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Environment, Safety, and Health

Volume I

Part 3: Safety Analysis and Work Plans and Procedures

Document 3.1
Nonnuclear Safety Basis Program

Recommended for approval by the ES&H Working Group

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3.1

Nonnuclear Safety Basis Program*

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Nonnuclear Safety Basis Program

1.0 Introduction

1.1 Purpose and Scope

Lawrence Livermore National Laboratory's (LLNL) Integrated Safety Management (ISM) system requires the identification, assessment, and control of hazards associated with the conduct of work. The safety analysis process formalizes this assessment and is applicable to both nuclear and nonnuclear facilities. This *Environment, Safety & Health (ES&H) Manual* document primarily addresses the nonnuclear safety analysis requirements, while nuclear safety analysis requirements are covered in Document 51.1, "Documented Safety Analysis Program Plan," of the *ES&H Manual*.

The Work Smart Standard (WSS), "Safety Basis Requirements for Nonnuclear Facilities at Lawrence Livermore National Laboratory Site Specific Work Smart Standard" (UCRL-ID-150214, revision 2), establishes nonnuclear safety analysis requirements. When coupled with the Integrated Safety Management System (ISMS) methods and other WSSs for assuring worker safety, they assure that the impacts of LLNL operations are well understood and controlled to protect the health of workers, the public, and the environment. All nonnuclear LLNL facilities shall be classified based on the potential for operations to adversely impact the health of colocated workers and the public. The terms "Low hazard," "Moderate hazard," and "High hazard" are used to classify facilities. However, these terms may not have the same meanings as in other WSSs or other LLNL requirements. A list of terms and definitions is attached as Appendix A.

1.2 Applicability

The nonnuclear requirements addressed within this document apply to all LLNL facilities operated for the Department of Energy (DOE) and the National Nuclear Security Administration (NNSA), including:

- Facilities not located at the Livermore main site or at Site 300, but operated by LLNL.
- Onsite transportation activities that do not meet Department of Transportation (DOT) requirements (e.g., explosives, biohazards, chemicals).
- Nonnuclear hazards within Category 2 or 3 nuclear facilities, when the hazard is neither the initiator nor exacerbator of the projected consequences of a nuclear incident. Determination of whether a hazard can initiate or exacerbate a nuclear hazard shall be done as part of the hazard analysis described in Document 51.1. For hazards meeting this criterion, use of a more rigorous accident analysis and control selection process is optional.

- Chemical, explosive, industrial, radiological and biological hazards as discussed in Section 2 of this document. Radiological hazards are radionuclides in quantities that fall below the threshold in DOE-STD-1027-92 for Category 3 nuclear facilities.
- Any other facility or operation not specifically excluded below.

This document does not apply to:

- Nevada Test Site facilities.
- Transportation operations meeting DOT or Document 51.1 requirements.
- Facilities located at the Livermore main site or at Site 300 but not operated by LLNL, unless specifically required within a subcontractor's contract or at the discretion of the governing Associate Director (AD). (These facilities are generally covered under subcontractor Safety Plans (SPs), in accordance with Document 2.5, "Procured Services ES&H Program," in the *ES&H Manual*.)
- Nuclear hazards that meet or exceed Category 3 Thresholds per DOE-STD-1027, Attachment 1.

This document does not supersede, nor alter the requirements of, 10 CFR 830, *Nuclear Safety Management,* Subpart B, "Safety Basis Requirements," or DOE Order (DOE O) 420.2A, "Safety of Accelerator Facilities." Guidance is provided in Section 2 and Section 3 regarding DOE O 420.2A.

1.3 Overview of the Safety Analysis Process

The level of formality and complexity of a facility's safety analysis process is directly related to the level of hazardous inventories and operations present (i.e., biological, chemical, radiological, explosive, and industrial hazards). As the hazards and risks associated with a facility increase, the formality, documentation, and general level of effort increase. For example, office-like facilities with no hazardous inventory beyond typical office supplies and equipment are simply recorded on a listing. On the other hand, facilities with hazardous inventories and operations are required to have all hazard types screened and classified, with the process recorded on a Screening Report form. If all hazards are classified no higher than "Light Science and Industry (LSI)," the Screening Report form is the only documentation needed. If the hazards are classified above this level, then more analysis and documentation is required. This concept is known as the "graded approach."

The facility classifications are:

- Office.
- Light Science & Industry (LSI).
- Low hazard.

- Moderate hazard.
- High hazard.

These classifications will be discussed in detail in Section 2.0

Figure 1 depicts the nonnuclear analysis steps, classification categories, and respective documentation requirements. A brief description of these steps is as follows:

1. Facility management shall first define the facility as either a building, a complex that includes several buildings, or a portion of a building that meets the segmentation requirements (Section 2.1.1).
2. Facility operations and inventories are checked against the Office criteria (Section 2.2). Facilities that meet the Office criteria are placed on a list maintained by the designated directorate facility representative (such as the facility manager or assurance manager). A copy is forwarded to the Hazards Control Department Authorization Basis (AB) Section for inclusion into the ES&H electronic library.
3. A screening evaluation is required for all facilities that do not meet the Office criteria. A list of maximum inventories and operations is completed and evaluated, and a facility classification is reached (Section 2.3). This process is documented in the Screening Report form (also known as a Tier 1 Document) discussed in Section 3.0 and located in Appendix B of this document. For facilities designated LSI, no more documentation is required.
4. For hazards that exceed LSI criteria, a hazard analysis is required. The hazard analysis is documented in a hazard analysis section (Section 2.4). This section is attached to the Screening Report form and represents the second part of the safety basis documents (SBDs) discussed in Section 3.0.
5. Hazardous events are then evaluated against the criteria in the Analysis Level Matrix discussed in Section 2.4, and an accident analysis is completed for those events that meet the criteria. The accident analysis is attached to the previous sections.
6. Controls are identified and evaluated in the hazard analysis and accident analysis. These shall be documented in a controls section and added as the last section of the document (Section 2.5).

This process and documentation are to be reviewed and renewed every three years, except for Office facilities.

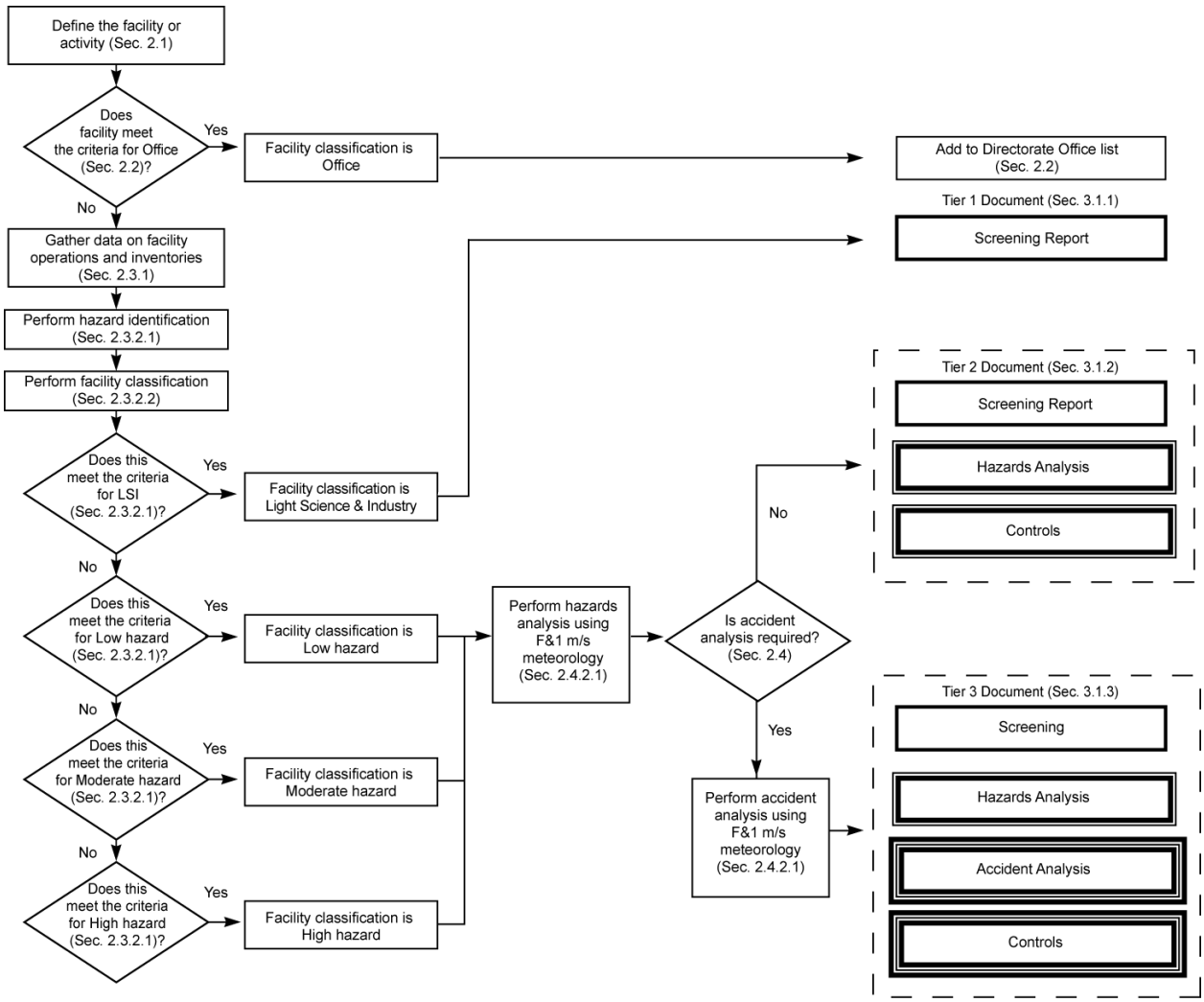


Figure 1. Safety Analysis and Documentation Process.

1.4 Implementation

Implementation of this *ES&H Manual* document shall be made in a phased approach.

1. The identification, categorization, and listing of all non-segmented Office facilities shall be completed within 60 days of the approval of this document.

2. LLNL is anticipating the delegation of authority from NNSA/LSO (Livermore Site Office) for risk acceptance in accordance with the WSS entitled “Safety Basis Requirements for Nonnuclear Facilities at LLNL.” Delegation may take place in a phased manner. Until risk acceptance for a given facility has been delegated to LLNL, NNSA/LSO retains approval authority of SBDs, including positive change control actions. Contact the AB Section to determine what risk acceptance LLNL has received and guidance on NNSA/LSO approval, if necessary. Since implementation with this version of Document 3.1 will take place in a phased approach, facilities that are still under the previous version of Document 3.1 (see

item 5 below), will seek NNSA/LSO approval only for SBDs and positive change control actions associated with Moderate and High hazard facilities.

3. For new facilities whose DOE pre-title I conceptual design will be completed beyond 120 days after approval of this document, task plans and preliminary SBDs shall be initiated per Section 3.2. For new facilities whose pre-title I conceptual plans are completed within 120 days after approval of this document, SBDs may be developed as originally negotiated with NNSA/LSO.

4. Safety basis documents for existing facilities shall meet the requirements of this document in accordance with an implementation plan, to be approved by the Deputy Director for Operations (DDO) and appended to or referenced in this document. This implementation plan shall also include a schedule for completing the analysis of onsite transportation activities that do not meet DOT requirements.

5. Facilities shall meet the requirements of the previous version of this Document 3.1 (dated September 1, 2000 and updated April 1, 2001), and Document 3.2 (dated September 1, 2000 and updated April 1, 2001), until required to meet the DDO-approved implementation plan (item #4 above) or by agreement of the facility management, if sooner.

6. The Hazards Control Department (HCD) shall develop a single point of coordination process to expedite HCD reviews, reconcile any disparate HCD comments, and obtain all HCD signatures on programmatic safety basis documents.

2.0 Safety Analysis Process

This section describes the safety analysis process in detail. The steps for completing the safety analysis process and the sections in which they are discussed are as follows:

1. The parameters of the facility or activity being analyzed are defined (Section 2.1).

2. The facility is evaluated against the Office criteria. No further safety analysis is needed if the facility meets the Office criteria (Section 2.2).

3. If the facility does not meet Office criteria, the facility screening is conducted. The screening process is composed of two main parts: identification of hazardous operations and inventories (this can also be thought of as setting the parameters for hazardous operations and inventories that may be conducted within the facility), and then classifying the hazard types and the facility as Light Science & Industry (LSI), Low hazard, Moderate hazard, or High hazard (Section 2.3).

4. The hazard analysis is completed for all hazards classified above the LSI classification (Section 2.4).

5. Determination is made to see if further analysis is required by developing possible scenarios and comparing the probability and consequences against the Analysis Level Matrix. If further analysis is required, then accident analysis is completed (Section 2.4).
6. Develop controls as determined by the hazard analysis and accident analysis processes (Section 2.5).

2.1 Defining the Facility or Activity

The first step of safety analysis is to define the facility or activity. An LLNL facility may be defined in several ways. The term “facility” is frequently used to describe a single building. However, a cluster of buildings or complex is occasionally defined as a facility. Facility complexes are typically managed by the same program or directorate, contain similar operations, and may be located close together in a fenced area. For management convenience, they are analyzed as a group.

In other instances, a facility may also be defined as a portion or segment of a building, with each segment defined as an individual facility for safety basis purposes such as when directorates share real estate within a large building, or when dissimilar levels of hazardous operations are conducted within a building. Splitting the building into two or more facilities is referred to as “segmentation.” Facility segmentation shall meet specific requirements as discussed in Section 2.1.1 below.

In most cases at LLNL, safety analysis is associated with a facility. But in the case of discrete activities not assigned to a particular facility, such as transportation of hazardous materials, a safety analysis is still required. Contact your ES&H Team to determine if an activity requires a safety analysis. If the Team recommends that the activity requires a safety analysis, proceed as if the activity were a facility. Contact the AB Section for assistance.

2.1.1 Facility Segmentation

In some cases, a building may be divided into segments that independently meet the nonnuclear safety requirements. Segmentation is intended to prevent the strict requirements needed for a hazardous operation from being applied to less hazardous operations in the same building. However, segmentation should not be considered lightly. There may be other considerations associated with segmentation that are not safety-related, such as revision of building numbers and associated equipment, renumbering on drawing, and maintenance procedures that may offset the benefits.

Facilities may be segmented if existing passive engineering facility features:

- Preclude the impacts of accidents in one segment from initiating hazardous releases in other segments.
- Preclude damage that, in turn, causes failure of credited controls in the impacted segment (see Section 2.5).

Physical barriers (such as firewalls and fire doors) or distance (adequate separation between segments) are the most commonly used passive engineering features. These features ensure that an accident in one segment does not initiate an accident in another (e.g., spread of a fire, sympathetic detonation of explosives).

Specific controls are required to maintain passive-engineering features. These controls are considered “credited controls” for both segments, per Section 2.5. If a facility is segmented, the facility management of both segments shall ensure that they maintain the passive engineering facility features intact, so the control of hazards is not impaired (e.g., ensure that firewalls are not compromised in any way, ensure that combustible loading remains low between segments that assume distance as justification for segmentation). The SBD shall include all controls required to maintain the segmented facilities. These are credited controls. Engineering controls that are credited shall also be included as configuration items in Configuration Management Plans. Administrative controls that are credited shall be included in facility implementation documents.

Active controls are mechanical or electrical systems that perform a positive function that provides protection in the event of a release or when a credited control, such as fire suppression systems, HEPA filters, and interlocks, fails. Active controls shall not be used as justification for segmentation. When considering segmentation, be aware of active controls or other devices that could spread an event from one portion of a facility to another, such as common HVAC ducting. These systems may spread the effect; therefore, segmentation may not be allowed when these are present. Contact the AB Section for more information.

