Materials Sciences Division

Integrated Safety Management Plan

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1. Introduction

The objective of Integrated Safety Management (ISM) is reliability: to consistently perform work in a safe and environmentally sound manner. Working safely is simply a part of how we do our jobs. Reliability, i.e. minimal frequency and severity of safety failures, benefits efficiency and performance. Safe planning and practice is not viewed as an add-on or as a strict compliance activity. Working safely is expressed in how we work to accomplish our mission.

The purpose of this plan is to describe the logic and design of the MSD ISM system. This document is intended to be used in tandem with other LBNL and UC Berkeley policy, such as the institutional ISM plan, the LBNL Health and Safety Manual or other documents.

1.1 Safety Culture

DOE's Integrated Safety Management System Guide[1] defines positive safety culture:

"Safety culture is an organization's values and behaviors modeled by its leaders and internalized by its members, which serve to make safe performance of work the overriding priority to protect the workers, public, and the environment."

This shared value system characterized by communications founded on mutual trust is fundamental philosophy at the basis of MSD's ISM system. High reliability depends on the willing participation of the entire workforce: safety is the result of organizational culture. We seek the following elements in our safety culture:[2,3]

A) Informed Culture: The scientists and others who manage and operate the Division have current knowledge about the human, technical, organization and environmental factors that determine the safety of Division operations.

B) Just Culture: An atmosphere of trust in which people are encouraged and rewarded for providing essential safety-related information, but in which a clear line has been drawn between acceptable and negligent or intentionally dangerous behavior.

C) Reporting Culture: A culture in which people are prepared to report their errors and near misses.

D) Learning Culture: An organizational willingness and competence to draw the correct conclusions from safety performance metrics and a willingness to implement major reforms based on these findings.

E) Flexible Culture: A culture in which the organization recognizes that "one size

[1] DOE G 450.4-1C, https://www.directives.doe.gov/directives-documents/400-series/0450.4-EGuide-1c
[2] http://www.airsafety.aero/Safety-Information-and-Reporting/OT-Safety-Bulletin/Issue-7-Winter-2014-15/Just-Culture.aspx

doesn't fit all" and is willing to consider multiple ways in which to achieve safety and cultural excellence. This also allows for evolution in practices in an effort toward continuous improvement.

F) Deference to Expertise: People possessing direct knowledge and technical skills are empowered to make safety-related decisions and implement necessary safety controls.

1.2 ISM Core Functions

Safe planning and practice is the starting point of all work we do, and we follow through by improving our plans on the basis of internal as well as external experience. These are the 5 core functions of ISM: (1) Define the scope of work, (2) Identify the hazards of the work, (3) Develop and implement controls for the hazards, (4) Perform the work, (5) Maintain continuous improvement from regular feedback. These core functions apply to all levels of work, including Integrated Safety Management system design.

1.3 Learning Organization

ISM System implementation in MSD integrates the lessons learned from industry experience, organizational research and operations in the Division and the Lab. The scientific literature on the safety performance of organizations contributes significant sources of insight, including the research and conclusions related to High-Reliability Organizations (HROs) and to Human Performance Improvement (HPI)[3] initiatives in organizations working with hazards. DOE ISM guidance[1] highlights that *"HRO and HPI tenets are very complementary with ISM and serve to extend and clarify the program's principles and methods."* [4]

The Materials Sciences Division integrates *"ISM core functions, ISM principles, HRO principles, HPI principles and methods, lessons learned, and internal and external best safety practices into a proactive safety culture where: facility operations are recognized for their excellence and high-reliability, everyone accepts responsibility for their own safety and the safety of others, organization systems and processes provide mechanisms to identify systematic weaknesses and assure adequate controls, and continuous learning and improvement is expected and consistently achieved."* [4]

HRO research has shown how mindful flexibility is a key principle characteristic of high reliability organizations. Reliability through flexibility is inherent in our way to work, in ISM, and in ISM system design. To quote DOE ISM policy[1]:

"The ISM core function of feedback and improvement calls for DOE to learn from available feedback and make changes to improve. This concept applies to the ISM

[3] The DOE Department of Health, Safety and Security maintains a comprehensive introduction to HPI at the site: http://hpi.doe-hss.wikispaces.net/Human+Performance+Improvement

[4] DOE Human Performance Improvement Handbook, volume 1: http://energy.gov/sites/prod/files/2013/06/f1/doe-hdbk-1028-2009_volume1.pdf

program itself. Lessons learned from both internal and external operating experience are reflected in this Manual to update the ISM program."

Like our research mission, our work on improving safety, including policies such as this ISM plan, is never finished – our commitment is *continuous improvement*.

The revitalized ISM system is expected to define and drive desired safety behaviors, to help DOE and its contractors create a world-class safety culture, and ultimately to result in achievement of performance excellence.

2. Description of Division and Scope of MSD ISM Plan

Vision of the Materials Sciences Division

The Materials Sciences Division (MSD) of Lawrence Berkeley National Lab (LBNL) is dedicated to discovery of new phenomena and new phases of matter to address global challenges in energy-related science.

MSD consists of approximately 613 individuals. A snapshot in 2016 showing the distribution of Division personnel is provided below:

MSD Personnel	**Number**
Faculty scientists	45
Scientific staff	27
Postdoctoral fellows	60
Graduate students	102
Undergraduate students	9
Admin staff	21
Affiliates	350

Division funding is approximately $45 M per year.

Most MSD personnel work on site at LBNL, but substantial work is performed on the University of California Berkeley (UC Berkeley) campus, either exclusively or at both locations. On site work at LBNL is performed primarily in buildings 2, 33, 62, 66 and related buildings, which are managed by the Division. MSD shares management of building 2 with ALS and CSD. In addition, single lab operations are present in buildings 53 and 64 and considerable Division work is performed at the Molecular Foundry (MF) and the Advanced Light Source (ALS). Work on the UC Berkeley campus is divided between the chemistry, physics and engineering complexes.

Materials Sciences Division Work off the LBNL Site

Except where noted, this plan applies to work conducted in LBNL facilities but does not

apply to work performed by MSD personnel at other sites which have a safety program. Work at other off-site locations (e.g. SLAC) is governed by the policies and management structures of the host institution.

In accordance with the *Partnership Agreement between UC Berkeley and LBNL Concerning Environment, Health and Safety Policy and Procedures (March 15, 2004)*[5], all UC Berkeley campus MSD laboratories implement an equivalent ISM program via UC Berkeley campus-based mechanisms with the assistance of the UC Berkeley campus Office of Environment, Safety and Health. MSD does conduct periodic assessments in UC Berkeley MSD labs and is available to assist on an on-call basis.

Work conducted by MSD personnel within the walls of the MF and the ALS facilities are managed by the MF and ALS and is governed by the MF and ALS ISM plans.

Work at other laboratories in the US or around the world is conducted pursuant to the local EH&S Policies. However, anyone working at another site is reminded that they are still responsible for performing their work safely and are expected to terminate their work if it seems unsafe. Work in "field locations" (e.g. mountains, deserts etc.) must be reviewed in advance and authorized by the Division (this is extremely rare in MSD).

3. Safety Responsibility, Authority, Accountability and a Just Culture

3.1 Responsibility and Authority through Line Management

Line Management Responsibility for safety is anchored in the MSD ISM system corresponding to the guiding principles of ISM[6]:

(1) Line management responsibility and accountability for ES&H
(2) Clear ES&H roles and responsibilities for managers and staff
(3) Competency commensurate with responsibilities
(4) An on-going balance between safety, research and operational priorities
(5) Working within standards and requirements
(6) Hazard controls tailored to the work
(7) Authorization basis established for the work

The Division Director and Deputy Division Directors are responsible for implementing the institutional expectations and for developing programs and procedures specific to the work of the Division. This includes the expectations in safety line management.

Safety line management for MSD staff follows standard LBNL practices flowing from the Division Director to their direct reports and from them down to first line supervisors and work leads. Lab owners and supervisors are responsible for implementation of this ISM

[5] *http://www.lbl.gov/ehs/ism/ucb_lbl_partnership_3_15_04.pdf*
[6] DOE P 450.4A, https://www.directives.doe.gov/directives-documents/400-series/0450.4-APolicy-a/view

plan in their labs and workplaces. However, it is important that hierarchy does not dictate authority for safety. All employees, contractors, and affiliates, etc., have important roles in managing safety (see section 5 for more detail). The MSD system heeds HRO research results showing that, as noted by Weick and Sutcliffe[7], important benefits result in organizational structures that distribute authority for safety-relevant *"decision making down and around."* In MSD, many *"decisions are made on the front line, and authority migrates to the people with the most expertise, regardless of their rank."*

Reflecting this insight, MSD gives substantial safety authority to work leads, individuals whose activities are close to the work involved. PIs/supervisors clearly identify work leads, as needed, for individual scope of work. Following LBNL policy[8],

"*Ensure that employees under their supervision are assigned to appropriate activities and authorized to work on those activities at a level commensurate with the employee's competency and receive specialized training...*"

Beyond work leads, all members and affiliates at LBNL have certain authority for safety, for example, Stop Work Authority extends to everyone at all times[9]: *"All Berkeley Lab employees, contractors, and affiliates have the right and responsibility to stop work activities considered to be an imminent danger."*

However, while authority and activities can be delegated down to the "front line", responsibility cannot. Responsibility for implementing the ISM program remains at the level of Lab Owner/Supervisor.

3.2 Accountability within a Just Culture

In this section we describe the essence of the MSD accountability policy. The goal of the policy is to provide a supportive, proactive safety environment, in the context of a "Just Culture". Our aim is that accountability is proactively taken by all, where people openly communicate and account for safety, as a means to continuously improve our safety systems both as an institution and as individuals.

