For example, chemicals were identified in the JBEI glassware washroom only with a label of "M9" and no hazard warning. Although the chemical constituents may have been known to the molecular biologists to be low hazard, it was largely unknown to the workers operating the washers. In another example, the hazards associated with synthesized ionic solution

developed in the JBEI chemical lab were not indicated on the chemical container, although these solutions were under the control of a senior chemist. A third challenge within PBD regarding hazardous chemicals is the determination of when or if a mixture of chemicals should be considered hazardous, and therefore the container must meet the requirements of the CHSP. The CHSP follows the OSHA requirement that “a mixture is assumed to present the same health hazards as each component that comprises 1 percent or more of the mixture.” There are a number of chemical mixtures within PBD labs that contain 1 percent or more of multiple hazardous chemicals (e.g., acids, solvents, and bases), that have no health warnings; however, the CHSP does not provide detailed guidance on how to establish hazard warning labels for such mixtures. One example is the aforementioned “M9” solution. A fourth challenge within PBD regarding hazardous chemicals is the lack of use of secondary containments (e.g., drip trays) when storing hazardous liquid chemicals, as required by the CHSP. A number of PBD labs do not store secondary chemical containers in drip trays because the chemicals are assumed to be “working solutions.” However, some of these “working solutions” are mixtures of low concentrations of hazardous chemicals that have been stored on laboratory bench shelves for many months and with limited use. The CHSP does not provide detailed guidance in these examples. Many of the aforementioned challenges with hazardous chemicals are attributed in part to a lack of detailed institutional and/or divisional guidance and training with respect to chemical bar coding, chemical labeling, and when a chemical mixture is to be considered hazardous and the controls specified within the CHSP must be followed. (See Finding #E-1.)

Chemical fume hoods are a critical engineering control within most PBD laboratories that are used when handling hazardous chemicals, particularly highly toxic or volatile chemicals. In many instances, these chemical hoods are state-of-the art with variable air flow based on sash height, and most chemical hoods have instrumentation on the front of the hood that indicates face velocities with an adjustable audible alarm. Calibration of the chemical fume hoods is performed every other year by an LBNL industrial hygienist, and all of the PBD chemical hoods observed were within their calibration period. All of the new chemical fume hoods or those chemical hoods that have been moved to new locations require an initial commissioning test performed in accordance with American National Standards Institute (ANSI)/American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 110 and as required by the LBNL ES&H manual.

However, Independent Oversight identified two concerns with respect to use and calibration of chemicals hoods. One concern is that the LBNL requirements for chemical fume hoods provided in Section 4.6 of the ES&H manual and Hazards Controls section of the CHSP are insufficient to provide chemical fume hood users with minimum operating guidance when using hoods. For example, there is no guidance on sash positioning when the hood is in use or in storage. Based on interviews, some researchers incorrectly believed that the mark on the hood indicated the sash operating position, whereas the mark actually indicates the position of the sash during calibration, which is typically too high when conducting work in the hood. In addition, the LBNL manuals provide no guidance or prohibitions for storage of materials, flammables, or locating satellite accumulation areas (SAAs) within the hood. Several PBD labs were observed in which the chemical hoods were being used to either house the SAA or store flammable chemicals. This practice is prohibited in JBEI, as explained in the JBEI ES&H plan, but the CHSP does not provide guidance in this area. The LBNL manuals do not provide any guidance on how to use the flow meter reading device to determine the operability of the hood, and there are no “safe practices” listed in the manuals (e.g., keeping lab doors closed unless required to be open to prevent drafts, minimizing foot traffic past the face of the hood, and not placing materials or working in the first 6” of the hood). It is unclear when a hood user should request a hood recalibration if using the hood for a new purpose or changing the configuration of hood internals (e.g., adding a large research apparatus), and there is no formal training of the research staff on hood principles of operation. As a result of these concerns, the LBNL Laboratory Director issued a site-wide memorandum on February 4, 2009, with a “1 Minute 4 Safety” slide to provide fume hood users with basic hood operation expectations. (See Finding #C-4.)

In addition to the lack of guidance for the chemical fume hood users, a second concern is that the calibration and inspection process for chemical lab hoods in general is minimal, not followed in some instances, and has not been updated since 1998 to incorporate a number of industry “good practices” such as those described in ANSI/ American Industrial Hygiene Association (AIHA) Z9.5, *Laboratory Ventilation*, issued in 2003. The impact of this concern is evidenced by the observed chemical fume hood calibration in Donner Room 230, which is one of the oldest in-service chemical fume hoods in the division. In December 2008, the face velocity was recorded as 151 feet per minute (fpm), which is above the 150 fpm LBNL maximum acceptance criteria, and yet the hood had not been posted as “not OK, conditional use only,” as stated in the LBNL local exhaust ventilation survey guidelines. During the observation of the hood calibration, some of the flow measurements were as low as 60 fpm, indicating that some areas of the hood were unacceptable for use. One of the two lighting fixtures inside the hood was burned out; however, lighting is not included in the testing criteria, and this deficiency had not been entered into CATS. This chemical fume hood was being used to house the SAA and the flammable chemicals for the group, contrary to good lab practices, and as a result only a few inches of working space was available within the hood, and the available space was near the front of the hood where work should not have been performed. A CATS action had been identified to remove the flammable chemicals, but was listed with a “low” priority (during this inspection, the CATS priority was raised to a medium priority). A box was stored on the floor in front of the fume hood as well as a large refrigeration device limiting access to only half the fume hood (i.e., the side of the fume hood with the poor lighting). There had been no smoke testing of the hood to observe the adequacy of the ventilation pathways, testing of the cross drafts, or a requirement to test the hood annually as recommended by the industry good practices. (See Finding #C-4.)

#### ***Core Function 4: Perform Work within Controls***

Where controls have been established and well documented, the PBD research staff is conscientious in following those controls. The controls documented in safe work authorization documents (RWAs, AHDs, and BUAs) were followed in all observed research activities. For example, research conducted within the JBEI radiation room was performed in accordance with the RWA established for this room. Laser protective eye wear as described on the laser AHD in Lab 306, Building 66, was followed as described in the laser AHD. Although a number of PBD procedures and research protocols do not include hazards and controls for specific experiments, work leads and supervisors routinely discussed such hazards and controls and ensured that the staff was adequately training prior to performing work.

In a few instances, work was not being performed in accordance with the controls specified within an individual’s JHA or in accordance with LBNL or PBD policies and procedures. For example, in several JHAs the researcher did not request that the EH&S Division perform an exposure assessment as required by the individual’s JHA. In another example, UV glasses and gloves are typically not worn by the research staff when working in the vicinity of a biological safety cabinet as required by the posting on the cabinet, although such posting does not reflect the expected administrative controls. Furthermore, two solid waste chemicals that were stored in the JBEI robotics lab SAA either had the incorrect storage start date or no date was listed, which are both contrary to LBNL waste storage procedures. Once identified, the labels were immediately corrected.

#### **C.2.3 Chemical Sciences Division**

The LBNL Chemical Sciences Division (CSD) consists of three main groups that perform research work at the LBNL site: the Chemical Physics group; the Atomic, Molecular and Optical Sciences group; and the Actinide Chemistry group. A portion of each of these groups operates on the UC Berkeley Campus under the UC Health and Safety Program, which is not within the scope of this assessment. The remainder of the CSD on the LBNL site, including activities within each of the three groups, was

evaluated to determine the effectiveness of their implementation of the core functions of integrated safety management. For the Chemical Physics and Atomic, Molecular and Optical Sciences groups, Independent Oversight observed ongoing experimental research, which principally related to work involving the use of class 3b and class 4 lasers in Building 2 laboratories. For the Actinide Chemistry group, Independent Oversight observed radiochemical operations in the Heavy Elements Research Center and other radiological and nonradiological chemistry operations in the balance of the Division's laboratory space in Building 70a.

### ***Core Function 1: Define the Work***

Scopes of work for most CSD activities at LBNL are defined through various mechanisms including individual research proposals developed in support of funding requests, individual job hazard analysis documents, and written work authorizations prepared pursuant to institutional safe work authorization requirements for specific hazards (e.g., radiological work, class 3b and 4 lasers).

A large portion of LBNL's CSD work involves use of radioactive materials or high power lasers, each of which requires a specific formal written authorization (safe work authorizations) prepared for that hazard which includes the work to be performed and the related hazards and controls. In general, these authorizations were sufficiently detailed to permit hazard analysis and development of controls for the hazards for which the authorization was prepared (e.g., ionizing radiation, nonionizing laser beam radiation).

Many other work activities use a combination of one or more safe work authorizations coupled to an individual JHA, or in some instances, only an individual JHA is used, such as when performing basic laboratory research using chemicals. Safe work authorizations are generally prepared for single hazards only. For other hazards not addressed by the safe work authorization, the individual's JHA is intended to define the scope of work, along with all hazards and necessary controls. In most instances, individual JHAs that were reviewed did not contain sufficiently detailed statements of work to be able to determine all task specific hazards and controls. LBNL's original implementation of the JHA process did not require scope of work statements to be included in individual JHAs. However, LBNL recognized this approach as insufficient to adequately determine all hazards unique to a particular work scope, and the JHA software was modified to include a field for a scope of work statements. However, this requirement only becomes effective at the next required review and update to the individual JHAs. As a result, many JHAs still lacked specific statements of work and individual task listings were too broad to be able to identify unique hazards and controls. (See Finding #C-1.)

Research proposals and specific experiment-related protocols are often developed and can sometimes be used to clarify individual work scopes. However, these mechanisms vary in content and quality, are not defined or referenced by the JHA process and are not governed by institutional requirements to ensure adequacy.

### ***Core Function 2: Identify and Analyze the Hazards***

The principal mechanisms for performing and documenting hazard analysis for CSD work are the JHA process for routine hazards, radiological work authorizations for ionizing radiation, and the AHD for nonionizing laser radiation hazards. In general, the RWA and AHD mechanisms were suitable frameworks for analyzing specific hazards and developing controls. For example, nonionizing radiation hazards associated with class 3b and 4 laser operations were clearly identified and analyzed through the AHD process. Several AHDs that were reviewed were associated with class 3b and 4 lasers and contained an adequate level of detail on the specific laser equipment including operating wavelengths and power, and pulse and beam parameters, such that appropriate controls and eyewear could be determined.

For radiological hazards, RWAs provided specific information on the allowed radioisotopes, physical and chemical forms, and unique hazards that may be present, such as neutron radiation or high beta or gamma emissions.

Use of the JHA process in CSD was generally not sufficient to ensure adequate identification of all applicable hazards associated with discrete work activities. As discussed in Core Function 1 above, this can be partly attributed to the fact that work scopes and tasks were defined only in general terms and/or for general hazard classes (e.g., “working with chemicals” versus “working with HF”). As a result, specific hazards and unique risks associated with particular chemicals, such as skin burns from HF, and requisite controls are not captured in JHAs. In CSD, there was also an indication of insufficient rigor applied to completing and reviewing JHAs, and in answering specific JHA questions in order to identify relevant hazards. For one work group, this lack of rigor resulted in an entire class of hazards associated with the work to be missed. Specifically, Labs 70A 2229A and B perform animal research with radioisotopes. While radiological hazards were identified and analyzed through the RWA process, biological hazards were not included on the JHA as required because the JHA question related to use of animals was answered incorrectly. These JHAs were reviewed and approved by supervisors without capturing this oversight. It should be noted, however, that supervisors do not currently have the ability to review JHA questions and answers as part of the review and approval process. As discussed in Core Function 3 below, required controls for this hazard were not appropriately reviewed and/or implemented. (See Finding #C-1.)

As cited above, safe work authorizations are written for single classes of hazards (e.g., ionizing or laser radiation) and thus do not address all hazards that may be associated with the work. In these instances, the JHA was not sufficient to identify all additional hazards or otherwise bound the authorized tasks such that activities that may introduce unforeseen hazards are not allowed. For example, a concern was self identified by CSD that neither JHAs nor AHDs covering class 3b and 4 laser operations contained reference to electrical stored energy hazards and any needed controls such as lockout/tagout to de-energize laser systems prior to servicing or maintenance of electrical components. While electrical hazards are generically listed in the laser JHAs, they are not clearly defined or linked to a specific task or activity, such as the potential for stored energy from capacitors during servicing or maintenance work. CSD self identified a concern in this area and consulted the site’s electrical subject matter expert (SME) for guidance. However, corrective actions were targeted solely at the specific laser lockout/tagout concern and did not address the underlying work control/JHA deficiency that triggered the situation to exist. (See Findings #C-1 and #D-2.)

Radiological work in CSD involves the use of a number of engineered control containment devices including hoods and glove boxes. While containments are generally effective in limiting potential airborne exposures, some radioactive materials can be released, especially during breaches of contaminated systems such as when performing glove changes or pass-ins and pass-outs. The potential airborne radiological hazards posed by these activities and radiological containments have not been adequately defined or documented through appropriate institutional technical basis documentation or the RWA process, resulting in subjective decisions as to the need for and adequacy of radiological air monitoring during work. This was particularly evident in the heavy element research laboratory (HERL), which generally process higher quantities of radioactive materials than other CSD laboratories. (See Findings #C-3 and #C-4.)

In another hazard analysis concern, RWA 1040 authorizes the use of transuranics in animal studies, which include a potential for small releases of particulates through unfiltered hood stacks when specimens are exposed to ash. This RWA has been classified as a class 2 RWA based on a numerical HGV derived from Procedure 707. As a class 2 RWA, high efficiency particulate air (HEPA) filtration is not required on hood or glove box exhausts, while class 3 RWAs require HEPA filtration. LBNL could not provide a

documented basis for the calculation and magnitude of numerical HGVs against which such radiological controls are specified. The use of the calculation may also be too liberal because assignment of the overall RWA risk category is currently being performed by calculating an HGV for each isotope allowed by the RWA and choosing the hazard classification based on the highest single HGV, without consideration of the collective contribution from all isotopes and quantities allowed by the RWA. This method of assignment of RWA hazard classes is not delineated in Procedure 707. In fact the procedure only provides a method to calculate a single isotope HGV but does not specify how personnel are to use HGVs to assign an appropriate hazard class for more than one radioisotope. Most RWAs allow for the use of multiple radioisotopes simultaneously. In the case of RWA 1040, lack of HEPA filtration on radiological use hoods and glove boxes also conflicts with a historical laboratory policy that was inferred from information printed on a legacy posting on a hood found in this laboratory, which prohibited the use of radioactive materials in unfiltered hoods. (See Finding #C-3.)

### ***Core Function 3: Develop and Implement Controls***

CSD uses engineering controls wherever possible to mitigate hazards. Some engineering and administrative controls within chemical science were robust. For example, entry to most radiological areas is strictly controlled through the use of key card and/or biometric access controls to prevent unauthorized entry. Entry to laser areas is also key card controlled and laser areas are equipped with postings, warning lights, and room interlocks to prevent inadvertent entry and exposure. There was also extensive use of laser protective curtains surrounding the immediate laser areas. Inventories of radioactive materials within CSD are maintained using a database system that tracks isotope locations, which are physically verified and reconciled with the site's radiation protection inventory database on a quarterly basis. Users are also required to complete individual isotope use logs whenever material is used or transferred to a separate location. Hoods and glove boxes are used extensively to provide containment for quantities that exceed predefined thresholds.

As discussed in Core Function 2 above, use of the JHA in CSD did not result in effective hazard analysis for all hazards posed by work operations. There were similar weaknesses in the application of the JHA process in specifying controls at the working level. While useful for outlining training requirements, the individual JHA was generally not sufficient to convey specific controls needed to mitigate activity level hazards. In many instances, the specific controls were not specified, resulting in a need for the worker to determine the needed controls at the time of work. For example, the JHA control in many CSD JHAs for working with chemicals is "perform hazard assessment and utilize controls specified." Similarly, another control is to "know the hazards of the materials you are working with. Consult the material safety data sheet (MSDS) or other sources for hazardous properties of materials and incompatibilities." For electrical hazards, a JHA control is to "ensure electrical hazards are addressed in the JHA." These examples are not consistent with ES&H manual requirements for the needed level of detail. In many instances, these weaknesses can be attributed to inadequate work scope and task breakdown in the JHA. (See Finding #C-1.)

As with radiological hazard analysis, the Independent Oversight team noted a variety of deficiencies in implementation of radiological controls for specific CSD work, a condition exacerbated by institutional weaknesses previously discussed. Specific examples include (see Findings #C-3 and #C-4):

- Radiological requirements associated with the potential for contamination spread during work have not been properly implemented through the RWA process, including details on specific radiological control measures needed. For example, glove box pass-in and pass-out requirements and requirements for doffing of gloves and frisking prior to removing hands and leaving radioactive material workstations are not defined, so as to prevent the inadvertent spread of contamination to clean areas. In Laboratory 2229A, workers dissecting mice injected with actinides moved freely and

touched other items in the laboratory with potentially contaminated gloves because there were no specific controls in the RWA to prevent such actions. Researchers also believed this to be acceptable practice because the laboratory was posted as an RMA. However, RMAs are not contamination areas and no measures were in place to prevent the potential transfer of contamination from the animal handling work area. Similarly, documented radiological surveys were not required by the RWA to verify that radiological protocols were effective and contamination was not spread to clean areas during work. Currently the radiation protection group performs only infrequent (i.e., monthly) documented surveys and users are not required to document surveys they perform unless positive results are obtained. The lack of survey records in support of contamination control verification does not meet the requirements of 10 CFR 835, Subpart H.

- Radiological postings in CSD were not always in accordance with institutional and/or DOE requirements. For example, bench-top locations in HERL where radioactive materials were present lacked either a "radiological work in progress" or "radiological storage area" (RSA) posting as required by institutional procedure. A floor area within HERL used for storage of bagged radioactive waste was not posted as a radioactive material storage area and surveys of the floor underneath were not routinely performed. RMA and RSA boundaries were not always clearly delineated with rope or tape as required. In addition, localized work areas with potential for contamination were not being evaluated for contamination area postings because there are no clear institutional requirements for posting and control of localized contamination areas. In Building 70A, CSD laboratories with hoods, glove boxes, and bench tops routinely used for processing dispersible radioactive materials did not reflect radiological area postings of "contamination area" or "high contamination area" as applicable depending on contamination levels, or alternatively surveyed and released as clean areas following each use.
- In HERL, some air sampling is performed by the radiological control technician (RCT). However, the basis for this air sampling, including locations and activities to be sampled, is not documented so it is not possible to determine if the air sampling is adequate or representative. In addition, air-sampling requirements are not contained in the RWA as required by Procedure 713. At the facility level, there is no documented basis (i.e., through institutional technical basis guidance) for the lack of fixed air monitoring around workstations within HERL or against RWA classifications.
- Current LBNL radiological worker training for researchers who work with dispersible radioactive materials and who must wear PPE for protection against radiological contamination lacks appropriate contamination control practical factors demonstration such as laboratory PPE use, and spill and alarm response actions.

#### ***Core Function 4: Perform Work within Controls***

Independent Oversight witnessed various research related activities within CSD and generally found that workers and researchers were diligent about following prescribed controls when controls have been clearly conveyed through work control processes and/or training. A number of observed work activities were performed in accordance with established controls. For example, laboratory workers handling chemicals or radiological materials donned appropriate PPE including lab coats, gloves, and safety glasses as required. Individuals present in HERL were also diligent in use of the supplied hand and foot monitor and in donning required booties in addition to standard PPE for entry. A liquid nitrogen dewer transfer was performed in accordance with required controls including use of a face shield and cryogenic gloves, an operable oxygen meter with alarming function, and proper ventilation configuration during the transfer. Chemicals and radioactive materials in CSD labs visited were stored with appropriate secondary containment. Laser operators were extremely knowledgeable of their systems and followed proper safety practices including removal of metal objects and use of remote viewing tools and indirect viewing



methods during alignment activities. In general, conservative laser safety protocols were observed in laser labs including use of appropriate laser eyewear at all times even outside of nominal hazard zone and when laser beam was blocked.

As discussed in Core Function 2 above, a legacy posting was present on a hood in Laboratory 2229A that prohibited the use of radioactive materials in or near the hood because it was unfiltered. The reason the hood was considered “legacy” was that the named group/individual to contact for questions is no longer in existence (i.e., “contact your chemistry monitor”). However, postings are a control that must be followed or corrected if not accurate. The presence and disregard of such a posting for many years in a laboratory performing work that would violate the posting is an isolated indication of insufficient rigor in following controls or requesting clarification from safety and health disciplines before proceeding with work.

#### **C.2.4 Life Sciences Division**

The mission of the Life Sciences Division (LSD) is to contribute to strategic laboratory and national efforts in key human health issues including environmental effects of low-level exposure to ionizing radiation and toxic chemicals, nuclear medicine, neuro-degenerative diseases, bio-fuel production, and bio-remediation. LSD has four departments that focus on research in the following areas: bioenergy/GTL (formerly genomes to life) and structural biology; cancer and DNA damage responses; genome dynamics; and radiotracer development and technology.

The Independent Oversight team observed multiple work activities including research in selected laboratories at the Potter facility, Donner building and various buildings across the LBNL campus. Examples of research activities included cell and tissue manipulations (RNA isolation, protein analysis, cell incubation, cell exposure to x-rays or chemicals), metal oxide reactions, and various forms of sample preparations that include hazardous chemicals. Associated hazards and hazardous materials included bio-hazards (Bio-Level 2 facility); hazardous chemicals such as hydrofluoric acid, asphyxiant gases, and metal oxides; x-ray equipment and various industrial hazards such as hydrogen torch work, lead soldering, electrical work; and some minor shop activities. In addition to work activities, the Independent Oversight team reviewed the application of the JHA process, walked down laboratories and material and waste storage areas, and observed user training.

#### ***Core Function 1: Define the Work***

Work within the LSD is defined in a manner typical of research settings and includes a variety of documents beginning with some type of grant or research proposal. Institutional committees determine whether the science is in keeping with the laboratory mission and division directors determine if the work fits within the Division safety envelope, Division safety plans, and LBNL ES&H policies and procedures. The Division then uses mechanisms, including the JHA and safe work authorizations, to further outline how work is defined and authorized. However, as with other LBNL Divisions, these mechanisms have not been sufficiently implemented to ensure adequate work scope definition for some research work and activity level tasks. (See Finding #C-1.)