In determining segmentation, the burden of proof is on the analyst. The rationale shall be completely documented or referenced in the SBD for each segment. Office facilities, which do not have such documentation, shall:

- Annotate the office facility list to denote that the office classification depends on segmentation.
- Ensure through the cognizant Facility Point of Contact (FPOC) that segmentation controls are maintained.
- Ensure that adequate coordination with the hazard ranked segment of the facility is adequate to maintain segmentation controls.

Hazard ranked facility segments adjacent to office facilities shall ensure adequate coordination with the office segment to maintain the integrity of segmentation controls.

2.2 Office Facility Listing Process

Formal SBDs are not required for an Office facility. Directorate management shall classify its Office facilities by identifying operations and associated materials and then comparing these against the Office facility classification criteria listed in Table 1. If the facility satisfies all criteria,

it is placed on a directorate listing of Office facilities. Facility management shall ensure that the facilities are periodically inspected to remain compliant with the classification criteria. An Office facility that is a segment of a building containing higher hazard segments shall provide controls on maintenance and modification activities, to ensure that the physical barriers credited in the segmentation are not degraded by any activity in the Office segment.

Table 1. Office Facility Classification Criteria.

Office Classification Criteria	
1.	Primary activities include: • Preparing, reading, communicating, and storing documents and data. • Interaction between workers through meetings, telephone conversations, and e-mail. • Use and maintenance of office equipment. • Use of hand tools to assemble small devices and minor electric soldering for maintenance activities to computers, etc. (but NOT significant soldering, sanding, use of fluxes, etchants, or cutting fluids.)
2.	Facility used to house people (e.g., offices, Almond Avenue childcare center).
3.	Primary types of equipment include computers, printers, copy machines, telephones, fax machines, paper shredders, hole punchers, laminators, pencil sharpeners, calculators. Mainframe computers are included if not cooled with large quantities of hazardous materials.
4.	Facility is constructed and maintained in accordance with LLNL's WSSs for office use.
5.	Repair and maintenance of Office facilities and the equipment contained therein shall be in accordance with ISMS for Office facilities.
6.	Quantities of cleaning materials and other potentially hazardous office supply chemicals shall be kept at a minimum and commensurate with LLNL's procurement and supply practices (No stockpiling of hazardous cleaning and office chemicals for long-term storage for other facilities).
7.	An Office facility shall NOT be used for planned transition or storage of hazardous materials to or from an experimental laboratory.
8.	Radioactive materials shall be limited to those that are considered "to be generally licensed items and articles," qualified sealed sources containing <10 CFR 835, Appendix E thresholds (e.g., class I and class II sources), or general materials that contain <10 CFR 835, Appendix E threshold quantities.[1]
9.	Ammunition may be present for operational use by duly authorized individuals (e.g., Protective Force Officers) in accordance with Section 5.4.3.4 of DOE-STD-1091-96.[2] Ammunition beyond that assigned for daily operational use shall not be stored in Office facilities.
10.	Shops (e.g., machine shops, print shops) and laboratories (e.g., chemical, diagnostic, or other experimental) shall NOT be defined as office facilities.

1 10 CFR 835, Occupational Radiation Protection/Radiological Protection Program, Appendix E, "Values For Establishing Sealed Radioactive Source Accountability and Radioactive Material Posting and Labeling Requirements."

2 DOE-STD-1091-96, "DOE-STD Firearms Safety," Section 5.4.3.4, "Storage of Munitions, Hazard Class/Division 1.4 Munitions."

The Office listing is then forwarded to the AB Section for maintenance in the ES&H electronic library. Whenever the list is modified, facility management shall forward the new list to the AB Section with the changes highlighted.

If a facility no longer meets the Office classification criteria, then it is required to enter the safety analysis process. When a building has been classified as an Office facility, and the AB Section Leader receives the Office listing, any prior SBD for the building can be cancelled by facility management. If a NNSA/LSO approved SBD is downgraded, however, then NNSA/LSO shall formally approve the downgrade.

2.3 Facility Screening

Screenings need to be performed on all facilities except Offices. The screening evaluation involves two process elements: identification of the hazardous operations and inventories (Section 2.3.1), and facility classification (Section 2.3.2). The Screening Report form (Appendix B) is used to report the screening conclusions. It is essential that an accurate report be generated, based on maximally planned inventories, because the Screening Report form represents either the entire safety basis for the facility or the justification for additional analysis of higher risk hazards and operations.

2.3.1 Identification of Hazardous Operations and Inventories

A facility's operations and inventories are identified and documented on the Screening Report form. Facility management shall accurately classify the facility on the form. This may involve coordination between facility management, personnel knowledgeable of facility operations, Hazards Control Department's ES&H Team disciplines, and AB Section safety analysts.

The key objective is to set an adequate maximum operational- and hazard-inventory threshold that accurately reflects standard operational needs over time. Therefore, facility management should be comprehensive in their assessment of operational needs by reviewing program plans, budget requests, facility documents [e.g., Facility Safety Plans (FSPs), Integration Work Sheets (IWSs), Safety Plans (SPs), National Environmental Policy Act (NEPA) reviews, and current safety basis documentation (if any)], and any other useful documentation. Additionally, discussions should be held with tenant program representatives to determine the following:

- Types of operations performed in the facility, both frequently and infrequently, and those planned for the near future.
- The maximum anticipated hazardous inventories associated with their operation(s); including current stored chemicals, waste inventory, and planned inventory of chemicals, radiological materials, and explosives. Also determine the planned types of biohazardous materials, radiation generating devices, and industrial hazards.

For planned facilities (not yet constructed or operational), all planning documents and operational and inventory information should be reviewed with key programmatic personnel.

By including comprehensive information, facility management can prevent last-minute change control processes that could delay implementation of LLNL's mission. If, at a later date, there is a need to introduce additional inventories and types of operations not listed in the Screening Report form, then the change control process as addressed in Section 3.4.4 shall be applied.

Once facility management has determined the maximally planned inventories for each hazard type, they may opt to have HCD complete the Screening Report form. If HCD prepares the form, facility management shall provide all information gathered. Facility management or designated HCD workers shall then perform the following steps:

- Review all information gathered.
- For existing facilities, physically inspect the facility to verify that
  - Operations conducted and equipment used are within the scope of the IWS and SPs. Inconsistencies shall be documented and reconciled if required by Document 2.2, “Managing ES&H for LLNL Work,” or Document 3.3, “Facility Safety Plans and Integration Work Sheets with Safety Plans,” in the *ES&H Manual* and/or the current SBD.
  - No undocumented legacy radioactive, biological, and chemical inventories exist.
  - Verify the nonstandard industrial hazards present within the facility.
  - All biological, chemical, explosive, and radiological materials in storage are included in the Safety Basis Envelope (SBE). Storage may not have an IWS, but is considered an operation that shall be captured in the SBD.
- Generate the facility screening report by filling in the facility Screening Report form.

Use the Hazard Identification Table in the Screening Report form as a checklist for the hazard identification process. Document any necessary facility classification information on the form. List hazards of proposed operations, using quantity amounts based on the maximum that will be needed for planned operations. Hazard criteria and ideas on how to obtain information for each of the five hazard types (biohazards, chemicals, radiological, explosives, industrial) are discussed in Sections 2.3.1.1 through 2.3.1.5.

2.3.1.1 Criteria for Biohazardous Materials. A building may contain numerous laboratories, each potentially with multiple biological organisms and materials. Some biological agents are innocuous, while others may be extremely hazardous. In order to gauge the level of biohazards within a facility and to avoid the need to attach a lengthy listing of all biohazards to the Screening Report form, several types of biohazard groupings shall be identified and recorded on the Hazard Identification Table included in the Screening Report form. The Hazard Identification Table requires the following information:

- Select Agent types.
- Risk Group (RG) agent type.
- Other biohazards (e.g., blood, nucleic acid, test animals, toxins, bio-waste).
- Facility biosafety level (BSL) from 1 to 3.

Select Agents. Select Agents are defined as specifically regulated pathogens and toxins, as defined in Title 42, CFR, Part 73, "Possession, Use, and Transfer of Select Agents for Humans," including pathogens and toxins regulated by both the Department for Health and Human Services (DHHS) and the United States Department of Agriculture (USDA) (i.e., overlapping agents or toxins). The term also includes some types of recombinant organisms/molecules as described in the Part 13, "Biological," of the *ES&H Manual*. If these agents are present within the facility (or planned to be used at the facility), check the entry on the Hazard Identification Table of the Facility Screening Report (Appendix B).

Risk Groups. The hazard level of microbial agents used within the facility shall also be noted on the Hazard Identification Table. This is classified according to Risk Groups. There are four levels of Risk Groups (RG1 through RG4), as defined in Part 13 of the *ES&H Manual*. LLNL only handles RG1–RG3 materials. The FSP or IWS/SP typically will include the Risk Group agent level and provide a listing of organisms. For new facilities, the facility management must provide this information based on planned operations.

Other biohazards. Any other biohazards present within the facility, such as blood, test animals, recombinant DNA work, or toxins, shall be noted on the Hazard Identification Table.

Biosafety level. Biosafety facilities are defined as a laboratory room ("four walls and a sink"); therefore, there could be several biosafety "facilities" within each safety basis defined "facility." Thus, the highest biosafety level (BSL) shall be chosen for each safety basis facility, and recorded on the Hazard Identification Table. Four BSLs are described in Section III of the *Biosafety in Microbiological and Biomedical Laboratories (BMBL)*. Each level consists of combinations of laboratory practices and techniques, risk assessments for certain operations, safety equipment, and laboratory facilities. Each combination is specifically appropriate for the operations performed, the documented or suspected routes of transmission of the infectious agents, and the laboratory function or activity. Biosafety levels are based on potential hazards of the agents in use and the laboratory function and activities. They are assigned based on the type of microbial agents and how the agents will be used (e.g., recombinant DNA), and generally not on the quantity of the agent. as long as quantities do not exceed 10 liters. Facilities are ranked from BSL-0, the least hazardous level, to BSL-4, the highest. LLNL does not have any BSL-4 facilities.

LLNL's Institutional Biosafety Committee (IBC) is the authority for determining a facility's BSL. The BSLs are typically listed in the facility documentation (e.g., FSPs or IWS/SPs).

2.3.1.2 Criteria for Chemicals. Facility management shall first establish a maximum chemical inventory threshold for the facility, as discussed in Section 2.3.1. To start the process, facility management shall assess the proximity of current inventories to their respective LSI Q values as discussed in Section 2.3.2.1. This assessment should take into account historical inventories exceeding those currently held, future operational flexibility needs, chemicals whose quantities are not explicitly tracked (e.g., material in secondary or waste containers, or materials that may be kept in one facility but moved into another facility for brief periods), and materials associated

with infrequent activities that may not be captured in the listing. Such considerations form the basis for specifying upper limits on chemicals held in excess of their LSI quantities.

Once a comprehensive listing of maximum chemical inventory threshold is developed, summarize it in the Screening Report form (e.g., acid, base, flammable, toxic, pyrophoric). Additionally, facility management shall attach a listing of all chemicals that exceed the LSI classification [Quantity (Q values)]. Maximum quantities of these chemicals shall be specified. Include the Chemical Abstract Service (CAS) Registry Number for each listed chemical, and provide the physical state (i.e., gas, liquid or solid) of the chemical. Chemical quantities classified as LSI do not need to be included in the listing. The maximum inventory thresholds for all chemicals used in the facility will be maintained in ChemTrack, LLNL's chemical inventory tracking system.

A special case exists when a facility handles relatively large quantities of chemicals in a process and where an inadvertent mixing of those chemicals results in the direct release of a known gaseous reaction product that is hazardous. In such a case, it is inappropriate to dismiss further analysis based solely on the available reactants being less than their respective LSI limits. The maximum amount of product that can be generated should be identified and included in the inventory for comparison to its appropriate classification Q value. Note that this situation is not anticipated to exist at most LLNL facilities. This stipulation also does not mandate a general by-product analysis for mixing all chemicals in the facility inventory. It is focused solely on well understood gaseous by-products that, by virtue of the processing (i.e., not lab-scale) quantities that can be mixed in an operation, produce a hazardous release in excess of LSI quantities.

A facility's inventory of chemicals shall be tracked at a level necessary to provide facility management an adequate degree of confidence that the facility's chemical inventory limits are not exceeded. It is the facility management's responsibility to implement a tracking system that ensures the facility's maximum inventory threshold limits are not exceeded. For most chemicals, facility management should be able to rely on the chemical inventory tracking system (e.g., ChemTrack) to provide an adequate representation of facility inventory. But for other chemicals, including materials such as lithium hydride and beryllium, facility management may need to track chemical quantities in secondary containers and waste containers in order to get a more accurate representation of total building inventory. The following factors should be considered by facility management in determining how chemical inventories are to be tracked:

- Proximity of the working-level inventory to an inventory limit (e.g., if above 50% of limit, then factor in quantities of chemicals not in the inventory system).
- The size and number of secondary containers typically in use as they relate to allowable inventory (e.g., tanks or vats of process chemicals).

- The size and number of waste containers and general nature of the chemical waste collected therein (e.g., original properties vs. reacted state).
- The magnitude and frequency of fluctuations in chemical inventories, particularly for those chemicals with lower limits.

The requirements for tracking chemicals (either through ChemTrack or by other methods) shall be documented and implemented through the Facility SP or specific SPs. The ChemTrack inventory tracking system does provide a process for tracking of secondary containers. Refer to *ES&H Manual* Document 21.1, "Acquisition, Receipt, Transportation and Tracking of Hazardous Materials," in the *ES&H Manual* for more information.

Chemical inventories that exceed the threshold quantity (TQ) specified in 29 CFR 1910.119, "Process Safety Management of Highly Hazardous Chemicals*,"* shall satisfy the requirements of process safety management, as well as the LLNL nonnuclear safety basis requirement standard (UCRL-ID-150214, revision 2). The chemical inventory tracking system contains the TQ threshold values associated with 29 CFR 1910.119. Most LLNL facilities have established administrative limits well below these thresholds.

2.3.1.3 Criteria for Radiological Materials and Radiation-Generating Devices. Radiological materials shall be listed by isotope, form, and activity, and the list is attached to the Screening Report form. A sum-of-the-ratio calculation of radionuclides is then performed as described in Section 2.3.2.1. This calculation result is used to determine the facility's radiological classification. If it is not practical to list all radioisotopes authorized for use in the facility, give a general description of the type, amounts, total activity and their form (for example: fission products, medical isotopes, actinides, and so forth).

Certain inventories may be excluded from hazard classification per DOE-STD-1027-92, "Hazard Classification and Accident Analysis Techniques for compliance with DOE O 5480.23, Nuclear Safety Analysis Reports." These include:

- Sealed radioactive sources meeting DOT 49 CFR 173.469, "Tests for Special Form Class 7 (Radioactive) Materials," or testing as specified by ANSI Standard N43.6, "Sealed Radioactive Sources, Categorization," as long as supporting documentation is available. [See DOE-STD-1027-92, Change Notice 1 (September 1997), for more information.]
- Material contained in exempted, commercially available products.
- Material contained in DOT Type B containers with current certificates of compliance, per DOE-STD-1027-92.

The Screening Report form should describe radiological inventory quantities excluded from inventory. The facility shall maintain documentation supporting this decision, in accordance with Section 3.4.2 of this document. A list of Type B containers' contents shall be maintained on file

and made available to safety analysts and inspectors/ auditors as required. If, however, the excluded inventory is greater than nuclear Category 3 threshold quantities, a hazard and accident analysis may be necessary if the containers can be exposed to stresses exceeding the certification requirements. If the excluded inventory is greater than the nuclear Category 3 threshold values, the facility shall be classified as Low hazard.

Radiation-Generating Devices (RGDs) are particle accelerators or photon emitters that produce ionizing radiation (e.g., x-rays, electrons, neutrons). Radiation-Generating Devices may be grouped by class as described in Document 20.3, “LLNL Radiological Safety Program for Radiation Generating Devices,” in the *ES&H Manual* and typically do not need further analysis or safety basis documentation if they are (1) contained in fixed, shielded areas, (2) operated in accordance with Document 20.3, and (3) have one of the following characteristics:

- Have particle energies <10MeV.
- Are laser-driven.
- Produce x-rays either for application or as an incidental byproduct.
- Generate neutrons using accelerated particles or photons.
- Do not produce enough activation to be of concern.