This MSD accountability policy draws on the results of research studying accident causation. James Reason[10] found that most accidents could be traced back to weaknesses in all levels of the system, including the decision makers' level: organizational influences, unsafe supervision, preconditions for unsafe acts, and the unsafe acts themselves. The system as a whole produces failures when all individual "*barrier weaknesses align*", permitting *"a trajectory of accident opportunity"*, so that a hazard passes through all of the holes in all of the defenses and leads to a failure.

[7] Weick, Karl E.; Kathleen M. Sutcliffe (2007). *Managing the Unexpected - Assuring High Performance in an Age of Complexity*. San Francisco, CA, USA
[8] PUB-3000, chapter 6, http://www2.lbl.gov/ehs/pub3000/CH06-quickstart.html
[9] PUB-3000, chapter 1, http://www2.lbl.gov/ehs/pub3000/CH01-quickstart.html
[10] Reason, James T, *Human Error* (1990), Cambridge University Press (New York, USA)

The meaning an organization implies by the term *accountability* is an indicator of the maturity of the organization's safety culture. Consequently, the MSD ISM system aims for an informed approach that helps *"to open up the ability for people to hold their account, so that everybody can respond and take responsibility for doing something about the problem."* A*ccountability* is not about the application of disciplinary consequences. *"Simply holding people accountable* [as a means to blame] *completely misses the point"*[11] because blaming people can very quickly degrade accountability – *"they will tell us fewer accounts, they may feel less compelled to have their voice heard, to participate in improvement efforts"*[12]*.*

Effective safety systems depend on the willing participation of the entire workforce, especially the workers who are in direct contact with hazards[13]. Fostering all personnel -- employees, affiliates, consultants, vendors, etc. -- to openly report problems and errors is crucial because these communications provide information that allows improvements in safety, human performance and defenses. To this end, MSD strives to maintain a[14]

"JUST CULTURE—A culture that understands and values the distinction between blame-free and culpable actions, and does not seek to punish errors that are unintentional and reasonable given the context. In a just culture, line managers demonstrate an understanding that humans are fallible and when mistakes are made, the organization seeks first to learn as opposed to blame. In a just culture, employees are more likely to report errors, near-misses, and error-likely situations, which help the organization to learn and improve."

LBNL policy guidance on accountability for safety[15] supports organizational learning:

"*The Laboratory recognizes that humans are fallible and that everyone makes errors. The most common causes of human error are weaknesses in the organization, not lack of skill or knowledge. When events occur, management's first reaction should be to look within the organization rather than to blame an individual."*

Far more than a reaction to failure, in MSD accountability means that each person acts out of a sense of mutual support and responsibility for one another and the environment.

We realize that latent conditions within the organization usually contribute to accidents in the form of process errors or as error-likely situations; therefore errors are usually the consequences, not the causes, of disturbances in the organization[16]. To promote

[11] Dekker, Sidney, *The Field Guide to Understanding Human Error*, 2006, Aldershot, UK: Ashgate Publishing Co.
[12] Dekker, Sidney, *Just Culture*, 2007, UK: Ashgate Publishing Co.
[13] This section, "3.2 Accountability", copies substantial content from policy C-A-OPM 1.26.1 (Y), Collider Accelerator Department of Brookhaven National Lab.
[14] DOE ISM Manual 450.4-1, https://www.directives.doe.gov/directives/0450.4-DManual-1/view
[15] LBNL PUB-3140, Integrated Environment, Safety, & Health Management Plan, http://www2.lbl.gov/ehs/ism/assets/docs/LBNL-ISM.pdf
[16] Human Performance Improvement Handbook, Volume 1: Concepts and Principles, DOE, http://energy.gov/sites/prod/files/2013/06/f1/doe-hdbk-1028-2009_volume1.pdf

proactivity, we maintain a rewards systems for exemplary contributions to safety and in cases where individuals have made significant contributions to safety that exceed expectations, this will be explicitly taken into account in their annual performance appraisals. We also acknowledge that there is a flipside where behaviors fall below expectations. LBNL policy draws the following section from the DOE Human Performance Improvement Handbook: [15]

"Accountability for personnel and facility safety, for security, and for ethical behavior in all facets of facility operations, maintenance, and support activities is achieved by a kind of "social contract" entered into willingly by workers and management where a "just culture" prevails. In a just culture, people who make honest errors and mistakes are not blamed while those who willfully violate standards and expectations are censured. Workers willingly accept responsibility for the consequences of their actions, including the rewards or sanctions. They feel empowered to report errors and near misses. This accountability helps verify margins, the integrity of controls and processes, as well as the quality of performance. Performance improvement activities facilitate the accountability of line managers through structured and ongoing assessments of human performance, trending, field observations, and use of the corrective action program, among others. The integrity of this line of defense depends on management's commitment to high levels of human performance and consistent follow-through to correct problems and vulnerabilities."

A completely no-blame culture is neither reasonable nor desirable, as a small fraction of accidents do result from what are considered unacceptable behaviors. Applying a general pardon for unsafe acts would create a lack of credibility and accountability among staff members. The types of behaviors that are considered unacceptable include willful safety violations and/or reckless behavior related to safety. In cases of "safety violations", we carefully consider whether disciplinary action is appropriate. We appreciate that violating behaviors are far more nuanced than a naive dichotomy of right- vs. -wrong; the range spans across "correct violations" (such as applying creativity outside of procedures in order to recover malfunctioning systems) as well as "malicious compliance" which is compliance to the letter of the law with the aim to obstruct progress (as work-to-rule used as a weapon in labor disputes)[17].

Realizing this, MSD may impose disciplinary consequences, but only for the extremely rare instances of clearly unacceptable behaviors (such as sabotage or recklessness). In cases where an individual's actions appear to be questionable, MSD uses a systematic method, described in appendix 1 of this ISM plan that explicitly balances individual vs. organizational culpability. The goal is clarification of the line between the majority of errors and unsafe acts that are blameless, and the much less common culpable actions.

[17] Reason J., *The Human Contribution, Unsafe Acts, Accidents and Heroic Recoveries,* Ashgate Publishing Ltd., 2008, England

"This discussion should not be interpreted as an argument against holding people accountable for violations. [Indeed, compliance is important and holding people accountable is a facet our safety culture]. *The problem is that holding people accountable in circumstances where there has been an accident almost inevitably involves blaming them for the accident, which is almost certainly unfair. The implication is that, if we want to hold people accountable for their non-compliance, we should do so only in circumstances where there has been no accident."*[18]

To ensure fairness, MSD policy follows EFCOG guidance[19] to separate investigations that deal with the causes of an event from investigations to deal with any potential disciplinary actions stemming from an event. In causal analysis investigations, there can be strong pressures to find the simple explanations and obvious causes. But experience also shows us that these events are always more complex and are rarely attributable to just the actions of the individuals involved. In learning from these events, it is critical to look beyond the individuals to ask what organizational or cultural factors contributed to the event. The line that separates the rare cases of blameworthy acts from the majority of blameless errors will only be considered once an event is thoroughly understood; culpability analysis is not a type of root cause analysis.

In summary, MSD accountability policy aims to foster a just culture that gives everyone the opportunity to be accountable without fear of reprisal, supporting both personal accountability and Division-level self-regulation.

[18] Hopkins, Andrew, *Failure to Learn* (2009), CCH Australia

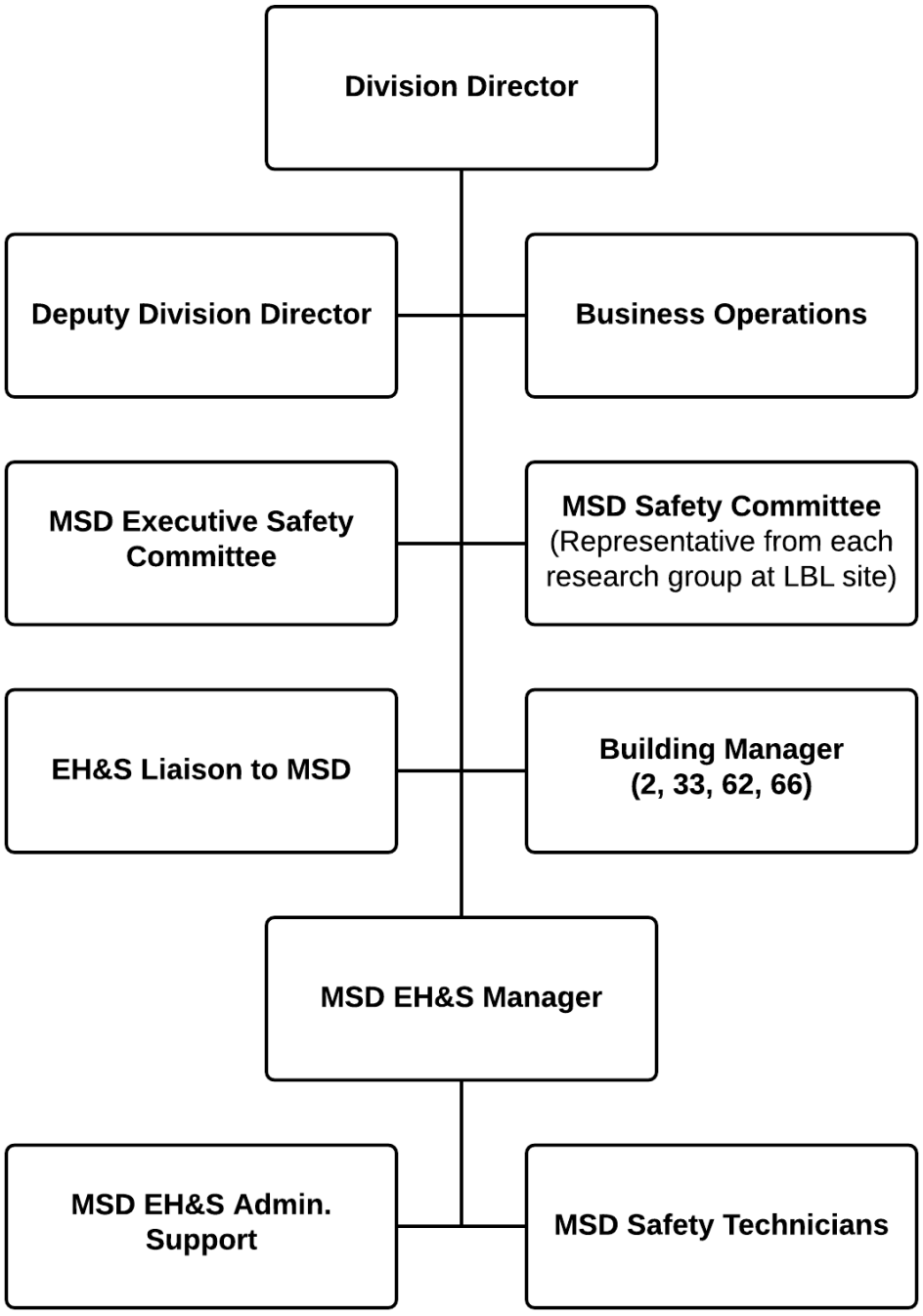
[19] http://efcog.org/wp-content/uploads/Wgs/Safety%20Working%20Group/_Integrated%20Safety%20Management%20Subgroup/_Safety%20Culture%20HRO/Old%20Site/ISM%20Human%20Performance%20Improvement/docs/White_Paper_HPI_and_Safety_Culture_Final.pdf