As part of the LBNL effort to improve and formalize the ISM process, LSD is working to improve its work control documents to include providing a clear definition of the work to be performed. Also, LSD departments are working to establish a more comprehensive hierarchy of documents to better describe the work at the group and individual task level. As part of this effort, LSD has recently improved various division work control processes including: JHAs, formal work authorization documentation (BUA, AHD, RWA), procedures and protocols, and mentoring/on-the-job training documentation. Additionally, LSD management has asked for input from LSD personnel to devise new and innovative ways to determine,

verify, and document hazards and controls and an LSD safety coordinator-led committee was recently formed to explore methods to enhance the institutional JHA and work authorization process.

Currently at LSD, the quality and consistency of the definition and scope of work at the group and individual activity level varies but is improving. Some JHAs have a comprehensive definition of work scope and includes work at the activity level, but LSD management recognizes that some JHAs do not have sufficient detail to define work scopes. The LSD Director has tasked personnel to better define and document their work tasks in the JHA and associated work authorization documents. The personnel interviewed are working toward that goal. The next set of revised scope of work definitions is scheduled for submittal to EH&S by September 2009. (See Finding #C-1.)

### ***Core Function 2: Analyze the Hazards***

Historically, LSD hazard analysis processes for such activities have been informal and LSD has relied on principal investigator/management expertise and walk-through, engineered controls (chemical hoods), EH&S support upon request, and EH&S processes and documents (e.g., PUB-3000 chemical hygiene plan) to ensure that hazards are analyzed and controlled. LSD has recently devoted significant attention to improving the rigor and formality of ISM processes, including JHAs and work authorization. These efforts have resulted in some improvements in hazard analysis for LSD activities. In addition, LSD and IH management recognize that improvements need to be made in the exposure assessment process including better procedures, improved data management and integration tools, and creation of similar exposure groups.

Many activities at LSD are laboratory scale experiments that use only small quantities of hazardous materials and LSD has analyzed some of the higher risk activities. Further, incidents related to chemical hazards are not currently problematic according to injury and illness reports. Observations and discussions with LSD workers indicated that principal investigators and staff were aware of most hazards at the activity level. In some instances, researchers performed their own analysis of hazards and/or determined the needed controls based on their own experience and judgment including glove selection, chemical compatibility, chemical storage, and waste management practices. In addition, there were a number of instances in which researchers contacted the EH&S Division with questions and for needed help with the hazard analysis process and the EH&S Division provided support.

Although improvements are ongoing, there are deficiencies in some aspects of hazard analysis at LSD; these deficiencies are similar to those at other LBNL divisions. There are no thresholds or criteria for contacting safety and industrial hygiene SMEs to ensure evaluations of the higher risk situations are adequately addressed. Safety walk-throughs and self assessments have not focused on specific work activities. As a result, some hazards, such as control of sharps, cryogen safety, ergonomic concerns, chemical inventory/chemical awareness, chemical storage (e.g., lead solder, secondary containment) are not always adequately analyzed. Within LSD, some common task activities that have not been specifically analyzed include use of high hazard chemicals (e.g., hydrofluoric acid), dust from crystal formulation, and work with lead. For example (see Finding #C-1):

- Hydrofluoric acid has long been used to clean glassware but this activity has not been sufficiently evaluated.
- Many areas in LSD facilities that use, store, and transport liquid nitrogen have not been evaluated for potential oxygen deficient conditions.
- The LSD machine shop has not recently been evaluated for noise or beryllium.

- An electronic fabrication room did not recognize the need to include lead solder in their chemical management inventory, has not had a recent evaluation of lead housekeeping practices, and may not have sufficient ventilation at the soldering work station which may indicate improvements are needed in both hazard recognition and hazard analysis at the activity level.
- Activities that use sharps such as razor blades, needles, and pointed tweezers have been improved but more analysis remains to prevent re-capping of needles, covers for tweezers, and storage of razor blades to further reduce lacerations and puncture wounds.

### ***Core Function 3: Develop and Implement Controls***

LBNL has developed an extensive ES&H manual and chemical hygiene plan document that addresses most hazards and controls common to the laboratory. However, additional detail on some topics such as cryogen safety, chemical safety (e.g., acids, carcinogens, lead, other high hazard chemicals) and sharps safety would be useful. For example, the oxygen-deficiency hazard with liquid nitrogen is not addressed in PUB-3000, recapping needles is only addressed informally at the Division level, some aspects of chemical safety such as emergency procedures are not risk specific, and hydrofluoric acid is not addressed. (See Finding #C-4.)

LSD has published a safety plan that effectively outlines the roles and responsibilities of managers, principal investigators, safety coordinators, committee members, researchers, students, and guests. Principal investigators are responsible for ensuring that all ES&H requirements are understood and followed. Employees and guests are expected to work safely, follow all ES&H regulations, watch out for others, and cooperate with safety officials. Awareness training for common laboratory-related hazards is mandatory and must be completed before work is authorized. Specific on-the-job training is required for students or new employees and a more formalized on-the-job process is being developed to better document content and effectiveness. The collective involvement of these various groups and disciplines enhances safety processes such as walk-downs, training, and mentoring.

Engineering and administrative controls were in place and used by employees. Many potentially hazardous work activities are performed in chemical hoods, interlocks were installed in hazardous equipment such as x-ray apparatus, postings were in place and most recently procedures and protocols were being modified to include hazard and control information. Mandatory training was routinely included in the JHA and, for all work observed, individuals were current with required training. LSD managers are required to sign documents that confirm on-the-job training/mentoring has been completed; however, no formal process has been established to define information that must be included in the on-the-job training. (See Finding #C-4.)

In several areas, LSD management has developed and implemented effective controls for LSD laboratories. Building on the new LBNL PPE requirements, LSD established a safety eyewear program that facilitates the use of comfortable prescription and non-prescription safety glasses that has improved usage of safety eyewear. LSD developed a detailed bio-safety, security, and incident response plan, as required for Bio-Level 2 activities. LSD has been proactive with the implementation of the LBNL ergonomic control program; LSD has the highest number of trained ergonomic advocates to help office workers assess and modify their office work stations and assist with ergonomic upgrades to research related work at microscope stations and bench operations. LSD also added a Division safety/IH professional to help determine and document the adequacy of controls throughout the Division, train managers and safety coordinators to better recognize hazards during safety walk-throughs, and support the institutional ES&H Division concerning the need for the development and implementation of controls.

LSD is currently working to improve their process for capturing and documenting task specific hazards and controls. LSD management recognizes that the current JHA process is somewhat difficult to use, has thresholds that may not recognize/capture specific hazards, and is not able to integrate information from other systems such as chemical inventory or high hazard work documents/permits.

#### ***Core Function 4: Perform Work Safely Within Controls***

Based on work observations and discussions, laboratory personnel (e.g., principal investigators, researcher, students, and technicians) have a strong awareness of the hazards and controls necessary to work safely in LBNL labs. When controls are specified in work documents or postings, workers follow the controls for work reviewed by DOE Office of Health, Safety and Security (HSS). Although not all procedures and protocols have been modified to include activity specific hazards and controls, work leads and supervisors were required to discuss and document that each worker was adequately trained to work in a safe manner.

In recent months, LSD management has devoted extensive effort to improving safety management, including two formal safety stand-downs. The safe performance of work within controls was discussed, validated, and emphasized by all LSD departments. Activities such as training, JHA development, chemical hygiene, chemical inventory reduction, postings, spill kits, and MSDS reviews were emphasized to all staff and improved through staff feedback. Procedures and protocols were revised and documented and hazards, along with controls, were validated and discussed by supervisors. On-the-job training was discussed by managers and staff. The majority of the division personnel who were interviewed indicated they believe that the stand-down exercise was beneficial, although some staff did not demonstrate a full understanding of the value of the ISM core functions to reduce activity-level risks.

#### **C.2.5 Maintenance and Fabrication**

Maintenance at LBNL is managed and conducted primarily by the Facilities Division. Maintenance functions include custodial, gardening, and lighting; electronics repair; operation, service, and repair or replacement of equipment and utility systems; and construction of modifications, alterations, and additions to buildings, equipment, facilities and utilities. Logistical support services include bus and fleet management, mail distribution, material and stores distribution, property disposal, and cafeteria operations. Ongoing Facilities Division activities include renewal and upgrade of site utility systems and building equipment. Maintenance activities are performed by approximately 39 maintenance employees. In fiscal year (FY) 2008, Facilities Division completed over 18,800 work orders.

Fabrication activities at LBNL are managed and conducted primarily by the Engineering Division. Fabrication functions include metal working such as machining, assembly, cutting, grinding, welding, surface cleaning plating, electronics assembly, etc. Ongoing Engineering Division fabrication activities include support to both LBNL research and operational divisions. A work request system and walk-in type support is provided for fabrication-related work. Fabrication activities are performed by approximately 34 Engineering Division employees. In FY 2008, Engineering Division completed over 6,300 fabrication type work orders.

ISM is incorporated into the maintenance and fabrication planning process through the use of maintenance service requests, work orders, and individual worker JHAs. Customers initiate maintenance requests by a computerized work request system or call-in center, and fabrication work requests directly with the Engineering Division work leads or supervisors. The maintenance work requests are processed through a work lead or supervisor in accordance with the Facilities Division maintenance work planning process.

Independent Oversight evaluated work performed by Facilities Division in facilities located throughout the site including laboratory, operations, support facilities, maintenance shops, and several other buildings, and included preventive and corrective maintenance activities. Work observed during this inspection included fabrication performed by different Engineering Division shops, inspection of shop work areas, and reviews of completed work orders. Specific tasks that were evaluated included preventive and corrective maintenance on fan units, chillers, compressors, and pumps; electrical maintenance; troubleshooting; inspection of equipment; fabrication of metal components; assembly; component cleaning; application of surface coating; electronic assembly; and tool repair.

### ***Core Function 1: Define the Work***

The scope of work for Facilities Division maintenance requests and Engineering Division work requests, work-in shops, and related fieldwork activities are typically minimally defined for most activities. Therefore, the process relies largely on the respective Division's supervision, safety coordinators, and/or craft personnel involvement in this process to ensure appropriate hazard analysis. For work orders or maintenance requests, work definitions were typically brief, and accuracy and detail vary depending on the expectations of the supervisors and workers. Work scope relies heavily on verbal direction of supervisors or is based on direct customer communication with the individual performing the work. Work orders for larger jobs may contain more detailed work descriptions, typically in the form of drawings. For work evolutions requiring the integration of maintenance crafts with construction or facility (customer) staff members, supervision or craft personnel sometimes conduct walk-downs to gather additional information. However, Facility Division supervision and/or craft personnel do not typically visit the job site and perform a walk-down to fully understand the scope of work before commencing work. Current efforts are underway to strengthen the work planning process through adding work schedulers/planners.

The work groups identified in support of the JHA process considered the broad definition of work potentially conducted by both the Facilities and Engineering Divisions. Additionally, each group was consulted for input into the development of the work groups currently in use. However, the JHAs typically were not sufficient to define the work at the activity level. (See Finding #C-1).

### ***Core Function 2: Analyze the Hazards***

The JHA is the primary means of hazard identification and analysis across the Facilities and Engineering Divisions. It is structured to identify work group tasks, determine the hazards associated with that task, and then identify the controls necessary to minimize or eliminate the hazards. However, JHAs contain only very general discussions of the tasks and potential hazards, do not link directly to sub-tasks or activities being performed for specific jobs, and do not identify the specific controls for many assigned tasks. LBNL PUB-3000, Chapter 32, Appendix C, Sub-part C.3, *The Task-based Job Hazard Analysis*, states, "Examples of situations that might be appropriate for a Task-based JHA include: Work requests through the Facilities Division." However, task specific JHAs were not issued or in use by the Facilities Division for the activities reviewed during the Independent Oversight inspection.

The Facilities Division work control process tool (Maximo) primarily appropriately uses four levels of work authorization and ties the required hazard analysis to that work authorization level. Most work orders contain some information about hazards and associated control in the form of precautions. These typically make reference to the need for hearing protection (based on location) or additional permit or training requirements (e.g., hot work permit and training).

The lack of detailed hazard analysis in activity-specific JHAs results in a heavy dependence on individual craft knowledge of the hazards, and has resulted in some hazards not being adequately addressed during the course of work. For example (see Findings #C-1 and #C-2):

- Many JHAs routinely list noise controls under hazard categories such as “working in a high noise area” and routinely provide only generic hazard controls such as “comply with the postings at the entrance(s) to the high noise area, wear hearing protection per posting, and direct any questions to LBNL-EH&S.” Some of these locations are not posted or the postings contain no actual level or stay times. Workers do not have the expertise or equipment to analyze the noise hazard potential without data and thus may use inadequate hearing protection, (e.g., no hearing protection when needed or the use of single hearing protection when the actual noise levels and duration would require double hearing protection).
- LBNL maintenance and fabrication workers routinely use materials or have materials available for use in their daily operations that have hazardous constituents (e.g., lead containing solder, grinding wheels containing naturally occurring radioactive materials, and various cutting fluids or lubricants). The JHA for these workers makes no specific mention of these hazards or associated controls.
- For a maintenance work order to repair a motor (e.g., replace bearings) in a shop area, workers used an induction heater to heat bearings before placement on the motor shaft. However, the hazards associated with potential for magnetic fields and manufacturer's warnings, including those to protect workers with pacemakers against hazards, were not evaluated in the JHAs for the individuals conducting the work.
- Some cleaning fluids, lubrication fluids, cutting fluids, brake fluids, machining coolants, dielectric fluids, etc., contained potentially hazardous chemical constituents for which exposure assessments or other IH reviews of the use of these materials have not been conducted or were not made available to supervision.
- For a roof blower motor trouble shoot and repair, the JHA and work order did not include the need to assess potential for chemical or radiological contamination prior to performance of the work. Although the supervisor obtained a radiological status by email, no information on chemical hazards was provided. Furthermore, the JHA did not link to the hazard management system database for this information.
- Exposure assessments for some materials, such as hexavalent chromium, are not specific to the material being used. For example, tungsten inert welding (TIG) was observed with 304 stainless steel base material and 308 filler wire (see below), which generates potentially hazardous fumes. No local ventilation was present, and the JHA did not specifically address this potential hazard.
- Review of IH data and exposure assessments conducted for fabrication activities indicates that monitoring has been conducted in the past (dating back as far as the early 1990s), resulting in some recommendations for additional PPE (e.g., 1/2 face respirator, hearing protection). However, the recommended PPE is not reflected in the JHAs for individual workers performing the same task. Additionally, some exposure assessment data reflects dated national standard limits that have since been lowered (e.g., chromium versus hexavalent chromium, or permissible exposure limits [PELs] versus threshold limit values [TLVs] for noise). Additionally, in some instances sampling has been conducted (e.g., TIG welding of stainless steel) but the documentation does not contain sufficient information and this cannot be reliably used to determine if the sampling is appropriate to control the work for a similar task (e.g., the task involves a base metal and filler material with a lower percentage of chromium content than the samples for which LBNL has data, and thus is bounded by the sample).

Exposure assessments for some activities observed, such as those for cutting fluids, have not been conducted.

### ***Core Function 3: Define and Implement Controls***

Facilities and Engineering Division crafts use a variety of controls at times during their work activities. Controls include lockout/tagout, hot work permits, penetration permits, fall protection, safety glasses, voltage rated gloves, hard hats, and other PPE and clothing.

With some exceptions, the process for coordinating and controlling electrical work is sufficiently established and implemented through LBNL electrical safety procedures. Many work activities were observed to be conducted in accordance with most requirements established LBNL procedures. However, some deficiencies were noted in identification and implementation of lockout/tagout controls during electrical work (see Finding #C-5):

- No zero voltage verification of a blower motor or zero energy check was performed by the plant maintenance technician before conducting hands-on work on the equipment internal components (i.e., attempt to bump the motor after opening the switch and applying the lockout/tagout).
- A plant maintenance technician was observed holding wires and providing hands-on assistance to an electrician, without having been on the actual lockout/tagout in place at the time of the work.
- Maintenance established temporary wiring in support of a generator repair, but the wiring was not established in accordance with LBNL and OSHA requirements. Electrical cords were in a daisy-chained configuration, several cords were fed through louvers in a wall to the generator positioned outside the building, and numerous wires were laying on the floor unprotected and resulting in a trip hazard.
- During an LBNL lockout/tagout, the electrician who conducted the initial opening of a breaker in Building 50 did not follow the entire stipulated category 0 PPE against arc flash. The worker was wearing an outer jacket that was not constructed of non-melting fibers (i.e., a fleece over the work uniform).
- A construction subcontractor verifying an LBNL lockout/tagout zero energy check did not wear appropriate PPE in accordance with National Fire Protection Association (NFPA) 70E and the individual did not test his volt meter to a known reliable source either before or after the zero voltage check to verify functionality of the meter.
- During conduct of a maintenance work order to provide lockout/tagout to vendor warranty service of a recently installed cooling water system for LSD at Building 55A, the vendor for the equipment had no JHA for work at LBNL so Facilities Division heating, ventilation and air conditioning (HVAC) mechanics conducted the lockout/tagout and troubleshooting activity under the direction of the vendor's representative. Although the HVAC technician verified arc flash category (category 0), used the required PPE for the lockout/tagout, and appropriately implemented lockout/tagout, the individual failed to check the meter used for the zero energy verification to a known source (to ensure operability) following de-energizing and prior to attempting to conduct work within the equipment. Additionally, the worker was unfamiliar with this requirement, as the training provided does not address this verification.

Following the above observations, LBNL filed an Occurrence Report (Number: SC-BSO-LBL-OPERATIONS-2009-0001) “Failure to Follow lockout/tagout Procedures During HSS Review – No injuries.”

JHAs typically identify PPE as a necessary control, but do not indicate the specific PPE needed and the tasks or activities that require PPE. For example, some JHAs refer to “wear gloves” or “wear gloves appropriate to the hazard” without identifying what type of gloves (e.g., leather, surgical, cotton, rubber, or electrical). This example is also applicable for controls such as “follow MSDS or PUB-3000 Chapter requirements.” This practice requires the worker to determine the specific PPE to be used at the time of work. Another example of insufficiently defined controls are those for noise hazards in the many LBNL JHAs for maintenance and fabrication activities; these JHAs do not provide sufficient notification to workers of potential noise hazards or notify them of areas which require hearing protection or could place workers at risk of unnecessary exposure. (See Finding #C-1.)

Some controls referenced in LBNL division-level procedures and/or JHAs have not been developed or implemented as listed on the work authorization (JHA and/or work order) before conducting the work. For example (see Finding #C-1):

- A new machinist had not completed all the training required by the JHA. Training deficiencies for this individual included key job elements such as working with chemicals. However, the individual was allowed to work with materials such as cutting fluids and other chemicals. Subsequently, the individual was required to complete training and the JHA was updated accordingly.
- A few JHAs for machinists did not include hazards and controls for working or using tools with exposed sharps, even though this a primary hazard for the work being performed.
- The JHAs for designated lead workers forming lead in the machine shop reference controls contained in a compliance plan; however, this plan has not been developed.
- During a pump motor replacement, two workers needed to manually move a large motor. No information was provided about weight of the motor (e.g., whether it was within their 50-pound maximum) or the lifting practices or tools needed for this task.
- Site wall penetration requirements were either inadequate or unclear and were not followed. The worker's JHA required a penetration permit for depths greater than 1-5/8 inches. However, the work included placing 2-inch screws into dry wall with no verification of electrical utility locations (the wall had outlets, indicating that electrical conduits could be within the wall). Additionally, in some instances no drill stops were used to ensure that the holes drilled into the walls did not exceed 1-5/8 inches. The worker used a magnet to identify stud locations but not an electronic line/stud finder, and thus some hazards could be missed.

#### ***Core Function 4: Perform Work within Controls***

A number of work evolutions observed by Independent Oversight were performed safely and in accordance with established controls. Examples include HVAC trouble shooting, hot work, fabrication, cleaning and surface coating of components, electrical breaker replacement, plumbing repair, and several lockout/tagout evolutions. With some exceptions, workers demonstrated a good understanding of EH&S requirements and a willingness to follow them. Work is authorized only after an approved work order is issued to craft workers by line supervisors. These work orders may be provided in groups of assignments for the day or a given week, or on an individual task basis. Turnover meetings are held each morning by Facilities Division to discuss prior shift carry over and proposed activities.



Although many activities are performed safely, some deficiencies were identified in work performance. Turnover meetings do not contribute significantly to the readiness to perform work safely because no additional work planning is performed and no additional documentation or work scopes are developed for use by workers. Pre-job briefs or tailgate meetings are not routinely conducted by craft supervisors, and workers were not observed to reference JHAs while performing work in the field. Controls were not always followed including the following examples observed by Independent Oversight (see Finding #C-1):

- During a maintenance work order for carpenter work (hanging and removal of shelves and office equipment), the worker did not follow ladder safety practices listed on the JHA and/or presented in the LBNL site ladder safety training. Poor practices included working in a direction 180 degrees away from the intended direction (e.g., back facing into the ladder, one foot on the ladder and one foot in the air while pressing a knee against a white board to maintain its position while screwing it into place) and working with both hands on movable surfaces (e.g., not maintaining three-point contact).
- Another ladder safety-related deficiency was observed during LBNL personnel inspection of a roof on Building 17 to determine appropriate fall protection. The ladder used for the roof access (24-foot extension ladder) was appropriately tied off and extended beyond the edge of the roof surface; however, the safety information on the ladder was obscured by labels such that the inspector could not verify safety information, such as inspection dates. This situation was not noted by the inspection prior to use by the worker.
- For an HVAC maintenance work order to trouble shoot and repair dampers on the air supply to the cafeteria conference room, work was conducted in a basement utility room. The work order required hearing protection but the worker did not wear hearing protection. Additionally, the MSDSs for the chemicals in use during this activity had not been reviewed by the worker before starting work and the work involved chemicals he had not utilized previously. The worker did not use PPE (i.e., protective gloves) during the course of work and was observed to wipe chemicals from his hands with a rag during the course of work. The MSDSs for the chemicals observed listed nitrile or neoprene gloves for skin protection.
- For fabrication activities in Building 77, Quick Turn Around Shop, a worker operated a lathe with loose-fitting clothing (hooded sweat shirt) with a dangling draw-string neck enclosure, which represented a choking or entanglement hazard if caught in the rotating equipment. The area was posted as prohibiting loose fitting clothing.
- A hot work permit was violated by a Building 77, Sheet Metal Shop, where an R&D fabrication worker conducted a welding activity. The permit required a fire watch and presence for 1/2 hour after work stoppage. However, the worker was working alone without an assigned fire watch, and the worker vacated the area immediately following welding to go to another work area (out of site of the welding location) within the building. When questioned, the individual believed he could self-perform these activities and thought that the 1/2-hour time requirement was met as long as he did not weld 1/2-hour before leaving the area.
- During an ALS storage ring roof block removal and replacement, riggers were working at an unprotected edge with a fall potential of greater than six feet without fall protection. According to interviews, this has been a long-standing practice.
- A machine worker operated a computer-controlled fabrication machine with a red warning light illuminated and flashing due to the interlock being in the release position. The marking placard on

the light had the following statement "Warning Never Operate Without Safety Door Interlock Switch In "Normal" Position Failure To Do So Could Cause Serious Injury Or Death." The worker stated he believed the door could not be opened, and demonstrated the door could not be opened, so he thought the equipment could be operated with the key in the interlock released position. The supervisor instructed the worker that the key needs to be maintained in the normal position during operation in accordance with the warning and manufacturer's manual.