An RGD is defined as an accelerator if (1) it is capable of producing an external beam of accelerated particle with energies in excess of 10 MeV and is also capable of creating a high radiation area (100 mrem/hour), or (2) an airborne radioactivity area (as defined in 10 CFR 835) from activation, with the potential for exposing the whole body of a receptor. Any RGD device that meets these specifications is subject to the documentation and approval requirements found in Appendix C of this document that are drawn from DOE O 420.2A, “Safety of Accelerator Facilities.” The facility screening documents the hazard classification of an accelerator facility, because no further subdivision of the classification is required.

Not all machines that accelerate charged particles are classified as accelerators and therefore do not require a safety analysis document. For example, machines that produce x-rays, either for application or as an incidental byproduct, are not included in this program. To be included as an accelerator, the machine shall be capable of producing an external beam of accelerated particles with energies in excess of 10 MeV and also be capable of creating a radiological area potentially exposing the whole body of a receptor. Any RGD device that meets these specifications is subject to controls in the WSS drawn from DOE O 420.2A, unless it meets the exclusion added to the WSS set on May 1, 2002. This exclusion applies to RGDs that:

- Do not create a high-radiation area (100 mrem in an hour) or an airborne radioactivity area (as defined in 10 CFR 835) from activation.
- Are operated in accordance with Document 20.3.

Radiation Generating Devices that typically fit within this excluded category include:

- Those capable of accelerating particles to energies <10 MeV.
- Laser-driven RGDs.
- Particle neutron generators.
- Photo-neutron generators.
- Other RGDs that produce particles with energies >10 MeV, but in insufficient quantities to produce activation as specified above.

If a facility meets accelerator criteria and does not qualify for exemption, then a safety analysis is required.

2.3.1.4 Criteria for Explosives. Explosives materials shall be summarized on Part III of the Screening Report form. Maximum-explosives weight limits should be denoted by the United Nations Organization (UNO) Hazard Class/Division and shall be listed or attached to the screening form. Maximum-explosives weight limits are determined during preparation of the facility Site Plan by explosives safety and facility management. This Site Plan document is used to site and assign explosives inventories for facilities, per the quantity-distance and level-of-protection requirements of DOE M440.1-1, *DOE Explosives Safety Manual*. This may also include powder-actuated tools used (other than routine maintenance and repair performed by the Plant Engineering Department) and ammunition used or stored in the facility. At a minimum, information adequate for proper facility classification shall be documented in the facility Screening Report form.

Facility management determine the maximum explosives inventory limits for new facilities, per the *DOE Explosives Safety Manual*. These maximum inventory limits are recorded in the SBD or Site Plan. For existing facilities, these maximum inventory limits (or smaller administrative limits) are recorded within the FSP or IWS/SP documents.

2.3.1.5 Criteria for Industrial Hazards. Industrial hazards observed during the facility walk-through and the review of facility documents (i.e., IWSs, FSP, and IWS/SPs) are recorded on the Hazard Identification Table by checking the general industrial hazard type. The location, storage, proximity to other materials and operations, and frequency and manner of use may also be necessary and should be noted on the Screening Report form whenever relevant. (Note: this is not required unless the facility exceeds the LSI classification.)

Most industrial hazards can be dangerous to workers within the immediate vicinity, but cannot impact workers 100 m from the source (colocated workers) or the general public (with their location determined to be at the LLNL site boundary). Industrial hazards to immediate workers are governed by other regulations as identified in the *ES&H Manual*, and are not a safety basis concern unless they initiate accidents that could impact colocated workers or the public (e.g., crane dropping large quantities of toxic materials, high voltage cable breaking and causing a

massive fire in a hazardous facility). From a safety analysis standpoint, hazards in this category are of interest for facilities that contain materials requiring hazard analysis.

Some industrial hazards, however, can directly impact the colocated worker or public when accidents occur. For example, equipment that makes a very high decibel noise can cause discomfort to colocated workers and can be heard offsite by the public. Any direct hazard shall be recorded on the Hazard Identification Table. Low, Moderate and High hazard facility classifications of industrial hazards are based on the impacts of direct hazards.

Determine the types of industrial hazards present, and those expected in the future. For existing facilities, obtain information from facility documents (e.g., FSP, IWS/SPs, budget plans), discussions with facility workers, and from observations during the walk-through. Use the Hazard Identification Table as a guide to indicate the level of information needed. Appendix B also includes a table, Screening Criteria for Standard Industrial Hazards, that screens out standard industrial hazards from industrial hazards that require further analysis.

2.3.1.6 De Minimis Inventory Levels. LLNL has established optional de minimis quantity levels for hazardous materials, below which a material is not considered to be part of the facility inventory for safety analysis purposes. Where simply operating within LSI limits does not fully address management needs, de minimis quantities can be used to avoid unnecessary effort associated with containers having only small quantities of material that could have no adverse impact on colocated workers or the public. Specific examples of how the concept of de minimis quantities can be applied are listed below. However, facility management shall recognize that other requirements for managing this material still apply. For example, integration worksheets and chemical inventory tracking, for reasons other than safety analysis, may still be needed when these quantities of materials are used. The application of the de minimis quantities concept to prevent unnecessary effort of tracking material for safety analysis may be used in the following situations:

- When trace quantities of materials may be present in samples.
- When dilute solutions of materials are handled.
- When minute quantities of a material may be a by-product of synthesis.
- When small samples are brought into a facility.
- When small amounts of materials are placed in workplace waste containers.
- When small amounts of materials are transferred from primary to secondary containers to perform laboratory operations.
- When small amounts of materials are in separate containers that are located in different locations within the same facility.

The de minimis quantities for radiological materials are those items that are considered “generally licensed items and articles” and materials that contain less than the threshold

quantities specified in 10 CFR 835. These quantities are also shown in Document 20.2, "LLNL Radiological Safety Program for Radioactive Materials," in the *ES&H Manual*, where the quantities are used to describe classes of sealed sources. Biological hazards are classified based on the BSL of the laboratory, not on the quantity of material. Hence, there are no de minimis quantities for biological hazards. There are no de minimis quantities of industrial hazards, with the exception of standard industrial hazards, which do not require analysis beyond listing in the Screening Report (see Section 2.3.1.5), and there are no de minimis quantities for explosives. The remainder of this section details de minimis quantities for chemicals.

Different chemicals will have different de minimis quantities, depending upon their potential human health effects. Those chemicals assigned TEEL values low enough to be deemed highly hazardous chemicals have individual de minimis values specified in Appendix D. Chemicals not assigned Q values, that are documented to present similar hazard potential to those in Appendix D, may be assigned the value for the closest analogous chemical. Alternatively, a generic de minimis allowance of 10 g is specified based on overall consideration of the values in Appendix D. These and other general rules are defined in Table 2.

Table 2. De minimis Quantities for Chemicals.

Chemical class	De minimis quantity
Highly Hazardous Chemicals	
Listed in Appendix D.	See Appendix D
Not listed in Appendix D but documented to be highly hazardous or a suspected unknown.	10 g or analogous Appendix D values[1,2]
All Other Chemicals	
1. Already assigned a Q value; or (2) not assigned a Q-value but not highly hazardous or a suspected unknown.	1 kg
1. Already assigned a Q value with a Q0(100m) of 10,000 kg; or 2. Not assigned a Q value but analogous to a chemical with a Q0(100m) of 10,000 kg.[1]	10 kg
Materials on the ChemTrack Priority 3 and 4 list (this list includes common materials such as adhesives, degreasers, and household materials) but not including pesticides and herbicides.	10 kg
Nonreactive metals (such as copper, steel, and aluminum, but not including magnesium, sodium, and so forth) in nonpowder forms (such as wire, sheets, ingots).[3]	1000 kg

1 Contact your ES&H team Industrial Hygienist for assistance in making the determination of analogous chemicals.

2 If using an analog to a listed chemical, use the de minimis of the analogous listed chemical.

3 Metal used in buildings, machinery, or the scrap metal yard are not subject to analysis and are therefore automatically excluded from inventory.

These de minimis quantities are again optional; formal classification of all material into the categories defined above is not required. De minimis quantities are also defined per container. Facility management shall not, however, break larger quantities down into lots below the de

minimis quantity in order to improperly reduce hazard classification for material cumulatively handled in quantities exceeding LSI limits. The limits defined above have been established to assure that the LSI facility limits are not likely to be exceeded, even when multiple containers with the material at de minimis quantities are present within the same facility.

The AB Section maintains documentation regarding the calculation of de minimis quantities and may be requested to establish a specific de minimis quantity for a given chemical.

2.3.2 Hazard Classification Process

Hazard classification is based on the potential for adverse health impacts to colocated workers and the public from an unmitigated release. The general concept of the criteria, described in Table 3, considers human health effects based upon a graded approach. Facilities are classified according to the potential of their operations impacting typical colocated workers (at 100 m distance) and the public (at the site boundary), based on the effects of unmitigated releases of hazardous energy or materials.

While analysis has been conducted to directly relate chemical exposure levels to these qualitative levels, facility classifications based on other hazards have been more loosely aligned. Radiological and biological hazards facility classifications are tied to existing WSS graded approaches (e.g., 40 CFR 302.4, "Designation Reportable Quantities and Notification Requirements"*;* DOE-STD-1027; and *Biosafety in Microbiological and Biomedical Laboratories,* U.S. Department of Health & Human Services, 1999).

Table 3. Classification of Health Effects to Colocated Workers and the Public from Accidental Conditions.

Facility classification	Colocated worker impact	Public impact
LSI	No more than mild, transient adverse health effects or the perception of a clearly defined objectionable odor or sensation.	No appreciable risk of health effects.
Low hazard	No irreversible or other serious health effects or symptoms that could impair a person's abilities to take protective action.	No more than mild, transient adverse health effects or the perception of a clearly defined objectionable odor or sensation.
Moderate hazard	Irreversible or other serious health effects or symptoms that could impair a person's abilities to take protective action.	No irreversible or other serious health effects or symptoms that could impair a person's abilities to take protective action.
High hazard	Potential for unmitigated release of hazards with impacts to colocated workers that are believed to include life-threatening health effects.	Irreversible or other serious health effects or symptoms that could impair a person's abilities to take protective action.

Facility classification is based on the highest hazard level determined for any of the five hazard types (biological, chemical, explosive, industrial, radiological). For example, if a facility contains biological materials classified as Low hazard, one type of chemicals classified as Moderate hazard, and another type of chemicals classified as LSI level hazards, the facility is classified as Moderate hazard. In this example, however, the safety analyses for the Low biological hazards and the Moderate hazard chemicals are performed as determined by the Analysis Level Matrix discussed in Section 2.4, and no further analysis above the Screening Report form is required for the LSI chemicals.

2.3.2.1 Perform Hazard Classification. Follow the steps for classifying each hazard type:

- **Chemical hazards.** EPI Code calculations determine the chemical inventory (Q value) for each chemical that, if released, would result in exposures equal to the Temporary Emergency Exposure Limit (TEEL) values at fixed distances from the release point. The TEEL values are posted on DOE's Chemical Safety Office website.

  The Chemical Quantity List of Q values is used to classify facilities where hazardous chemicals are used. (Please note that some chemicals may be further restricted based on other regulatory limits or worker safety considerations). Table 4 shows how TEELS and Q values correlate at each hazard level and Appendix E gives further information on the parameters used in the EPI Code calculations.

Table 4. Correlation Between TEELS and Q Values.

Hazard Classification	Colocated worker (distance column on Q list = 100 m)	Public (use the distance column on the Q list that applies - see step 1 below)
LSI	≤TEEL 1 ≤Q1	≤TEEL 0 ≤Q0
Low hazard	≤TEEL 2 ≤Q2	≤TEEL 1 ≤Q1
Moderate hazard	≤TEEL 3 ≤Q3	≤TEEL 2 ≤Q2
High hazard	>TEEL 3 >Q3	>TEEL 2 >Q2

Table 5 is an example of the Chemical Quantity List for LLNL Site 200. There are four sets of columns. The sets are calculated for the following distances: 100 m, 200 m, 300 m and 600 m. (Site 300 has an additional fifth set calculated for 1100 m).

Table 5. Sample Chemical Q List Excerpt for Site 200.

SUBSTANCE NAME	CAS #	Q-0 Limiting Mass (kg) 100 m	Q-1 Limiting Mass (kg) 100 m	Q-2 Limiting Mass (kg) 100 m	Q-3 Limiting Mass (kg) 100 m	Q-0 Limiting Mass (kg) 200 m	Q-1 Limiting Mass (kg) 200 m	Q-2 Limiting Mass (kg) 200 m	Q-0 Limiting Mass (kg) 300 m	Q-1 Limiting Mass (kg) 300 m)	Q-2 Limiting Mass (kg) 300 m	Q-0 Limiting Mass (kg) 600 m	Q-1 Limiting Mass (kg) 600 m	Q-2 Limiting Mass (kg) 600 m
ACENAPHTHENE; (1,3-ACENAPHTHALENE)	83-32-9	2.70E+03	8.30E+03	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04
ACENAPHTHYLENE	208-96-8	4.00E+02	1.30E+03	8.30E+03	1.00E+04	1.60E+03	5.30E+03	1.00E+04	3.40E+03	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04
ACETALDEHYDE	75-07-0	4.80E+01	4.80E+01	9.60E+02	4.80E+03	1.90E+02	1.90E+02	3.80E+03	4.00E+02	4.00E+02	8.10E+03	1.50E+03	1.50E+03	1.00E+04
ACETAMIDE	60-35-5	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04
ACETIC ACID	64-19-7	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04
ACETIC ACID, 2-PROPENYL ESTER	591-87-7	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04	1.00E+04

To classify a facility's chemical hazards, complete the following steps:

1. Determine the maximum facility inventory of each hazardous chemical to be authorized to the de minimis criteria discussed in Section 2.3.1.6. If any material inventory is less than its de minimis value, it can be screened out and does not require further analysis. Furthermore, if a larger quantity of the material inventory is stored in containers, none of which contains more than the de minimis value and which are not stored together, then these do not require further analysis.

2. Check Appendix F (building zone map) to determine the approximate distance zone your building resides in as compared with the nearest site boundary.

   - Site 200:

     — Default distance zone: 100 m, 200 m, 300 m, 600 m or
     — Determine an intermediate Q value (between default distance zones) by using the following interpolation (scaling) calculation:

$$Q_a = Q_d \left(\frac{a}{d} \right)^{1.8}$$

where:

Q = Q value

a = actual distance (of facility) from fence line (meters).

d = default distance (use the default distance nearest to "a"), in meters.

   - Site 300:

     — Default distance zone: 100 m, 200 m, 300 m, 600 m, 1100 m or
     — Determine an intermediate Q value (between default distance zones) by using the interpolation (scaling) calculation shown above.

3. Compare the maximum facility inventory of each hazardous chemical to be authorized to the TEEL-based ("Q") classification boundary quantities. An example table is presented in Table 5 (using parameters for LLNL Site 200). There are four sets of distances: the first set is calculated for a colocated worker at 100 m (and facilities located 100m) from nearest fenceline, the others for the public at a distance of 200 m, 300 m and 600 m. First determine which chemicals meet the LSI criteria (for colocated worker: LSI -≤Q1; for public: LSI- ≤Q0). For chemicals that exceed the LSI criteria, compare their inventories to Low hazard, Moderate hazard or High hazard chemical criteria as shown in the classification criteria in Table 6.

Table 6. Classification Criteria.