4. MSD EH&S Organization

4.1 MSD EH&S Program Support Structure

Key roles of the Division Director are to:

- Establish an appropriate safety culture
- Provide a set of expectations for implementation of EH&S within the Division
- Provide the required resources for implementation of the ISM plan.
- Oversee compliance with EH&S requirements



Currently, the Director of MSD provides an EH&S program support structure as shown below:

MSD receives technical support from the EH&S Division. The current individual in each position is listed (note these assignments are as of 10/01/2016).

- EH&S Division Liaison (Kurt Ettinger)
- EH&S Division Waste Generator Assistant (Mabel Fong)
- Laser Safety Officer (Greta Toncheva)
- Deputy Laser Safety Officer (Robert Fairchild)
- Electrical Safety Officer (Mark Scott)
- Industrial Safety (Herb Toor)
- Health and Safety Representative (Kurt Ettinger)
- Radiation Safety (Melissa Mannion)
- Environmental Permits (Robert Fox)
- Fire Protection (Todd LaBerge)

4.2 Institutional EH&S Databases

MSD actively participates in the management of Division data in the following institutional EH&S Databases:

- Chemical Management System (CMS)
- Comprehensive Health Environment and Safety System (CHESS)
- Biological Use Authorizations/Notification (BUA/BUN)
- Corrective Action Tracking System (CATS)
- Work Planning and Control (WPC)
- Subcontractor Job Hazards Analysis (SJHA)
- Laser Inventory Database

5. Specific ISM Tasks of MSD Members

This section lists specific responsibilities of people working in MSD facilities based on their roles

5.1 Everyone

All employees, users, and affiliates performing work in an MSD facility are responsible for ensuring that all activities are carried out in a safe manner and in accordance with all applicable EH&S requirements. Everyone also has an important role in the implementation of the ISM plan, including:

- Full awareness of all hazards present in any area doing work and any changes in the hazards as operations continue, which might require changes to work authorization and training requirements
- Completing the WPC or approved alternate to identify hazards and controls, updating it at least annually, or whenever the nature of their work changes (LBNL and UC Berkeley). If your LBL work is exclusively at a non-LBNL, offsite work

location including UC Berkeley, or do not perform "Work" at LBNL you may choose to opt out of the questionnaire section.
- Completing required formal training and on the job training
- Identifying when new work may require formal authorization, and discussing this with their supervisor before proceeding
- Correcting or reporting EH&S problems they identify
- Discussing all new work with their supervisor
- Stopping work if there is an unsafe or unapproved condition[20]
- Being mindful of effects of fatigue and long hours on safety

5.2 Supervisory Staff

Supervisory employees at LBNL are defined as:
https://commons.lbl.gov/display/rpm2/Glossary

"individuals who, regardless of their job descriptions or titles, directly supervise two or more employees, and (1) have authority in the interest of the employer to hire, transfer, suspend, lay off, recall, promote, discharge, assign, reward, or discipline other employees; or (2) have responsibility to direct them, adjust their grievances, or effectively recommend such action if, in connection with the foregoing, the exercise of such authority is not of a merely routine or clerical nature but requires the use of independent judgment."[21]

Supervisors play a critical role in the implementation of ISM in MSD labs. Supervisors are responsible for

- Being aware of hazards in the work area and ensuring that effective controls are in place.
- Timely completion of the WPC activities of all direct reports.
- Ensuring that supervisees' training and medical evaluations are completed in a timely manner.
- Assuring supervisees adhere to training requirements for each activity they have.
- Designating work leads as needed.

5.3 Lab Owners

A lab owner is a staff member, with appropriate expertise who oversees the operation of a laboratory space, as assigned by the Division Director or designee. Lab owners often are Principal Investigators, or may be other staff, and may or may not be a designated supervisory employee. The lab owner has responsibility and authority to manage safety of laboratory operations.

Lab owners are responsible for ensuring that a range of EH&S functions are

[20] LBNL Pub-3140 6.7.1.1 (5)
[21] https://commons.lbl.gov/display/rpm2/Glossary

implemented for all lab users *including those they do not supervise*:

1) General Responsibilities
2) Creating and communicating meaningful EH&S expectations for all lab users, including consistent with the LBNL and MSD ISM programs and maintaining a culture of proactive accountability as described in section 3.2.
3) Ensuring that new or significantly modified projects or facilities are reviewed for hazards in the planning stage.
4) Conducting periodic safety meetings with laboratory staff, students and affiliates.
5) Designating Area Safety Leaders and representatives to MSD Safety Committee as appropriate.
6) Ensuring formal authorization documents, such as WPC Activities, are appropriately prepared, maintained and updated.

Specific Responsibilities

1) Identifying equipment or processes that may pose safety concerns and thus require specific “on the job training”.
2) Ensuring that a safety review is conducted when significant, potentially hazardous new equipment is brought into the lab from any source.
3) Conducting periodic safety walkthroughs of labs, offices and other workplaces for which they are responsible to identify problems in the facilities, equipment or work practices, identifying and promptly correcting hazardous conditions or practices.
4) Participating in scheduled lab inspections with the MSD EH&S Technician (LBNL only) and with the Division EH&S Manager and EH&S Liaison (UC Berkeley campus and LBNL).
5) Managing of the accumulation, storage and disposal of hazardous waste, designating managers/backups for all Satellite Waste Accumulation Areas (SAAs).
6) Prior to starting work under any new or significantly modified formal work authorization, hold a pre-start review that includes the MSD EH&S Manager or Designee and an appropriate subject matter expert from the EHS Division.
7) Arranging for the repair or replacement of electrical equipment that is tested and found to be unsafe.
8) Ensuring that SJHAs are prepared for vendor and contractor work planned in their work areas.
9) Each lab owner must identify activities that are conducted in his or her lab that are of the type that are prohibited when working alone.

5.4 Work Leads

Work leads for WPC’s are designated by the supervisors. As described in PUB 3000[22], work leads have important responsibility and authority in drafting, reviewing, and

[22] PUB 3000 chapter 32, *Work Planning & Control*

approving of WPCs (or approved WPC-equivalent documents) together with the Workers they lead. They also have important roles in on-the-job training of the workers they lead.

The substantial safety line management authority extended to work leads has important implications. The work lead retains authority over work in their area even when the status of a worker they lead may be higher. For example, when a user at an lab user facility is a PI from an another division and the work lead responsible for the work happens to be a postdoc or a technician, this user's work is contingent upon authorization given by the postdoc (or technician). Based on the work lead's familiarity with the particular work, this organizational structure reflects the "Deference to Expertise" principle[3] of high reliability organizations (see also section *3.1 Line Management Responsibility and Authority* for background and references supporting this organizational structure).

By default the Lab Owner is also the work lead for that lab. The Lab Owner is encouraged to appoint other group members as work leads via the WPC system as appropriate.

5.5 Area Safety Leaders

Although they have no line management responsibility, area safety leaders will assist in implementation of the LBNL as well as specific lab safety requirements. These include Working Alone Policy as described in section 6.4 and compliance with PPE requirements. Area safety leaders will also act as conduit between Division work leads and the EH&S Division for coordination of Work Authorization and WPC activities that include Working Alone Hazard assessments as requested.

A lab owner or a work lead may assign area safety leads.

5.6 Affiliates

Affiliates are afforded the same protections and assume the same obligations with regard to EH&S as other non-supervisory personnel at LBNL***. Affiliates*** must complete the same EH&S classes as staff***, unless they meet the exception for short-term personnel.***

5.7 Students

With respect to ISM, the Division ISM plan does not distinguish between students and other personnel working in the Division. Students are afforded the same protections and assume the same obligations with regard to EH&S as other non-supervisory personnel at LBNL. Students must complete the same EH&S classes as staff.

5.8 Vendors

MSD implements LBNL policy with respect to vendor safety[23]. All vendors technicians performing "hands-on" work at LBNL are required to complete the Subcontractor Job Hazards Analysis (SJHA) form and meet with the MSD EH&S Manager or EH&S Technician and the managing scientist or technician, to review the document before beginning work. For designated "low hazard work" the role of authorizer can be fulfilled by other staff who are trained and able to review the safety of the proposed work, at the discretion of the lab owner.

The vendor technician(s) are issued a permit once they have demonstrated that they can meet LBNL and MSD EH&S expectations. As part of the process, subject matter experts in the EH&S division may be consulted and the need for any formal work authorization is identified and addressed. The permit is good for up to a year as long as the work is conducted by the listed technician(s) and the work scope has not changed. Multiple sites within the Division can be listed on one permit if the work is the same.