## **C.2.6 Construction**

Construction work at LBNL is managed by the Facilities Division and performed by LBNL employees and subcontractors. Subcontractors perform essentially all of the work on large capital projects (greater than \$5M capital cost). Work on smaller projects is performed by subcontractors (including a labor-only contractor and two job-order contractors) and by LBNL employees. Large capital projects that were inspected included demolition of Building 51, construction of a user support building for ALS, and seismic upgrade of Building 50. Small projects inspected included construction of library work stations in Building 50, construction of offices in Building 71, construction of an enclosure inside Building 72A to house a large electron microscope, and construction of a utility center at Building 77.

### ***Core Function 1: Define the Scope of Work***

To assess performance in this area, the Independent Oversight team reviewed contract documents, procedures, and records and observed work activities to determine whether the broad scope of work in construction projects has been divided into work tasks with sufficient detail to support task-specific hazard identification and analysis.

The scope of subcontracted work is defined in contracts, drawings, and specifications and tasks to be performed within this scope of work are defined in task-level JHAs, which are prepared by subcontractors and approved by LBNL. The scope of construction work performed by LBNL employees is defined on work orders issued by the requesting organization (typically the Facility Division construction manager).

Subcontracted construction work is defined in sufficient detail to support effective identification of hazards and controls. Contracts require JHAs for most subcontracted work to be prepared and submitted to LBNL for approval, and guidance for implementing this requirement is included in start-up kits that are provided to new construction subcontractors. The scope of planned work is adequately defined in contracts, drawings, and specifications and tasks to be performed within this scope of work are defined in JHAs, which are prepared by subcontractors and approved by LBNL. Workers are briefed on planned tasks during pre-job briefings and, for large capital projects, during daily planning meetings.

Construction work performed by LBNL employees is not well defined in work control documents. The work is defined on work orders and in verbal communications; however, procedures do not specify the extent to which work is to be described and the work descriptions documented on work orders is not sufficient to define the scope of work or to support systematic analysis of hazards. For example, one description stated "Add subpanel to 25A6A. See Matt for more information." PUB-3000, Chapter 32, provides a process for preparing individual baseline and task-based JHAs for LBNL employees. Individual baseline JHAs have been prepared for each employee performing construction work but these JHAs do not describe tasks to be performed on a particular job. Task-based JHAs are not typically prepared for construction activities performed by LBNL employees. (See Finding #C-1.)

## ***Core Function 2: Analyze the Hazards***

Independent Oversight reviewed the hazards identified in work control documents and observed work activities to assess the adequacy of hazard identification and analysis and to assess the extent to which workers were informed of workplace hazards associated with construction activities.

LBNL has established several mechanisms for identification and analysis of hazards associated with construction work. Hazards associated with subcontracted work are identified and analyzed through requests for proposal and pre-bid and pre-start meetings. Requests for proposals describe potential hazards in the work environment. Pre-bid meetings, which are conducted before work begins, include a discussion of site-related hazards that may be encountered. Pre-start meetings, which are also conducted before work begins, include additional discussion of site-related hazards as well as discussion of work-related hazards and controls. LBNL has also established work order and JHA processes for identification and analysis of hazards associated with construction work performed by LBNL employees. A work control software tool (Maximo) identifies hazards on work orders. Procedures require hazards encountered by LBNL employees on a regular basis to be identified on a baseline JHA and hazards associated with work that is unpredictable, short-term, or unusual to be documented on a task-based JHA.

Implementation of the above mechanisms is effective for large construction projects. Hazards that may be encountered are identified in requests for proposals and are discussed in pre-bid and pre-start meetings. Worker involvement in hazard identification is encouraged during daily planning meetings and safety professionals are involved in hazard analysis when needed. With few exceptions, hazards were adequately addressed in work control documents reviewed during this inspection. JHAs are prepared by subcontractors, approved by LBNL construction managers, and signed by workers for subcontracted construction projects that meet the criteria specified in Chapter 10 of the LBNL ES&H manual. These JHAs describe the potential hazards associated with each phase of planned work. A few exceptions to this generally good performance were identified on the JHAs for one construction project (Building 71 remodel).

The Facilities Division recently identified the need to strengthen control over construction work performed by LBNL employees; however, at the time of this Independent Oversight inspection corrective actions were not sufficiently developed or implemented to ensure compliance with the above 10 CFR 851 requirements. Procedures for developing individual baseline and task-based JHAs for work performed by LBNL employees do not fully comply with 10 CFR 851 in that they do not require JHAs for construction work to be approved by a construction manager, and some JHAs for construction work observed during this inspection were not approved by a construction manager.

Hazard analysis is adequate for much of the work performed on smaller construction projects. Much of this work is of limited scope, is within the skill of the craft, and is enveloped by subcontractor JHAs and LBNL individual baseline JHAs. Examples of such work include assembling office cubicles, installing an electrical receptacle, and building book shelves. LBNL has provided support to small contractors in the area of hazard analysis. For example, on a number of occasions, LBNL has supported subcontractors in analyzing and monitoring potential exposures to hazardous materials.

However, hazards are not always identified with sufficient detail on work orders or JHAs for work on small projects performed by LBNL employees. For example, hazards identified on a work order for installing an electric circuit at ALS include “acutely toxic, carcinogen, combustible liquid, corrosive, flammable gas, flammable liquid, flammable solid, highly toxic, irritant, particularly hazardous substances, reproductive toxins, pyrophoric” and others. The precaution was to coordinate with room occupants to determine if the work could be performed safely. This work was performed without a task-based JHA. It is unlikely that the electrician would encounter all of these hazardous materials. The same

hazards and precautions were specified on a work order for unclogging a toilet in the Molecular Foundry. More effective planning would have identified the actual exposure hazards and the specific controls required. (See Finding #C-1.)

### ***Core Function 3: Develop and Implement Controls***

Independent Oversight reviewed programs, procedures, and JHAs and observed work to determine if adequate requirements and controls were developed and implemented to mitigate identified hazards.

LBNL has established a comprehensive set of safety requirements in the LBNL EH&S manual and in construction subcontracts that reference this manual. Additional requirements applicable to subcontractors are included in subcontractor health and safety plans that are reviewed and approved by LBNL. Subcontractors are required to comply with applicable Federal and California OSHA requirements, 10 CFR 851, DOE Policy 450.4 (*Safety Management System Policy*), and the requirements in subcontractor health and safety plans. While this set of requirements is comprehensive, some of the requirements are not appropriate for subcontractors and LBNL does not expect or enforce compliance. For example, LBNL does not expect subcontractors to submit worker safety and health programs to DOE for approval as specified by 10 CFR 851.11, and does not expect subcontractors to follow the JHA requirements specified in PUB-3000, Chapter 32, even though these requirements are imposed by construction subcontracts.

Inconsistencies between LBNL-approved subcontractor site-specific health and safety plans and the LBNL EH&S plan indicate a lack of rigor in the LBNL review of subcontractor plans. For example: (1) subcontractor health and safety plans do not require the posting of high noise areas as specified in PUB-3000, Chapter 10; (2) the lockout/tagout procedures in two subcontractor health and safety plans do not meet NFPA 70E or PUB-3000, Chapter 18, and the lockout/tagout training required by Chapter 18 is not included in a listing of required training in one of the plans; and (3) the hearing protection requirements specified by the Building 51 Health and Safety Plan reference OSHA permissible sound levels, which are less conservative than the American Conference of Governmental Industrial Hygienists (ACGIH) TLVs required by Chapter 10. (See Finding #C-1.)

LBNL requires all lockout/tagouts to be performed in accordance with PUB-3000, Chapter 18,. Chapter 18 provides lockout/tagout requirements that meet OSHA regulations and most NFPA 70E requirements. A few inconsistencies between NFPA 70E and Chapter 18 were identified. Specifically, Chapter 18 permits working on a cord and plug device without lockout/tagout when the work extends beyond a single shift, but NFPA 70E does not.

LBNL has also established work control process requirements for construction work. Construction subcontractors are required by contract to identify applicable controls on safety checklists and JHAs and to submit these documents to LBNL for approval prior to the start of work. LBNL provides guidance for developing these documents in a start-up kit given to each construction subcontractor before work begins. Contracts also require subcontractors to conduct informal toolbox safety training at least monthly. Controls applicable to work performed by LBNL employees are identified on individual baseline and on task-based JHAs developed pursuant to PUB-3000, Chapter 32.

Implementation of the above work control processes for large subcontracted construction projects is more rigorous than contract requirements. JHAs (in the form of pre-task hazard analyses and integrated work documents) are prepared daily and are reviewed with workers before the start of work each day. These JHAs specify appropriate controls for identified hazards. PPE requirements are consistent with MSDS recommendations, and permits for hot work, excavations, energized electrical work, and lockout/tagouts are specified when required.

The JHAs for smaller subcontracted projects meet contract requirements. They are prepared by subcontractors and approved by LBNL before the start of work and include most applicable controls. A few controls specified on these JHAs were not in accordance with PUB-3000, Chapter 10 or approved contractor health and safety plans. For example, the JHA for pouring concrete on two projects did not require the use of wire mesh face screens, which are required by Chapter 10, paragraph A.19.4, to prevent caustic burns to the face and the workers did not use face screens. As previously discussed under Core Function 1, the JHAs for LBNL employees do not always describe specific construction tasks to be performed and consequently they do not specify the controls applicable to these tasks. (See Finding #C-1.)

Engineered controls were used by construction subcontractors to reduce hazards. For example: local ventilation was used to control welding fumes; electric drills were equipped with dust collection systems and HEPA filtered exhausts to control silica exposures; and a non-slip polyethylene moisture barrier was used as a ground cover to reduced the potential for slips and falls.

Much of the construction work performed by LBNL employees is within skill of the craft and is adequately addressed in individual baseline JHAs. However, some work involves hazards not normally encountered and, as discussed above, work requests and JHAs for this work do not always define tasks and hazards well enough to support specification of required controls. For example, several work orders for electrical work at the ALS facility identify numerous hazards associated with exposures to hazardous materials, but the materials are not identified and the required controls (e.g., coordinate with room occupants) lack detail. (See Finding #C-1.)

All construction work is managed by LBNL construction managers who are line managers responsible for safety. These individuals demonstrated a good understanding of construction trades and of LBNL requirements and expectations for safety and compliance. In addition, safety professionals from the EH&S Division perform daily inspections of construction activities and issue daily reports to Facility and EH&S Division managers. The attention to safety by construction managers and safety professionals was evident in jobsite conditions such as effective access controls, up-to-date and complete training records, appropriate postings of permits and PPE requirements, and a workforce that understands the expectation to work safely.

Expectations for oversight of apprentices by journeymen craftsmen have not been adequately defined by LBNL and are not well understood. An apprentice electrician handled exposed conductors in a junction box without participating in a lockout/tagout for the circuit on which she was working. This practice violated LBNL and subcontractor lockout/tagout programs. The journeyman electrician providing oversight acknowledged that he was responsible for the apprentice's work but did not have a clear understanding of her level of experience or qualifications. LBNL has not established written guidance or requirements for the oversight of apprentices by journeymen. (See Finding #C-1.)

#### ***Core Function 4: Perform Work Safely Within Controls***

Independent Oversight observed construction work to assess the safety of work practices and compliance with controls in subcontractor programs, permits, and JHAs.

On large construction projects, daily meetings are used effectively to remind workers of hazards and controls before the start of work each day. Documented hazard analyses are used as a guide in conducting the meetings. Safety professionals were present for meetings attended during this inspection. Hazards that may be encountered are discussed. Briefings are conducted in both English and Spanish, when appropriate. Worker participation in these discussions is encouraged. JHAs, including pre-task hazard analyses and/or integrated work documents (IWDs), are signed by the workers following the

meetings. Tailgate safety training meetings are conducted at least weekly for small projects as required by construction contracts.

Most observed work was performed within established controls. Required PPE was consistently worn, permits were obtained and posted when required, and requirements specified on permits were followed. Workers were properly trained and subcontractor training records were maintained at each jobsite to demonstrate that training requirements were met. A noted exception involved an apprentice electrician working on a circuit that had been locked out by others without hanging her personal lock. As discussed above, a lack of clear expectations for oversight of apprentices by journeymen contributed to this event. (See Finding #C-1.)

Supervisors and workers understood that they were expected to work safely and, with few exceptions, work was performed safely in accordance with established controls. Workers carefully hand-dug excavations for which hand digging was required. Operators of forklifts and other heavy equipment were properly trained and exercised caution when pedestrians were near their work areas. Workers participated in daily planning meetings, identifying hazards and suggesting controls. Workers frequently pointed out hazards to visitors in their work areas. Supervisors provided appropriate PPE to their employees and made it clear that safety was more important than schedules.

A few isolated practices were observed that did not conform to safety requirements. One individual did not maintain three points of contact while working on a ladder more than six feet off the ground and some extension cords were not properly managed.

### **C.3 OPPORTUNITIES FOR IMPROVEMENT**

This Independent Oversight inspection identified the following opportunities for improvement. These potential enhancements are not intended to be prescriptive or mandatory. Rather, they are offered to the site to be reviewed and evaluated by the responsible line management organizations and accepted, rejected, or modified as appropriate, in accordance with site-specific program objectives and priorities.

#### **LBNL – Institutional – EH&S Division**

**1. Continue to strengthen application and use of the JHA process in defining manageable and discrete work scopes, analyzing associated hazards, and more effectively tailoring JHAs with specific controls applicable to the work.** Specific actions to consider include:

- Revise EH&S manual to provide additional detail on acceptable work scopes and task listings and level of detail needed for hazards and controls. Migrate away from the use of hazard-based task listings with a goal of activity-based task listings.
- Provide better definition on the boundaries of individual JHAs, which should primarily be used to envelope “skill of the craft” or “skill of the researcher” type activities in which selection of appropriate controls do not require input from outside sources and can be safely chosen based on education and training. Ensure appropriate linkage to the specific training or education requirements.
- Establish criteria for developing task-based JHAs or other safe work authorizations when work involves hazards that require additional input from outside sources, such as review by an SME, or otherwise may involve the need for exposure monitoring.

- Consider adding another column to the JHA defining the implementation strategy for the listed controls (e.g., training course, qualification card, pre-job brief, procedure, protocol, etc.).
- Establish a mechanism that ensures a timely update to JHAs when institutional requirements that may impact approved JHAs change.
- Provide training to LBNL divisional supervisors and work leads in the development and use of JHAs.
- Establish a JHA working group with representation from LBNL divisions for feedback and improvement on the JHA process.
- Include guidance within PUB-3000, Chapter 32, *Job Hazard Analysis*, on the following topics: the level of detail of hazard identification expected in a JHA, the application of a risk-based approach to developing and approving JHAs, and guidance on “risk thresholds” and when a JHA may no longer be adequate as a result of introducing a greater hazard or risk to workers.

**2. Continue the development and implementation of the LBNL IH Exposure Assessment Strategy.**  
Specific actions to consider include:

- Develop a detailed IH exposure assessment strategy for non-radiological hazards (e.g., chemicals, noise, non-ionizing radiation, biological hazards, etc.) that addresses how the LBNL exposure assessment process is to be performed, the technical basis of the program and the exposure assessment methodologies, and methods for achieving LBNL commitments in the LBNL Worker Safety and Health Program and 10 CFR 851.
- Incorporate, as appropriate, recent exposure assessment guidance from the AIHA and the National Institute for Occupational Safety and Health (NIOSH) including the use of Bayesian statistics, to determine sampling adequacy to achieve a 95 percent confidence level.
- Establish guidance and protocols for conducting and documenting qualitative and quantitative exposure evaluations for all potential workplace stressors (e.g., chemicals, noise, ergonomic hazards, vibration, heat and cold stress, etc.) based on the guidance in the IH exposure assessment strategy.
- Integrate the various exposure assessment methods for chemicals, noise, non-ionizing radiation and biological hazards into a single IH exposure assessment strategy.
- Perform and document qualitative and/or quantitative exposure assessments on all LBNL work areas and operations construction work activities that are likely to exceed the thresholds for initiating such exposure assessments as documented in the IH exposure assessment strategy.
- Develop or refine a user-friendly exposure database and ensure that the results from qualitative and quantitative exposure assessments are entered for all non-radiological hazards.
- Ensure that any hazard controls recommendations resulting from conducting qualitative and quantitative exposure assessments are incorporated into LBNL work documents or individual JHAs.
- Establish a well-defined plan and schedule, including resource needs, for developing and implementing the IH exposure assessment strategy.

**3. Develop and implement a more robust procedure/program for laboratory hoods and local exhaust systems.** Specific actions to consider include:

- Establish and document operating guidance for staff that use chemical fume hoods, biological safety cabinets, or local ventilation exhaust systems. Consider guidance already established by other DOE laboratories as well as guidance provided by UC.
- Develop and provide training for users of chemical fume hoods, biological safety cabinets, and local exhaust ventilation systems to address scope and limitations, design principles, and safe operation and testing.
- Update the LBNL hood calibration and testing guide to incorporate and document the technical basis for conducting such calibrations. Evaluate and incorporate industry guidance into the technical basis, such as ANSI/AIHA Z9.5, *Laboratory Ventilation*.
- Consider the establishment of a dedicated, trained, and qualified staff technician to perform the testing and calibration of chemical fume hoods.

**4. Consider the development of a PBD ES&H or chemical hygiene manual to supplement the guidance provided in LBNL PUB-3000 for those activities that need greater clarification.** Specific actions to consider include:

- Expand the scope of the existing JBEI Environmental, Health and Safety plan to include other PBD laboratories, and/or develop a comparable but separate ES&H plan for these labs.
- For those ES&H topical areas in which PUB-3000 lacks detail, provide additional guidance for PBD staff. Examples include mentoring and on-the-job training, labeling of chemical mixtures in secondary chemical containers, etc.

**5. Consider development of an institutional-based training course for the purchase, storage, and use of hydrofluoric acid.** Specific actions to consider include:

- Ensure general chemical training courses and postings associated with this hydrofluoric acid are consistent across LBNL and validated by health services and IH.
- Ensure that local training for hydrofluoric acid at individual Divisions is consistent with institutional requirements and training and addresses the concerns of individual users.

**6. Increase emphasis on ensuring adequate flow down and proper implementation of radiological requirements, particularly in such areas as radiological contamination control, surveys and monitoring, posting, technical bases, and training.** Specific actions to consider include:

- Conduct an assessment and gap analysis of existing LBNL radiological protection group policies and procedures in the above areas against DOE guidance contained in DOE Order 441.1-1B and the DOE Radiological Control Standard to identify areas in which improvements are needed.
- Revisit and revise institutional posting requirements, particularly in the area of RMAs and the distinction between RMAs and contamination areas.



- Revise posting requirements to eliminate existing procedural conflicts related to hoods and glove boxes and to ensure actual or potential contamination areas are adequately defined, identified, and posted.
- Consider formally adopting the DOE Radiological Control Standard methodology regarding use and designation of radiological buffer areas in all laboratories that have potential for localized contamination areas such as hoods, glove boxes, and bench top work areas.
- Revise radiological survey procedures to address the need for documented radiological surveys to verify the effectiveness of administrative controls and PPE in limiting the potential spread of contamination to clean areas during work.
- Develop a site-wide technical basis document for radiological air monitoring, consistent with DOE Guide 441.1-1B provisions, that establishes the basis and protocols for identifying and integrating radiological air monitoring and sampling needs at the facility and activity levels. Revise existing procedures to closely align with requirements of the new technical basis document.

**7. Improve the RWA/radiation work permit processes to ensure adequate specification of controls for research and other radiological work activities.** Specific actions to consider include:

- Revise RWA and RWP procedures to ensure expectations for content and preparation of these documents are clearly defined and to ensure that these work authorizations are tailored to the authorized work with detailed information on radiological hazards, suspension limits, and specifics on required work related radiological protocols and controls. Consult the DOE Radiological Control Standard and DOE Guide 441.1-1B for guidance on the type of information that should be included in written RWAs.
- Establish a requirement during RWA preparation to ensure radiological personnel review other applicable safe work authorizations (e.g., BUN, BUA, AHD, etc.) associated with the work such that synergy of controls can be properly reviewed and established.
- Eliminate the use of LAS authorizations when dispersible radioactive material are to be used if their allowed quantities have the potential for creating regulatory radiological areas (e.g., contamination area, etc.). Instead, tailor the appropriate radiological controls within an RWA prepared for these materials.
- Establish an appropriate technical basis or eliminate the grading of RWAs based on single isotope calculations focusing more on tailoring the appropriate radiological controls based on the potential hazards. Consider a formal requirement for fixed or portable HEPA filtration for work that has the potential to release radioactive particulates through ventilation systems.
- Consider a requirement for a formal RWA briefing to convey radiological expectations for RWAs, in addition to the existing “read and sign” requirement.