Hazard Classification	Biohazard	Chemical	Radiological	Explosive	Industrial
Light Science & Industry	BSL 1 or 2 operations	Generally, small-scale chemical labs, dye laser labs, small quantity chemical storage, chemical inventories. ≤Q1 (colocated worker); ≤Q0 (public) as defined in the LLNL chemical Q List for classification.	Radiation generating devices not covered by DOE O 420.2A, radiological material sum of ratios <1 for RQs (See Table 7).	Powder-actuated tools, room inventories involving: • Secondary explosives ≤10 mg. • Primary explosives ≤1 mg. • Storage of ammunition classified as 1.4S per 5.4.3.4 of DOE-STD-1091-96.	Plumbing, carpentry, and machine shops using steel, aluminum, copper, plastic, wood, or other common materials; electronics shops; laser labs; and equipment design and testing labs.
Low hazard	BSL 3 operations	Facility inventory levels are ≤Q2 (colocated worker); ≤Q1 (public) as defined in the LLNL chemical Q List for classification.	Radiological material sum of ratios >1 for RQ but <Category 3 threshold (See Table 7), or qualified sealed sources >Category 3 threshold but exempt from inventory. Radiation Generating Devices covered by DOE O 420.2A (Accelerators).	The maximum credible event (used to meet the Level of Protection and QD requirements of the *DOE Explosives Safety Manual*) involves: • ≤10 grams of UNO Hazard Class 1.1, 1.2, 1.4 (except as stated for 1.4S for LSI facilities above), 1.5 or 1.6 explosives, or • ≤200 grams for UNO Hazard Class 1.3 explosives.	Industrial hazards that meet the following conditions for unmitigated releases: • No irreversible or other serious health effects or symptoms that could impair a colocated worker's ability to take protective action. • No more than mild, transient adverse health effects or the perception of a clearly defined objectionable odor or sensation to the public.

Table 6. Classification Criteria (cont'd).

Hazard Classification	Biohazard	Chemical	Radiological	Explosive	Industrial
Moderate hazard	Not applicable	Facility inventory levels are ≤Q3 (colocated worker); ≤Q2 (public) as defined in the LLNL chemical Q List for classification.	There is no Moderate classification for radiological hazards. If inventory exceeds DOE-STD-1027 hazard Category 3 thresholds (i.e. sum of ratio ≥1), follow *ES&H Manual* Document 51.1.	• All activities or materials that are not allowed in Low facilities that: • Meet the QD requirements specified in DOE Manual 440.1-1. • Does not meet DOT requirements, when transporting explosive material in excess of LOW quantities on-site.	Industrial hazards that meet the following conditions for unmitigated releases: • No life-threatening health effects on colocated workers. • No irreversible or other serious health effects on the public or symptoms that could impair their abilities to take protective action.
High hazard	Not applicable	Facility inventory levels exceeding Q3 (colocated worker); Q2 (public) as defined in the LLNL chemical Q List for classification.	There is no High classification for radiological hazards. If inventory exceeds DOE-STD 1027 hazard Category 3 thresholds (i.e. sum of ratio ≥1), follow *ES&H Manual* Document 51.1.	Any activities or materials necessitating an exemption from the Quantity Distance (QD) specified in DOE Manual 440.1-1.	Hazard level exceeds that for Moderate.

4. The highest classification is your classification for chemical hazards.

   Note, however, that the Q value quantities for liquids and powders are derived using a damage ratio of 0.2 for the overall facility inventory. This presumes the typical LLNL inventory of a number of commercially obtained bottles or other sources distributed throughout a room or facility. If the facility inventory includes liquids in a large processing tank or powder stored in large drums, and those quantities form a significant fraction of the overall inventory, the Q-list values should be divided by a factor of 5 for classification.

   Note also that highly toxic specialty agents such as mustard gas and nerve agents (e.g., Sarin, VX) are not provided Q values. Such agents are already governed by stringent standards and are not present onsite in production quantities. Handling of small (<10 grams per facility) or dilute analysis samples of such materials is consistent with a chemical hazard classification of LSI. If quantities beyond these minimums are envisioned, the facility classification should not be LSI and the activities involving such materials should be directly forwarded to hazard analysis and, as appropriate, accident analysis. Hazard classification in that event will be assigned on a case-specific basis.

5. One final consideration involves chemicals with no assigned TEEL values and thus no derived Q values. Given that the TEEL list includes all hazardous chemicals identified as triggers for OSHA Process Safety and EPA Risk Management regulations, most omissions are anticipated to represent acceptable residual risk issues for which no specific derivation of limits is required. To maintain confidence in that conclusion, however, a simple check mechanism is established.

   One kilogram represents a value smaller than 99.5% of the LSI limits derived for LLNL Site 200 and 98.5% of the LSI limits derived for LLNL Site 300. It is taken as a point of obvious residual risk. The facility should survey its cumulative Chemtrack listing for those chemicals that are (1) not assigned TEELs, and (2) expected to be handled in quantities exceeding 1 kg. These chemicals are then evaluated to determine if they are clearly innocuous (e.g., dilute solutions, standards, buffers, many salts), commercially available products not typical labeled as poisons or highly toxic (e.g., fertilizers, cleaning products, motor oils), or analogous to chemicals with very large LSI limits relative to their foreseeable use. In such cases, the material is deemed a residual risk issue not relevant to hazard classification. That is, no additional Q values need be defined for these materials. Future discovery that a chemical without a limit is being handled in quantities in excess of 1 kg also does not constitute a violation of the safety basis. The chemical in question should simply be evaluated in the manner described above.

There may, however, be cases when a chemical without an associated TEEL value cannot be determined to be an obvious residual risk. In those cases, industrial hygienists and accident analysts should be consulted to determine if the severity of the chemical's hazard potential relative to the quantities being handled warrant formal definition of a Q value. Formal definition of a Q value requires the concurrence of the AB section.

- **Radiological hazards.** The radiological maximum authorized inventory (see Section 2.3.1.3 for exclusions) is compared against the threshold quantity standards shown in Column 2 of Table 7. The sum-of-the-ratio calculation shall be performed for the radionuclides, using the appropriate Reportable Quantities (RQs) as outlined below:
  - If the sum of the ratios of each radiological nuclide to its Reportable Quantities (RQ) (listed in 40 CFR 302.4, Appendix B) is less than 1, then the radiological classification is LSI.
  - If this sum of the ratios is equal or greater than 1, then the inventory shall be compared against the nuclear facility Category 3 thresholds found in Table A.1 of DOE-STD-1027-92, “Hazard Categorization and Accident Analysis Techniques,” Attachment 1.
- If the sum of the ratios of each radionuclide to its nuclear facility Category 3 threshold is less than 1, then the radiological classification is Low.

Table 7. Standards For Radioactive Materials Inventory Thresholds.

Classification Threshold	Rule/Standard
Low	40 CFR 302.4, Appendix B - Reportable Quantity (“Final”)
Category 3 (Nuclear)	DOE-STD-1027, Table A.1 - Category 3 Thresholds

- If the sum of the ratios of each radionuclide to nuclear facility Category 3 thresholds is equal or greater than 1, then the facility is classified as a nuclear facility and has no radiological classification under the nonnuclear facility standard. In this case follow the requirements for completing safety analysis for nuclear facilities addressed in Document 51.1. This process is illustrated in Figure 2.
- If the sealed source and Type B container exclusions are used per DOE-STD-1027-92, and the excluded inventory exceeds category thresholds, then the facility classification is at least Low hazard and the contents shall be analyzed. See Section 2.3.1.3.
- **Explosive hazards.** Compare the maximum amount of explosives that can be authorized against the criteria listed in Table 6.
- **Biological hazards.** Once the BSL Facility level is established (see Section 2.3.1.1), verify with Table 6 to ascertain the biological safety basis classification level.
- **Industrial hazards.** Compare the types of industrial hazards in the facility and their potential health hazards against the criteria listed in Table 6. (Also consult the Hazard Identification Table in the Screening Report form.) Select the most appropriate description in Table 6. The highest hazard level associated with industrial hazard is the industrial hazard classification level.

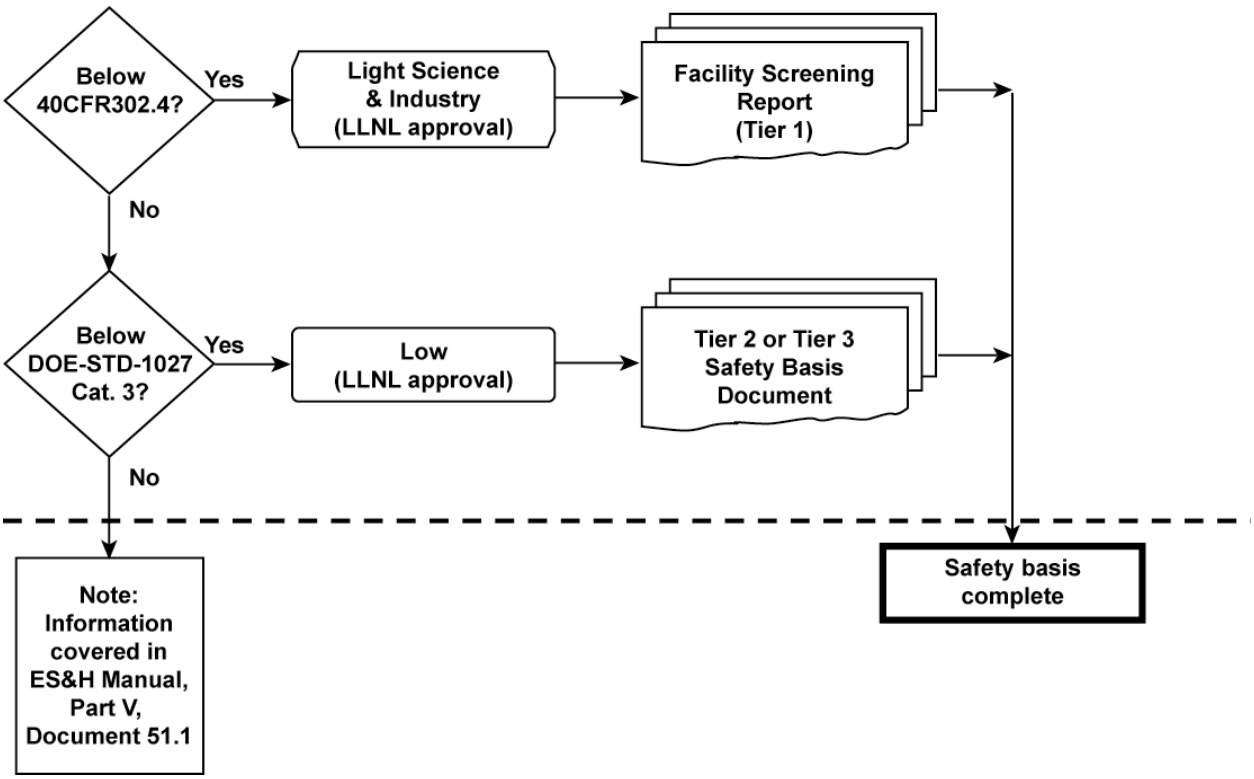


Figure 2. Flowchart for the Safety Basis Process for Radioactive Materials Hazards.

Return to the Hazard Identification Table and annotate all observed hazard types classified above the LSI level. These will be investigated in more detail during the hazard analysis process.

2.3.2.2 Facility Classification. The final facility classification is based on the highest-level hazard determined for any of the five hazard types. For example, if a facility is classified to be LSI for explosive hazards, Low hazard for biological materials, and Moderate hazard for chemicals, the facility itself is classified as Moderate hazard.

For facilities designated LSI, the Screening Report form completes the SBD. See Section 3 for further guidance on the documentation process. This form will need to be approved in accordance with Section 3. For all hazards that are classified above LSI, perform a hazard analysis. Note that hazard analysis is only completed for the hazards classified as Low, Moderate, or High, and is not required for the LSI hazards within the same facility.

2.4 Hazard and Accident Analysis

When LSI limits are adequate for a facility's needs, the facility can be simply classified as LSI without the need for the detailed analysis. LSI classification is understood to indicate that any residual risk, after meeting the requirements of the *ES&H Manual,* is acceptable without the need for hazard and accident analysis. If the hazard level of a desired operation results in a

classification at Low, Moderate, or High hazard, additional analysis is required. The first step is to conduct a hazard analysis that documents a summary set of hazardous events that exceed their respective LSI thresholds. As part of that activity, the resulting hazard analysis events are screened to determine if accident analysis is necessary, based on general estimates of consequence and probability. The second step, accident analysis, formally documents facility-specific consequences and probabilities to determine what credited controls are needed to reduce risk to an acceptable level. Controls may also be directly derived from the initial conditions specified in hazard analysis.

Both hazard and accident analysis address only hazards classified as Low, Moderate, or High hazard. If a facility handles 300 chemicals and is willing to operate within the LSI limits for 299, it is required to analyze just the handling and use of the 1 for which a higher limit is desired. The other 299 would only be noted, by generic category whenever possible, to the extent they are initiators or exacerbators for hazardous scenarios involving the additional chemical. In the case of multiple radionuclides desired in excess of LSI quantities, the characterization approach can be generic for a group of radionuclides or theoretically bounding based on one. Accident analysis is further limited to only those scenarios that represent a potentially elevated risk.

Note that many of the hazards covered by this *ES&H Manual* document represent commonplace industrial or commercial activities carried out by the general public. While LLNL desires to establish upper bounds on such activities, many are governed by standards with historically acceptable levels of residual risk, whether explicitly or implicitly defined. It is often not cost-effective, or at times even a technically meaningful activity, to evaluate the sufficiency of those standards in an analytical context. Accordingly, this *ES&H Manual* document applies a graded approach based on a “preponderance of the evidence” standard for conclusions, as opposed to the “demonstration beyond a reasonable doubt” standard more familiar from the traditional nuclear safety perspective. That distinction allows for common sense judgment in analysis.

The remainder of this section and Section 2.5 (Controls), is not focused on general top-level provisions. It is specifically written at a level of detail intended to assist analysts in performing and documenting the safety analysis.

2.4.1 Probability Estimation

The following qualitative descriptors are used in this document:

- **Probable:** event is likely to occur several times during the facility or operation lifetime.
- **Expected:** event could be expected to occur once during the facility or operation lifetime.
- **Marginal:** event is not expected to occur, but may occur during the facility or operation lifetime.

Probability estimation in both hazard and accident analysis is intended to be general order and does not require evaluating scenarios to extremely low frequencies (i.e., 1×10^{-6}/yr for initiating events + conditional probabilities). The pertinent time scale for evaluation is intended to be "facility or operation lifetime." For example, the Probable earthquake is considered a noticeable tremblor that does minimal, if any, damage to a facility. The Expected earthquake is stronger, on the order of the 1980 Greenville Fault event or a more powerful event at regional faults resulting in equivalent damage at LLNL. The Marginal event is one whose effect is on the order of that experienced at California State University at Northridge (~ 10% glassware breakage/spillage) in the 1994 Northridge event. Marginal events correspond to either something stronger than is currently anticipated for the Greenville Fault or an event at other regional faults with an epicenter close to, or within, the Tri-Valley area. In general, facility collapse should not be postulated unless the facility in question has major deficiencies relative to the Uniform Building Code for which it was designed.

The storage and use of compressed gas cylinders provides another example of this "preponderance of the evidence" approach. Based on general industrial data alone, a major leak would not be expected to occur several times during the operation lifetime. If caps, regulators, seismic mounting, retention chains, and other components are properly used, a major leak would not be expected to occur once during the facility or operation lifetime. This would place the event in the Marginal probability ranking. Storing the cylinder some minimal distance from vehicular traffic and falling hazards would likely support a ranking even below that. Thus, risk rankings and their associated control considerations should be based, to the maximum extent possible, on codified practice and industrial "common sense." Tens of thousands of facilities throughout the nation use laboratory quantities of chemicals and radionuclides; many more encompass a wide variety of industrial hazards. The residual risk associated with such operations is well understood, and this *ES&H Manual* document does not require its formal quantification.