Both the laboratory scientist and the requester or his/her designee requesting the vendor work are responsible for ensuring that the permit is issued when needed and for periodically inspecting the contractors work to assure that the stipulations on the permit are met.

Permits are not required for work that is not "hands-on" such as training, attending meetings, giving or attending seminars, or upgrading software.

5.9 Matrixed Employees/Employees Working in MSD Facilities

"Matrixed" employees' supervisors from the home divisions retain most health and safety responsibilities for their employees, except where some of the responsibilities have been transferred to MSD through a formal Memorandum of Understanding or as stated herein.

MSD personnel will provide operation-specific training to matrixed individuals, perform hazard assessments of their work in the Division and include these personnel in Division-specific EH&S training and meetings. The home Division is responsible for managing the WPC process and investigating incidents and accidents for matrixed personnel. Division members may be assigned as "work leads" within the WPC system for the activities performed by matrixed personnel in MSD, at the discretion of the line manager and the matrix supervisor.

5.10 EH&S Manager

The Division EH&S Manager evaluates and implements current and new ISM policies and procedures after receiving input from Division management, the Executive Safety Committee, the Division Safety Committees, and staff.

[23] Pub3000, Chapter 31

5.11 MSD Building Managers

MSD manages buildings 33, 62 and 66 and shares the management of building 2. The building managers:

- Manage the emergency response teams for all 4 buildings
- Manage minor building modification, equipment installation and maintenance activities
- Track and arrange for correction of building-related EH&S deficiencies
- Provide the interface between Division personnel and the Facilities Management Division

5.12 MSD EH&S Technicians

The MSD EH&S Technicians carry out a range of planned and ad hoc activities in support of the implementation of the EH&S program in the Division, such as:

- Semiannual inspections of LBNL labs with Lab Owners
- Chemical management, SAA management, peroxidizable solvent management inspections
- Consultation and training, upon request and scheduled
- Preparation and updating of WPC work groups
- Review SJHAs and provide input prior to the start of work, except in the cases of low-hazard work where the permit is prepared by a scientist involved with the work
- Electrical safety inspections with the EH&S Subject Matter Experts and the Division Electronics Technician
- Tracking of deficiencies in CATs and working with scientists and others to make required corrections
- Tracking status of WPC Activities and updates
- Representing the Division in meetings and at presentations
- Approving all outgoing shipments of chemicals and research samples
- Ergonomic evaluations

5.13 Electronics Support

The Division provides a mechanism that facilitates access by Division personnel to technicians and professionals from the Engineering
Division and EH&S organizations. The services provided include:

- Participating in electrical safety inspections in laboratories
- Identifying, inspecting and approving or repairing LBNL-made, damaged or unapproved equipment
- Troubleshooting electrical equipment/repair of scientific equipment
- Providing guidance/assistance for individuals involved in building electronic systems

6. Training and Authorization of Work

6.1 On-The-Job Training and Peer-Assist

Training through web-based courses, classroom courses, and formal on-the-job training forms an important basis for work authorization. In addition and very importantly, experience has shown that reliability of operations increases as individuals acquire skills *while they do* their work. A crucial and valued role of lab owners is the guiding of workers in informal, hands-on interactions. An important goal of the "Work Lead" concept is to foster frequent interaction, and open communication, between less-experienced and more-experienced peers *while carrying out the work*.

6.2 Training Courses

Generally, training should be completed prior to starting work. For work that falls below the threshold for formal authorization, training requirements are captured in the WPC process (or in an approved WPC-equivalent process).

For certain cases, policy allows these exceptions:

- Employees, Affiliates, Students, with appointments of 30 calendar days or less are not required to complete most institutional EH&S training (other than GERT) and do not need to fill out the Work Planning & Control (WPC) questionnaire, but must be under constant supervision by a trained individual.
- New employees, affiliates and students may work for up to 30 calendar days without completing required institutional training, with no need to fill out the Work Planning & Control (WPC) questionnaire, unless the training is required by a formal authorization document. Such personnel must work under constant supervision by a trained individual.

Training prior to initiating any work is required for radiation-generating machines, radiological materials, confined space entry, respirator use and several other topics that are rare or non-existent in MSD.

<u>Training for Supervisors and Work Leads</u>
Supervisors and Work Leads receive specific training via EHS0042, "Implementing Safety: Supervisors and Work Leads."

Supervisors of those whose work on UC Berkeley campus must ensure the UC Berkeley campus training requirements are met. LBNL training is optional for these individuals if they do not work at LBNL.

MSD manages several Division-specific training classes:
MSD 0010: Integrated Safety Management: Principles and Case Studies
This class is required for all Division members except for people who don't work in labs, work exclusively off-site (e.g. UC Berkeley) or fall under the short-term exemptions rules. This is taught regularly by MSD staff in a classroom.

MSD 0015: Individual Hazardous Waste Briefing. This is a hands on class taught by MSD EHS technicians to supplement the LBNL-required Waste Generator Training class (EHS 00604).

6.3 Authorization of Work

Line Management Authorization

In accordance with chapter 6 of Pub3000, work that falls below the threshold for formal authorization is authorized by the work leads/supervisors via the institutional Work Planning & Control (WPC) process. This does not apply to work at UC Berkeley.

Off-Site Work and Telecommuting

Other than on the UC Berkeley site, as of this time MSD performs no off-site work where the Division retains control of the EH&S hazards and controls. Any off-site work, e.g. at other national laboratories, UC Berkeley or light sources, falls under the ISM program, policies and procedures of that institution. Selected provisions of this document apply on the UC Berkeley campus, where specifically stated.

At this time, the Division does not have any specific policy on telecommuting and therefore aligns itself with the LBNL Flexible Work Options Policy[24]. In the event that this is necessary, the request will be reviewed on a case-by-case basis.

6.4 Working Alone Policy[25]

Certain types of work are so hazardous that an accident may render an individual unable to manage their own rescue, e.g. unable to find the phone to call for help or unable to get to the emergency shower. Examples include the handling of significant quantities of corrosive materials on the bench top or in a hood, the handling of pyrophoric materials in a hood, work on a ladder or changing cylinders of highly toxic gases. Work of this type is prohibited when individuals are working alone in a lab at night, on a weekend or holiday or when the area is sparsely populated. A second person must be present within sight or earshot or this work may not be performed.

Policy from the RPM is included here (as of 10/1/2016):

Policy Statement

1. Workers at Berkeley Lab are not allowed to work alone when the mitigated hazards associated with their work could incapacitate them such that that they could not "self-rescue" or activate emergency services. This policy supports the Laboratory's Environment, Safety & Health (ES&H) Core Policy to perform all work safely and with full regard to the well-being of workers, contractors, affiliates, the public, and the environment.

[24] https://commons.lbl.gov/display/rpm2/Flexible+Work+Options+Policy
[25] https://commons.lbl.gov/display/rpm2/Working+Alone+Policy

2. The Working Alone Policy is implemented through the Work Planning & Control (formerly Job Hazards Analysis or JHA) process at the division level:
    a. Each division must assess its work activities and find those in which the severity of mitigated hazards may prevent workers from self-rescuing or activating emergency services in the event of an accident.
    b. Authorizations for the identified work activities must place restrictions on working alone.
    c. During the work authorization development and review process, authors and reviewers determine whether and when a Working Alone restriction is necessary and include it in the controls listed in the Work Authorization Document.
    d. This Working Alone restriction then flows down to individual workers through their JHAs or other authorizations, such as AHDs.
    e. Work leads may also determine that a Working Alone restriction is needed for workers whose assignments are not covered by a formal authorization, and may place the restriction in the individual's JHA.
    f. For construction activities, the policy is implemented through the construction safety review process; for nonconstruction subcontractors, it is implemented through the Subcontractor Job Hazards Analysis and Work Authorization (SJHAWA) process.
    g. The policy does not address activities "commonly performed by the general public" that include hazards commonly accepted by the public, the control of which requires little or no specialized guidance or training. These activities include walking or driving while alone, or the consequences of personal medical conditions that may arise while at work.

7. Assurance Mechanisms

Inspections and Assessments

Technician/Lab Owner Inspections
Annually, the MSD EH&S Technician performs a laboratory inspection with the lab owner or lab primary contact if this role is performed by another individual. The inspection evaluates new work, laboratory changes and work practices. The technician documents these joint inspections and tracks items that cannot be immediately corrected in the CATS database.

Waste Accumulation Area Inspections
The EH&S Waste Generator Assistant and the MSD EH&S Technician conduct a periodic comprehensive review of the satellite waste accumulation areas in the Division. A representative from EH&S inspects the Building 62 and 66 Waste Accumulation Areas (WAA’s) monthly and notified MSD if problems are identified.

Annual Leadership Walkthough Inspection
Annually, MSD Management (Division Director, Deputy Director and Business Manager), the MSD EH&S Manager, the EH&S Liaison, the MSD EH&S Technician, the

Lab PI, the Lab Safety leads and others as appropriate, conduct a joint inspection of each laboratory. The EH&S Manager documents these joint inspections and track items that cannot be immediately corrected in the CATS database.

Self-Assessment Plan

Each year, in accordance with LBNL policy, the Division develops and implements a self-assessment plan, conducting targeted evaluations of areas of interest in the Division.

MSD Laboratory Incident Response Policy

MSD seeks to identify and understand the causal factors underlying incidents, near misses and accidents in the Division ("events"), with the goal of making the Division a safer workplace. MSD uses a graded approach to investigating events that is consistent with LBNL policy on ISM and incident investigation. MSD seeks to foster a *Just Culture* where individuals are encouraged and even rewarded for reporting near misses, incidents and injuries.