**8. Consider the following actions to strengthen oversight and control of construction health and safety.** Specific actions to consider include:

- Increase oversight of construction worker health hazards and controls by performing periodic IH inspections of construction work areas. Consider performing such inspections in conjunction

with ongoing routine industrial safety inspections and consider documenting observations in the DB02 Data Base.

- Increase the rigor in the review of subcontractor health and safety plans. Replace portions of construction subcontractor health and safety plans with sections of, or references to, PUB-3000, Chapter 10, when the subcontractor sections are redundant to or in conflict with Chapter 10.
- Consider the following changes to the electrical lockout/tagout requirements in PUB-3000, Chapter 18, to eliminate inconsistencies with NFPA70E:
  - Change Chapter 18 to prohibit working on a cord and plug device without lockout/tagout when the work extends beyond a single shift.
  - Change Chapter 18 to require the disconnecting means to be adjacent to and clearly visible to the worker when working without a lockout/tagout.
  - Consider adding the permitted conditions listed in NFPA 70E Article 120.2(D)(3)(a ) to the conditions requiring an equipment-specific written energy control procedure listed in Chapter 18, Section 18.5.1. Although these procedures are not required, further consideration of the conditions listed in NFPA 70E appears to be warranted.

**9. Establish an appropriate hierarchy of safety documents and associated configuration control mechanisms and improve documents detailing safety requirements.** Specific actions to consider include:

- Establish a formal site document hierarchy that defines the purpose, content, authorities, and requirements for the collection of documents (e.g., policies, program descriptions, plans, procedures of all types, manuals, instructions, and guides) used to manage LBNL activities and communicate requirements and expectations from source documents and management decisions to the persons responsible for implementation.
- Establish predetermined structured numbering/identification schemes for each type of document.
- Establish a set of standard formats and writers guides for the various documents to ensure complete and consistent content and to foster clear communication of requirements and expectations and procedure compliance.
- Establish a formal document control system that addresses issues such as review and approval requirements, formal owner/SME periodic review frequencies and scopes, change control mechanisms that provide criteria and processes for formal temporary changes, and criteria for review and approval of permanent revisions.
- Conduct a comprehensive review of all current documents to identify and eliminate ambiguities regarding requirements and guidance and the consistent use of essential terminology.

**LBNL - Advanced Light Source Division**

**1. Further strengthen and formalize the ALS facility work permit process to better define and document to review of activities against the trigger criteria.** Specific actions to consider include:

- Revise the EH&S Risk Level table in procedure ALS 02-03, Criteria for Issuing an ALS Work Permit, to provide more comprehensive and quantitative criteria. For example, in the “working with chemicals” category, provide criteria for toxins, carcinogens, biological hazards, etc., in addition to NFPA flammability and toxicity ratings.
- Revise ALS 02-03, Criteria for Issuing an ALS Work Permit, to better define and document the review of soft and hard triggers. For example, provide a screening mechanism to document trigger reviews of existing job or activity lists or schedules such as SWAMP lists, long-term shutdown schedules, and beam line shielding change forms.

## **LBL - Physical Biosciences, Chemical Sciences, and Life Sciences Divisions**

### **1. Explore activity-level work control processes that are within the LBNL JHA process framework, but tailored to the experimental research conducted within each division. Specific actions to consider include:**

- Within each of the division research groups, segment the research activities into discrete research tasks either at the experiment or laboratory level.
- Evaluate research work control models, such as individual JHAs, experiment/task based JHAs, and/or laboratory based JHAs, or other applicable models for identifying work tasks, hazards, and controls at the experiment level. In some PBD laboratories, consider the use of research protocols and procedures as a mechanism for describing work identifying hazards and documenting controls. In some instances, it may be prudent to consider the use of the individual JHAs as a “skill-of-the-researcher” document to be supplemented with an experiment-level work document.
- Evaluate research work control processes at other DOE national laboratories.
- Interface with other LBNL Divisions that are also exploring work activity research work control processes.
- Develop a prototype experiment-level research work control process.

### **2. Enhance the ability of managers, work leads, and principal investigators to recognize hazards and verify proper implementation of controls during self assessments, management walk-throughs, and work authorization. Consider using the expertise of the recently added safety staff to train and assist the management team and researchers to maintain the safety envelope and recognize hazards, determine the effectiveness of controls, and recognize thresholds for invoking quantitative and qualitative assessments.**

### **3. Consider development of an institutional based training course for the purchase, storage, and use of hydrofluoric acid. Specific actions to consider include:**

- Ensure general chemical training courses and postings associated with this hydrofluoric acid are consistent across LBNL and validated by health services and IH.
- Ensure that local training for hydrofluoric acid at individual divisions is consistent with institutional requirements and training and addresses the concerns of individual users.

## **LBNL - Maintenance and Fabrication Activities**

### **1. Improve analysis and control of inhalation hazards.** Specific actions to consider include:

- Perform a comprehensive assessment of inhalation hazards associated with maintenance and fabrication activities with potential to generate these hazards (e.g., welding) and establish detailed engineering, administrative, and PPE controls that would be adequate to control these hazards. Incorporate the output of these assessments into JHAs.
- Consider restricting the use of certain base materials and weld filler materials (for which an exposure assessment has not been conducted), such as those with potential to generate hexavalent chromium, and requiring IH approval of materials that have not been sampled, evaluated, and approved.
- Ensure that JHA requirements for IH sampling ensure that the conduct of needed exposure assessments are clearly stated, understood, and followed by workers.

### **2. Enhance electrical safety.** Specific actions to consider include:

- Consider revisions to existing lockout/tagout programs to detail work steps for qualified workers to ensure appropriate controls (i.e., lockouts) are in place and zero-voltage verification has been conducted in accordance with NFPA 70E prior to the conduct of further hands-on work.
- Establish and implement controls to ensure that PPE is required for protection against arc-flash. At a minimum, meet the requirements stipulated in NFPA 70E.
- Consider application of NEC-2008 arc-flash revisions to marking of existing installations as a best management practice.

### **3. Strengthen analysis and control of noise hazards.** Specific actions to consider include:

- Review and revise maintenance and fabrication JHAs for fixed shops and field activities to add specific requirements for training, medical evaluation, and/or PPE for those individuals with existing known need, based on IH exposure assessments, access to high noise areas or unevaluated activities with the potential to generate elevated noise levels.
- Evaluate the need for hearing protection on a work group and task-specific basis, such as for plant maintenance technicians who may spend significant time in equipment rooms with known elevated noise levels, during one part of the day and then be assigned to a different task involving hammering metal components, where loud noises may occur for relatively short periods of time.

### **4. Establish a more formal work planning and pre-job process to effectively ensure hazards are identified early, controls are established, and readiness to perform work is confirmed.** Specific actions to consider include:

- Assign individuals to work planning to ensure activities are evaluated for potential hazards through analysis, anticipation, elimination, and/or mitigation of potential hazards.
- Consider conducting activities such as walk-downs, working with EH&S databases, and coordination with the crafts, division, or facility safety coordinators and LBNL EH&S SMEs as required to identify and control hazards.

- Consider implementing a line management pre-job briefing process to review maintenance tasks to be performed and relevant JHAs or other work permit (e.g., hot work, fall protection) hazard controls, any established EH&S hold points (e.g., required environmental certification, EH&S monitoring, radiological controls), and facility specific health and safety requirements.
- Consider use of a check-list or other documentation method to ensure briefings conducted include all the appropriate information, including EH&S requirements, and that workers understand the hazard and requisite control information presented.

**5. Revisit the trigger levels for conduct of activity level hazard analysis and the establishment of appropriate controls.** Specific actions to consider include:

- Develop additional activity-based maintenance JHAs that include identification of the specific hazard, analysis of that hazard, and documentation of the requisite controls.
- Implement mechanisms to conduct and document a location/activity specific hazard analysis that is robust enough to include hazard or exposure assessment recommendations by LBNL EH&S SMEs.
- Consider lowering the threshold in Maximo for activity specific JHAs to ensure that controls from any other LBNL work authorization and/or hazard control document are incorporated or referenced as appropriate.

**LBNL - Facilities Division Construction Activities**

**1. Strengthen the planning process for construction work performed by LBNL employees to ensure that work is clearly defined, hazards are analyzed, and controls are established before the work is performed.** Specific actions to consider include:

- For work performed by LBNL employees, require supervisors or planners to visit job sites to analyze hazards and establish controls before the start of work.
- For work performed by LBNL employees, require a JHA to be prepared, approved by a construction manager, and signed by workers for each construction project (large and small) as a means of complying with the construction safety requirements of 10 CFR 851.
- Extend to small construction projects the current practice of conducting daily planning meetings for review of tasks, hazards, and controls. Consider developing a checklist to aid supervisors in conducting these meetings. Add requirements for conducting these meetings to LBNL procedures and future construction contracts.

**2. Improve the flow down of health and safety requirements to construction workers.** Specific actions to consider include:

- In future construction contracts, require compliance with PUB-3000, Chapter 10, and the sections of PUB-3000 referenced by Chapter 10, instead of requiring compliance with the entire PUB-3000.
- Replace sections of contractor health and safety plans that are redundant with PUB-3000 with references to PUB-3000.

## **APPENDIX D**

### **Core Function #5 – Feedback and Continuous Improvement**

#### **D.1 INTRODUCTION**

The U.S. Department of Energy (DOE) Office of Independent Oversight evaluated DOE and contractor feedback and improvement processes at Lawrence Berkeley National Laboratory (LBNL). The Independent Oversight team examined the following areas:

- Berkeley Site Office (BSO) feedback and improvement processes, including assessments, self-assessments, operational awareness, corrective action tracking, Federal Employee Occupational Safety and Health (FEOSH) program, the technical qualification program (TQP), and operating experience program; and the differing professional opinion (DPO) program and the employee concerns program (ECP) for LBNL, which are managed by the Office of Science (SC) Integrated Service Center (ISC). (See Section D.2.1.)
- LBNL feedback and improvement processes, such as assessments, corrective actions and issues management, injury and illness investigation and prevention, lessons learned, ECP, and activity-level feedback processes. (See Sections D.2.2.)

For each of the organizations above, Independent Oversight examined applicable institutional, facility-level, and activity-level feedback and improvement programs and processes, with primary emphasis on their application to LBNL facilities and organizations reviewed on this inspection (see Appendix C). Independent Oversight interviewed BSO and LBNL personnel and reviewed various program documents and assessment reports.

#### **D.2 RESULTS**

##### **D.2.1 Berkeley Site Office**

Prior to December 2004, BSO operated under the auspices of the Oakland Field Office with no authority for the LBNL contract and limited environment, safety, and health (ES&H) onsite presence. The past four years have been a period of significant change. Currently, BSO is responsible for contract management, program and project management, Federal stewardship, and oversight of LBNL activities, including ES&H programs.

During the past four years, BSO has devoted significant effort toward staffing its office to implement the current mission and responsibilities. BSO now has 23 professional staff, currently with three vacancies. The staffing additions were achieved in a period in which BSO also experienced significant turnover in personnel, with only eight original staff members remaining from the time BSO was established. BSO management has been effective in recruiting ES&H staff that have relevant ES&H experience with skill mixes needed to strengthen BSO's ability to perform effective oversight. BSO, in coordination with the Stanford Site Office, has also implemented an initiative to share individuals who have specialized technical expertise (fire protection and accelerator safety) needed by both offices.

During the same period, BSO has also dedicated significant effort toward developing management systems needed to implement the current mission and responsibilities. Under the direction of the BSO manager, BSO and the SC ISC have worked effectively together to improve BSO oversight processes and

their implementation and to conduct oversight of LBNL ES&H programs. For example, to further enhance BSO management systems, a BSO workspace portal is in the final phases of development during this inspection, with implementation expected in a few months. The workspace portal is designed to provide a central location for BSO personnel to track deliverables, view BSO documents, and distribute collective information. The BSO workspace gathers information from various resources such as the BSO tracking system (called ORION), SMART, the annual performance plan, the contract deliverables matrix, and lessons learned. When fully implemented, the workspace has the potential to be a powerful management tool that facilitates access to the information needed to effectively conduct oversight and other office functions.

BSO has adequately defined and documented its oversight program and responsibilities through the BSO Oversight and Issues Program manual, which appropriately describes BSO oversight activities to be performed by BSO at LBNL. The manual documents the oversight responsibilities of key BSO personnel and defines and addresses the four major components of BSO oversight: operational awareness, assessments, self-assessments, and contractor performance evaluation. For example, management walk-throughs are a key component of BSO operational awareness; the manual appropriately describes the walk-through process including documentation of the results of walk-throughs in the ORION database. Also, the BSO ES&H Fiscal Year (FY) 2009 Program plan appropriately sets expectations, assigns responsibilities, and establishes oversight activities for ES&H oversight, including a schedule for assessments.

BSO management has been instrumental in developing a qualification program that is appropriately tailored for non-nuclear sites. The BSO Manager received the US DOE Secretarial Honor Award for the qualification program, which is now being considered for adoption across all SC site offices.

Currently, with the support from the ISC, BSO coverage and staffing is adequate to perform oversight of LBNL ES&H programs in most areas. BSO previously recognized a lack of qualified in-house health physics resources needed to oversee LBNL radiation protection activities and recently hired an individual with nuclear experience to fulfill this function.

**Assessments.** BSO assessments are providing management with performance information to make informed decisions and facilitate improvement. BSO has established a three-year assessment schedule to ensure that required assessments are scheduled and performed and to facilitate planning and resource utilization. The three-year assessment plan is updated annually.

The BSO Integrated Assessment Schedule (IAS) is established in the BSO Annual Assessment plan. For FY 2008, BSO completed seven ES&H assessments. The assessments evaluated appropriate areas such as electrical safety, fire protection, facility hazard categorization, ECP, biosafety, ventilation, and verification of ISM corrective actions. Where performance deficiencies were noted, BSO appropriately issued letters of concern to the contractor.

The schedule considers performance information. For example, BSO decided to conduct an electrical safety assessment based on an increase in occurrence reports and a trending analysis indicating electrical safety warranted attention.

BSO's assessments are being used to promote improvements in ISM at LBNL. For example, BSO's ISM effectiveness review, performed in September 2008 while the JHA process was in its early stages of implementation, noted deficiencies in work statements in JHAs and prompted LBNL to take corrective action (i.e., having employees add complete work descriptions). However, the BSO assessment of ISM implementation did not identify some of the other weaknesses with the JHA process and its

implementation, as discussed in Appendix C, indicating that increased focus on JHA process refinement and implementation at LBNL organizations is warranted.

BSO appropriately decided to postpone certain assessments based on the need for LBNL to focus on corrective action plan (CAP) development to address findings from previous assessments. BSO also conducted an ISMS verification and validation effectiveness review for 13 divisions focused on verification and validation of six corrective actions.

BSO management recognized the need to improve its assessments and initiated actions, with the support of the ISC, to improve assessments. BSO is appropriately using ISC staff to provide necessary expertise to supplement BSO personnel on assessments. The BSO initiatives and ISC support have contributed to the improved rigor and technical quality of recent assessment reports. Issues are identified and are clearly communicated to the contractor and effectively documented in the SC-supported ORION database.

BSO is also using its assessment program to facilitate improvement in LBNL assessment programs. For example, BSO is allowing LBNL to use plans developed by BSO and the ISC for some of LBNL's recent assessments.

**Self-Assessments.** The BSO Oversight and Issues Program manual adequately describes the BSO's self-assessment process. Self assessments are included in the three-year assessment plan and integrated assessment schedule. In FY 2008, BSO has performed self-assessments of FEOSH, ISM, hazard categorization, and maintenance and transportation. As an innovative practice, the BSO Manager is using the ISC to perform parallel assessments of LBNL ES&H programs and the effectiveness of BSO oversight in the same program area. With this approach, the effectiveness of BSO oversight can be evaluated with the benefit of performance data for the corresponding LBNL program.

BSO self-assessments reviewed were of good technical quality and being used to facilitate improvements in BSO office activities and oversight. For example, a recent BSO review of facility hazard categorization determined that improvements in BSO oversight of these areas were warranted to drive improvements in LBNL's control of radiological sources and QA program implementation. As a result, BSO took action to improve its oversight capabilities (i.e., hiring a nuclear engineer to oversee radiation protection).

**Operational Awareness.** The BSO ES&H FY 2009 Program plan assigns responsibilities for operational awareness activities. The BSO Manager has set an expectation for the ES&H staff to spend 30 percent of their time in the field. Expectations for divisional oversight are clearly delineated and appropriately include work observations, focused surveillances, meeting attendance, and document review. Appropriate plans are established for operational awareness activities for each ES&H functional area that describe the program and requirements and identify operational awareness activities such as meetings, field observations, and document and system reviews. The functional area plans appropriately include reviews of related assessment activities. Although a facility representative (FR) program is not required at LBNL, the actions by various BSO staff members provide for operational awareness comparable to activities conducted by facility Representatives at other sites.

Day-to-day operational awareness actions effectively provide information about current site conditions and activities. BSO ES&H personnel have unencumbered access to most assigned facility spaces and operations and are normally accompanied by LBNL staff. Walk-through surveillances that were observed were professionally conducted and identified and documented physical hazards in the workplace and communicated them to the contractor. Although BSO has a small number of ES&H staff, these individuals have conducted a substantial number of operational awareness activities including 175 walk-throughs during FY 2008 and 2009, and have identified meaningful issues and observations. Walk-



through surveillance activities were generally consistent among BSO staff members and included observation of work activities, hazard identification and prevention, facility conditions, and contractor procedures. Many walk-through surveillance results are documented in the ORION database and thus support analysis efforts such as trending. However, some walk-through activities, such as walk-throughs that assess facility radiological condition, are not consistently captured in ORION as required.

BSO has conducted periodic trending of operational data to support management decisions on resource utilization. BSO recently completed an independent trending analysis of occurrences, injury and illness logs, issues identified during assessment walkthroughs, and issues entered into NTS. The results of the trending analysis were also factored into the annual assessment of contractor performance for FY 2009.

**Corrective Action Process.** The BSO Oversight and Issues Management Program manual describes expectations for contractor CAP development and approval. Review of a sample of assessments demonstrated that CAPs are developed when appropriate for formal assessments that identify priority 1 or 2 findings. BSO uses the ORION tracking system to track assessment data and develops quarterly reports from the ORION database to identify and evaluate trends. BSO's oversight of the LBNL has identified concerns with causal analysis and corrective action plans; these weaknesses have been communicated to LBNL and remain an area of BSO focus.

**Contract and Contract Performance Evaluation.** BSO has established several ES&H performance measures within the FY 2009 Performance Evaluation Measurement plan (PEMP). These performance measures are related to worker protection, accident illness reporting, ISM implementation, contractor assurance, waste management, and environmental management. The contract evaluation mechanism is being used to drive improvements in safety. As an example, the 2008 PEMP was used effectively to focus LBNL efforts to establish and implement the new job hazards analysis (JHA) process. The effort was successful in prompting LBNL to ensure that JHAs were in place for all work and that all work was authorized by the JHA process. While the establishment of JHAs is a significant accomplishment and required extensive effort, as discussed in Appendix C, the quality of JHA process implementation warrants further improvement. To continue to drive improvements considering the current state of maturity of LBNL ISM systems, additional focus on the quality of implementation of processes will be necessary.

**ES&H Reporting.** BSO staff work closely with LBNL in the preparation and review of occurrence reports to ensure that reports are accomplished in a timely manner. The BSO Occurrence Reporting and Processing System (ORPS) Implementing Process and the Duty Officer plan are BSO standard operating procedures that adequately describe the BSO ES&H reporting functions. The BSO duty officer program provides an ES&H point of contact that is always available (24 hours per day, seven day a week) to enable LBNL to promptly notify DOE of reportable events. However, BSO's oversight of event reporting has not identified the contractor process and performance deficiencies discussed in Section D.2.2 of this Appendix. The Independent Oversight Team identified deficiencies LBNL's processes and in the accuracy of LBNL's documentation of discovery dates and times that resulted in categorization and notification that did not meet the requirements of DOE Manual 231.1-2. In addition, the Independent Oversight team identified deficiencies in the analyses of causes and extent of condition for some events and inadequate investigation, documentation, and management of DOE significance category 4 reportable events.

**Employee Concerns and Differing Professional Opinions Programs.** Responsibility for the ECP and DPO programs has recently been transferred to the ISC. The program is established and managed utilizing Office of Science Management System (SCMS) procedures that include appropriate provisions. A local BSO point of contact has been assigned with responsibility for coordination with the ISC. Appropriate training on the ECP and DPO processes has been provided to BSO staff. There were no

differing professional opinions or employee concerns during FY 2008 or 2009. BSO performed an assessment of LBNL employee concerns and whistleblower protection in December 2008, identifying one finding and six observations.

**Federal Employee Occupational Safety and Health Program.** The FEOSH program meets applicable requirements of DOE Order 440.1B, *Worker Protection Program for DOE (Including NNSA) Federal Employees*. The BSO FEOSH Program manual appropriately defines the program. The FEOSH Program Manager's functions and responsibilities are appropriately established in the BSO Functions, Responsibilities and Authorities manual (FRAM). A FEOSH program manager has been assigned by the BSO Manager and the program is being implemented consistent with requirements and the program manual. BSO performed a FESOH self assessment in September 2008 that identified seven recommendations to improve the program. In addition to the formal program, the BSO Manager has established clear expectations for BSO staff to perform work safely.

**Technical Qualification Program.** The BSO TQP is documented in the BSO TQP manual and provides a comprehensive methodology to develop and ensure technical staff competency. The BSO TQP manual establishes the training and qualification requirements for Federal technical personnel with safety or security oversight responsibilities. BSO ES&H employees are responsible for three qualification cards: general technical base, functional area, and office specific. The office specific qualification card provides core training on ISM as it applies to LBNL. The program is being managed appropriately to further develop technical staff competencies.

**Operating Experience Program.** The BSO operating experience program is implemented through an SCMS procedure that meets the requirements of DOE Order 210.2, *DOE Corporate Operating Experience Program*. The procedure defines the responsibilities for the BSO Manager and the designated operating experience program coordinator. The BSO program coordinator provides information to BSO and LBNL based on a review of a variety of sources including DOE Office of Health, Safety and Security (HSS), LBNL, BSO, and ISC-Oak Ridge for applicability. The documents are forwarded for information, action, or feedback.