Note that while the accident analysis risk matrix uses the term "credible," it is used in the Webster Dictionary's definition of "plausible." That corresponds to "not expected to occur but may occur in the facility or operation lifetime." It does not require extension of event probability down to estimated frequencies of 1 (10^{-6}/yr) in hazard or accident analysis. The bottom threshold for the "Marginal" probability ranking is the point at which the preponderance of the available evidence indicates a given event will not occur in the facility during its operating lifetime. One result of this departure from the traditional nuclear safety approach is that the evaluation of airplane crash scenarios is not required.

2.4.2 Hazard Analysis

The hazard analysis process used in developing safety bases has two functions. The first function is to identify any potential operating errors and other initiators capable of generating hazardous scenarios for colocated workers and the public, the preventive and mitigative controls associated with those scenarios, and estimated probabilities and consequences. That information may be documented in the form of either a standard Hazard Evaluation Table, a

more informal table (see Appendix G for content specification and examples), or in text explaining the same information (e.g., cause, preventive and mitigative controls) for simpler hazards or operations. In order to demonstrate thoroughness, the hazard analysis identifies both fundamental worker-safety controls and controls having release prevention/mitigation functions, but only the latter are candidates for designation as credited controls with OSR coverage. The former are managed at the local level via the Facility SP and other activity-specific safety documentation.

In order to minimize complications with Change Control Forms (see Section 3.4.4), all hazards considered should be identified, however briefly. For example, if the use of cranes or local crane traffic is considered, state that the associated consequence and/or event probability either (1) do not require accident analysis per the Analysis Level Matrix, or (2) are bounded by another scenario that addresses the relevant controls. Otherwise, a subsequent reviewer could see the issue as a new accident or indication of an inadequate safety analysis.

The second function of the hazard analysis is to screen hazardous events. Analysts can determine if, based on unmitigated consequences binned in the Analysis Level Matrix (Figure 3), accident analysis is required for a particular release scenario of a given hazard. Specific guidance is provided by individual hazard type in Sections 2.4.2.2 through 2.4.2.6.

2.4.2.1 Analysis Level Matrix. Both the Analysis Level Matrix, presented here as Figure 3, and the accident analysis Residual Risk Matrix, presented later in Section 2.4.3, use the consequence categories defined in Table 8.

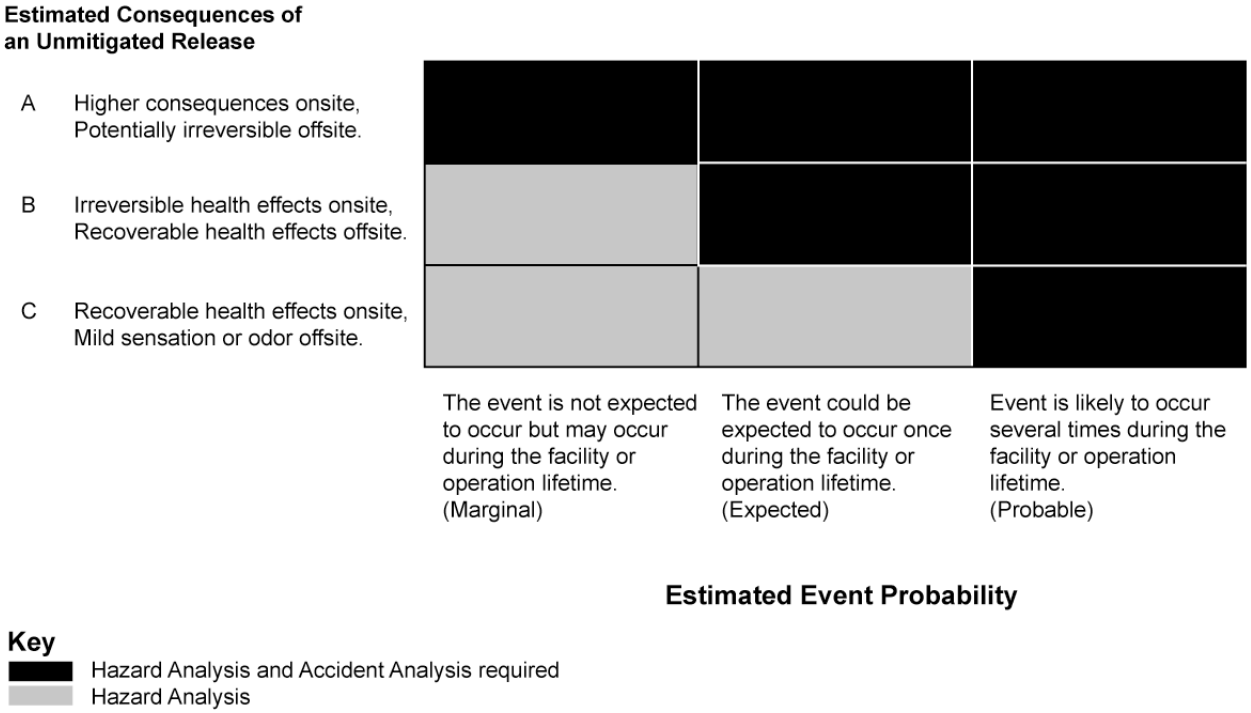


Figure 3. Analysis Level Matrix.

Table 8. Consequence Categories.

Consequence Category	Onsite Health Effects*	Offsite Health Effects
D (not in ALM)	Mild sensation/odor (x ≤TEEL-1)	None (x <TEEL-0)
C	Recoverable (T1< x ≤T2)	Mild sensation/odor (T0< x ≤T1)
B	Potentially irreversible (T2< x ≤T3)	Recoverable (T1< x ≤T2)
A	Potentially lethal x (>TEEL-3)	Potentially irreversible (x >T2)

* Onsite is a generic worker at least 100 m from the facility but inside the LLNL fence.

The consequences defined by these categories, combined with the probability definitions previously discussed in Section 2.4.1, comprise the Analysis Level Matrix. Its purpose is to prevent detailed facility-specific calculations when it is obvious that the risk for a given scenario is low. If the risk ranking assigned for the unmitigated consequence (with any exceptions allowed as discussed in this section) is in the lightly-shaded bins requiring only hazard analysis, the conclusion that accident analysis is not required can be simply stated.

Events are ranked on the Analysis Level Matrix in accordance with the following rules:

1. Consequence estimates are assigned based on the greater-than-LSI limit desired for a given hazard and the most hazardous planned condition of an operation (e.g., largest inventory in storage, largest production rate of a hazardous by-product, largest ingot in lathe). Administrative limits on greater-than-LSI hazard quantities represent the initial conditions for analysis.

2. Consequence rankings should be unmitigated. This means the ranking may consider intrinsic aspects of the operation (see discussion below), but not facility-specific controls. Intrinsic aspects of operation also represent initial conditions of analysis.

3. Frequency rankings do not have to be unmitigated in a theoretical sense. For example, a large facility-wide fire need not automatically be considered a Probable event. The probability estimated for such a fire should be based on average building conditions. The likelihood of a single room fire spreading to multiple rooms should be based on the specific construction of the facility. However, facility-specific controls, such as a fire suppression system or proper handling of compressed gas cylinders, should not be factored into the probability assigned. Those are properly identified, to the extent needed, as credited controls in accident analysis.

4. Use 95% probable meteorological conditions for hazards evaluated by downwind dispersion. (F class stability with 1 m/sec wind speed unless higher wind speeds can be justified). For elevated releases, the issue of enhanced meteorological turbulence bringing plumes to ground more quickly is adequately assessed by single-point examination, using the 50% meteorology assigned for classification (D class stability with 3 m/sec wind speed).

Intrinsic aspects of an operation are defined as passive definitional parameters that are resistant to change by simple human error. For example, the use of a number of 2.5-L jugs of acid in a

laboratory, instead of one 400-L storage tank, is an intrinsic aspect of operation that can limit the size of spills in the event of an accident. Another example is a compressed gas cylinder. The basic structural strength of a metal gas cylinder is an intrinsic aspect of operation; handling the cylinder in accordance with Compressed Gas Association regulations is a specific control.

The key distinction revolves around the degree to which obvious human errors can defeat a given safety capability. The structural capacity of a building inherently provides a given level of protection, a capability that does not change absent major modification activities. The safety function of a low berm, however, can be defeated by as obvious an error as not pumping it out after a rainstorm.

Note: One exception to this rule involves the use of non-propagating arrays for explosives storage. Per Section 2.4.2.5, such arrays may be assigned as initial conditions of analysis provided they are automatically designated credited controls as well. This exception is allowed because such arrays represent a generic, consensus end-point for safety.

The perceived value of intrinsic aspects of operation is based on broad information about similar operations and facilities such as operating history, engineering judgment, or industry data. All initial conditions for analysis, including quantity limits, must be specifically evaluated for designation as credited controls. As previously noted, consideration of facility-specific controls belongs in accident analysis.

Accident analysis (Section 2.4.3), which may result in the assignment of additional credited controls, is required if scenarios are ranked in the black-shaded bins. It is not required if scenarios are ranked in either the lightly-shaded bins or beyond the lower ends of the matrix. If no accident analysis is required, the limits to the planned operations and any other initial conditions of analysis, as appropriate, are included in the SBD's control section. The Associate Director approves the SBD because the associated risk falls into the bins of the Residual Risk Matrix indicated for Associate Director approval.

2.4.2.2 Radiological Hazards. The radiological activity levels in the facilities covered by this document are significantly less than the threshold levels in DOE-STD-1027-92 that require accident analysis for nuclear facilities. Accordingly, as long as the total facility inventory remains less than the category 3 limits in Appendix A of DOE-STD-1027-92 on a cumulative sum-of-the-ratios basis for all isotopes, accident analysis is not required.

As further supporting basis for this conclusion, consider a nominal worst-case isotope such as Cf-252, present in dispersible powder quantities equal to its Category 3 threshold. If this material is subjected to impact by falling debris in a seismic event, the resulting doses at 100 m and 300 m respectively are consistent with a nuclear DSA ranking of Low consequences. This would translate into the Analysis Level Matrix as Category C at worst. Such an event is not expected to occur several times during the facility or operation lifetime, which qualifies this example as not requiring accident analysis. Thus, none of the radiological preventive or

mitigative controls identified in the hazard analysis should become credited controls. The overall limit on radiological material will be the only credited control.

A special case occurs when inventory is in excess of the DOE-STD-1027-92 Hazard Category 3 thresholds, but present in forms exempted from nuclear facility classification (e.g., sealed sources, within DOT Type B shipping containers). In such cases, maintaining the relevant container certification becomes an initial condition and credited control to meet the necessary Category 3 limit previously specified. Additionally, if the total quantity of such sources exceeds the DOE-STD-1027-92 Hazard Category 3 limit, the hazard analysis shall consider the possibility of an event severe enough to compromise the container design specifications within the defined probability categories. If so, accident analysis may be required.

Most radiation generating devices, except lasers and accelerators, are considered either standard industrial hazards or LSI, provided they conform to appropriate national codes and standards (e.g., ANS N537/NBS123 for X-ray equipment or ANS 43.1 for simple accelerators). Accelerators are classified as Low hazard if they meet DOE O 420.2A and are analyzed in accordance with that Order. Even if a radiation generating device were to be evaluated in hazard analysis, it would not be expected to yield significant hazards at 100 m from a facility.

Lasers are acute hazards (nonionizing) and are covered under industrial hazards. However, when lasers are capable of generating radiation via material interactions, that radiation hazard should be identified and addressed appropriately.

2.4.2.3 Chemical Hazards. A table of generic Q values for F stability and 1 m/sec wind speed is available. The values are lower than the Q values used to determine facility hazard classification, due to the use of more conservative meteorological parameters. They are provided as a “go/no go” means of concluding that individual scenarios of a given probability do not require accident analysis due to the amount of material involved. Where the more conservative meteorology generates generic Q values too small to support such a conclusion, a simple notation that facility-specific accident analysis is required may take the place of formally documented ranking on the Analysis Level Matrix. Hazard analysis then focuses only on identifying potential events and controls.

One notable exception to this case may be solid masses used for shielding. In some cases, the Q values will provide larger LSI limits reflecting this reduced dispersibility. In cases where larger limits aren’t provided, it may be obvious that the Q values would increase by several orders of magnitude to preclude any need for accident analysis.

Hazardous Waste Management may identify its Single Container Inventory Limits (SCILs) as an initial condition and then use SCILs as the basis for assessment in both hazard and accident analysis. Waste accumulation areas operated in accordance with SCIL provisions may do the same. Where used, the SCILs would become initial conditions and credited controls.

2.4.2.4 Biohazards. Only BSL-3 operations are required to perform a hazard analysis. There is no established corollary between the consequence categories of this *ES&H Manual* document and assessment criteria for biohazards. For any BSL-3 facilities, specific assessment criteria will be developed and agreed upon.

2.4.2.5 Explosive Hazards. The Quantity Distance site plan for the facility or operation shall be used to determine consequences to colocated workers and the public. The distances used for determining effects to the public vary, depending upon the actual location and the facility's allowable explosives inventory. Facilities and operations meeting the QD and level of protection requirements of the *DOE Explosives Safety Manual* (i.e., no exemption is required) by definition meet Consequence Level D with respect to public impacts.

Expected colocated-worker distances vary. For example, many explosives operations such as pressing or machining of HMX-based explosives, are done remotely and danger zones are established, from which colocated workers are excluded. However, unlike the facility location and terrain features that are considered with respect to public impacts, the control of these danger zones with respect to colocated-workers is not an intrinsic characteristic of the operation or facility. Thus, if the operation is not conducted within a robust facility capable of blast containment, colocated worker consequences can range from Consequence Level C effects to Consequence Level A effects for "unmitigated" events.

Note that, in the Contract standard for safety analysis, colocated workers are defined as being outside the facility that is undergoing analysis. On the other hand, the *DOE Explosives Safety Manual* may consider certain workers inside a facility as not directly involved in an operation and require a greater level of protection for these workers than directly involved workers. Additionally, Chapter II of the *DOE Explosives Safety Manual* establishes requirements for the performance of hazard analyses for specific types of explosives operations. The hazard and accident analysis requirements in this document are intended to simultaneously meet these requirements (i.e., an *DOE Explosives Safety Manual* requirement for a hazard analysis does not require a separate document).

Colocated-worker issues will usually require accident analysis for any facility handling significant amounts of explosives. This analysis will be the same or similar to analyses performed that set worker-protection limits for the facility.

The use of nonpropagating storage arrays to limit the amount of explosives involved in an accident is considered an inventory control. Such arrays may be assumed in hazard analysis and automatically forwarded to the control section as initial conditions to become credited controls.

2.4.2.6 Industrial Hazards. In terms of unmitigated consequences, it is not necessary to assume that industrial machinery will malfunction in some extreme way (e.g., gears rapidly grinding just before the mechanism flies apart being identified as an unmitigated noise hazard). It is expected that most industrial hazards will not present a significant consequence potential at

100 m from the facility. The following hazards may also be generically screened out for Industrial Hazard classification:

1. General flammable/combustible material.
2. Class 1, 2, and 3 (with enclosed beams) lasers.
3. Normal electrical supply systems.
4. General-use vehicles and equipment (e.g., cars, trucks, forklifts, cranes).
5. Commercially-available pressurized gas cylinders up to 3000 psig. (Note: nonstandard pressurized gas cylinders should not be screened out.)
6. Local high-temperature sources (e.g., hot plates, small furnaces).
7. Utility water-heating furnaces.
8. Typical lab/operation asphyxiant containers (e.g., dewars, cylinders).

These hazards should be noted, however, if they can (1) initiate or exacerbate a release of other hazards (e.g., toxic material release); (2) present a concurrent nonindustrial hazard (e.g., pressurized toxic gas cylinder); or (3) present a hazard requiring notification of other facilities within 100 m.

2.4.3 Accident Analysis

An accident analysis is performed when the greater-than-LSI limits are desired for a given hazard and an associated hazardous scenario is ranked in the Analysis Level Matrix (Figure 3) accident-analysis-required bins. Accident analysis formally estimates consequences and frequencies; by doing so, it assists in identifying appropriate credited controls. Accident analysis may be qualitative in assessing the consequences to onsite workers, but should be quantitative for offsite individuals.