The outline of the graded approach is presented below. Where indicated with an "x" MSD commits to include the identified action in the response to an incident or set of related incidents. Other actions not indicated with an X are optional and will be determined by the Division Director on a case-by-case basis.

X = Required	O = Optional	na = Not applicable			
	Near Miss	Minor injury	Major injury	Several incidents of any type in a specific area	Several incidents involving multiple locations
Investigation with corrective actions	x	x	x	x	x
Limited Stand Down	O	O	x	x	na
Full stand down	O	O	O	O	x
Management concern ORPS	O	O	O	O	x
Lessons Learned internal to MSD	O	O	x	x	x
Institutional Lessons Learned	O	O	O	x	x
Formal Causal Analysis	O	O	O	x	x

8. Medical Surveillance

Few MSD personnel are required to participate in a medical surveillance program. The exceptions at this time are:

- Laser Eye exam (EHS 280): Must be completed prior to working on a class 3b or 4 laser system. This must be completed within 30 days of starting work with a class 3b or 4 laser system even if fully supervised
- Respiratory protection medical review: Must be completed prior to starting work where a respirator is required.

Other medical surveillance programs may be offered to Division personnel, but are not mandatory, such as the new Nanoparticle Worker Medical Exam.

9. Communication and Feedback

MSD employs a variety of tools to facilitate communication of EH&S issues and feedback.

9.1 General: Reporting Employee Concerns Encouragement

All Division personnel are strongly encouraged to communicate EH&S questions, concerns, near misses and accidents. Issues are typically referred to the supervisor, EH&S Manager, the EH&S Technician, the safety committee representative or the Deputy Director. The Division strives to maintain a culture where Members feel comfortable reporting EH&S issues, and where support from the Division is viewed positively. As outlined in the introduction and in section 3 of this ISM plan, our goal is to maintain an environment of trust and mutual respect upwards and downwards the management line, an environment where the EH&S Manager is viewed as a resource rather than a “cop”.

Most LBNL-based personnel know who to contact in the EH&S Division to address problems. Also, LBNL maintains a variety of institutional mechanisms. The Lab’s EH&S homepage has links to provide either regular email [safetyconcerns@lbl.gov] or anonymous [http://www.lbl.gov/ehs/safety/safety-concerns-form.shtml] submission of safety concerns.

As described in 9.3, there is a near miss incentive reporting program that has been quite successful.

9.2 MSD Safety Communication Tools

- Safety Bulletin–A short safety notice addressing a single, timely EH&S issue or accident. Members of the Safety Committee are asked to bring topics to the attention of the EH&S Manager for consideration as an edition of the bulletin. Suggestions may also come from any Division employee, student or affiliate. This serves much the same purpose as the institutional “Lessons Learned” system, but with a much quicker turn around and tailored specifically for the Division. They are

distributed via Level-1 email to all members of the division as well as posted in key location in MSD occupied buildings.

- MSD Safety Committee–Representatives from all LBNL-based research groups attend a monthly Division Safety Committee meeting to review Division EH&S performance and incidents, discuss problems and support the self assessment process. After these meetings the representatives are expected to return to their group and present relevant points they have learned at the safety committee meeting. The committee is chaired by the EH&S Manager and includes the Deputy Director (*ex officio*), the MSD EH&S Technicians, the Electrical safety technician, building managers and the liaisons from the EH&S Division.

- Research Group Meetings–Each PI meets with members of his or her research group and EH&S topics are discussed, in varying level of detail, at many of these group meetings. Approximately annually, the EH&S Manager will attend one of these group meetings to facilitate the safety discussion.

- Annual PI meeting–A discussion of safety is presented at the Division Strategic Planning Meeting every year. All Division PI's are invited to attend this important meeting.

- Review of accidents and near misses –MSD initiated a program to elicit the reporting of "near hits (misses)", review them in detail and inform all members of the division in a manner that will decrease the likelihood of another, similar event occurring. The discussion is fully positive in nature—focused on learning from earlier mistakes rather than on blaming those involved. To this end, management works collaboratively with other Division staff to investigate and remediate as appropriate. The EH&S Manager manages the reporting and investigation process for near misses. The near misses are also discussed at a variety of other divisional meetings and are the subject of posters that are prominently displayed throughout the Division.

- Occurrence Reporting: The EH&S Manager serves as the Occurrence Reporting Officer for the Division as required in Pub3000 section 15.2.2. He reviews all incidents and injuries against criteria stated in Chapter 15 to determine if they are reportable to the Department of Energy as an "Occurrence report". He determines reportability after discussion with Division Management and the EH&S Division ORPS SME, prepares the initial and follow up reports and tracks issues in the CATS database to completion. If appropriate, he will initiate an internal "Materials Safety" bulletin to inform Division personnel of key issues pertaining to reported incidents.

- Annual Self-Assessment: The Division participates in the annual self-assessment process, as described in LBNL Publications 5344 and 3105. Key findings are relayed to Division Management and other Division supervisors and serve to inform Division ISM policy. Findings are presented to the Safety Committee for discussion at the next meeting.

9.3 Recognition of Safety Performance

The Division intends to expand our program for recognition and reinforcement of positive safety performance. Efforts are underway to establish specific rewards to recognize outstanding achievement.

Supervisors will be encouraged to nominate people for safety awards. Nominations will go to the Executive Safety Committee, which will review the submittals and rank them. The Division Director will then review the ranked nominations and make monetary or non-monetary awards as appropriate.

10. Emergency Response

The Division manages the emergency response self-help capability in buildings 33, 62, 66 and shares this responsibility with the ALS and CSD in building 2 on a rotating basis.

The MSD building managers' role in emergency response:

- Manage the roster and training of emergency response teams for all 6 buildings
- Serve as the emergency response leaders in the event of evacuation of buildings.

During a site-wide emergency, the response in building 66 it is led by the EH&S Technician; in building 2 it is led by a representative from Chemical Sciences Division (this rotates periodically between MSD, CSD and ALS). The EH&S Manager, EH&S Technician and Building Manager provide backup support for each other.

The emergency response leader is the single point of contact for the evacuation and re-occupancy of their assigned building. Each emergency response leader is assigned a walkie-talkie radio for communication with the LBNL EOC and among the MSD emergency response leaders. For multi-building evacuations, the EH&S Manager coordinates the emergency response effort in buildings 62 and 66.

GLOSSARY OF TERMS

(This glossary collates definitions given in DOE M 450.4, DOE M 450.4-1, Hobbs A., *Human Performance Culpability Evaluations,* Whitepaper, UT Battelle, 2008, and various LBNL documents)

ADMINISTRATIVE CONTROLS – Provisions related to organization and management, procedures, record keeping, assessment, and reporting necessary to ensure safe operation of a facility. With respect to nuclear facilities, administrative controls means the section of the Technical Safety Requirements (TSRs) containing provisions for safe operation of a facility including (1) requirements for reporting violations of TSRs, (2) staffing requirements important to safe operations, and (3) commitment to the safety management programs and procedures identified in the Safety Analysis Report as necessary elements of the facility safety basis provisions.

ALS, ADVANCED LIGHT SOURCE

AREA SAFETY LEADER – The individual assigned by the Division controlling the Technical Area to oversee coordination of safety issues within the Area

BEHAVIOR – A human act or sequence of human actions. Behavior consists of a plan or intention (a goal plus the means to achieve it), a sequence of actions initiated by the plan, and the extent of success in achieving the goal as each action is performed.[26]

CATS, CORRECTIVE ACTION TRACKING SYSTEM

CAUSAL ANALYSIS – A process used to analyze an incident and determine the actual factors that caused the incident, thus identifying which factors if corrected would prevent the recurrence of the incident.

CMS, CHEMICAL MANAGEMENT SYSTEM

CONSEQUENCES – The final, overall effect(s) or outcome(s) of an individual's behavior with respect to the situation or environment in which the behavior occurred.

CONTROLS – Administrative and engineering mechanisms that can affect the chemical, physical, metallurgical or nuclear process of a nuclear facility in such a manner as to effect the protection of the health and safety of the public and workers, or the protection of the environment. Also, error-prevention techniques adopted to prevent error and to recover from or mitigate the effects of error; to make an activity or process go smoothly, properly, and according to high standards. Multiple layers of controls provide defense in depth.

CORE FUNCTIONS (or **ISM CORE FUNCTIONS**) **–** The core safety management functions are defined in DOE P 450.4, Safety Management System Policy, to be: (1)

[26] Hobbs A., *Human Performance Culpability Evaluations,* Whitepaper, UT Battelle, 2008

define the scope of work; (2) analyze the hazards; (3) develop and implement hazard controls; (4) perform work within controls; and (5) provide feedback and continuous improvement. These functions are also identified in DEAR 48 CFR 970.5223-1(c).

CULPABILITY – The amount of blameworthiness that an individual's behavior merits based on the nature of the deviation from expected behavior, the outcomes of the deviation, and the responsibility and authority of that individual, in the context of the situation in which the behavior occurred.

CULTURE – An organization's system of commonly held values and beliefs that influence the attitudes, choices and behaviors of the individuals of the organization.

CSD, CHEMICAL SCIENCES DIVISION

CXRO, CENTER FOR X-RAY OPTICS

DOE, DEPARTMENT OF ENERGY

EH&S, ENVIRONMENT, HEALTH &SAFETY

ENGINEERING CONTROLS – Physical controls, including set points and operating limits; as distinct from administrative controls.

EOC, Emergency Operations Center

ERROR – An action that unintentionally departs from an expected behavior.

ERROR-LIKELY SITUATION – A work situation in which there is greater opportunity for error when performing a specific action or task due to error precursors (also known as "error trap").