The BSO workspace management tool, which is currently in development as discussed above, will provide an automated mechanism for the program coordinator to disseminate information and track feedback activities. An innovative feature of the tool will be the capability for the program coordinator to readily determine the disposition of information by requiring SMEs to enter responses.

BSO assessed the LBNL operating lessons learned program in FY 2008, identifying the need to improve sharing of lessons learned with the DOE complex. The 2008 BSO assessment noted the limited LBNL actions to share lessons learned; since then LBNL performance in this area has improved (e.g., LBNL has submitted several issues to the HSS database). BSO has also appropriately scheduled an assessment of the LBNL program in FY 2009 to ensure that LBNL has made necessary program improvements. However, this assessment lacked sufficient rigor to identify the process and performance weaknesses and deficiencies discussed in Section D.2.2 of this Appendix.

BSO takes steps to ensure that lessons learned are evaluated and used to make improvements in ES&H programs. BSO managers discuss lessons learned with their LBNL counterparts and provide feedback to the BSO lessons learned program coordinator. BSO also shares information with the LBNL lessons learned coordinator and BSO SMEs comment on lessons learned originated by LBNL. There are instances in which BSO actions related to lessons learned have resulted in safety improvements at LBNL. For example, BSO personnel and LBNL personnel held discussions about a laboratory fire at the University of California at Los Angeles campus, which resulted in LBNL reviewing their chemical inventory for pyrophoric and spontaneously combustible compounds.

## **D.2.2 Lawrence Berkeley National Laboratory Feedback and Improvement Systems**

The LBNL assurance system elements and requirements are detailed in the UC Assurance plan for Lawrence Berkeley National Laboratory and the Integrated Environment, Health & Safety Management plan, each signed by representatives of LBNL, the University of California, and the BSO. These process descriptions and requirements are also delineated in other institutional documents including the Operating and Quality Management plan, institutional implementation manuals and procedures, and division EH&S ISM plans. The Office of Contract Assurance, reporting to the LBNL's Chief Operation Officer, administers the CAS, with oversight provided by the University of California Contract Assurance Council.

**Assessments.** LBNL has established a variety of self-assessment and inspection programs and activities that evaluate safety programs and performance and drive continuous improvement, including division self-assessments, ES&H subject matter expert (SME) technical assurance reviews, and management of ES&H (MESH) assessments performed by the institutional Safety Review Committee (SRC). The requirements for these assessment activities are outlined in a program description document, ES&H Self-Assessment Program (PUB-5344). These processes include assessments by independent parties, both external and internal to LBNL, not directly responsible for the activity or process being evaluated. Documented walk-throughs and safety inspections performed by managers, supervisors, and safety coordinators and, in some instances, individual workers, identify and resolve physical condition deficiencies. In addition, the LBNL's progress in meeting safety performance goals, objectives, and measures detailed in the PEMP, negotiated between LBNL and DOE, is self-assessed quarterly and at the end of the fiscal year.

LBNL has developed formal program manuals detailing the program requirements and processes for the conduct of division self-assessments and for EH&S functional area SME assessments called the technical assurance program (TAP). These program manuals adequately describe the expectations and requirements for effective assessments. Although the general description of the MESH reviews are contained in high level policy and program documents such as the Regulations and Procedures manual and the UC Assurance plan, the process steps, requirements, and guidance are communicated on the Safety Review Committee website rather than a formal procedure. The Office of Contract Assurance, reporting through the Office of Institutional Assurance to the LBNL Director, provides institutional management of the self-assessment program.

Each division is required to generate an annual self-assessment report reflecting an evaluation of how the division is implementing ISM as described in their division ISM plans, how they have met goals and opportunities established in the prior year's assessment report, and an evaluation to a set of performance measures developed between the Office of Contract Assurance and division management. Important elements of the division self-assessment program are safety inspections and management walk-throughs. Over 400 LBNL personnel have completed a training course provided by EH&S that provides classroom presentations and actual walk-through demonstrations on the conduct of safety evaluations in field locations. This course includes an appropriate focus work observation, application of ISM, and specifically the application of the JHA process, with an introduction to human performance improvement concepts. The Division ES&H Self-Assessment manual provides a link to a suggested inspection/walk-through checklist that addresses physical condition inspections and criteria/line of inquiry related to work observation. Although this checklist does not directly address ISM elements, the mix of hardware, PPE, compliance inspection items, and items related to procedure use provides a vehicle for documenting work observations. The Advanced Light Source (ALS) facility has developed a rigorous supervisor walk-through checklist that specifically addresses ISM, including questions on each ISM core function, JHAs, ALS Experiment Safety Sheets, and ALS operations policy/practices/personnel. ALS documents results

of supervisor walk-downs in a database identifying safe and unsafe acts and assigns trend codes for unsafe acts.

The Office of Contract Assurance conducts formal quality reviews of the division self-assessment process to provide feedback to division management for improvement of the process and products. The FY 2007 effectiveness review provided guidance to improve the self-assessments to broaden the scope of their assessments beyond the institutional performance measures and provide more detail and analysis in their reports.

The TAP is an aggressive, comprehensive program documenting SME inspections, data analysis, document reviews, field observations, lessons learned dissemination, identification of trends and assessment of program effectiveness for approximately 45 functional areas, with approximately five additional areas being added for FY 2009. The TAP, which is still evolving after replacing a program of multi-discipline ES&H team assessments in late 2007, requires functional area SMEs to develop comprehensive assessment plans that include descriptions of the program and hazards, the frequency and scope of quarterly or semi-annual, and annual roll-up reviews. Most of the assessment plans reviewed by Independent Oversight provided the expected comprehensive description of the functional area and the assurance functions to be performed by the SME. A sampling of TAP quarterly review reports and annual summaries indicated valuable information on the implementation of safety programs was being collected.

MESH assessments of individual divisions are conducted by teams from the SRC on a two- to four-year basis with a focus on the implementation and effectiveness of the division's ISM plan. MESH reports included brief analyses of each core function of ISM with reviews of actions taken for issues identified in the previous review.

LBNL performs quarterly and annual self-assessment reviews of progress in meeting contractual performance measures specified in the LBNL/DOE PEMP. The University of California (UC) Assurance Council, a panel of senior officers from the UC Office of the President and external independent experts, routinely monitors performance and provides guidance to LBNL on contract performance and other safety issues.

In addition to the above described assessment activities, periodic, documented safety inspection and testing of hardware is performed by organizations such as the fire department (fire extinguishers), Facilities Division (safety showers, eyewashes, cranes and rigging gear, and pressure systems and devices), and EH&S (fume hoods and ventilation systems). In 2006, LBNL also contracted with an external party to perform an assessment of LBNL's implementation of ISM, with a follow-up review in 2008 to evaluate the effectiveness of corrective actions addressing issues identified in the initial assessment.

The Office of Contract Assurance compiles the information from the division self-assessment reports, with additional analysis, into an annual institutional self-assessment report. At the conclusion of this Independent Oversight inspection, the FY 2008 institutional self-assessment report had not yet been issued, four months into FY 2009. The division self-assessment program manual specifies that at the beginning of each performance year, divisions plan the actions they will take to address the self-assessment performance criteria.

Although many safety inspections and assessment activities are performed at LBNL, weaknesses and deficiencies in processes and implementation are hindering the effectiveness of these assurance systems. The requirements specified for conducting division and MESH self-assessments lacked sufficient emphasis on evaluating work performance and tailoring of assessment activities to division specific

activities, processes, hazards and risks, management systems, and management prerogatives. The focus of division self-assessments, both in the expectations communicated from the institution and as implemented by the divisions, is directed at addressing the institutionally established “performance measures.” The Division ES&H Self-Assessment manual provides inadequate descriptions of “formal” and “informal” inspections and “self-appraisal” activities. Although this manual describes an assessment process that is ongoing throughout the year, the primary expectation for a deliverable is an annual report. Much of the manual is formatted as guidance rather than requirements for implementing the program. For example, expectations and process descriptions specified for areas such as the steps for planning assessments, conducting assessments throughout the year rather than one time, the makeup of appraisal teams with knowledgeable individuals, periodic data analysis, the format and content of annual reports, and that the report conclusion analyze if the division’s performance was effective are all prefaced with “should.” The manual does not require divisions to identify the pertinent safety processes, facilities, activities, and management systems and tailor their self-assessment activities to these elements. With the exception of the ALS facility, the divisions included in this review did not assess areas beyond the provided performance measures. (See Findings #C-4 and #D-1.)

There is no formal program plan/procedure/implementation plan document detailing the implementing requirements/procedures for the SRC conduct of the MESH assessments. Periodic assessments of the programs for assurance system functional areas such as lessons learned, occurrence reporting, issues management, and self-assessment are not specified in site documents. Work control/JHAs are identified as a TAP functional area and were a high priority management safety initiative during the past year; however, no formal assessments were conducted to evaluate the adequacy of implementation and identify needed process changes for this new, resource intensive activity affecting all organizations and personnel. Although a suggested walk-through checklist is provided, divisions have the option to develop their own walk-through checklists, and all divisions evaluated by Independent Oversight, except for the ALS facility, have developed or chosen walk-through checklists that are not as comprehensive as the suggested checklist, only contain physical condition line items, and do not include criteria for evaluating ISM implementation or quality of procedures. The use of terminology such as “concerns,” “issues,” “observations,” “opportunities for improvement,” “recommendations,” and “findings” are not defined in all assessment manuals and processes and are often inconsistently and incorrectly used to document issues in assessment reports. (See Finding #D-1.)

Self-assessment reports from all three primary assessment program elements lacked sufficient rigor and did not reflect an appropriate focus on ISM and observation and analysis of work activities. For the six divisions reviewed during this inspection, only 15 deficiencies and opportunities for improvement were identified in the FY 2008 self-assessments, all ranked as low risk. One division identified no issues. Completed walk-through checklists, Corrective Action Tracking System (CATS) data, and division databases of walk-through results reflect the identification and resolution of numerous physical condition deficiencies, but rarely identify performance or ISM related deficiencies. The observation of work activities and interaction with workers regarding ISM are not being documented on inspection/walk-through reports. Division and TAP assessment reports, while addressing quantitative evaluation of performance measures, do not sufficiently analyze performance activities or the quality of products. For example, the number and timeliness of generating JHAs was evaluated in all division self-assessments, but the accuracy and quality of the content of JHAs were not rigorously assessed. Although several divisions made statements that the accuracy of the JHAs needed improvement, the basis for this conclusion and the scope of the problem were not described. Similarly, TAP reports focused on division compliance with specific criteria with insufficient evaluation of the adequacy of programs or the quality of performance documentation. Findings (deviations from requirements) were frequently identified as observations or opportunities for improvement. (See Finding #D-1.)

The individual “validation” reports and the collective effectiveness review of division self-assessments and SRC ES&H reviews for FY 2007 conducted by the Office of Contract Assurance lacked sufficient rigor to identify and address deficiencies in processes and division/committee performance (e.g., no findings were identified, only opportunities for improvement). (See Finding #D-1.)

**Issues and Corrective Action Management.** Many safety issues are being effectively managed and tracked to resolution at LBNL using an action management tool (i.e., CATS), the issues management process detailed in the ISM manual and manuals for conducting root cause analysis, and trending/analysis and monitoring of data. Issues are entered into CATS and categorized as “worker safety and health” issues or adverse conditions. Although undefined, the former is applied to hardware or physical condition deficiencies and the latter are defined as program or performance related deficiencies. Either type of issue is assigned a risk ranking of either low, medium, or high and identified as “significant” if it meets criteria such as DOE significance category 1 or 2 reportable events, Price Anderson Amendments Act (PAAA) reportable issues (e.g., 10 CFR 851 or 10 CFR 835), Type A or B accidents or other issues management determines could significantly impact safety or operations of LBNL, personnel, the environment, or the public. The rigor applied to management of the issues is dictated by the above categorization decisions.

The need to improve organization compliance and effective implementation of the LBNL issues management program has been identified as an issue in many division and laboratory wide self-assessments. LBNL management has taken actions to improve the timelines of closing CATS actions and revisions are being prepared to the program manual and CATS software to better describe program requirements and improve user-friendliness of the tracking tool. The use of CATS to document and manage issues by LBNL organizations and staff has increased in recent months. The implementation of the LBNL issues management program has been one of the specified performance measures for division self-assessments for FY 2007 and FY 2008. Many safety issues are effectively analyzed for causes and extent of condition with appropriate corrective and preventive actions identified and implemented. However, the issues management program is in an evolutionary stage and many issues are not being managed in accordance with the institutional process.

The issues management process manuals address the required elements of issues management as described in DOE Orders 414.1C, *Quality Assurance*, and DOE Order 226.1A, *Implementation of DOE Oversight Policy*. However, the procedures do not provide sufficient guidance and direction in several areas. The table provided for determining issue risk levels does not provide definitions or criteria reflecting the level of safety hazard or the substance of the deficiency, but categorizes issues based on the source. For example, adverse conditions identified through a formal assessment are designated as medium risk, but adverse conditions not identified through a formal assessment are designated as low risk. DOE defined significance category 3 reportable events are all designated as medium risk issues without consideration of the actual risks associated with the specific event. Further, there is no indication of any difference in management elements whether an issue is categorized as a low or medium risk. Terminology related to issues are not adequately defined and inconsistently used. The term “worker safety and health issue,” which for CATS purposes is applied only to hardware or physical condition deficiencies, is undefined and is misleading, as safety process or performance deficiencies are also issues related to worker safety and health. Some responsibilities are not adequately identified. The definition and assignment of responsibilities for “originators,” “approver,” and “cognizant managers” are insufficiently detailed. For example, issues are not assigned to an owner, but the “originator,” defined as a generic term for the person entering the issue into CATS, is designated as the person responsible to designate risk and significance, develop corrective actions and due dates and specifies responsible cognizant manager. However, the person entering the issues into CATS may not have the qualifications to perform these issues management tasks. If a formal CAP is required, the development of corrective actions is assigned to the cognizant manager. The issue management manual requires the approver of an

adverse condition to determine if a formal corrective action plan is required (after the steps for the originator is to identify corrective actions), but provides no guidance or criteria for determining when a formal action “plan” is required. The qualifications (e.g., level of training, position, or authority) for the person approving corrective actions are not specified. (See Findings #C-4 and #D-2.)

The matrix of issue types and management elements that establishes the rigor of management applied to safety issues is non-conservative and does not adequately address cause and extent of condition determination requirements of DOE Order 414.1C and DOE Order 226.1A. For example, although steps in the procedure require determining the “apparent” cause of certain issues, only “root” cause analysis is listed as an element in the matrix. There is no definition, procedure, guidance, or link to other documents for the performance of apparent cause analysis, although a less formal causal analysis approach called “direct derivation” is included in the root cause analysis program manual. The matrix indicates that no causal analysis is required for “worker safety and health issues,” without recognizing that these issues could be medium or high risk, which do require analysis. Although the issues management program manual requires that trend codes (from the root cause analysis manual) be assigned by the initiator for worker safety and health issues, the use of this code selection as an analysis tool and for crafting recurrence controls is not described. Root cause and extent of condition analysis is only required for adverse conditions if deemed necessary by management, without recognizing that these conditions could be classified as high risk, which would require a root cause analysis. In addition, CATS does not contain fields for management to document this decision. Further, the matrix specifies that a root cause analysis is required for DOE significance category 2 reportable events, which conflicts with the LBNL occurrence reporting manual requirements that specify an apparent cause analysis. (See Findings #C-4 and #D-2.)

The definition, process, and responsibilities for identifying and managing institutional issues are not adequately defined in the program manual. Although not identified as a process step or responsibility, the Office of Contract Assurance has been classifying and documenting which issues were deemed to be institutional or division responsibilities in division self-assessment validation review reports. Although the completion of corrective actions is required to be noted in CATS, there is no direction or specific field to document the actual action taken or require the reference to or attachment of objective evidence. The introduction of the issues management program manual specifies that cognizant managers are responsible for ensuring analysis of issues individually and collectively to identify programmatic or system issues and to identify recurrence of issues and trends. The responsibilities section of the manual, however, does not address this activity and there are no process steps for conducting these analyses. The manual on data monitoring and analysis, while providing the mechanics of performing analysis, does not provide any requirements for when it is done, by whom (other than “analyst” and “management”), or at what frequency. (See Findings #C-4 and #D-2.)

The EH&S Radiation Protection Group conducts periodic evaluations of performance for radiation work authorizations and sealed source authorizations. The process documents and the ES&H manual define sets of conditions that result in three levels of “non-compliance findings.” However, these procedures provide no requirements or linkage to use the LBNL issues management process or the use of CATS for these findings. The Radiation Protection Group sends cover letters to affected organizations citing that corrective actions for the level 2 or 3 non-compliances (most significant) are to be tracked in CATS, but not level 1 non-compliances, even though these are still deviations from requirements and issues required to be managed in accordance with the institutional process. (See Findings #C-4 and #D-2.)

Regardless of the weaknesses and deficiencies in the issues management process documents, the requirements and management expectations that issues be entered into CATS are unambiguously specified in numerous LBNL documents and management communications. However, use of the formal issues management process at LBNL remains problematic. Many issues are not being entered into CATS or managed in accordance with the LBNL issues management program manual. The manual requires

issues to be entered into CATS within five days of identification. Although division self-assessment reports for the organizations reviewed were issued in October 2008, findings from three divisions were not entered into CATS until mid-January 2009 and for another division were not entered into CATS until questioned by the Independent Oversight team in February 2009. One of the divisions included in the Independent Oversight team's review had only entered eight items into CATS for FY 2008, while two divisions had entered over 200, one approximately 100, and another approximately 60. All of the issues from the division self-assessments entered into CATS as adverse conditions were categorized as "low risk," which conflicts with the matrix in the issues management manual that specifies these should have been "medium risk." In a sampling of 12 TAP functional area assessment reports from 2008, at least 20 issues had not been entered into CATS. LBNL has not taken sufficient actions to ensure that division personnel comply with requirements for reporting and timeliness. (See Finding #D-2.)

CATS entries reflect that issues are often described in the form of a needed action rather than a statement of a deficient condition or identification of the requirement that was violated. (See Finding #D-2.)

Independent Oversight identified instances of inadequate causal analyses, extent of condition reviews, and effectiveness reviews. For example, a report that was titled a root cause analysis and extent of condition review was issued in July 2008, apparently as a corrective action for a significance category R occurrence report involving recurring electrical safety incidents, "to gauge the effectiveness of the other corrective actions." The root cause analysis and extent of condition review did not meet this objective. The analysis consisted of a review of each of the causal analyses previously done for the individual ORPS events that resulted in the recurring event report and three electrical safety events reported in the year following, and concluded that "less than adequate work planning" was the common cause. "Recommended" corrective actions from each of the event reports were described, but their adequacy or effectiveness in preventing the three subsequent events was not established. The only additional recommended action resulting from this review was to issue an "Electrical Safety Newsletter" on current electrical safety topics. The reason for this action was not specified. The extent of condition review consisted of two sentences stating that the extent of the non-compliances was not limited to a single condition and the involved work was being performed by employees, students, and subcontractors. A "severity of condition" analysis using an electrical safety measurement tool developed by a contractor owners group was included in the analysis. This analysis concluded that six of the 10 events should not have been reportable due to low significance. The relevance of the results of this unofficial process was not identified. The events were reported by LBNL management using site and DOE criteria. There was no conclusion statement or discussion in the analysis. (See Finding #D-2.)

The following sections in this appendix also discuss additional deficiencies in the management of issues related to events, employee concerns, and injuries and illnesses.

**Event Investigation and Reporting.** Many incidents and events are identified, reported, and investigated and related issues are being resolved in accordance with formal processes defined in the EH&S manual and the issues management procedure. The threshold for reporting events to the DOE ORPS and associated significance categorizations was appropriate. The evaluations and corrective actions on most of the significance category 3 and R event reports reviewed by the Independent Oversight team were sufficiently detailed and actions and recurrence controls were adequately identified and had been entered into CATS for tracking. LBNL has been performing the quarterly analysis of reportable events covering a 12-month period to look for trends and recurring events as required by DOE Manual 231.1-2, *Occurrence Reporting and Processing of Operations Information*. These reports have included analysis of PAAA non-compliance tracking system and internally tracked incidents. Separate quarterly analyses are now also being conducted on 10 CFR 851 worker safety and health reportable issues. In the past few years, these reviews have identified and reported recurring events regarding the ALS facility radiation protection program, electrical safety issues, construction safety, and penetration permit



violations. LBNL management has recently established an informal “near hit” process in each division to encourage personnel to identify and report incidents in which injuries or reportable events were narrowly avoided. This has resulted in the identification and correction of a number of safety concerns. Some divisions have established awards for identification and reporting of such incidents.

Although most events are properly identified, investigated, and managed, the Independent Oversight team identified some weaknesses and deficiencies in processes and performance. Three separate documents establish similar institutional requirements for ORPS reporting (i.e., EH&S manual Chapter 15, EH&S Division document LBID-2488, and a procedure on the EH&S Division website entitled “Procedures for LBNL Occurrence Reporting and Processing System [ORPS]”). These documents refer to DOE guidance on causal analysis but do not refer to the LBNL manual that specifies requirements and processes for conducting root cause analysis. These procedures specify that no causal analysis is required for significance category 4 reportable events. Although DOE Manual 231.1-2 does not require causes to be reported for such events, it specifies that management is to be in accordance with contractors’ CAP. DOE Orders 414.1C and 226.1A specify that the causes of issues are to be determined and addressed. Other than submittal of ORPS reports to DOE, the requirements for the documentation of investigation and causal analysis of events are not specified in the EH&S manual chapter. None of the four 2008 DOE significance category 4 reportable events selected by the Independent Oversight team for evaluation of investigations and corrective and preventive actions had been entered into CATS. (See Findings #C-4 and #D-2.)