There are two essential products of an accident analysis:

1. Identification, on the Residual Risk Matrix, of the achieved risk rankings.
2. A clear statement of the controls and conditions assumed to achieve those rankings.

2.4.3.1 Residual Risk Matrix. The Residual Risk Matrix is presented as Figure 4 in Section 2.5.2. Its purpose is to demonstrate, through detailed calculations of consequences, that accounting for existing or planned facility-specific controls results in a lower residual risk. It is also the means to identify the controls credited with achieving that lower risk.

Accident analysis evaluates the effect of potential controls, prioritized in terms of effectiveness and ease of use, on the consequences and probability of a given scenario. Ideally, it is a simple exercise to identify the optimal control(s). A single risk ranking may be assigned in that event. When control selection becomes more complicated, the choice of an appropriate control set

may be aided by developing a risk ranking for each potential control set. If the controls included in the evaluation are sufficient to reduce the residual risk of all scenarios to the unshaded bins, the facility AD may approve the safety basis without further analysis. If not, new or additional controls should be proposed.

The final risk rankings assigned in this matrix determine the appropriate approval authority for the SBD. If the ranking is considered too high, consider applying additional or more rigorous controls (e.g., less hazardous material, better containment of released material, better separation of initiators from hazards) for risk reduction. The goal of this process is always to reduce the residual risk to a level that may be approved by the Facility AD, if practicable. In the event that is not practicable, this fact or decision should be clearly documented in the executive summary of the SBD submitted to the appropriate approval authority.

2.4.3.2 Standard Radiological Assumptions. Accident Analysis is not anticipated.

2.4.3.3 Standard Chemical Assumptions. Compare toxic chemical exposures, calculated in the analysis to current TEEL concentration values, to determine the appropriate consequence level in the risk matrix. Use 95% probable meteorological conditions (F Class stability with 1 m/sec wind speed) unless higher wind speeds can be justified. For elevated releases, the issue of enhanced meteorological turbulence bringing plumes to ground more quickly is adequately assessed by single-point examination, using the 50% meteorology assigned for classification (D class stability with 3 m/sec wind speed). The colocated worker is located at 100 m unless the site boundary is closer than that, in which case the colocated worker concept is not used. The public is located at the actual site boundary distance for a given facility. Both colocated and public maximally exposed individuals are at a standard receptor height of 1.5 m (average standing breathing elevation).

The following generic assumptions are allowed:

1. Most small-scale chemical operations at LLNL (inside or outside in transit) can be considered a standard residual risk issue to the extent they fall under OSHA's definition, per 29 CFR 1910.1450, of "laboratory use of hazardous chemicals." That definition covers handling and use of such chemicals in which all of the following conditions are met:
    - Chemical manipulations are carried out on a "laboratory scale" (work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person).
    - Multiple chemical procedures or chemicals are used.
    - The procedures involved are not part of the production process nor in any way simulate a production process.
    - "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals. (See Part 14, "Chemicals," in the *ES&H Manual*.)

Where these conditions are met, dispersion analysis of individual bottle/jug spills is not normally required. The exception occurs when: (1) a greater than LSI limit is desired for a given chemical, thus invoking analytical requirements, and (2) that chemical's TEEL values are sufficiently low so that its LSI limit approximates individual bottle quantities. Specific assessment is required in such cases.

2. Consistent with assumption #1, delivery of small-scale, commercially available chemical bottles/containers can also be considered a standard residual risk issue. Dispersion analysis of individual bottle/jug spills is not normally required. The exception occurs when (1) a greater than LSI limits is desired for a given chemical, thus invoking analytical requirements, and (2) that chemical's TEEL values are sufficiently low that its LSI limit approximates individual bottle quantities.

   This assumption also applies to pallet delivery of multiple small-scale containers, provided their cumulative quantities do not approximate the LSI limit. It does not apply to tanker or drum deliveries.

3. Consistent with Item #1, airborne releases are not typically analyzed for fires in rooms containing accumulations of laboratory-size bottles. For a fire large enough to truly accelerate evaporation rates, the resulting toxicity addition to the smoke plume is equaled, or exceeded by the base toxicity of the plume itself. Any significant lofting-which can be presumed for a fire of sufficient size involving a generalized facility area-will also reduce the estimated effects dramatically. Making use of this assumption requires only the designation of a basic fire safety program, including proper housekeeping to minimize combustible accumulation and a functional fire suppression system as a credited control. In keeping with precedents already set at some nuclear facilities, the fire suppression system can be required per a program without the need for a system-specific OSR. Citation in a program carries with it an implicit allowance for outages due to basic maintenance and repair.

   Fires should be considered as accident analysis scenarios to the extent they can involve (1) heating of large tanks or vessels, (2) very large accumulations of liter-sized (approximate) bottles (on the order of 50 or more) of a chemical of concern in one storage location, or (3) concentrated sources in nonrobust facilities (e.g., small leaky buildings/sheds).

4. Multiple bottle spills (e.g., during seismic events) or large tanks can use the EPA bounding model for vaporization of liquids spilled onto a flat, level surface without containment. That equation is:

   $$Q = (0.284*\mu^{0.78}*MW^{0.67}*A*VP)/(82.05*[T+273])$$

   Where

   Q = release rate (lb/min)

   μ = wind speed (m/sec)

MW = molecular weight

A = surface area (1 cm-depth for general puddles or berm-specific)(ft^2)

VP = vapor pressure at a given temperature (mm Hg), and

T = solution temperature (°C).

Outdoor spills use the dispersion wind speed of 1 m/sec for calculations. Indoor spills can estimate internal wind speed by taking the overall facility ventilation rate and dividing it by the smallest facility cross-sectional area.

5. For seismic events, the rough damage/spill estimate for California State University at Northridge labs of 10% is generically doubled to 20% and is used for cases involving normal storage in shelves with glass or wood doors. If a specific chemical is held in stable, ground level cabinets or other relatively robust means of storage, a 10% factor can be used (this would become a credited control, if needed to attain a given approval level on the Residual Risk Matrix). If storage practices are generally loose and open, a 30% factor should be used. If the building experiences substantial collapse, a factor of 50% or higher is appropriate.

   Absent major structural damage (e.g., exterior wall collapses), estimate the wind speed for evaporation in a stagnant building without ventilation, by assuming one air change per hour. The wind speed thus becomes the total facility volume divided by the smallest facility cross-sectional area, to a minimum of 0.05 m/sec.

   Without ventilation, the source term for a slow leak from within a building shell can also be modeled as an area release using the building's shortest length and height.

6. For solid materials, estimate total quantities released by using the airborne release fraction data in DOE-Handbook-3010-94, "Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities," or other chemical-specific data. For relatively short-duration events, a release rate may be conservatively estimated by assuming full facility exit over a period of fifteen minutes.

7. Gas leaks may use an assumption of total venting within 15 minutes or specific flow rates based on flow-restriction orifices (the latter would typically become a credited control).

8. The TEEL definition is for a one-hour exposure to a given concentration. Typical computer codes use shorter averaging times. Additionally, the Gaussian dispersion models used tend to overpredict chemical concentrations. Accordingly, some small leeway is appropriate in determining if TEEL levels are truly exceeded. For example, consider a TEEL-2 exposure defined as 10 parts per million (ppm) for 1 hour. If calculations show an exposure of 13 ppm for 10 minutes, that exposure need not be considered as exceeding the TEEL, unless available toxicological data indicates that the effects at 13 ppm are noticeably worse than at 10 ppm for brief exposures. Analysts should not, however, assume that direct linear

extrapolations from 1-hour exposures to significantly smaller time frames are valid. Such extrapolations can yield concentrations considered lethal for even brief exposures.

2.4.3.4 Standard Biohazard Assumptions. Evaluated on a case-specific basis.

2.4.3.5 Standard Explosion Assumptions. The establishment of nonpropagating arrays demonstrate that the mitigated explosion is limited in size per array definition.

Explosive events for some operations (e.g., large storage magazines) may have the intrinsic capacity to cause injury or death out and beyond 100 m from the building where the explosives operations occur. In such cases, accident analysis is allowed to assume that the facility boundary is the edge of a quantity distance boundary (the appropriate distance, such as inhabited building distance, public traffic route distance, or intraline distance, may vary with the specific facility) if workers are provided notification (e.g., posted sign or briefing) that they are entering an explosives hazard area at or prior to reaching such boundaries.

2.4.3.6 Standard Industrial Assumptions. Evaluated on a case-specific basis.

2.5 Controls

The control section of the SBD formally summarizes all identified credited controls. In this document, controls fall into four general categories:

1. Facility safety controls identified in the hazard analysis process that do not become credited controls (e.g., general *ES&H Manual* operating controls, ventilation to an elevated release point where such mitigation is not needed for any analyzed release).
2. Initial conditions in hazard analysis that may become credited controls (e.g., building seismic capacity precluding the need to examine a total collapse scenario, no large chemical storage tanks thus limiting any spill size).
3. Any greater-than-desired LSI hazard limits (e.g., maximum material amounts), which will become credited controls.
4. Credited controls identified in accident analysis that ensure that residual risk is maintained at a level consistent with the approval authority (e.g., ventilation to an elevated release point is determined to be necessary to reduce the residual risk of an analyzed release).

Facility safety controls are largely composed of worker safety and environmental impact controls required by LLNL's WSSs, as implemented through the *ES&H Manual*. They may also include safety equipment whose importance is recognized, but is not needed to satisfy the risk matrices. These controls are managed at the local level via the Facility SP and other activity-specific safety documentation. They are not included in the control section of the SBD.

For initial conditions assumed in hazard analysis, a specific basis must be stated for their designation as credited controls, or lack thereof. That basis may be stated in either the pertinent

hazard analysis section or the controls section of the SBD. If the basis for exclusion is stated in the hazard analysis, initial conditions left undesignated are not forwarded to the controls section. The only initial conditions automatically designated as credited controls are the greater-than-LSI limits specified as the upper bound of analysis.

Credited controls from accident analysis require specific identification to prevent inadvertent compromise by later modifications to facilities or their operations.

Basic considerations in control designation include the following:

- Hazardous material inventory should be minimized.
- Hazardous operations should be replaced with alternative operations, if possible.
- Engineered controls are preferred over administrative controls (e.g., interlocked doors over procedure).
- Passive engineered controls are preferred over active engineered controls (e.g., firewall over fire sprinklers).
- Preventive controls are preferred over mitigative controls (e.g., DOT specification containers over eyewash stations).
- Controls that protect against multiple hazards can be resource-effective.

These are not absolute rules: all determinations are facility-specific. In many situations, one consideration may conflict with another. Engineering judgment shall ultimately be used to choose among competing factors.

Except in limited cases dealing with High hazard facilities, the control section of the SBD is not expected to provide detailed design documentation. The facility description in the SBD should provide sufficient information to develop a simple mental picture of major facility features. The control section need only augment the description to the degree necessary, to understand the specific functioning of high-value components, such as interlocks.

2.5.1 Initial Conditions

Initial conditions are intrinsic aspects of operation factored into the hazard analysis. As previously noted in Section 2.4.2.1, intrinsic aspects of operation are definitional parameters resistant to change by simple human error. They may range from acknowledgment of a vessel design, to gas cylinder structural strength, to overall building seismic capacity. Any features used to justify segmentation would also qualify as significant initial conditions. The control section of the SBD should list all initial conditions upon which the hazard and accident analysis are premised. To the extent such conditions determine the final approval level, they shall be designated as credited controls. The greater-than-LSI limits specified for analysis will always be credited controls.

Note: Undesignated initial conditions need not be listed in the control section of the SBD if a specific basis for their exclusion was stated in the hazard analysis.

To avoid needless complications in change control, accurately identify the minimum safety function for initial conditions. For example, if a building specification defaults to general terms such as “provides a confinement function,” minor building alterations (e.g., wiring penetrations) become potential change-control issues. For example, if the actual specification is limited, per the analysis, to “a structural shell must remain relatively intact after a seismic event for low wind-speed evaporation of spills,” then most alterations may be promptly dismissed from the change control process, because they are unlikely to jeopardize the basic structural functionality assumption. Likewise, the term “standard commercial gas cylinder” invokes less detailed considerations than “pressurized gas containment vessel.”

2.5.2 Credited Controls

Credited controls include initial conditions designated per Section 2.5.1 of this document and specific controls identified through accident analysis necessary to reduce the risk shown in the Residual Risk Matrix (Figure 4). The assignment of credited controls is made by a safety analyst or individual with equivalent experience and training in safety analysis (see Section 6.0). After a required control is identified and justified (Section 2.4.3.1), the analyst shall clearly define the safety function being credited.

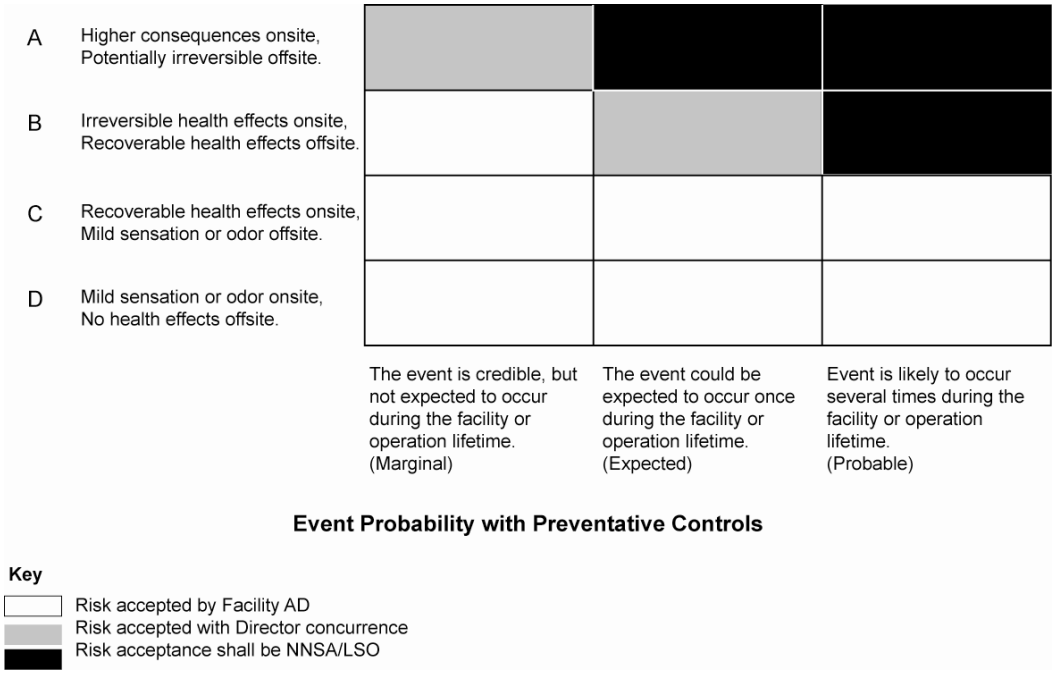


Figure 4. Residual Risk Matrix.

As with facility safety controls, it is necessary to be precise when defining safety functions in order to minimize complications in the change control process. For example, change control

associated with a ventilation system that provides an overall confinement function often descends into detailed reliability considerations; change control for a ventilation system whose function is simply to direct exhaust airflow to a stack addresses only a basic, top-level capability. The latter case is expected for most operations covered by this document. In that event, a credited control ensuring that active operations cease upon the loss of ventilation would adequately minimize the chance of an accidental release.

The degree to which maintenance activities such as checking room exit flow through a hood, a facility safety control required by LLNL's WSS, may be drawn into Operational Safety Requirements [(OSRs), see Section 2.5.3] depends on the degree to which the overall building ventilation flow depends on hoods. In other words, if any given hood malfunction would simply divert accidental releases to another local exhaust path, that failure is not an issue for protecting personnel at 100 m from the facility and/or the site boundary.