GSRA, GRADUATE STUDENT RESEARCH ASSISTANT

GUIDING PRINCIPLES (or ISM GUIDING PRINCIPLES) – Conditions for performance of work that an integrated safety management system must address. The guiding principles are defined in DOE P 450.4, *Safety Management System Policy,* to be: (1) Line management Responsibility for Safety, (2) Clear Roles and Responsibilities, (3) Competence Commensurate with Responsibilities, (4) Balanced Priorities, (5) Identification of Safety Standards and Requirements, (6) Hazard Controls Tailored to Work Being Performed, and (7) Operations Authorization. These principles are also identified in DEAR 48 CFR 970.5223-1(b).

HAZARD – A source of danger (i.e., material, energy source, or operation) with the potential to cause illness, injury, or death to personnel or damage to a facility or to the environment (without regard to the likelihood or credibility of accident scenarios or consequence mitigation).

HAZARD CONTROLS – Measures to eliminate, limit, or mitigate hazards to workers, the public, or the environment, including (1) physical, design, structural, and engineering features; (2) safety structures, systems, and components; (3) safety management programs; (4) technical safety requirements; and (5) other controls necessary to provide adequate protection from hazards.

HMS, HAZARD MANAGEMENT SYSTEM

HRO, HIGH-RELIABILITY ORGANIZATION – Organizations that consistently operate under trying and hazardous conditions, and manage to have relatively few accidents. These organizations operate in settings where the potential for error and disaster is very high. They have no choice but to function reliably because failure results in severe consequences. HRO theory holds that significant accidents can be prevented through proper management of prevention and mitigation activities. Examples of high-reliability organizations: nuclear aircraft carriers, nuclear power generating plants, power grid dispatching centers, air traffic control systems, aircraft operations, hospital emergency departments, hostage negotiating teams, firefighting crews, continuous processing firms. HRO characteristics include: (1) personal technical excellence and commitment to continuous training: (2) sustained, high levels of operational performance, encompassing both productivity and safety objectives; (3) robust technical systems and structures, and organizational processes that provide redundancy and flexibility; (4) decentralized authority patterns, including deference to capable individuals with the most technical expertise and individuals closest to the problem; (5) a committed workforce where every individual understands and accepts their roles and responsibilities for safe mission performance; (6) a deep commitment to continuous performance improvement, openness and trust, and cultivation of a continuous learning environment; and (7) the use of systems of checks and audits to build reliability.

HUMAN ERROR – A phrase that generally means the slips and mistakes of humankind. See also active error and latent error.

HUMAN PERFORMANCE – (1) Individual sense: A series of behaviors executed to accomplish specific task objectives (results); (2) Organizational sense: The sum of what people (individuals, leaders, managers) are doing and what people have done; the aggregate system of processes, influences, behaviors, and their ultimate results that eventually become manifest in the physical plant.

HPI, HUMAN PERFORMANCE IMPROVEMENT – Human Performance Improvement is fundamentally about reducing errors and managing defenses. Striving for excellence in human performance is an ongoing effort to reduce events caused by human error. Human error is caused by a variety of conditions related to individual behavior, management and leadership practices, and organizational processes and values. Behaviors at all levels need alignment to improve individual performance, reduce errors and prevent events. Alignment involves facilitating organizational processes and values to support desired behaviors.

ISM, INTEGRATED SAFETY MANAGEMENT – The DOE approach for systematically integrating safety into management and work practices at all levels so that missions are accomplished while protecting the public, the worker, and the environment.

ISMS, INTEGRATED SAFETY MANAGEMENT SYSTEM – A safety management system that provides a formal, organized process whereby people plan, perform, assess, and improve the safe conduct of work efficiently and in a manner that ensures protection of workers, the public, and the environment. This management system is used to implement ISM to systematically integrate safety into management and work practices at all levels so that missions are accomplished while protecting the public, the worker, and the environment.

JUST CULTURE – A culture that understands and values the distinction between blame-free and culpable actions, and does not seek to punish errors that are unintentional and reasonable given the context. In a just culture, line managers demonstrate an understanding that humans are fallible and when mistakes are made, the organization seeks first to learn as opposed to blame. In a just culture, employees are more likely to report errors, near-misses, and error-likely situations, which help the organization to learn and improve.

KNOWLEDGE-BASED ERROR – An error associated with behavior in response to a totally unfamiliar situation (no skill, rule or pattern recognizable to the individual). Usually arises as a problem-solving situation that relies on personal understanding and knowledge of the system, the system's present state, and the scientific principles and fundamental theory related to the system. In terms of failing to achieve the intended goal, actions conformed to the plan, but the plan was inadequate to achieve its intended outcome due to an inaccurate mental picture.

LATENT ERROR – An error, act, or decision that results in organization-related weaknesses or equipment flaws that lie dormant until revealed either by human error, testing, or self-assessment.

LATENT ORGANIZATIONAL WEAKNESSES – Loopholes in the system's defenses, barriers, and safeguards whose potential existed for some time prior to the onset of the accident sequence, though usually without any obvious bad effect. These loopholes consist of imperfections in features such as leadership/supervision, training and qualification, report of defects, engineered safety features, safety procedures, and hazard identification and evaluation. Most accidents originate from or are propagated by latent weaknesses.

LBNL, LAWRENCE BERKELEY NATIONAL LABORATORY

LEARNING ORGANIZATION – One that values continuous learning. An organization that is deeply committed to continuous performance improvement and develops and

sustains organizational processes, such as incident critiques, that facilitate continuous improvement; encourage openness and trust so that problems are reported; cultivate an environment that encourages and rewards ongoing efforts to learn from experience, learn from others, and from self-directed studies; aggressively seek to know what it doesn't know; demonstrate excellence in performance monitoring, problem analysis, solution planning, and solution implementation; systematically eliminate or mitigate error-likely situations; and remain obsessed with the liabilities of success.

LINE MANAGEMENT – Any management level within the line organization, including contractor management that is responsible and accountable for directing and conducting work.

MESH REVIEWS – Objective of the MESH Review is to evaluate the Division's management of environment, safety, and health in its operations and/or research, focusing on the implementation and effectiveness of the Division's Integrated Safety Management (ISM) Plan. The MESH Review Team normally consists of three SAC members.

MINDFULNESS – The combination of ongoing scrutiny of existing expectations, continuous refinement and differentiation of expectations based on newer experiences, willingness and capability to invent new expectations that make sense of unprecedented events, a more nuanced appreciation of context and ways to deal with it, and identification of new dimensions of context that improve foresight and current functioning. Mindfulness is a pre-occupation with updating. Mindful people accept the reality of ignorance and work hard to smoke it out, knowing full well that each new answer uncovers a host of new questions. Mindfulness is exhibited by high reliability organizations through the following five hallmarks of reliability: (1) preoccupation with failure, (2) reluctance to simplify interpretations, (3) sensitivity to operations, (4) commitment to resilience, and (5) deference to expertise. [Reference: Weick & Sutcliffe]

MSD – MATERIALS SCIENCES DIVISION

OCA – OFFICE OF CONTRACT ASSURANCE

ORPS – The Occurrence Reporting and Processing System (ORPS) at Lawrence Berkeley National Laboratory (LBNL) notifies and keeps Laboratory management and applicable elements of the Department of Energy (DOE) informed of abnormal occurrences that could adversely affect (a) the health and safety of employees, guests, visitors, and the general public; (b) the environment; (c) the intended purpose of LBNL facilities; or (d) the credibility of the DOE and/or LBNL.

PERFORMANCE – The behavior of an individual or group of individuals plus the results of that behavior, considered as a whole. (If the behavior under evaluation involves multiple individuals acting together as a team, their performance as a single unit should also be evaluated in addition to that of individual members of the team.)

PERFORMANCE MODE – The manner in which a person acts in terms of information processing when executing a task or activity. The three performance modes are skill-based, rule-based and knowledge-based.

PI - PRINCIPAL INVESTIGATOR

RESULTS – The final outcomes of behavior strictly in terms of success or failure in achieving the intended goal, irrespective of the correctness or accuracy of risk perception on the part of the individual(s) involved.

RULE-BASED ERROR – an error associated with behavior based on selection of stored rules derived from one's recognition of the situation; it follows an If (symptom X) / Then (situation Y) logic. In terms of failing to achieve the intended goal, actions conformed to the plan, but the plan was inadequate to achieve its intended outcome due to misinterpretation.

SAA – SATELLITE ACCUMULATION AREA

SAAR – SUPERVISORS ACCIDENT ANALYSIS REPORT

SABOTAGE – Behavior in which both the act and the damaging outcome were intentional.

SAC – SAFETY ADVISORY COMMITTEE

SAFETY – In ISM, the term "safety" is used synonymously with environment, safety, and health (ES&H) to encompass protection of the public, the workers, and the environment [DOE P 450.4]. Safety is a dynamic non-event; a stable outcome produced by constant adjustments to system parameters. To achieve stability, change in one system parameter must be compensated for by changes in other parameters, through a process of continuous mutual adjustment [Reference: Weick & Sutcliffe].

SAFETY CULTURE – The safety culture of an organization is the product of individual and group values, attitudes, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization's health and safety programs. Organizations with a positive safety culture are characterized by communications founded on mutual trust, by shared perceptions of the importance of safety, and by confidence in the efficacy of preventive measures. The term safety culture entered public awareness through the vocabulary of nuclear safety after the Chernobyl nuclear power plant explosion.

SKILL-BASED ERROR – An error associated with highly-practiced actions in a familiar situation usually executed from memory without significant conscious thought or with little attention. In terms of failing to achieve the intended goal, the plan was adequate, but the action(s) failed to go as planned.

SME – SUBJECT MATTER EXPERT

UC Berkeley – UNIVERSTY OF CALIFORNIA AT BERKELEY

VIOLATION – Deliberate, intentional acts to evade a known policy or procedure requirement for personal advantage usually adopted for fun, comfort, expedience, or convenience.

WPC**, WORK PLANNING & CONTROL**

WORK LEAD – "Work Lead" is anyone who directs, trains, and/or oversees the work and activities of one or more workers. Work Leads provide instruction on working safely and the precautions necessary to use equipment and facilities safely and effectively. Work Leads need not be Line Managers, HEERA-designated Supervisors, or LBNL Employees, yet are Safety Line Managers.