In some instances, event analysis was inadequately documented or untimely. For example, for a DOE significance category 2 electrical shock event (ENG-2008-0001) that occurred in March 2008, the root cause analysis report was not completed and signed until August 29, more than four-and-one-half months later—months after the corrective actions had been input to CATS. As of February 4, 2009, two of those corrective actions were overdue for completion by more than four months. In another instance (ALS-2008-0003), the root cause analysis consisted of an unsigned and undated TapRoot® flow chart and pictures, with no report discussing event details or the analysis. The flow chart did not address any work control aspects of this OSHA recordable injury event. For a significance category 4 August 2008 event at ALS, in which the cap on a pressurized liquid nitrogen dewar separated and caused an injury to a guest sponsored by the PBD, LBNL did conduct a causal analysis and put corrective actions into CATS. However, an action to conduct an extent of condition review for the incorrectly retained dewar caps was limited to the ALS facility and PBD divisions, although liquid nitrogen dewars are used in a number of other divisions and locations at LBNL. Further, two specified corrective actions for the hazard control deficiencies identified in the analysis were not input to CATS for tracking, but were identified as “will be addressed in FY 2009.” (See Finding #D-2.)

Although Section 5.1 of the EH&S manual, *Incident Reviewing & Reporting*, describes various types of incidents/events and provides processes for managing the investigation of injuries and illnesses, it provides no step-by-step process for documenting, investigating, and managing other events and incidents that are determined to not meet DOE reporting requirements. Sections 5.1 and Chapter 15 do not reference each other. Although LBID-2488 and the website procedure specify that the occurrence investigations for significance category 3 and 4 events consist of critiques and fact-finding meetings, the EH&S manual chapter refers to “trained investigators.” Further, there are no procedures, requirements, or guidance provided on the conduct and documentation of critiques or fact-findings. Although the manual chapter reiterates the DOE requirement to include “LBNL determined non-reportable occurrences” in the quarterly performance analysis, it does not specify what data set LBNL has determined. (See Finding #C-4.)

For numerous 2007 and 2008 ORPS reports, the notification of DOE was not timely, reflecting a misunderstanding of event reporting requirements or the definition of discovery date and time. DOE

Manual 231.1-2 defines the discovery date and time as “when the facility staff became aware of the event or condition,” and requires categorization within two hours of discovery, and notification timeframes by facility managers and reporting staff no later than two hours after categorization for significance category 1, 2 and 3 occurrences. However, the significance category 2 event OPERATIONS-2008-0010 that occurred in the morning on June 17, 2008, was identified as “discovered” in the afternoon on June 18 and significance category 3 event OPERATIONS 2008-0005 occurred on April 10, but was reported as discovered on April 14. Numerous other reports, including significance category 4 events, cited discovery dates from two to seven days after the event occurred, even though the facility staff was immediately aware of the events.

**Injury and Illness Investigations.** Occupational injuries and illnesses identified as recordable and first aid cases in accordance with OSHA regulations are being identified and recordable injuries and most first aid cases are investigated, documented, and reported using a structured process. Management of occupational injuries and illnesses is governed by EH&S manual Chapter 5.1 and administered by the Incident Review Program Manager in the EH&S Division. This manual chapter generally describes an adequate process for managing OSHA recordable injuries. Employees are directed to report all injuries to supervisors and report to health services for evaluation and treatment. Injuries and illnesses deemed recordable as well as first aid cases require an investigation by a team including the worker, the supervisor, the division safety coordinator and the EH&S liaison that is documented on a Supervisor’s Accident Analysis Report (SAAR) using a standard report template. If the injury or illness is categorized as recordable, an “incident investigator” also assigned to the investigation team by the Incident Review Program Manager and a root cause analysis are required and an investigator’s report is to be prepared in addition to the SAAR. Formal classroom training is provided to division safety coordinators and EH&S liaisons on the conduct of investigations, including root cause analysis. Data from the DOE Computerized Accident/Incident Reporting System (CAIRS) database indicates that LBNL’s total recordable case (TRC) rates and days away/restricted time (DART) rates have increased over the past three years and that TRC rates are the highest and DART rates second-highest among SC laboratories. However, these rates reflect that a significant portion of these recordable injuries are ergonomic cases, with an increasing number of ergonomics cases being reported as the site has focused on identification and prevention of ergonomic injuries over the past 18 months.

In response to the rates of ergonomic injuries, LBNL has committed significant staff effort, technical expertise, and funding to identify, resolve, and prevent ergonomic injuries in office and laboratory settings over the past several years. The ergonomic staff utilizes existing division resources to address potential ergonomic injuries and discomfort quickly and effectively. Beginning in 2002, following an LBNL pilot in the Life Sciences Division that addressed problems with 10 computer workstations, the program has evolved into an increasingly proactive multi-disciplinary approach that focuses on prevention. Computer software initiated by the ergonomic staff, “The Remedy Interactive Program,” is a self-assessment tool that evaluates and grades office workstations into 3 risk levels. Situations with the greatest risk are automatically evaluated by ergonomic professionals, the medium risk situations are evaluated by trained departmental ergonomic advocates, and a low risk rating is kept as a baseline to monitor if conditions change. A recent external evaluation determined that the program reduced injuries and was a sound investment. The Joint Genome Institute stand down in December 2007, due to production related ergonomic concerns, resulted in a comprehensive evaluation and re-design by ergonomic experts, safety and health professionals, workers, engineers, and management resulting in a significant reduction of injuries and a national level safety award for their efforts. The ergonomic program staff continues to educate workers, train department advocates, and encourage management to provide ergonomically correct workstations in both the office and laboratory environment.

Although injuries and illnesses are being investigated and reported, there are process weaknesses, and in many instances LBNL has not conducted sufficiently rigorous and documented investigations of

occupational injuries and illnesses that identify ISM deficiencies and implement effective recurrence controls.

Section 5.1 of the EH&S manual is not sufficiently detailed in a number of areas. It lacks any definition of terms and does not address the applicability of injury and illness investigation and reporting (e.g., employees, students, guests, and subcontractors). For example, review teams are required for “serious incidents” including those “deemed of sufficient severity” or “potential significance to require a detailed impartial analysis” and includes “many ORPS reportable events.” These terms are not defined, no other guidance is provided, and the persons authorized to make these decisions are not specified. There is no description of subcontractor responsibilities for reporting and investigating subcontractor injuries.

The need for stop-work or other immediate or compensatory actions are not addressed. The SAAR template does not include specific fields addressing ISM core function elements such as whether hazards had been identified, controls were adequately specified and/or implemented, work was performed in accordance with procedures, work was adequately supervised, etc. The procedure specifies that the EH&S liaison is on the team reviewing non-recordable (“minor”) injuries, but does not discuss his or her role or responsibilities in the process steps. The procedure later specifies in the responsibilities section that the liaison document “SAAR codes” on the investigator’s report form for first aid cases. However, SAAR codes are not defined or listed, their application is not described, and the process states that no investigator is used for first aid cases and no investigator’s report form is addressed in the process steps. Although the manual specifies in the responsibilities section that the division safety coordinator is responsible for using CATS to coordinate tracking and documentation of divisional corrective actions, actions required to be taken at the institutional level and by support organizations are not addressed and the procedure steps in the manual do not address the use of CATS or the LBNL issues management procedure. (See Findings #C-4 and #D-3.)

The TAP title for the occupational injury and illness functional area and the associated assessment plan only address the CAIRS reporting and recordkeeping aspects of this area and quarterly reports have not included any elements of qualitative analysis of investigations. Although an assessment of injury and illness data for FY 2008 being conducted by the Incident Review Program Manager has been ongoing for several months, no formal assessments addressing the adequacy of injury and illness investigations have been conducted. (See Findings #D-1 and #D-3.)

In a sample of approximately 20 FY 2008 and FY 2009 OSHA recordable and first aid cases reviewed by Independent Oversight, the investigation documentation for most of the cases and the associated actions were deficient in one or more areas. (See Finding #D-3.) Examples included the following:

- There was no investigation report for a burn to a graduate student’s arm from exposure to liquid helium in September 2008. In addition, the health services report stated that the injured student did not report to the LBNL clinic for six days after the injury. The Independent Oversight team noted several other case reports in which workers did not report injuries and exposures promptly as required by procedures and the issue of late reporting was not addressed by the investigation report. Other first aid cases had no investigation reports on file.
- The SAAR report investigating a July 2008 event in which a researcher splashed a polishing solution in his or her eyes was not issued until October 2008. The cause was identified as the failure to wear safety glasses and the corrective action was to provide safety glasses in the room where this work was done, with a due date in September 2008. There was no discussion of work planning or why required PPE was not available. Further, it would appear that goggles, not safety glasses would be a more appropriate control for a liquid splash hazard.

- The investigation report for an event in December 2008 in which a graduate student working in a fume hood splashed a powdered chemical into his or her face did not address immediate actions taken or any work planning aspects, did not identify if or which PPE was specified in JHAs or procedures, and did not address any aspects of the fume hood such as sash position or flow velocity test status. The only recurrence action taken was “the user was instructed to operate more safely.”
- The investigation report for a technician’s exposure to caustic chemical fumes during oversight activities for a lead paint removal operation in October 2008 did not address the work planning aspects other than to note more detailed work planning could have prevented the accident. How work planning would be improved in the future was not addressed. In addition, the possible exposure of the subcontract workers was not addressed in the description of the incident or the analysis, although two corrective actions were specified to revise the subcontract specifications for this work activity to require active ventilation and use of acid/gas respirator cartridges. The only action identified to address the technician was a statement that the IH staff “will try to more accurately anticipate this type of condition.”
- No SAAR investigation report was generated for a recordable event in July 2008 in which a guest cut a finger, although a root cause analysis flow chart was on file. The causal analysis flow chart and the DOE reporting form on file did not address any work planning aspects of the injury. The reporting form question about PPE worn was not answered and the specified corrective actions taken were related to redesign of the hardware and the recommended action was to write a procedure for the task.

Common to many of the cases reviewed were inadequate descriptions of the incident details and conditions and any immediate actions taken, failure to address ISM core function aspects, inadequate identification of causes, and recurrence control actions that were inadequate, typically addressing only the direct cause and not other causal factors. Many of the injuries and exposures involved students and guests. Of special concern was that the SAAR investigation reports are approved by the division safety coordinator and reviewed by EH&S liaisons that have taken a training course on the incident review process and causal analysis procedures. Further, a search of CATS for 11 of the cases reviewed indicated that corrective actions had only been entered in four cases. (See Finding #D-3.)

The EH&S Incident Review Program Manager has been conducting an analysis of FY 2008 injury and illness reports to identify ISM opportunities for improvement. Although still in draft form, this report identifies that, of the approximately 160 incidents reviewed, the investigation documentation was inadequate to allow identification of causal factors or corrective actions in more than 20 percent of the cases; for several divisions as many as half of the investigations were deemed inadequate.

Appendix E provides additional information about occupational injury and illness recording and reporting.

**Lessons Learned.** The LBNL has established a Lessons Learned and Best Practices Program manual (PUB-5519) that defines the operating experience program. There is much evidence that lessons learned are generated from local incidents/events and locally generated and external operating experiences are being disseminated to targeted audiences and applied to work activities. The Independent Oversight team observed sharing of lessons learned during safety meetings and pre-job briefings in line organizations. External operating experience databases are screened by the institutional Lessons Learned Administrator in the Office of Contract Assurance, adding those deemed applicable and appropriate to the site lessons learned database and forwarding other potential candidates for dissemination to SMEs for applicability reviews. Posted lessons learned are also pushed out to a set distribution of managers, safety coordinators, and employees. The LBNL lessons learned software has a unique feature that is linked to the JHA software and sends applicable lessons learned to a targeted audience via e-mail transmission to JHA

signatories based on the safety functions identified in their JHAs. Cognizant managers are responsible for conducting appropriate briefings for lessons learned and for ensuring that lessons learned and best practices are considered during work planning. The lessons learned database provides various search capabilities to support work planning. LBNL has improved in sharing local lessons learned with the DOE complex. Although no lessons were posted to the DOE headquarters lessons learned database in FY 2007, eight lessons have been posted between October 2008 and January 2009.

Internal lessons learned from the ALS facility operations cycles have historically been identified, documented, and addressed for subsequent operating cycles and periodic operational lessons learned meetings are held with supervisors and safety personnel. Although most of the lessons are operations-related, some safety issues are addressed in these reviews.

Evaluation of the generation and application of lessons learned was a part of the institutional performance measures provided for the FY 2008 division self-assessments and most divisions addressed some aspects of lessons learned in their annual reports. Evaluating the implementation and effectiveness lessons learned are also part of the TAP requirements for conducting SME functional area reviews. Some TAP reports for FY 2008 did address lessons learned.

Although many lessons learned are being screened, generated, disseminated, briefed in safety meetings, and applied to work activities, demonstration of program effectiveness is hindered by process and implementation weaknesses and deficiencies and some pertinent external lessons are not being posted to the site database and disseminated to potential users. In addition to the program manual, the EH&S manual includes a chapter for lessons learned; a document that was last revised in 2002 and is not in compliance with DOE Order 210.2 or in agreement with the program manual. The processes and requirements described in the program manual lack sufficient detail in a number of areas. For example, the position and responsibilities of the lessons learned administrator, identified in the LBNL ISM plan and required by DOE Order 210.2, are not described. Institutional responsibilities for lessons learned are described as belonging to the Office of Contract Assurance. The responsibilities and process for screening external lessons learned are not adequately described. There is no discussion of the need for the screeners and reviewers to identify any necessary specific, directed actions other than posting to the database and dissemination (e.g., inspect hardware or review and/or change policies, ISM documents, procedures, or processes). The responsibilities and process for distributing lessons learned to subcontractors is not addressed in the program manual. (See Findings #C-4 and #D-4.)

DOE Order 210.2 requires that lessons learned procedures and processes be integrated into ISMS programs and that DOE and contractor lessons learned be incorporated into maintenance and work planning and construction processes. However, no requirements or expectations for research or consideration of lessons learned have been incorporated into the JHA work planning processes in Chapter 32 of the EH&S manual, in construction safety policies and processes in Chapter 10 of the EH&S manual, or in standard subcontractor contract specifications. (See Findings #C-4 and #D-4.)

The manual assigns responsibility to cognizant managers for communicating locally generated lessons learned to the DOE Operating Experience Program, although this is a responsibility of the site coordinator per the DOE Order. The manual assigns responsibilities to “reviewers” in several sections but never defines the qualifications or position/identity of these persons. Two of the responsibilities of these reviewers are to periodically review disseminated lessons learned briefings and feedback forms and to determine the effectiveness and implementation of lessons learned within their area of responsibility. However, there are no criteria, metrics, or guidance on how to determine implementation or effectiveness. No metrics have been established to measure program performance and evaluate the effectiveness of actions implemented from lessons learned as required by DOE Order 210.2. Although a random sample of the “target audience” is requested to complete and send a feedback form to the cognizant manager,

SME, or other designee, the scope of the program is not detailed (i.e., only a sample of recipients are requested to provide feedback) and there is no requirement for the lessons learned administrator or the Office of Contract Assurance to monitor compliance or content of the feedback. (See Findings #C-4 and #D-4.)

External lessons learned screening activities by the institutional lessons learned administrator and SMEs and results are not being documented in a focused, retrievable manner. Records consist of electronic mail that is not maintained in consolidated folders and is not easily retrievable. DOE HSS operating experience documents are not being reviewed and/or some apparently pertinent external lessons are not being screened or deemed applicable to LBNL. For example, monthly DOE Operating Experience Summaries are not being screened at the institutional level. In addition, only one of a sample of nine DOE Safety Bulletins and Advisories, issued since March 2007, that had apparent applicability to LBNL work activities (e.g., silica dust exposure, beryllium, unwanted chemical reactions, lead safety, and compressed gas cylinder safety) had been put into the LBNL database. No evidence could be located that the remaining eight external lessons had been screened. Only five of 29 lessons learned posted to the LBNL database in FY 2008 were from external sources. (See Finding #D-4.)

No documented gap analysis between the LBNL program and DOE Order 210.2 was conducted when the new Order was issued in 2006. No formal self-assessments of institutional program compliance or effectiveness have been conducted, although an effectiveness review of the issues management program, including lessons learned is scheduled for June 2009. (See Findings #D-1, #D-4, and #C-4.)

**Employee Concerns Programs (ECP).** LBNL employees have informal and formal means to communicate and obtain resolution of safety concerns. Workers are encouraged to report concerns at the lowest level through supervisors, EH&S staff, or bargaining unit representatives. Two formal LBNL programs address safety concerns and are communicated to LBNL personnel in general employee training, posters, websites, and in documents such as the site and division ISM plans. Concerns can be reported to the Research and Institutional Integrity Office (RIIO) reporting to the Chief Operating Officer, or to the EH&S Division through two electronic mail forums for ES&H concern and suggestions.

Few substantive safety concerns have been reported to the formal safety concerns programs. Only one formal concern identified as being ES&H related was communicated to the RIIO in the past two years. Approximately 65 concerns and suggestions have been reported to the EH&S program since March 2007. Some of these concerns were also the result of verbal or electronic mail communications with various personnel in the EH&S Division. These e-mails and communications are logged, assigned to appropriate parties to resolve, and tracked in a database maintained by EH&S. Most of the issues were traffic and walkway/roadway condition issues, most of which were addressed by work orders. Responsibilities and the processes for resolving ES&H concerns for both of these programs were described in desk instructions.

The evidence file for the one RIIO safety concern was well organized and complete, providing evidence of the concern, the investigation, the resolution, and communication with the concerned individual. The concerned individual was informed of the LBNL intent to maintain confidentiality as far as practical and the LBNL policy of no retribution for reporting safety concerns and an invitation to report any related retribution concerns. The concerned individual was informed of the final resolution of his or her concern. The investigation conducted by Facilities Division personnel and several reports addressing the concerns adequately addressed the direct problem reported: inadequate work by a subcontractor that resulted in unsafe installations. With some exceptions, the resolutions of concerns and suggestions to the EH&S were appropriate, timely, and adequately documented.

However, the Independent Oversight team identified some deficiencies in process and performance. The investigation of the one formal safety concern managed by the RIIO lacked sufficient rigor to identify causes and demonstrate that all causes and associated issues were addressed. The investigation of the one RIIO managed ES&H related employee concern failed to address all ISM elements related to the concern. Specifically, the failure of the LBNL construction safety oversight program to identify the improper installations and the failure of the organization to adequately investigate and address the concern when initially identified to supervision were not addressed in the investigation reports. Further, the rigorous and appropriate initial sampling plan specified in the first of three investigation reports was not fully implemented and the subsequent decision to terminate the sampling program was not adequately justified. The EH&S concerns and suggestions log information reflected that a few of the issues were either closed without sufficient information describing the resolution, were not documented as resolved, or were not resolved in a timely manner. (See Finding #D-2.)

Neither formal employee concern program has formal, approved, controlled documents that detail the processes and requirements for managing formal employee concerns. The existing desk instructions do not address communication of confidentiality expectations and escalation options to concerned individuals. (See Finding #C-4.)

**Activity Level Feedback.** LBNL feedback and improvement processes at the work activity level include several mechanisms to solicit continuous feedback and improvement with respect to ongoing work. For example, some LBNL managers and supervisors conduct regular walk-throughs, maintenance work orders have a provision for post job feedback, and various activity level critiques are performed. Several of these processes are relatively new and have been implemented as a result of LBNL recent initiatives to improve safety management.

In several instances, management at the facility and supervisor levels has devoted attention to activity level feedback processes and is using the process to identify areas that warrant corrective actions or improvements. For example, ALS management is implementing several effective activity-level feedback and improvement processes, including daily user interface with beam line scientists, user satisfaction surveys, a formal lessons learned process for activities controlled by work permits, weekly accelerator operations critique meetings, shutdown and maintenance plans that address lessons learned, and surveillance procedures contain specific requirements to perform activity-level feedback. Also, in the Facility Division, the Facilities Division Safety Coordinator issues a feedback report on a monthly basis that contains safety-related concerns raised by staff and actions taken. At the research experiment level, feedback and improvement is an integral and ongoing element of the research conducted within the PBD laboratories, although informal and seldom documented. Feedback is also routinely provided to new PBD staff as well and graduate and undergraduates through mentoring activities.

In some instances, activity level feedback is not resulting in effective corrective actions. For example, the Chemical Sciences Division (CSD) appropriately self identified an issue with a lockout/tagout concern that arose during laser maintenance through the near hit program. An issue and three corrective actions were entered into CATS in October 2008. However, the proposed corrective actions were too narrowly focused to ensure their effectiveness. For example, the corrective actions did not address site-wide extent of condition, the need for compensatory measures, or the underlying work planning deficiencies that contributed to the fundamental concern (e.g., a situation in which work scope was not properly defined and/or a hazard was not analyzed and controlled). (See Findings #C-2.)

Overall, activity level feedback is ongoing and provides value. However, some of the processes are in the early stages of implementation and are implemented with varying degrees of formality, maturity, and effectiveness.

**Other Feedback Mechanisms.** LBNL has established and effectively uses other less formal mechanisms that provide two-way feedback between workers and management to promote continuous improvement. Divisions routinely use safety meetings and research planning meetings and interactions between researchers and supervisors to communicate safety concerns and lessons learned.

The institutional SRC, comprised of representatives from each division, meets regularly and provides recommendations to the LBNL Director on ES&H processes and issues. The SRC has established sub-committees that review programs and address issues regarding emergency preparedness, laser safety, mechanical safety, and traffic and pedestrian safety. Division safety coordinators meet monthly with EH&S management and liaisons and BSO to discuss and make recommendations regarding safety documents and processes and ongoing safety initiatives, concerns, and issues.

In recent months, senior LBNL managers have demonstrated their commitment and engagement in improving safety performance through forums that provided for communication of expectations and feedback from LBNL personnel. These included an all-hands presentation and question and answer session conducted by the LBNL Director and an offsite management retreat with substantial discussion of safety issues and processes, including communication of the expectations and processes for the substantially revised and strengthened technical assurance assessment program.

### **D.3 OPPORTUNITIES FOR IMPROVEMENT**

The Independent Oversight review identified the following opportunities for improvement. These potential enhancements are not intended to be prescriptive. Rather, they are intended to be reviewed and evaluated by the responsible line management and prioritized and modified as appropriate, in accordance with site-specific programmatic objectives.