Accident analysis parameters also do not automatically become credited controls. For example, if the facility's overall design flow-rate is divided by the limiting cross-section to determine interior wind speed for an evaporation calculation, testing requirements to measure the actual flow rate are not mandatory. It is understood that the value is a nominal approximation, and that most unnoticed deviations will tend to decrease flow rate as opposed to dramatically increasing it. That is consistent with use of a "preponderance of the evidence" standard for analysis. This document does not seek guarantees that every parameter assumed is absolutely bounding. Instead, the assumed parameters may range from best-estimate to conservative within an overall conservative methodology.

2.5.3 Operational Safety Requirements

Operational Safety Requirements document, describe, and maintain credited controls in the form of equipment and administrative controls. They also define the minimum conditions necessary to ensure safe operations, with respect to colocated workers and the public, at a distance removed from the immediate facility. They may include operating limits, testing requirements, administrative controls, use and application provisions, and design features.

Each credited control will be covered by being assigned one of the following:

1. An operating limit in the form of Minimum Functional Requirements (MFR) with associated Testing Requirements (TRs).
2. A specific administrative control (AC) requiring or prohibiting some action.
3. Inclusion in a general AC that covers an overall program/capability.
4. Status as a design feature to be maintained.

Controls do not have to be assigned to all four categories. In Moderate hazard and Low hazard facilities, the decision as to whether an MFR or an AC is most appropriate for a given control is left to facility management. It is expected that a graded approach will be used, with the most

stringent controls assigned to High hazard facilities and minimal controls assigned to Low hazard facilities. For example, Low hazard facilities are not expected to need MFRs unless facility management finds that logic structure advantageous in dealing with a specific issue. High hazard facilities would be expected to control an active safety system with an MFR to the degree it is relied upon to prevent high consequences. Likewise, Low hazard facilities have considerable leeway, relative to High hazard facilities, to cover potential specific ACs as elements of general ACs. The reduced hazard allows for less stringent specification.

2.5.3.1 Minimum Functional Requirements. Minimum Functional Requirements are specifically intended to cover major active equipment. The MFR structure defines an active capability and how it is to be maintained. Passive equipment, such as a facility structure, is not normally covered by MFRs but is instead designated an OSR Design Feature.

Minimum Functional Requirements should only be used when an active piece of equipment is required to minimize consequences from a distinct threat (e.g., a fire suppression system protecting a large vessel containing hydrogen fluoride or a significant accumulation of toxic nerve agents). In such cases, the added formality of an MFR is appropriate. A fire suppression system minimizing the general risk of some fire-related release from a lab does not require such formality and may be appropriately handled as part of a fire safety program commitment.

Each individual MFR shall contain an MFR statement, applicability statement, action statements, and associated TRs, which are defined as follows:

- MFR specification statements provide a precise statement of required operability (e.g., the fire suppression system shall be operable as indicated by correct valve positioning and an external fire main pressure of greater than 60 psig).
- Applicability statements define when the MFR is required.
- Action statements describe (1) the specific operating limit issue that requires a response (Condition Statement); (2) the response to be made (Required Action); and (3) the allowable time in which to perform that response (Completion Time).
- Testing Requirements specify the requirements relating to test, calibration, or inspection necessary to ensure that the associated MFR is met (e.g., annual fire suppression system test, monthly water pressure check).

MFRs should be written in direct, simple language focused on clarity, action verbs (e.g., verify, restore, perform), and single, distinct statements. Appendix H provides amplifying details on the logic structure associated with MFRs. If MFRs are included in an OSR document, the AB Section can assist with proper development of facility-specific MFRs within that logic structure.

2.5.3.2 Specific Administrative Controls. Specific ACs state an administrative requirement to be met when operating. (For example: “active handling of chemical containers in Room 1342

shall immediately cease upon loss of ventilation.”) A separate AC should be developed for each specific administrative requirement.

Note that failure to meet a specific AC constitutes an OSR violation. However, specific ACs can incorporate limited short-hand versions of MFR action statements. Consider the following: “Containers stacked on a second level shall be banded together per pallet upon initial placement. Damaged bands shall be replaced upon discovery.” This allows obvious deviations to be corrected upon discovery without becoming an OSR violation. Such provisions for ACs should, however, be conceptually simple. MFRs would be the proper venue for detailed timelines to repair a fire suppression system.

2.5.3.3 General Administrative Controls. General ACs are part of a safety management program/capability that will oversee day-to-day activities. General ACs identify the program (e.g., fire safety) or capability (e.g., procedures) being specified, the top-level requirement controlling it (e.g., *ES&H Manual* Part or Document), and any features of primary importance. For a conceptual topic such as training, no specific features may be identified. For a program such as fire safety that covers facility-specific controls and/or equipment, those major features would normally be highlighted.

One example is the identification of a fire-safety program. A fire safety program shall be established to minimize the likelihood of fire in accordance with Document 22.5, “Fire” in the *ES&H Manual*. Key provisions of this program include:

- A functional fire detection and suppression system (allowing for normal maintenance and repair outages).
- Proper housekeeping to minimize combustible accumulations, as verified by periodic inspections.
- Appropriate use of flammable or combustible liquid storage cabinets.

Specifying key elements does not make those elements specific ACs. They remain under the control of a general AC, which requires cumulative violations of sufficient quantity and magnitude that the overall intent of the referenced program/capability is not fulfilled in order to constitute an OSR violation.

Generic AC commitments (i.e., independent of analysis) are required for deviations from OSRs, training, procedures, and emergency planning. The AC for deviations from OSRs is always the first AC, and is specified in Appendix H.

2.5.3.4 Design Features. Design features are those passive controls that, if altered or modified, could change the approval level required for the SBD. They are passive facility characteristics not subject to easy alteration by workers (e.g., fixed shielding, structural walls, relative locations of major components) and that accomplish their function intrinsically as opposed to being activated.

Active safety features are subject to other OSR types (e.g., MFR, AC) and should not be included in the design features section.

Completely describe the attributes of the passive design features in the SBD. As previously noted, those attributes should be restricted to the minimum actual need in order to avoid change control complications. Design feature specifications are intended to be relatively straightforward.

3.0 Documentation

This section addresses the documentation requirements for recording the safety analysis process discussed in Section 2.0, the process for documenting the safety basis of proposed facilities, and the quality assurance requirements such as document review, approval, and configuration management.

- Section 3.1 outlines the contents of Tier 1–Tier 3 documents for facilities that are operational.
- Section 3.2 covers the process and SBD requirements for proposed facilities from conceptual design through construction.
- Section 3.3 describes the review, approval, and renewal requirements for SBDs.
- Section 3.4 addresses configuration management and includes flow-down requirements from the SBDs to facility implementation documents, records retention requirements, and the change control process.

3.1 Facility Safety Basis Documents

Facility management shall ensure that an operation's safety analysis is consistently documented, so that the information is available during development of work practices, worker training, and operation review for possible safety improvements. This information is also needed for proposed operational changes.

There are three levels of SBDs: Tier 1, Tier 2, and Tier 3. This meets the graded approach concept in that the higher the risk, the more documentation required. The document levels, designed to build detail without duplicating information, consist of the following:

- Tier 1 documents consist of a Screening Report form. This is the only document required for LSI facilities. It is also the first chapter for facilities classified as Low, Moderate, and High hazard.
- Tier 2 documents include a Screening Report form, a hazard analysis chapter, and a controls chapter. All Low, Moderate, and High hazard facilities are required to have all Tier 2 chapters.

- Tier 3 documents contain a Screening Report form, a hazard analysis chapter, an accident analysis chapter, and a controls chapter. If the hazard analysis indicated that an accident analysis is also required, then a Tier 3 document shall be required. An accident analysis chapter is added, and the controls chapter is expanded to include credited controls, as necessary.

The safety analysis and documentation process is shown in Figure 1. The safety analysis process is addressed in Section 2.0, and the documentation is addressed in Section 3.0. These analyses shall be documented as described in the following sections.

3.1.1 Tier 1

The first document in the safety analysis process is the Screening Report form, which constitutes the Tier 1 documentation for all facilities not classified as offices. It records the following safety analysis process steps (see Section 2.3):

- Identification of operations and inventories.
- Identification of hazards.
- Facility classification and highest classification in each of the five hazard types.

The Screening Report form shall also include the following items:

- Facility description (e.g., location, owner organization, building layout, primary missions).
- Identification of hazardous inventories and operations.
- Identification of credible external threats from nearby facilities (see Section 4.0).
- Facility classification and information supporting the decision.
- Description of controls to ensure that facility operations do not exceed the facility classification.

The Screening Report form is available in Appendix B.

3.1.2 Tier 2

Contents of the Tier 2 SBD are as follows:

Executive summary

Chapter 1: Screening Report.

Chapter 2: Hazard Analysis.

2.X Hazard
Each hazard type that exceeds the LSI classification is discussed under its own heading (e.g., explosives, radiological material, chemicals).

2.X.1 Controls
Brief description of facility operations and controls relevant to hazard analysis (can consist solely of identifying initial conditions for simple operations).

2.X.2 Postulated Hazardous Events
Events for each identified hazard are compared against Analysis Level Matrix; includes hazard analysis tables and summary discussion. Some means of identifying controls assumed in the Analysis Level Matrix ranking should be provided (e.g., bold credited items, written comments, asterisks).

Chapter 3: Controls

3.X Hazard
Controls for each hazard type exceeding the LSI classification are summarized. Specific justifications are provided to the extent that is not done in Chapter 2.

3.Y Derivation of Operational Safety Requirements
The manner in which each credited control will be covered in the Operational Safety Requirements (OSRs) (i.e., MFR, AC, and/or Design Feature) is specifically stated. If controls such as MFRs involve detailed parameter specification (e.g., pressure, ACTION times), justification for those parameters should be stated in this section.

3.Z Impacts on nearby facilities.

Chapter 4: Operational Safety Requirements

This section provides the facility-specific OSRs as a distinct, formally-defined entity.

If MFRs are assigned as controls, the format is as follows:

4.1 Use and Application section.

4.2 MFRs and TRs.

4.3 Administrative Controls.

4.4 Design Features.

If MFRs are not assigned as controls, the format is as follows:

4.1 Administrative Controls.

4.2 Design Features.

Appendices

A. References.
B. Supporting Technical Details.
C. Definitions/glossary.

D.-Z. Other relevant information.

3.1.3 Tier 3

Contents of the Tier 3 SBD are as follows:

Executive summary

Chapter 1: Screening Report form.

Chapter 2: Hazard analysis chapter (see Tier 2 above).

Chapter 3: Accident analysis.

3.1 Methodology
This section describes any computational methods used and identifies all relevant parameters.

3.2 Accident #1
This section formally documents a consequence calculation, its final result, the scenario ranking on the Residual Risk Matrix, and any credited controls needed to support that ranking.

3.3 Accident #2
Each accident is detailed under its own heading.

Chapter 4: Controls (See Chapter 3, Tier 2 above).

Chapter 5: Operational Safety Requirements (see Chapter 4, Tier 2 above).

Appendices

A. References.
B. Supporting Technical Details.
C. Definitions/glossary.
D.-Z. Other relevant information.

3.1.4 Accelerator Safety Basis Documentation

Because screening reports are required for all facilities not classified as Offices, screening reports will be completed for accelerator facilities. If a facility meets accelerator criteria and does not qualify for exemption per Section 2.3.1.3, then a safety analysis is also required.

If only accelerator hazards are identified within the facility, a Safety Assessment Document (SAD) is also prepared. This document differs from other safety analysis documents because it describes the safety features and procedures that prevent individuals from becoming exposed to radiation, either primary or induced. (The SAD should contain the elements outlined in Appendix C.)

When other hazards (e.g., chemical, biological, explosives, radiological, industrial) above LSI hazard are identified within the same facility, housing an accelerator, a tier 2 or 3 nonnuclear SBD is required. The SAD for the accelerator hazard is attached to the SBD as an Appendix.

The SAD (or the SAD appendix) shall be submitted to NNSA/LSO for processing and approval. NNSA/LSO will conduct an accelerator readiness review prior to start-up or restart.

3.2 Preliminary Safety Basis Documents

The preliminary safety analysis and SBD shall be prepared and submitted to NNSA/LSO for the construction of any new facility that is not a tent, trailer or an Office facility, and for a major modification to an existing non-Office facility (i.e., a complete facility-wide refurbishment requiring cessations of current activities). The analysis and documentation level shall be consistent with the appropriate classification. Submit the SBDs to NNSA/LSO in coordination with the project design and construction schedules per DOE O 430.1B, “Life Cycle Asset Management,” as shown in Table 9a and 9b.

3.2.1 Screening Report for LSI Facilities

Once the conceptual design for a new facility is nearly complete and hazardous inventories and operations reasonably estimated, facility management shall prepare a preliminary Screening Report for proposed facilities. Initial facility classification can then be determined, and the level of required preliminary safety basis documentation can be established. Planned office facilities are exempt from this requirement if they meet the Office facility criteria specified in Section 2.2. However, once constructed, the facility shall be officially designated as an Office facility before being activated.

If the classification is LSI, complete the steps in Table 9a.

If the proposed new facility is classified as an LSI facility, then no further documentation is needed. The preliminary Screening Report shall be forwarded to NNSA/LSO with a cover letter that provides construction schedule information. A final screening document shall be filed before the facility is activated.

Table 9a. Coordination of AB Schedules with Project Design and Construction Schedules for LSI Facilities.

AB Process for LSI facilities	Design/construction process
Screening Report form. Send to NNSA/LSO with cover letter outlining the construction schedule.	Completed during pre-Critical Design (CD)-1, when enough information exists regarding the planned operations and hazards.

If the classification is Low, Moderate, or High hazard, complete the steps in Table 9b.

Table 9b. Coordination of AB Schedules with Project Design and Construction Schedules for Low, Moderate, and High Hazard Facilities.

AB Process for Low, Moderate, and High hazard	Design/construction process
Task plan. (The Screening Report form is an appendix to the task plan.)	Submitted with CD-1 package to NNSA/LSO. NNSA/LSO approval of package allows expenditure of Plant Engineering Department funds for design.
Preliminary safety basis document.	Submitted with CD-2 package to NNSA/LSO. NNSA/LSO approval of package allows construction.
Final safety basis document.	Required by NNSA/LSO with other CD-4 deliverables. Once CD-4 deliverables are approved, facility operations may commence.

3.2.2 Task Plan for Proposed Low, Moderate, or High hazard Facilities

When facility management plan a new facility classified as a Low, Moderate, or High hazard, a task plan is required. Once the conceptual design is in place, this plan is submitted to NNSA for approval with the “CD-1 package” per DOE O 413.3, “Program and Project Management for the Acquisition of Capital Assets.” The task plan explains how and when the preliminary and final SBD shall be written. The task plan also documents:

- Negotiations between NNSA/LSO and LLNL regarding the preliminary SBD.
- The scope of the safety basis.
- Whether or not analysis and documentation can be performed in phases.
- The project schedule.
- The extent of hazard and accident analysis.

The Screening Report form is included as an appendix to the task plan and fulfills the DOE O 413.3 requirement for a preliminary hazard analysis.

The task plan consists of the following components:

- Introduction.
  - Facility overview:

    Identify the landlord directorate/program, customer or facility user organizations (if different than landlord), proposed operations and hazardous materials, higher-level equipment, and conceptual drawings (if available). This type of information is typically available in the *DOE’s Blue Book for Project Management* (see the project design engineer for a copy).