Appendix 1: Human Performance Culpability Evaluations

Basics of Culpability Decisions[27]

LBNL institutional ISM policy[28] employs the term *"willful safety violations"* in suggesting the threshold of unacceptable behavior, but leaves open what is meant by this term. The purpose of this section is to provide a systematic approach to help determine what is acceptable or not.

MSD guidance on culpability evaluations follows EFCOG advice to conduct *"separate investigations to deal with the root cause of an event and another to deal with any potential disciplinary actions,"*[29] such as culpability evaluation. This serves to balance pressure the root cause team may experience to come up with a quick answer and a more objective approach dealing with all the facts to address personnel issues.

In his analysis of rule-related behaviors, Reason[30] demonstrates how, under unforeseen circumstances, even *"willful safety violations"* may be the correct thing to do. Vice-versa, compliance can be malicious, and nuance distinguishes varieties of rule violations. Hollnagel and Amalberti[31] have argued that the dichotomy of human actions as "correct" or "incorrect" is a harmful oversimplification of a complex phenomenon. Clearly, how we respond to "violations" merits careful deliberation.

When an adverse safety incident involved an individual's actions, the first question to ask relates to intention. If both actions and consequences were intended, then there may possibly be criminal behavior, such as sabotage, which is clearly blameworthy. While sabotage is rare, deliberate violations of rules are less rare. However, most violations of rules are not done to produce a bad outcome. When the consequences of the act were not intended or expected, we need to ask if the system (i.e., the local conditions or the organization) promoted or discouraged the violation. We need to understand if the violation was automatic, i.e. part of the routine way of doing business such as short cuts and thus an organizational issue. We may need to check whether the rule was good to begin with. Thus the quality, workability, correctness and availability of procedures and rules, including work planning for the activity, must be examined.

One key element in this tool is the Substitution Test. This test is consistent with the understanding that even the best people can make the worst errors. Ask the following questions of peers: Would a different, well-motivated, comparably competent and qualified individual have made the same error under similar circumstances? In the light

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[27] Some paragraphs in this section copy substantial content from policy C-A-OPM 1.26.1 (Y), Collider Accelerator Department of Brookhaven National Lab.

[28] LBNL PUB-3140, *Integrated Environment, Safety, & Health Management Plan*, http://www.lbl.gov/ehs/ism/assets/docs/LBNL-ISM.pdf

[29] EFCOG, White Paper: EFCOG HPI Implementation Tools Project, HPI and Safety Culture. http://efcog.org/wp-content/uploads/Wgs/Safety%20Working%20Group/_Integrated%20Safety%20Management%20Subgroup/_Safety%20Culture%20HRO/Old%20Site/ISM%20Human%20Performance%20Improvement/docs/White_Paper_HPI_and_Safety_Culture_Final.pdf

[30] Reason J., *The Human Contribution: Unsafe Acts, Accidents and Heroic Recoveries*, Ashgate Publishing Ltd., 2008, Hants, England

[31] Hollnagel, E. and Amalberti, R. (2001). *The Emperor's New Clothes, or whatever happened to "human error"?*

of how events unfolded and were perceived by those involved in real time (no hindsight), is it likely that you would have committed the same or similar type of unsafe act or error? If the answer is 'Yes', then the individual who made the error may be considered to be blameless.

However, in any of these situations there could be other reasons for the behavior such as performing the work under the influence of alcohol or drugs, fooling around, being overly fatigued, or using equipment, PPE or tools known to be inappropriate. Explicitly balancing individual vs. organizational culpability fosters both personal accountability and helps the Organization improve by revealing systemic error precursors.

Guidance for Using the Culpability Decision Tree[32]

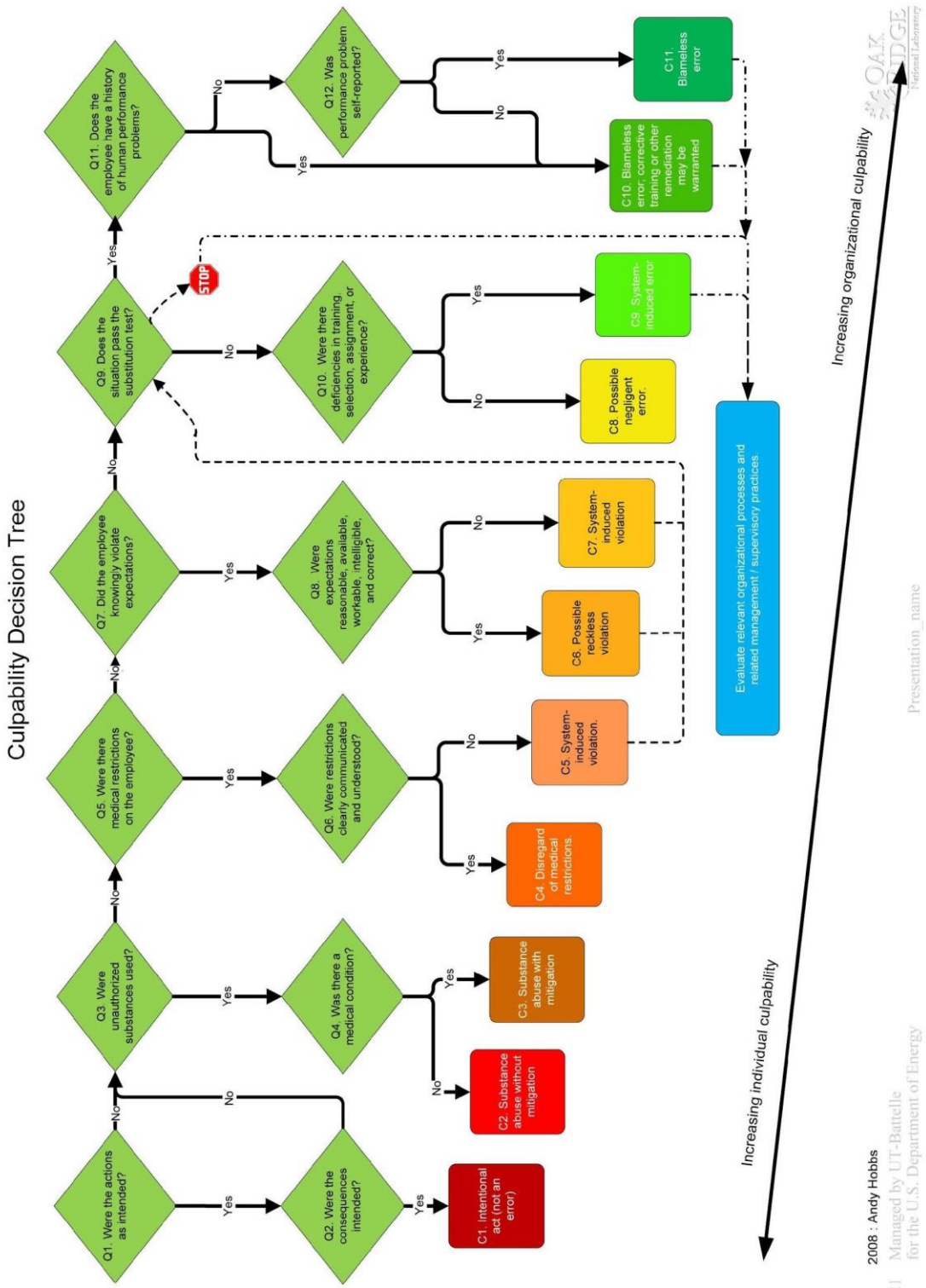
This guideline provides instructions for evaluating human performance in cases where individual culpability for certain behavior is not clear. The Culpability Decision Tree (Figure 2) is a tool to be used in the investigation and analysis of an event that involved behavior that deviated from that which was expected.

Once facts and first-hand information have been obtained from the individual or individuals involved (by means of interviews, critique, etc.), this tool can be used to understand the mindset of the personnel involved, the context of the situation, and the systemic and organizational influences that may have affected their decisions and resultant behavior.

If the violations apply to an accident, injury or near miss, each violation or error shall be analyzed separately. In an organizational accident, there are likely to be a number of unsafe acts or errors and Figure 1 is to be applied separately to each of them.

[32] With minor editorial changes, much of this section is copied from: Hobbs A., *Human Performance Culpability Evaluations,* Whitepaper, UT Battelle, 2008

Figure 1: Culpability Decision Tree



Definitions

Behavior – a human act or sequence of human actions. Behavior consists of a plan or intention (a goal plus the means to achieve it), a sequence of actions initiated by the plan, and the extent of success in achieving the goal as each action is performed.

Consequences – the final, overall effect(s) or outcome(s) of an individual's behavior with respect to the situation or environment in which the behavior occurred.

Culpability – the amount of blameworthiness that an individual's behavior merits based on the nature of the deviation from expected behavior, the outcomes of the deviation, and the responsibility and authority of that individual, in the context of the situation in which the behavior occurred.

Error – an unintentional deviation from expected behavior.

Knowledge-based Error – an error associated with behavior in response to a totally unfamiliar situation (no skill, rule or pattern recognizable to the individual). Usually arises as a problem-solving situation that relies on personal understanding and knowledge of the system, the system's present state, and the scientific principles and fundamental theory related to the system. In terms of failing to achieve the intended goal, actions conformed to the plan, but the plan was inadequate to achieve its intended outcome due to an inaccurate mental picture.

Performance – the behavior of an individual or group of individuals plus the results of that behavior, considered as a whole. (If the behavior under evaluation involves multiple individuals acting together as a team, their performance as a single unit should also be evaluated in addition to that of individual members of the team.)

Performance Mode – the manner in which a person acts in terms of information processing when executing a task or activity. The three performance modes are skill-based, rule-based and knowledge-based.