#### **Berkeley Site Office**

- 1. Continue efforts to improve and refine BSO oversight activities.** Specific actions to consider include:
  - Consider devoting increased oversight attention to the effectiveness of the LBNL contractor assurance system (CAS).
  - Continue efforts to enhance oversight of the LBNL radiation protection program.
  - Develop additional contractual performance measures to focus LBNL attention on improving the quality of JHAs.
  - Coordinate with LBNL to identify targets during major improvement initiatives to evaluate implementation.
  - Ensure that relevant data is entered into the ORION system in accordance with BSO processes.

#### **LBNL**

- 1. Strengthen the LBNL assessment programs to ensure that safety programs, topical areas, management systems, and work activities are rigorously assessed on an appropriate frequency and with a sufficient emphasis on performance.** Specific actions to consider include:



- Review and revise the EH&S Self-Assessment Program document (PUB-5344) and the Division Self-Assessment Program manual to clarify responsibilities, processes, and requirements such that line and support organization management takes ownership of all aspects of the self-assessment program, including the selection of assessment topics and verification of a quality effort before approving assessment reports. Strengthen requirements for qualitative assessment of management systems and performance in applicable safety functional areas.
- Plan, schedule, and conduct topical self-assessments individually and focus the annual report on analysis and rollup of individual assessments and inspection results and overall performance, addressing analysis and reporting of a minimum set of other topics such as events, injuries and illnesses, lessons learned application, and safety initiatives. Establish mechanisms to engage senior LBNL management in reviewing and approving and providing feedback on division assessment plans, schedules, and reports to improve accountability.
- Formalize the requirements and expectations for non-division organizations (e.g., Directorate and Operations) to conduct self-assessments. Ensure that institutional assurance functions (e.g., assessments, employee concerns, issues management, lessons learned, ORPS, and PAAA) are assessed.
- Designate personnel in each division/directorate as a self-assessment coordinator and hold periodic meetings between institutional assessments program manager and division/directorate coordinators to share information, feedback, and management expectations.
- Focus management walk-throughs and the associated checklists on observation of work, interaction with workers, and evaluation of ISM implementation. Develop and require the use of standard checklists and requirements for conducting physical condition inspections and management walk-throughs, allowing additional criteria to be added as desired by division management.
- Establish a formal procedure document that details the processes and requirements for the conduct of MESH reviews that are aligned with and complimentary to the other self-assessment elements. Ensure report planning, preparation, and identification of findings are also aligned with institutional processes and focus on qualitative evaluations such as the adequacy of division ISM plans and the quality of the objective evidence reflecting implementation.
- Establish clear expectations and mechanisms for all types of self-assessments to ensure a focus on performance, with reliance on observation of work and qualitative analysis of procedures and objective evidence of compliance, rather than process descriptions, survey results, and interviews.
- Provide practical training and mentoring in the planning, conduct, and documentation of assessments for division personnel, EH&S SMEs, and the SRC members conducting MESH reviews. Consider incorporating actual team management self-assessments into training/mentoring regimen. Consider more extensive training to a core group of employees who could then act as mentors for future assessments.
- Ensure that the requirements and processes for all inspection and assessment activities, including those mandated by rules, regulations, and DOE directives, are appropriately detailed in institution level documents.
- Establish formal requirements for periodic analysis of worker and manager workplace safety inspection and walk-through results to identify adverse trends and most frequent deficiencies and

at-risk behaviors to determine if additional actions are needed to address performance weaknesses.

- Reduce the level of direct involvement in assessment activities by the Office of Contract Assurance such as specification of extensive, mandatory performance measures and lines of inquiry for division self-assessments and the determination of institutional and division level issues from division self-assessment reports. Focus resources on training and mentoring. Establish a more structured approach to monitoring and feedback on self-assessment reports. Consider use of a checklist and weighted grading system that addresses administrative elements (e.g., format, review and approvals, and issues entered into CATS) as well as rigor and quality of the review (e.g., clearly defined purpose, scope and lines of inquiry, thorough description of what was evaluated and well written conclusions with clearly defined bases, and well articulated and supported findings and observations).
- Consider expanding the scope of the TAP to include annual safety program reviews of Industrial Hygiene and Occupational Safety.

**2. Strengthen the issues management program to ensure safety problems are entered into CATS and formally managed to resolution with effective analysis and identification of recurrence controls.** Specific actions to consider include:

- Review and revise the format and content of the issues management procedure and CATS as required to clearly communicate the responsibilities, action steps, and other requirements to persons responsible for implementation:
  - Revise and strengthen requirements for determining causes and extent of condition to encourage these analyses for all issues with the rigor applied based on a risk-graded approach. Establish defined requirements and processes for determining apparent cause.
  - Clarify/simplify the terms and relationships between risk, significance and the rigor to be applied to managing issues and correct/clarify the matrix in Section 4 of the program manual. Ensure that risk/significance categorization and the applied rigor be based on the substance of the issues, not its source. Define and provide examples for terms such as “de-minimis,” “low,” “medium,” “high,” and “significant,” and ensure examples and criteria reflect these terms.
  - Define and establish formal process steps for determining whether an issue is “institutional” and the requirements and processes for assigning ownership and management of institutional issues.
  - Reconsider the use of the term “worker safety and health issue” as the description of physical condition deficiencies.
  - Clarify the criteria for requiring a formal CAP.
  - Provide guidance/requirements on proper descriptions of issues (e.g., not a statement of needed actions), linkage of deviations to specific requirements, and identification of discrete actions rather than one comprehensive action objective (e.g., revise the EH&S manual).
  - Identify training requirements for conducting more rigorous causal analysis.

- Define and assign issues and actions to individual owners responsible for managing their evaluation and resolution.
- Clarify the definitions and appropriate use of terminology such as “issues,” “observations,” “concerns,” “findings,” and “opportunities for improvement” and ensure they are consistently used in all LBNL documents.
- Designate a person in each organization to function as an issues management coordinator and provide training on issues management processes and techniques. Hold periodic meetings with all coordinators and the institutional issues management lead to share information.
- Establish a corrective action review board to provide a more formal process for monitoring the adequacy of implementation of the issues management program and provide feedback, at least until all organizations are consistently achieving management expectations. Panel personnel should have assurance process expertise and technical safety knowledge and review higher significance issues and a sampling of all types of issues. Review activities should involve the responsible personnel and managers owning the issues. Focus quality reviews on elements such as adequate description of issues, proper determination of risk/significance levels, cause and extent determinations, and the adequacy of actions to address extent of condition and causes to prevent recurrence. Include routine trending of collective and organizational performance and report results to senior LBNL management.

**3. Strengthen processes for incident/accident investigations, reporting, and documentation incidents and events, including injuries and illnesses.** Specific actions to consider include:

- Review and revise procedures in the EH&S manual to clarify the format, content, and requirements for the conduct of investigations and reports for all types of incidents and events (e.g., injuries, exposures, operational, and radiological), including those below DOE reporting requirement thresholds:
  - Eliminate redundant procedural documents.
  - Manage DOE significance category 4 reportable events in accordance with LBNL’s issues management process and identify causes and extent of condition as appropriate.
  - Provide guidance and direction for investigations to focus on evaluating and documenting the adequacy of the core functions of ISM as they relate to the incident or event.
  - Include requirements for support organization review and concurrence and management approval to ensure quality.
  - Establish mechanisms to ensure that all issues associated with events are entered into CATS for management to resolution.
  - Establish a formal process and defined thresholds for conducting critiques/fact-finding meetings with established protocols and a template for documenting minutes.
- Revise the questions and data fields of the SAAR report to specifically address ISM elements of work control in the description of the events and analysis. Ensure that the adequacy of pre-job planning, including defining the scope of work, hazard identification, and specification of hazard

controls and work performance such as pre-job briefings, adherence to procedures and controls, and supervision, are evaluated and factored into corrective actions and recurrence controls.

- Now that the “near hit” program has been piloted in several divisions, issue a formal notification of senior management expectations for this initiative, encouraging the division reward/recognition policies and the “no fault” concept for workers to report all safety incidents. Identify examples of the substantial benefits gained from identifying these incidents, including actions and recurrence controls that were implemented. Also, reinforce the expectation that reported incidents must be appropriately and formally reviewed for formal reporting, issues management, and lessons learned in accordance with site processes.

**4. Strengthen the lessons learned program to ensure that pertinent external lessons are being appropriately screened and evaluated for needed actions or dissemination and to establish mechanisms to better evaluate program effectiveness.** Specific actions to consider include:

- Review and revise the program manual:
  - Specify and describe the position of institutional coordinator.
  - Specify the process and requirements for screening external lessons learned for applicability and needed actions.
  - Establish more rigorous documentation methods to monitor and demonstrate screening activities and results.
  - Establish specific, documented review criteria to establish if lessons are applicable; if LBNL processes, facilities, or equipment need review, inspection, or change; the target audience; and form of communication (e.g., required reading, dissemination for information, or formal presentation at a briefing or safety meeting).
  - Specifically address the requirements for communication of lessons learned and any needed action to subcontractors.
- Ensure that all safety-related reports and reviews that are posted to DOE HSS websites are included in the source documents for lessons learned screening.
- Designate persons in each division to act as the lessons learned coordinator for that organization. Hold periodic meetings with institutional and division coordinators to share information, feedback, and communication of expectations.
- Strengthen the feedback mechanisms to provide meaningful measures and mechanisms to assist in the evaluation of program effectiveness. Require division coordinator feedback to the site coordinator on the disposition of posted safety lessons learned. Require a detailed discussion of the generation and application of lessons learned in annual division/directorate self-assessment reports.
- Ensure that the recommended actions for lessons learned from external sources posted to the database are rewritten and tailored to LBNL and do not include references to other site specific facilities, organizations, processes/procedures, and management systems.

**5. Improve processes for reporting employee concerns.** Specific actions to consider include:

- Publish the processes and requirements for the RIIO and EH&S employee concerns programs in institutional documents.
- Ensure that factors such as anonymity and confidentiality are fully addressed.

# APPENDIX E

## Management of Selected Focus Areas

### E.1 INTRODUCTION

The U.S. Department of Energy (DOE) Office of Independent Oversight inspection of environment, safety, and health (ES&H) programs at Lawrence Berkeley National Laboratory (LBNL) included an evaluation of the effectiveness of the Berkeley Site Office (BSO) and LBNL in managing selected focus areas.

Based on previous DOE-wide assessment results, the Independent Oversight team identified a number of focus areas that warrant increased management attention because of performance problems at several sites. During the planning phase of each inspection, the Office of Independent Oversight selects applicable focus areas for review based on the site mission, activities, and past ES&H performance. In addition to providing feedback to the DOE Headquarters Office of Science (SC), BSO, and LBNL, the Office of Independent Oversight uses the results of the review of the focus areas to gain DOE-wide perspectives on the effectiveness of DOE policy and programs. Such information is periodically analyzed and disseminated to appropriate DOE program offices, sites, and policy organizations.

The focus areas selected for the review at LBNL and discussed in this Appendix are:

- Chemical Management (see Section E.2.1)
- Hazardous Waste Management (see Section E.2.2)
- Worker Rights and Responsibilities under 10 CFR 851 (see Section E.2.3)
- Operational Injury and Illness Recording and Reporting (see Section E.2.4)

The evaluation of the long-term focus area—implementation of DOE Order 226.1, *Implementation of DOE Oversight Policy*—is accomplished by evaluating SC, BSO, and LBNL feedback and improvement systems, as discussed in Appendices C and D.

The focus areas are not rated separately, but results of the review of the focus areas are considered in the evaluation of integrated safety management (ISM) elements, where applicable.

### E.2 RESULTS

#### E.2.1 Chemical Management

DOE regulations promulgated under 10 CFR 851 establish requirements for contractors, if not otherwise regulated by the Occupational Safety and Health Administration (OSHA), to comply with OSHA regulations. In addition, contractors are required to comply with environmental regulations. The Federal regulations governing chemical management include 29 CFR 1910, Subparts H and Z; 29 CFR 1926, Subpart D; and 40 CFR, Subchapters E and R. These regulations establish the requirements for managing, storing, and using hazardous chemicals, pesticides, and toxic materials in a manner that protects the health and safety of employees and the environment. In addition, information maintained as part of a chemical management program may be used to support other programs and initiatives, triggering additional regulatory or policy requirements.

The Independent Oversight team reviewed a number of activities associated with research, production, construction, and maintenance conducted at LBNL in which chemicals were procured, stored, and used. In addition, the institutional processes, data management systems, and requirements were reviewed as part of the inspection process.

Recently, LBNL initiated a site-wide effort to identify, collect, and properly dispose of outdated and unneeded chemicals. Researchers and operations personnel have reviewed existing stored chemicals and have collected outdated or unneeded chemicals for disposal. Staff operating the LBNL-permitted hazardous-waste-handling facility have worked diligently to store, package, and dispose of this additional waste stream. Considerable progress on this initiative was observed.

In addition to the effort to minimize legacy chemicals, LBNL has implemented actions to reduce the hazard from chemicals used in research and operations. For example, many laboratories have replaced some of the hazardous chemicals used in research activities with pre-measured test kits. Many of these test kits contain less hazardous chemicals and also result in less waste. The Facilities Division uses water-based paints where possible. Engineering has significantly reduced electroplating activities and utilizes a powder coating operation to reduce the use of solvent-based paints.

LBNL operates its chemical management program under a single set of requirements that are a combination of the hazard communication and laboratory standard requirements under OSHA. These institutional requirements are established in the Chemical Hygiene and Safety Plan (CHSP). By adopting a combined program, LBNL has eliminated confusion over which OSHA requirement applies to a given situation or workplace. The CHSP includes specific direction and guidance on roles and responsibilities, chemical procurement, transportation and storage, data management, chemical labeling, hazard analysis and controls, employee training, and exposure assessments.

Line management is responsible for ensuring material safety data sheets (MSDSs) are readily available to LBNL employees. In many instances, employees use one of the MSDS search engines accessible through the LBNL website as a resource. Some divisions, such as Facilities, maintain binders of MSDSs for their employees. Research divisions use binders, the online search engine, or a combination of both to ensure MSDSs are available. Using the various options available, employees were observed to have ready access to MSDSs during this review.

The electronic system used by LBNL to manage its inventory of hazardous chemicals is the chemical management system (CMS). CMS has the capability to maintain a container by container inventory of chemicals which are identified through unique identification numbers and barcodes. Some chemicals, such as compressed gas cylinders at fixed locations, are tracked in CMS as static inventory where a specified number of cylinders are secured, but the specific cylinders are changed out for ones with the same content. Institutional procedures also allow the use of a single identification number/barcode to represent multiple identical containers. Overall, the CMS is a robust inventory tracking and analysis system that is used to support a variety of safety, industrial hygiene, environmental, and fire protection data requirements. Chemical users are responsible for entering information on newly procured chemicals into the database. In addition, the CMS inventory is updated during an annual site-wide chemical reconciliation review process to physically verify the location and quantity of hazardous chemicals on-site.

Although CMS is used by LBNL to provide the hazardous chemical list required under OSHA regulations, some hazardous chemicals are not included in the CMS inventory. For example (see Finding #E-1):

- LBNL has excluded a number of materials under the OSHA “article exemption;” however, some of those materials do not meet the exemption requirements and were improperly excluded. For example, metal alloys used in machine shops, lead solder, and consumable items such as grinding wheels and welding rods were generally excluded from the CMS inventory, although they should be included because under normal conditions of use, they can release hazardous chemicals that may pose a physical hazard or health risk to employees.
- A number of chemicals used within laboratories such as analytical kits, biological media components, and stock buffer solutions that may be hazardous were excluded from CMS inventory for a number of laboratories in multiple divisions. In some instances, the researchers incorrectly deemed that the materials were nonhazardous. However, a review of some of the MSDSs and sample containers indicated that some of these chemicals, such as DNA Away, malt extract, and SDS Running Buffer, presented potential health hazards.

Labeling of secondary containers frequently does not meet the OSHA requirements that the labeling identify both the appropriate chemical name and hazard warning. Numerous secondary containers are labeled with only abbreviations or chemical formulas. Although researchers may be knowledgeable of the contents of these chemicals within their labs, other individuals may have direct or inadvertent contact with these materials. For example (see Finding #E-1):

- Within the Joint Bioenergy Institute (JBEI), workers responsible for cleaning and sanitizing glassware were unaware of the content and potential hazards associated with glassware containing residual chemicals.
- In many laboratories, waste management operations workers routinely access chemical fume hoods to collect accumulated waste scheduled for disposal. These workers could contact the contents of adjacent secondary containers stored or in use within the hoods.
- There are a number of researcher-prepared chemical mixtures in secondary containers that contain one percent or more of multiple hazardous chemicals (e.g., acids, solvents, and bases), and that have no hazard warnings. The CHSP does not provide detailed guidance on how to establish hazard warning labels for such mixtures. The CHSP follows the OSHA requirement that “a mixture is assumed to present the same hazards as each component that comprises 1 percent or more of the mixture.” Based on discussions with LBNL staff, it is not always clear when or if a mixture of chemicals should be considered hazardous, and therefore when the container must meet the requirements of the CHSP.

The CHSP provides general guidelines on proper storage of chemicals, including segregation by chemical class, consideration of incompatibilities, use of secondary drip trays, and storage in cabinets. In addition, the CHSP outlines control procedures for several specific chemical classes. However, in some instances, the CHSP provides guidelines in lieu of explicit institutional requirements where regulatory requirements exist. These guidelines were not always followed. For example (see Findings #E-1 and #C-4):

- In one Physical Biosciences Division (PBD) laboratory in JBEI, peroxide-forming chemicals did not have receipt date and annual testing results identifiable through the LBNL labeling requirement.
- Several compressed gas cylinders were stored unsecured or improperly secured in Facilities, the Advanced Light Source (ALS) facility, and PBD.
- In a number of research laboratories in Life Sciences Division (LSD), PBD, and Chemical Sciences Division (CSD), acids and flammables were stored together in flammable storage cabinets.



- Flammable liquids and flammable compressed gas cylinders were stored together in one flammable storage cabinet in Facilities.
- In a number of locations, significant quantities of flammable chemicals were stored outside of approved flammable storage cabinets. For example, the Facilities Stores stocks over 10 gallons of flammable liquids outside of a flammable storage cabinet. A cabinet for corrosive chemicals in JBEI was used primarily to store alcohol. A number of laboratories store significant quantities of flammable liquids in secondary containers outside of flammable storage cabinets, along with additional flammable chemicals stored inside hoods.
- Many hazardous chemicals were not stored on drip trays.
- In many laboratories, hazardous chemicals are stored in chemical fume hoods. This practice is prohibited in JBEI through the JBEI ES&H plan, and the CHSP recommends against this practice in its storage guidelines.

The Fire Marshal uses monthly reports from CMS as the source data for determining whether facilities are maintaining quantities below the California building code exempt amounts for a variety of hazardous chemicals including flammable liquids, flammable gases, corrosives, reactives, and other materials. As part of this monthly review, the threshold for verifying actual on-hand quantities is 50 percent of the exempt amounts. While this may be sufficient for many chemicals, it may not ensure compliance with limits for flammable chemicals, especially those stored outside of flammable storage cabinets. Quantity information maintained in CMS does not always accurately reflect the quantities of material that are present; for example, within the Facilities Division, quantity information in CMS is adjusted only annually based on the quantity at the time of the annual inventory; increases in the amount of hazardous materials throughout the year would not be reflected in CMS. As discussed earlier, in a number of research and operations locations, flammable materials were stored outside of a flammable storage cabinet and many laboratories store some flammable chemicals inside of chemical fume hoods. The CHSP does not require the content of secondary containers to be tracked in CMS. Information on whether specific containers are stored within an approved storage cabinet is not recorded within the CMS data. In addition, although tracking of quantities of ignitable hazardous waste is clearly outside of the scope of the CMS, these materials contribute to overall fire loading and reduce the margin of safety.

LBNL has developed institutional requirements and training for working with cryogenics. Much of this effort has focused on pressure safety. In addition, LBNL has initiated action to identify and evaluate the potential for creating an oxygen deficient atmosphere in some areas where cryogenics are stored and used. Evaluations of the potential for oxygen deficiency have been conducted for some high risk activities, such as nuclear magnetic resonance machine locations covered by activity hazard documents (AHDs). In addition, oxygen deficiency evaluations have been performed for some of the ALS facility operations involving cryogen use in enclosed spaces, vehicle transport of cryogenics, and some additional locations where cryogenics are delivered or used. However, LBNL has recognized that additional action is needed to fully address this hazard. Locations where cryogenics are piped have been identified by the EH&S Division, but locations where cryogenics are used are not always identified in the hazard management system. Many locations where cryogenics are piped, transported, or used within buildings have not been assessed for the potential for an oxygen-deficient atmosphere. For example, a number of laboratories in multiple divisions use large dewars containing liquid nitrogen, although many of these locations have not been assessed for oxygen deficiency potential and most locations are not monitored for oxygen level. Researchers responsible for these areas have not been provided with storage limits that would prevent the potential for an oxygen-deficient atmosphere in the event of a sudden release of container contents. Some researchers using cryogenics were not aware of LBNL procedures for transporting cryogenics on elevators, which is outlined in the Compressed Gas and Cryogen Safety training course but not reflected as

requirements in an institutional document such as the LBNL EH&S manual. (See Findings #C-2 and #C-4.)

### **E.2.2 Hazardous Waste Management**

DOE Order 450.1A, *Environmental Protection Program*, requires DOE sites to implement “sound stewardship practices that are protective of the air, water, land, and other natural and cultural resources impacted by Department of Energy (DOE) operations and by which DOE cost effectively meets or exceeds compliance with applicable environmental; public health; and resource protection requirements.” To selectively evaluate the environmental protection program, Independent Oversight chose compliance with hazardous waste requirements as a focus area. Independent Oversight’s review of hazardous waste compliance will provide feedback to DOE management on line management’s effectiveness in implementing requirements for generating, storing, treating, transporting, and disposing of hazardous waste established under Federal and state regulations, applicable permits, and DOE directives.

At LBNL, the Independent Oversight team evaluated the site-wide guidance and support for hazardous waste management and the compliance with hazardous waste requirements within facilities and processes. Independent Oversight observed operations, research, construction, and maintenance activities performed by LBNL and subcontractor personnel at various laboratories, user facility worksites, construction and maintenance worksites, and waste management facilities.

Hazardous wastes generated on the main LBNL site and the Donner building are accumulated in various satellite accumulation areas (SAAs) and waste accumulation areas (WAAs). Under LBNL policy, hazardous wastes may be accumulated for up to 275 days in SAAs and up to 60 days in WAAs before it must be transported to the Hazardous Waste Handling Facility (HWHF) by technicians in the EH&S Division. Some treatment, such as pH neutralization, is permitted at HWHF. Hazardous wastes are then periodically packaged and shipped offsite for disposal. LBNL conducts these activities under a hazardous waste treatment and storage permit issued by the California Environmental Protection Agency to the Department of Energy. The EH&S Division has developed various written procedures to ensure requirements from the Hazardous Waste Facility Permit are flowed down to workers.

As authorized under the LBNL hazardous waste facility permit and the BSO-approved Transportation Safety Document, waste is transferred from the Donner building to HWHF. Requirements for conducting the transfers are outlined in EH&S Procedure 811, Hazardous Waste Handling Procedures. However, because of complexity of the permit language, recordkeeping requirements in Procedure 811 may not be sufficiently robust.

In addition, LBNL generates hazardous waste at offsite facilities, such as the Joint Bioenergy Institute (JBEI) and the Joint Genomics Institute. These locations operate under separate generator identification numbers. For these facilities, hazardous wastes generated at these locations may also be accumulated for up to 275 days in SAAs and up to 60 days in WAAs, but the wastes are packaged by EH&S Division technicians and shipped directly to an offsite facility for disposal.

Employees who generate hazardous waste establish SAAs at or near the point of generation, which is often within a laboratory or shop where the waste is generated, or in a nearby room under the control of the generator. SAAs are established or eliminated by the waste generators based on their needs. The majority of these SAAs are operated in accordance with the LBNL guidelines outlined in the waste management services generator guidelines (PUB-3092), and hazardous waste labeling and secondary containment requirements were generally understood and followed. However, explicit institutional requirements are not clearly defined and there were a few instances in which waste or safety controls were not properly implemented (see Finding #C-4):

- One SAA was accepting waste from another SAA. Only a permitted facility or a WAA, which must comply with additional regulatory requirements, can accept waste from an SAA. When operated in this manner, the location would become a WAA and is not compliant for that purpose. This situation was identified by LBNL during the course of the inspection and the SAA manager was provided clarification.
- A few hazardous waste containers in PBD had missing or incorrect start dates.

There is a regulatory requirement to conduct weekly inspections of WAAs. The EH&S Division conducts these inspections, to provide additional technical expertise and independent review, in support of line management organizations that are responsible for operating the WAAs in compliance with institutional requirements. A checklist for documenting these inspections is included in EH&S Procedure 815. The checklist includes the issues critical to meeting regulatory and institutional requirements. However, some items on the checklist are open to interpretation, the option is given to mark any item "N/A," and no instructions are included for use of the checklist or follow-up to ensure correction actions are taken and documented. Also, during the Independent Oversight review, concerns with implementation of the LBNL inspection process were noted and some safety controls were not effectively implemented (see Finding #C-4):

- In one instance, an Engineering WAA in a normally unoccupied building was locked and EH&S does not have key access to the building. The EH&S inspector viewed the container through small perforations in the door; only a small portion of the container was visible with this method. EH&S has arranged with Engineering for the waste generator to turn the container so the label points toward the door if there is waste in it. This approach is not adequate to fully meet the regulatory inspection requirements and minimizes the effectiveness of an independent review.
- Several containers of waste had exceeded the institutional time limit of 60 days, although they were well within the regulatory limit of 90 days. A requisition for pick-up of the waste had been submitted a few days before the 60-day deadline but not in time to schedule transportation of the waste to the HWHF before the 60-day limit was reached.
- There is an institutional requirement for eyewashes and showers at all WAAs; however, access to the eyewashes and showers was obstructed in a few instances. The eyewash and shower at an Engineering WAA can only be reached by climbing one or more steps to exit the WAA and then descending several steps. At a Facilities WAA, the eyewash and shower are on the other side of a road from the WAA. However, in both instances, no deficiencies or concerns were identified during the observed WAA inspection.

In a few isolated instances, some wastes that may be hazardous were not appropriately identified and managed as hazardous waste. For example, within ALS, lead-containing solder scraps and lead-based paint chips from flaking paint were disposed of along with trash; both practices were ended when identified by the Independent Oversight team. As discussed in the Section E.2.1, some hazardous chemicals, such as lead-containing, had not been identified by the chemical user as hazardous and may be a contributing factor to this observation. In addition, some waste streams rely on old characterization that may not reflect current waste composition. For example, used sandblasting grit in Engineering has not been analyzed for waste characterization for more than 12 years. This waste is generated over time from sandblasting a variety of metals/alloys with a variety of paints and coating and periodically disposed as non-hazardous waste.

Once accumulated waste containers are full or otherwise designated for disposal by the waste generator, a requisition is entered into the data management system (called Shoebox) used by LBNL to manage

hazardous waste. Shoebox is well designed for assisting HWHF personnel with managing hazardous waste. It facilitates review of requisitions to ensure that the waste is properly described and all information necessary for waste pick-up is provided. It also supports assignment of waste codes, identifies appropriate storage locations in the HWHF, and randomly selects waste containers for additional quality assurance (QA) review. The system also generates waste pick-up lists, ensures shipment holds are placed on containers undergoing quality assurance review, identifies compatible wastes for lab packing, and generates the necessary paperwork for shipping waste offsite. Because the initial data entry occurs after the waste has been accumulated, it does not support tracking of hazardous waste being accumulated in SAAs and WAAs, which can be in these locations for up to 275 days and 60 days, respectively.

Once a requisition has been reviewed and the waste has been scheduled for pick-up, EH&S technicians are responsible for pick-up and transport of hazardous wastes from SAAs and WAAs across the site. Observed pick-up activities were conducted with adequate staffing and followed the direction provided in EH&S Procedure 811. However, several concerns were identified during observations of these activities including hazards that were not adequately identified, analyzed, and controlled through the job hazard analysis (JHA) process or other site hazard analysis processes (see Finding #C-1):

- Protective gloves used for this activity consisted of nitrile exam gloves. At one location, the researcher was also handling the waste containers, although the researcher wore different gloves. In addition, waste was collected from multiple labs. Based on a review using the LBNL glove selection link for the SpecWare guide, there is no single type of glove that is appropriate for all of the chemicals collected at these various locations. The technicians' JHAs provided only a generic statement to "wear gloves appropriate for the material being handled."
- Waste collected from SAAs may only include several containers that are co-located with other containers still in use to collect additional waste. Technicians must physically sort through other waste containers, not identified in advance, to locate those which are for pick-up. In this situation, HWHF subject matter experts (SMEs) and technicians cannot plan for protection from all wastes that may be contacted during pick-up. The JHAs do not identify the hazards posed by working around chemicals that cannot be researched in advance and provides no controls to mitigate those hazards.
- Wastes were transported in an open pick-up truck bed in secondary containment tubs. Although the tubs were secured with straps, the individual containers (often glass bottles) were not packed in the tubs to prevent shifting and sliding during transport, increasing the possibility of container breakage. Neither the JHAs nor EH&S Procedure 811 addresses securing individual waste containers.

Ten percent of the hazardous waste containers processed through HWHF are subject to quality assurance sampling and analysis. The containers to be sampled are randomly selected by the Shoebox system and a generator assistant, assigned from the EH&S Division, determines the analytical test(s) to be performed to confirm the contents as reported by the waste generator. The generator assistant can also request additional analysis if he or she had reason to suspect that the contents might vary from what the waste generator reported. Once a container is selected for quality assurance sampling, an administrative hold is placed on it to prevent it from being lab packed or shipped from HWHF until the generator assistant reviews the analytical results and resolves any significant discrepancies between the reported composition and the analytical results. While this process is well managed, it relies heavily on the individual knowledge and expertise of the generator assistants to recognize when the reported contents may not reflect the actual waste composition. The omission of some hazardous chemicals from CMS may also impact the ability to recognize the contribution these materials may have on the waste characterization.

### **E.2.3 Worker Rights and Responsibilities**

Communication of worker's rights and responsibilities is an important element of 10 CFR 851, *Worker Safety and Health Program*. The Independent Oversight team evaluated the mechanisms used by contractors to communicate rights and responsibilities under 10 CFR 851 and the degree to which workers and first line supervisors understand those rights and responsibilities.

LBNL management has informed laboratory personnel about their individual rights and responsibilities, as stated in 10 CFR 851. Elements of these rights were found in institution and division documents, numerous postings of the "It's the Law" poster, and orientation materials including LBNL Orientation Pamphlet 177E. Interviews with selected laboratory personnel and subcontractors indicated that these rights have been communicated by supervisors or work leads and recently reinforced. LBNL personnel who were interviewed indicated they would not feel intimidated by raising safety related questions or concerns. Personnel were also aware of the formal and informal avenues available to resolve safety related questions or concerns, including the contractor employee concerns program (ECP) and the safety divisions email program.

While the general intent of worker rights and responsibilities under 10 CFR 851 were understood, some employees did not demonstrate an understanding that their rights were founded in Federal regulations (10 CFR 851). A few construction subcontractors did not know they have the right to have their representative accompany DOE personnel inspecting their workplace, which is a specific right detailed in 10 CFR 851. However, these workers indicated that they would contact their supervisor if they had questions. In addition, some personnel were not aware of the posters and several non-native English speaking employees who had viewed the posters had some difficulty understanding some aspects of the specific provisions. One reason that some individuals may not have been familiar with the poster and/or its foundation in 10 CFR 851 is that in most areas, LBNL has placed the "It's the Law" poster over the bottom center of an existing California employment poster, in a manner that it appears to be part of the California posting and thus making it difficult to discern that the "It's the Law" poster is separate and unrelated.

Bargaining unit officials representing unions with workers at LBNL were also interviewed and indicated their belief that the trend at LBNL was positive concerning management's support and commitment to maintaining a safe work environment and recognizing workers involvement in that process. Union officials recognized that workers have the right to a safe work environment and most, but not all, union officials understood that worker rights have a foundation in 10 CFR 851. Several union officials expressed concern that the past behavior-based safety observation programs (WOW program) had not been sufficiently maintained and stated that this program needed to be resurrected and/or replaced with a comparable program. Although most comments concerning LBNL management's support of worker rights and responsibilities were positive, there were isolated concerns that some individual managers or supervisors in research and/or operations may not be fully supportive of the worker rights and responsibilities as stated in the LBNL Worker Safety and Health Program (WSHP).

### **E.2.4 Occupational Injury and Illness Recording and Reporting**

**Berkeley Site Office.** The BSO ES&H Division is responsible for recording and reporting occupational injuries and illnesses to Federal employees at the site office. Injured employees can obtain medical treatment through the LBNL Health Services Division. Procedures are in place to collect the required injury and illness reporting information. The 2008 Summary of Work-Related Injuries and Illnesses (OSHA Form 300A) was posted, as required. No instances were reported by BSO in 2008.

Data collection and reporting responsibilities were transitioned to a new employee in late 2008. Although quarterly work hours are being reported to DOE, this information is not reported electronically as required by DOE Manual 231.1-1A, *Environment, Safety and Health Reporting Manual*. Periodic assessments of contractor occupational injury and illness recordkeeping and reporting have not been performed in recent years.

**Lawrence Berkeley National Laboratory.** LBNL has established a process for identifying, classifying, and reporting occupational injuries and illnesses to contractor and subcontractor employees. EH&S Division has written a draft internal process description document that details the process steps for injury and illness recordkeeping and reporting. The EH&S Division staff assigned to these tasks is trained and knowledgeable in the subject area and exercised sound judgment in classification decisions. Information collected on occupational injuries and illnesses is analyzed and shared within LBNL to show trends and identify areas that need improvement.

The Independent Oversight assessment of this program included a review of procedures and case records and interviews with responsible staff and injured employees. Case information for LBNL and subcontractor employees is processed and recorded by LBNL Occupational Safety staff. As established in the EH&S manual chapter on Incident Reviewing and Reporting, all occupational injuries and illnesses must be reported to Health Services, which is also a part of EH&S. In most instances, medical treatment is provided exclusively through Health Services staff. Information from treatment received offsite is reported back to the LBNL through Health Services.

The Health Services' Occupational Health Medical (OHM) database includes the employee's initial statement and the diagnosis. Through a separate interface, OHM collects case information supplied in the Investigator's Report and the Supervisor's Accident Analysis Report (SAAR), and limited information from the Occupational Injury and Illness Process Manager (OIIR PM). An e-mail notification from Health Services is sent to each of these individuals and other pertinent LBNL staff when a new case is identified and initiates the data collection process.

The collection and reporting of occupational injuries and illnesses has resulted in proper classification in most cases. Of 173 cases reviewed by the Independent Oversight team, three cases were not classified, recorded, and reported as required. LBNL has initiated the process to collect complete data on each case and each case will be recorded and reported.

However, some process and performance deficiencies were identified by the Independent Oversight team, as discussed in the following paragraphs.

Proper recording and reporting of occupational injuries and illnesses is dependent on complete information being provided to the OIIR PM from Health Services and through the SAAR and the Investigator's Report. The review of 2008 work-related occupational injuries and illnesses revealed that the SAAR and the Investigator's Report were generally late and missing some necessary information. As a result, most cases are reported to DOE late. PUB-3000 requires these reports to be submitted within seven calendar days of the notification of injury. Although the current process does not include an elevation of notifications when reports are late, a pending Corrective Action Tracking System (CATS) database item includes actions to address this problem.

The OIIR PM has access to information regarding the nature of the injury and the diagnosis from the initial information entered into OHM by Health Services. Medical treatment information, which is necessary to document classification decisions, is not generally entered in OHM by Health Services. Although the OIIR PM receives treatment information and other information available from the nurse notes and follow-up visits through e-mails and phone calls to Health Services, the information is not

being documented in the case files. Case files without this information lack documentation to support classification decisions. During the assessment, the OIIR PM, with assistance from LBNL computer support staff, identified a data field in the safety section of the OHM database that will be used to document this information in the future. The OIIR PM manually tracks case and lost time information that is currently not available through reports generated from the OHM interface. These manual processes entail duplication of effort and increase the potential for errors. Another area in which efforts are being duplicated with an increased potential for errors is the current practice of manually entering recordable injury reports to DOE through the Computerized Accident/Incident Reporting System (CAIRS) rather than directly uploading the information to CAIRS from the local database.

With the exception of late reporting, communication between pertinent individuals to collect information for classification of occupational injuries and illnesses is effective in most cases. However, two of the three misclassified cases identified by the Independent Oversight team were due to data flow problems. Health Services, the OIIR PM, and other pertinent parties do not conduct periodic meetings in an effort to reduce errors due to miscommunication and to improve data quality.

Employees who were interviewed were aware of the responsibility to promptly report all work-related injuries and illnesses. Data recorded on the 2008 Log of Work-Related Injuries and Illnesses was consistent with information reported to DOE through the CAIRS. Likewise, the Summary of Work-Related Injuries and Illnesses was properly certified and posted. These records will change when the misclassified/unreported cases previously discussed are recorded and reported properly.

The CAIRS case input module collects information equivalent to data recorded on the OSHA Form 301, Injury and Illness Report. This information is used to generate the DOE equivalent form, DOE F 5484.3, Individual Accident/Incident Report. As required by 29 CFR 1904, the case number on the DOE equivalent to the OSHA Form 301 should match the case number on the OSHA Form 300. The LBNL case numbers do not match. LBNL records two case numbers in the local data collection system, one generated by the local system and one assigned by the OIIR PM.

The OIIR PM completes the DOE F 5484.3 with information taken from the SAAR and Investigator's Report. The information reported to CAIRS in many cases lacks sufficient detail to identify hazards and corrective actions that can be shared within the DOE community. See Appendix D for additional discussion of deficiencies in injury and illness investigations. (See Finding #D-3.)

The EH&S Division internal process document for Occupational Injury and Illness Recordkeeping and Reporting provides, in general, sufficiently detailed processes for collecting, documenting, and reporting this information.

Within the past 6 months, EH&S has conducted two technical assurance program (TAP) assessments of occupational injury and illness reporting. A June 2008 assessment report identified a finding that the draft internal procedure had not been finalized and should be put into the EH&S manual. However, the corrective actions were not sufficient. Specifically, the procedure was not approved and not included in the EH&S manual (only a policy statement was included in the EH&S manual). Also, the unapproved procedure contains institutional requirements but remains an internal EH&S Division process. (See Findings #C-3 and #D-2.)

### **E.3 OPPORTUNITIES FOR IMPROVEMENT**

The Independent Oversight review identified the following opportunities for improvement. These potential enhancements are not intended to be prescriptive. Rather, they are intended to be reviewed and

evaluated by the responsible line management and prioritized and modified as appropriate, in accordance with site-specific programmatic objectives.

### **BSO – Hazardous Waste Management**

- 1. As permit owner, obtain a written legal opinion to verify that LBNL procedures adequately address the complexity of the permit language relative to waste transportation from the Donner building.**

### **LBNL – Chemical Management**

- 1. Continue efforts to reduce quantities of stored hazardous chemicals.** Specific actions to consider include:

- Establish formal requirements for identifying unused chemicals on an ongoing basis, possibly as part of the annual inventory reconciliation process.
- Use the CMS to identify hazardous chemical containers remaining in inventory for extended periods of time. Establish procedures for periodic review of the need for chemicals that remain longer than a defined duration.
- Institute a just-in-time chemical procurement program through one or more vendors. Investigate the possibility of providing CMS access to approved vendor(s) to barcode and input chemicals directly into inventory upon delivery.

- 2. Update institutional procedures to ensure requirements are clearly defined and communicated.** Specific actions to consider include:

- Provide additional direction in the CHSP to assist chemical users with identifying which chemicals must be included in the CMS.
- Revise chemical storage information in CHSP to clearly distinguish mandatory requirements from optional guidance.
- Establish uniform requirements for labeling secondary containers to adequately communicate the contents and provide appropriate warnings to all employees who work in proximity to those chemicals.
- Incorporate requirements into PUB-3000 to address the potential for oxygen deficient atmospheres during cryogen transport, use, and storage.
- Consider incorporating the requirements from the CHSP into PUB-3000 as a separate chapter.

- 3. Enhance use of CMS to support greater monitoring and oversight of chemical storage and use.** Specific actions to consider include:

- Track hazardous chemicals on a container basis, including secondary containers that are stored between work shifts.
- Use static inventory data entries to account for bulk chemicals, such as cryogen dewars, acid baths, solvent baths, etc.



- Provide additional data field, or modify existing field, to permit tracking of hazardous chemicals to a specific storage location within a room. Based on programmatic needs, evaluate which chemicals should be tracked to this level of detail (such as peroxide formers, particularly hazardous substances, flammable liquids, etc.).
- Track status of hazardous chemicals requiring special storage or management, such as those which present additional hazards after extended storage.
- Establish a consistent process for tracking chemical kits that are provided by manufacturers, and guidance on labeling and storage of individual chemical containers within these kits.

## **LBNL – Hazardous Waste Management**

**1. Modify EH&S Procedure 815 to improve the WAA weekly inspection process.** Specific actions to consider include:

- Explicitly define the intent of checklist items.
- Ensure response options for checklist items are appropriate to ensure compliance.
- Incorporate requirements to ensure corrective actions are appropriately documented.

**2. Modify institutional requirements for managing SAAs to ensure they are clearly defined and communicated.** Specific actions to consider include:

- Expand TAP requirements to include review of SAA locations to ensure they are at or near the point of waste generation and under generator control.
- Require segregation of hazardous waste requisitioned for pick-up to minimize EH&S technician contact with unanticipated wastes.
- Track hazardous waste from the time of initial accumulation in Shoebox to assist with identifying new SAAs as they are established, provide data to support refined exempt amount evaluations, and provide information to minimize EH&S contact with unanticipated wastes.
- Establish guidance or prohibitions on storage of waste in chemical fume hoods.

**3. Enhance waste characterization processes and procedures.** Specific actions to consider include:

- Document the evaluation process and considerations followed by generator assistants to facilitate continual improvement and aid in training newly assigned personnel.
- Establish formal requirements for characterizing waste in which process knowledge may be of limited value, such as sand blasting waste.

## **LBNL – Injury and Illness Recordkeeping and Reporting**

**1. Enhance systems for implementing injury and illness recordkeeping and reporting.** Specific actions to consider include:

- Implement a system to generate reminders to supervisors, investigators, and division safety coordinators with overdue investigation reports. Late report reminders would also be forwarded to appropriate management.
- Consider realigning the responsibilities for collection of the data used by the OIIR PM to make classification decisions.
- Implement changes to the OHM interface that allow for data collection and report generation to meet current needs.
- Enter the issue of the informal recordkeeping and reporting process document into CATS and prioritize the revision and inclusion of the processes and requirements into the EH&S manual.
- Reinstate the practice of holding periodic case management meetings between Health Services, the OIIR PM, and other pertinent parties to help eliminate errors due to miscommunication and to improve data quality.
- Reinstate the uploading of injury and illness information to CAIRS directly from the local database.
- Consider methods to automate processes for documenting treatment information and tracking case and lost time information to reduce the duplication of effort and the potential for errors.

## **LBNL – Worker Rights and Responsibilities**

### **1. Strengthen mechanisms for informing workers of their rights and responsibilities under 10 CFR 851.** Specific actions to consider include:

- Revisit the current manner for displaying the “It’s the Law” poster such that the poster is more prominently displayed separately from other employment postings. Consider adding a heading or notice above the poster to indicate to workers the existence of a new DOE safety and health regulation.
- Consider revising LBNL EH&S training materials to include more detail on 10 CFR 851 including worker rights and responsibilities. Include in the exam section a question verifies that workers understand the source of the worker rights in Federal regulations (e.g., to choose the correct regulation – 10 CFR 851 – from a list of regulations).
- Evaluate the benefits of resurrecting the WOW program or a similar behavior-based safety program at LBNL.