Results – the final outcomes of behavior strictly in terms of success or failure in achieving the intended goal, irrespective of the correctness or accuracy of risk perception on the part of the individual(s) involved.

Rule-based Error – an error associated with behavior based on selection of stored rules derived from one's recognition of the situation; it follows an If (symptom X) / Then (situation Y) logic. In terms of failing to achieve the intended goal, actions conformed to the plan, but the plan was inadequate to achieve its intended outcome due to misinterpretation.

Sabotage – behavior in which both the act and the damaging outcome were intentional.

Skill-based Error – an error associated with highly-practiced actions in a familiar situation usually executed from memory without significant conscious thought or with little attention. In terms of failing to achieve the intended goal, the plan was adequate, but the action(s) failed to go as planned.

Violation – the intentional deviation from expected behavior as specified in operational procedures, rules, or standards, but in which the consequences were not intended.

Questions

Q1. **Were the actions as intended?**

At this point you are only concerned about behavior. In order to answer this question, as the evaluator you must know:

a. the actions being evaluated
b. the goal and how those actions related to the goal
c. the degree of success the individual had in executing the actions he/she planned to execute

No – the behavior is almost certainly an error, since what he/she did is not what he/she intended to do. It could very well have been a skill-based error, which Reason [6] calls "the least blameworthy of errors," but further evaluation of the behavior is still needed. If the answer is "Yes," you need to more completely describe the behavior and what the outcomes of that behavior were.

Q2. **Were the consequences intended?**

In order to answer this question, as the evaluator you need to know:

a. the planned actions intended to achieve the goal
b. how successful the actions were in achieving the goal
c. the expected outcomes
d. the actual outcomes (i.e. results)
e. the other outcomes that occurred, and if they were considered/conceived of by the individual

Even though item "e" above relates the most to consequences, it is important to have as much insight into the individual's actions as possible in order to fully evaluate his/her behavior.

No – the error was most likely a mistake or (possibly) a violation. This case is likely to be a rule- or knowledge-based error. Continue to the next branch of the tree.

Yes – go to conclusion C1.

Q3. **Were unauthorized substances used?**

The purpose of this question is to establish whether or not the individual was under the influence of alcohol or drugs known to impair performance at the time the actions were committed.

Q4. **Was there a medical condition?**

This question prompts you to determine if there was an actual medical condition that precipitated the individual using/taking the substance, albeit without authorization.

Q5. **Were there medical restrictions on the employee?**

If a medical condition had been reported to and acknowledged by the company, then there may have been medical restrictions imposed on the employee's job duties and tasks.

Q6. **Were restrictions clearly communicated and understood?**

If medical restrictions were in place, this follow-up question seeks to determine how well those restrictions were communicated to the employee and if the employee understood them.

Yes – the employee disregarded the medical restrictions (C4).

No – the violation of the medical restrictions was system-induced (C5). So, further evaluation about the violation is warranted. Jump to Q9 (as indicated by the dashed line).

Q7. **Did the employee knowingly violate expectations?**

If it is established that the individual was aware of the expectations, but consciously elected not to conform to those expectations, then the answer would be „Yes."

No – proceed to question Q9 on the next branch of the tree.

Yes – proceed to question Q8 below on the same branch of the tree.

Q8. **Were expectations reasonable, available, workable, intelligible, and correct?**

To answer this question, you may need to obtain feedback from the supervisor or even other employees who perform the same task or have similar duties.

No – the violation was induced by organizational weaknesses. Nevertheless, because the deviation was intentional, you should compare the individual's behavior to that of peers. Therefore, jump to Q9 on the next branch of the tree (as indicated by the dashed line).

Yes – the problem lies more with the individual. However, further evaluation may still be warranted before drawing a final conclusion about the violation. Jump to Q9 (as indicated by the dashed line).

Q9. **Does the situation pass the substitution test?**

Could have (or has) some well-motivated, equally competent and comparably qualified individual behaved differently under those or very similar circumstances? The answer to this question will probably need to be obtained from "peers" in a manner and environment that will yield frank and honest responses. This question will indicate if violations are condoned and/or have become routine.

Yes – the situation passes the test.

No – the situation does not pass the test, and the person should not be individually blamed.

<table>
<tr><th>Previous Point on Tree</th><th>Conclusions / Path Forward</th></tr>
<tr><td>From "No" to Q7, i.e. the employee did not knowingly violate expectations.</td><td>
Interim conclusion: This was an error.
Does situation pass substitution test?
<table>
<tr><th>‘Yes’ (likely, a peer would have acted differently)</th><th>‘No’ (likely, a peer would <u>not</u> have acted differently)</th></tr>
<tr><td>Then proceed right to the next branch of the tree as indicated.</td><td>Then continue down to the next question regarding system-induced deficiencies as indicated.</td></tr>
</table>
</td></tr>
<tr><td>From C6 – possible reckless violation</td><td>
Interim conclusion: This was not an error, but a violation.
Does situation pass substitution test?
<table>
<tr><th>‘Yes’ (likely, a peer would have acted differently)</th><th>‘No’ (likely, a peer would <u>not</u> have acted differently)</th></tr>
<tr><td>Stop.

Conclusion: This was a reckless violation. Invoking the organization’s disciplinary process may be warranted.</td><td>This was not a reckless violation.

Conclusion: This must have been system-induced.

Stop.

Use causal analysis to determine systemic / organizational causes that prompted or influenced the violation.</td></tr>
</table>
</td></tr>
<tr><td>From C5 – system-induced violation (of medical restrictions)</td><td>
Conclusion: This was a system-induced violation. However, does situation pass substitution test?
<table>
<tr><th>‘Yes’ (likely, a peer would have acted differently)</th><th>‘No’ (likely, a peer would <u>not</u> have acted differently)</th></tr>
<tr><td>Stop.

Invoking the organization’s disciplinary process may be warranted.</td><td>Stop.

Causal analysis should be used to determine the causes associated with medical restrictions that prompted or influenced the violation.

Any required disciplinary or corrective action toward the individual should take into account that peers would probably not have acted differently in the same situation.</td></tr>
</table>
</td></tr>
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<table>
<tr>
<td>From C7 – system-induced violation (of adequate expectations)</td>
<td>
<table>
<tr><td colspan="2">Conclusion: This was a system-induced violation. However, does situation pass substitution test?</td></tr>
<tr><td>‘Yes’ (likely, a peer would have acted differently)</td><td>‘No’ (likely, a peer would <u>not</u> have acted differently)</td></tr>
<tr><td>Stop.

Invoking the organization’s disciplinary process may be warranted.</td><td>Stop.

Causal analysis should be used to determine the type of violation (routine, optimizing or necessary) and the systemic causes that prompted, or influenced the violation.

Any required disciplinary or corrective action toward the individual should take into account that peers would probably not have acted differently in the same situation.</td></tr>
</table>
</td>
</tr>
</table>

Q10. **Were there deficiencies in training, selection, assignment, or experience?**

Training provides workers the appropriate behavioral skills, related knowledge, and attitudes needed to perform their job duties. *Selection* and *assignment* refer to considerations and processes used to hire people and assign them specific responsibilities and on-the-job tasks. *Experience* is knowledge, skill or practice derived from direct observation of or participation in events.

No – Go to conclusion C8, and use the information about peers gathered for the substitution test in order to determine if the error was indeed attributable, at least in part, to negligence on the part of the individual.

Yes – Go to conclusion C9. Subsequent analysis should be directed at the specific deficiency in order to determine systemic causes.

Q11. **Does the employee have a history of human performance problems?**

Have there been any previous instances where the individual had this performance problem?

Q12. **Was the performance problem self-reported?**

Self-reporting can be in the form of the individual notifying management of an error, or if the individual acknowledged that an error was made when it was identified or pointed out by a supervisor or co-worker.

Conclusions

C1. *Intentional act* (not an error) – this was not an error; the behavior is possibly sabotage, malevolent damage, willful violation, etc.

C2. *Substance abuse without mitigation* – company procedures for dealing with instances of substance abuse should be initiated.

C3. *Substance abuse with mitigation* – company procedures for providing mitigation when dealing with instances of substance abuse should be initiated.

C4. *Disregard of medical restrictions* – company procedures for establishing and enforcing medical restrictions should be initiated.

C5. *System-induced violation* – this was a violation of medical restrictions that were not clearly communicated or understood by the employee. However, influences from the system on behavior also need to be evaluated.

C6. *Possible reckless violation* – If the situation passes the substitution test, this type of behavior is more culpable than system-induced violations because of reasonable and correct expectations were available and others (peers) would not have done the same thing in the same situation.

C7. *System-induced violation* – this was a violation that was induced by weaknesses in the system. You should see if the situation passes the substitution test, and then evaluate the system for influences on behavior.

C8. *Negligent error* – This is an appropriate conclusion if another person (peer) would have foreseen and avoided bringing about the consequence. It suggests more individual culpability than a system-induced error. Corrective action should seek to understand why the individual did not recognize the potential consequence and why he/she believed his/her behavior was appropriate for the situation.

C9. *System-induced error* – This was an error provoked by the system in which the individual was working. If there was a deficiency in selection and/or assignment, further analysis should focus on the hiring process. Deficiencies in training or experience should analyze the training and qualification process for the individual's job position. Other parts of the system should also be evaluated for related causes.

C10. *Blameless error with remediation* – this was an error. However, the behavior (or history of this type of behavior) may warrant some form of remediation to correct it. Determining the performance mode of the error (skill-, rule- or knowledge-based) will serve to indicate the appropriate training or form of remediation needed. Analysis of organizational processes and management/supervisory practices should also be conducted.

C11. *Blameless error* – this was an error; the individual should not be individually blamed. Analysis of organizational processes and management/supervisory practices should be conducted to identify conditions that provoked the error and weaknesses in the defenses that did not mitigate the consequences of the error.