- Task definition.
  - Task deliverables, acceptance criteria, and schedule:

    Task deliverables are the preliminary SBD and final SBD. Acceptance criteria are defined as the nonnuclear standard and this document, and any others negotiated with NNSA/LSO. The schedule provides a delivery schedule for each SBD.
- Key inputs and assumptions.
  - Document classification assumptions, initial conditions, technical negotiations, and assumptions to source terms (e.g., airborne release fractions, damage ratios, and leak path factors), if different than the standard approach. All proposed changes to the design shall be evaluated against the key inputs and assumptions to assure that required safety design features are not eroded. Document if some of the analyses are prepared by a different group than the safety basis analysts (e.g., fire hazard analyses, quantity-distance analyses), and what major guidance references, if any, shall be followed, such as Document 17.1, “Explosives,” in the *ES&H Manual*.
- Contents of SBDs.
  - Describe the level of detail for each section of the preliminary SBD and the final SBD.
- Change control and quality assurance.
  - Describe the change control process to be used, to reflect changes to the task plan and preliminary safety basis report when the plans and designs change during the design or construction process. Include what DOE Orders, Standards, and other guidelines shall be followed. Include a review plan for the documents, with statements such as:

    “The task plan shall be reviewed and approved by the stakeholders.”

    “Independent reviews shall be performed for all support documents (e.g., fire hazard analyses), analysis results, AB documents, and implementation plans.”

    “The proper mix of knowledgeable workers shall take part in all evaluation sessions.”
- Approval process for final SBD.
- References.
  - Include references that shall be used in the development of the documents.
  - Attach the Screening Report form as Appendix A.

3.2.3 Preliminary Safety Basis Documents

The preliminary SBD should follow the content requirement of the task plan. Preliminary SBDs may have less detail than final documents, and are prepared in accordance with agreements negotiated between NNSA/LSO and LLNL, as recorded in the task plan. The preliminary SBD shall be approved by NNSA/LSO before funds are committed to initiate construction or modification.

3.2.4 Final Safety Basis Documents for Newly Constructed Facilities

The final SBDs for newly constructed facilities should follow the content requirements of facility SBDs, as outlined in Section 3.1. The content of the preliminary safety analysis plan should be used as a starting point, and refined using the “as-built” construction documents, planned inventory types and quantities, and more detailed facility and operational descriptions. The final SBDs for the new facility shall be approved as specified within the task plan.

3.3 Review, Approval, and Revision of Safety Basis Documents

Safety basis documents shall be reviewed to assure their accuracy, quality of contents, and compliance with this *ES&H Manual* document. The SBD authorizes the facility to operate in a manner consistent with the terms of that document, and is the signatory’s acceptance of the risk of the operations within the facility. This section covers SBD review approval and revision requirements.

3.3.1 Review of Safety Basis Documents

The process for assuring the accuracy and consistency of SBDs, including the conditions upon which analyses are based, is covered in this subsection. In order to meet the criteria listed below, the SBD undergoes several types of review: technical review, institutional review, and management review. The process assures that:

- The safety analysis meets LLNL requirements (institutional review).
- Information input (e.g., hazard identification, material inventory, references) is accurate, complete, correctly cited, and retrievable (management review).
- Qualitative assessments are based on sound technical justification (peer review).
- Calculations and analyses are peer reviewed for technical accuracy (peer review).
- Documentation is properly reviewed for completeness and accuracy (all).

The Hazards Control Department coordinates the technical peer review and institutional review process through a single point contact.

3.3.1.1 Technical Peer Review. Technical peer reviewers shall be qualified to review the Tier 2 and Tier 3 SBDs and the qualitative assessments within them. Quantitative analyses may be reviewed by the technical peer reviewer, or by a specialist in the particular analysis

methodology, as directed by the technical peer reviewer and as coordinated by the ES&H Team Leader [e.g., fire safety engineer, explosives expert, industrial hygienist, health physicist, National Environmental Policy Act (NEPA) analyst].

The review of qualitative assessments (e.g., event scenario development) confirms that:

- The assessment has a sound technical basis clearly described within the text or appendices.
- The conclusions derive logically from the technical basis.
- The assessment is consistent with the methodology presented in Section 2.0

The review of quantitative analyses confirms that:

- Calculations are accurate and appropriate to the conditions of the event.
- The computer software used to make the calculations is identified and appropriate for the use.
- Inputs are valid.
- Appropriate output is reviewed to assure correct conclusions were drawn.

Commonly accepted air dispersion modeling codes shall be used in performing safety basis calculations. The AB Section maintains a listing of such codes. Where such codes are not available, justification for using an alternate code shall be included in the documentation package. Calculations previously prepared for this or other projects may be used instead of developing new calculations, if the technical peer review process was completed (or shall be completed). Evaluation and acceptance are performed in accordance with this section.

3.3.1.2 Institutional Review. The SBDs shall also be submitted to the AB Section for an institutional review. Institutional review is conducted at a level of detail appropriate to the document submitted. The review focuses on the consistency across the nonnuclear facilities in assumptions and approaches, and on compliance with institutional requirements. This is a high-level review and shall consider issues such as:

- Cross-directorate or cross-facility impacts (e.g., nearby facilities).
- Adherence to the requirements of this document.
- Consistency with NEPA and Emergency Preparedness analyses, as appropriate.

The AB Section leader or designee shall concur with the document as indicated in Section 3.3.2. If the document is not acceptable, a memorandum with review comments shall be forwarded to the facility management.

3.3.1.3 Management Review. Facility management shall ensure that the inventory and operations described accurately reflect the facility's operational needs and that the occupants have an opportunity to review the SBD. Management shall ensure that informational input to the analyses is accurate, complete, correctly cited, and retrievable. The level of review is commensurate with the level of hazards present in the facility.

3.3.2 Approval of Safety Basis Documents

The following subsections address the process in which SBDs are concurred and approved for existing LLNL facilities. This section does not pertain to new facilities not yet activated or for accelerators. See Section 2.3.1.3 for more information on accelerators. Preliminary SBDs for planned facilities and final SBDs for newly constructed facilities shall be approved by NNSA/LSO prior to activation (unless facility is a tent, trailer or office facility). Triennial revisions of these documents need not be submitted to NNSA/LSO unless the Residual Risk Matrix indicates otherwise. Prior to forwarding these documents to NNSA/LSO for approval, internal signatures shall be obtained from the AB Section leader or designee, the ES&H Team leader or designee, facility management appointee, and the AD.

Table 10 outlines the signatures needed for Tier 1–3 documents.

Table 10. Concurrence and Approval Signatures for Tier 1–3 Documents.

Documentation	Classification Level	Concurrence Signatories	Approval Signatories
Tier 1	Light Science and Industry (LSI)	Preparer AB Section leader or designee ES&H Team Leader or designee	Facility management (as designated by cognizant directorate)
Tier 2	Low, Moderate, or High hazard	Preparer AB Section leader or designee ES&H Team Leader or designee Facility management	Facility AD
Tier 3 with "Risk Accepted by Facility AD" per Residual Risk Matrix	Low, Moderate, or High hazard	Preparer AB Section leader or designee ES&H Team Leader or designee Facility management	Facility AD
Tier 3 with "Risk Accepted with Director Concurrence" per Residual Risk Matrix	Low, Moderate, or High hazard	Preparer AB Section leader or designee ES&H Team Leader or designee Facility management Director Concurrence	Facility AD
Tier 3 with "Risk Acceptance Shall Be By NNSA/LSO" per Residual Risk Matrix	Low, Moderate, or High hazard	Preparer AB Section leader or designee ES&H Team Leader or designee Facility management Facility AD Director Concurrence	NNSA/LSO

3.3.2.1 Light Science and Industry. The following signatures are required for Tier 1 documents:

- Review signatures:
  - Preparer.
  - The AB Section leader or designee (to document the institutional review).
  - The ES&H Team leader or designee (to document the peer review of ES&H disciplines).

The Hazards Control Department coordinates the AB Section and ES&H Team review signatures through a single point contact.

- Approval signature:
  - Facility management (as designated by the cognizant directorate).

3.3.2.2 Low, Moderate, and High hazard. In addition to the reviewers listed for Tier 1 documents, the AD responsible for the facility approves all Tier 2 documents. Tier 2 documents do not require any higher level of approval. Tier 3 documents are approved as shown in Table 10 and described below.

The facility AD is required to provide justification to the Director for any Tier 3 document in which the analyzed residual risk, after controls has been selected, remains in the area of the Residual Risk Matrix's "Risk Accepted with Director's Concurrence" area. This justification shall include defensible reasons for not reducing the residual risk to the level that can be approved by the AD.

LLNL is required to provide justification to NNSA/LSO with the submission of any Tier 3 document when the analyzed residual risk, after controls have been selected, remains in the area where NNSA/LSO acceptance is required. For example, the justification may include arguments supporting programmatic need, limited duration of operations at elevated risk levels, and that the proposed approach is the best of all other options considered. The LLNL Director shall review this justification and concur that operation at this residual risk is essential to critical LLNL missions prior to submittal to NNSA/LSO for approval.

3.3.3 Revision of Safety Basis Documents

Safety basis documents shall be kept current and updated at intervals of no more than three years from the date of the last approval. Change control mechanisms addressed in Section 3.4.4 shall be used to modify an existing document between revision cycles as necessary. If Change Control Forms have been conducted during this three-year interval, the revised SBD shall include the new information (including the new information from "negative" change reviews as well as "positive" reviews).

Revised editions of SBDs shall be reviewed and approved by the same levels of management as the original document, if classification and residual risk level remain the same. If classification or residual risk levels change, then consult Section 3.3.2 for requirements on who shall approve the document. Triennial revisions of three-year-old buildings need not be re-submitted to NNSA/LSO, as was required with preliminary and final SBDs for new facilities, unless the Residual Risk Matrix indicates otherwise.

3.4 Configuration Management of Facility Safety Systems

Configuration management of (1) passive engineering controls for segmentation, and (2) credited engineering controls for risk reduction, is required to assure their proper continued function. Refer to Document 41.2, “Configuration Management Program Description,” in the *ES&H Manual* for additional requirements and Directorate Configuration Management (CM) Plans for exact requirements. Facility specific CM Plans may also exist.

3.4.1 Flow-down of Requirements Derived from Safety Basis Documents

The SBDs assumptions and conclusions shall be implemented through facility- and activity-level documents. The controls stated in the SBD shall be implemented within the facility analyzed. These assumptions and controls shall flow down from the SBDs to facility implementation documents such as FSPs, SPs, IWSs or facility and/or equipment operating procedures and ES&H programs. Workers shall be trained in safety basis requirements (per Section 6.0) as they pertain to their assignments, and comply with the requirements as written in the implementation documents.

Facility management shall address changes to the facility using the change control process (Section 3.4.4). The facility implementation documents shall be updated promptly to reflect changes and workers advised of the changes. Changes to implementing documents and procedures may be made without invoking the safety basis change control process, as long as the controls and assumptions of the safety basis are unaffected.

3.4.2 Records Retention

Safety analysis input needs to be described or clearly referenced and fully retrievable. Important input such as the Hazard Identification Table, material inventories, referenced documents, calculations, and engineering notes are examples of information that shall be retained, as long as they remain relevant to the current SBD. The facility management shall establish a system that facilitates easy retrieval of all SBDs and Change Control Forms, so that the information shall be available upon request (e.g., for Freedom of Information Act requests, regulatory reviewers, auditors, and future safety analysts). Additionally, all signature pages shall be maintained on file.

3.4.3 Distribution of Completed Safety Basis Documents

Facility management shall keep and maintain the original SBD and make institutional distribution as follows:

- Facility (original).
- ES&H Team file (copy).
- AB Section file (copy).

The AB Section shall ensure that the document is entered into the ES&H electronic library database, unless facility management objects due to classification issues or other sensitivities.

Facility management shall determine the distribution list for facility management and workers. In some directorates, the facility AD and facility Assurance Manager require a copy of all directorate SBDs. The distribution list shall also be used for the distribution of Change Control Forms that concluded with a “Positive” finding (unless the document is classified, in which case it is stored as required).

3.4.4 Change Control Process

Facility management shall maintain the approved safety basis analysis and documentation through the change control process, as documented on the Change Control Form (Appendix I), so that it continues to adequately describe and bound (or cover) the operations within the facility. This section covers the change control process for all nonnuclear facilities except accelerator facilities, which are addressed in Appendix J.

The formal change control process shall be initiated by:

- A proposed change in inventory or operations beyond that authorized in the existing SBD.
- The discovery that previous analyses (including Change Control Forms not yet incorporated into the SBD) were inadequate (e.g., a potential hazard was discovered but not identified or was incorrectly analyzed).
- A modification to the credited controls.
- A change in the WSS for the safety analysis of nonnuclear facilities or table entries upon which the analysis process is based in the various standards in the WSS set (DOE-STD-1027, 40 CFR 302.4, DOE M 440.1-1, BSL definitions, TEEL Tables). DOE typically updates the TEEL Tables on an annual basis. The AB Section shall prepare updates of the Q List when the TEEL Tables updates are issued by DOE. The new listing will be made available on the Hazards Control Department’s Nonnuclear Hazards Website. Occasionally, changes may represent significant potential health impacts. If so, these changes will be communicated to the ES&H

Working Group members, who shall forward this information to facility management within their directorate. Facility management shall determine if any of these significant TEEL changes are relevant to their facility, and if so, shall see to it that a Change Control Form is completed and processed per this section. (Normally, changes are not expected to include significant health impacts, in which case, facility management shall continue to use the Q List version upon which their SBD was based, until their next triennial revision).

- A reduction in the facility hazard classification.

A Change Control Form (Appendix I) is used to update the SBD whenever one of the above listed conditions exists. This precludes the need to revise and update the entire SBD more often than the normal review cycle, unless the classification level is exceeded for LSI facilities. The Change Control Form may also be used to formally downgrade a facility's classification or approval authority. By using the Change Control Form, the current approval authority can approve the downgrade and delegate safety basis oversight to the appropriate level, per Section 3.3.2.

Facility management shall assign a distinct identification number to each control form. It is important that the Change Control Forms are easily retrievable, because they serve as amendments to the current SBDs.

Change Control Forms utilize a graded approach. The purpose of the Change Control Form is to:

- Document changes to inventory and operation (including the addition of a new hazard type) without having to revise, reauthorize and reissue the entire SBD (unless an LSI facility's classification is increased, in which case a higher level documentation is required).
- Determine if a change shall increase the facility classification of an LSI facility and therefore require the development of a higher-tiered SBD. Additional analysis for a Low, Moderate, or High hazard facility can be addressed within the Change Control Form.
- Indicate the approval level for the changes.
- Document the analysis of the change.
- Establish any new and required controls.

The result of a change control review is either a conclusion that the proposed change is already covered within the SBD (a negative finding, where no additional analysis is required), or that it is not covered (a positive finding, where an additional analysis is required).

When a Change Control Form has a negative finding, the facility management can approve the finding on the form.

Positive findings, and all changes to OSRs, shall be reviewed and approved by the same level of authority that approved the SBD, unless the proposed change results in an increased level of residual risk [in which case a higher authority may be required to assume the risk (see Table 10)]. The approved change review form, accompanied by the necessary analysis, becomes part of the facility safety basis and its information shall be incorporated in the appropriate authorizing document during the next update.

When a Change Control Form has a positive finding, a copy of the form shall be distributed as per Section 3.4.3. The original form shall be filed with the facility safety basis report. A Change Control Form with a negative finding is filed with the facility SBD files and needs no further distribution. If the change involved the addition of a chemical or chemical limit, then the chemical inventory tracking for the building should also be revised to reflect the change.

3.4.4.1 Changes to LSI Facilities. The Change Control Form shall briefly describe the proposed change and compare it against the classification criteria in Table 6. If the proposed change falls within the LSI row, then the Change Control Form can be authorized by facility management. It is unnecessary to consider nearby facilities, because by definition, an LSI facility cannot have a significant impact on a nearby facility. Alternately, a facility manager may simply update the SCR form as long as it is signed and redistributed as the original.

However, if the comparison check reveals that the proposed change will exceed the LSI classification and the proposed change cannot be modified to fall within the LSI parameters, then further SBDs (Tier 2 or Tier 3) shall be completed. Determine the level of documentation required by following the methodology in Section 2.4. The increased documentation only applies to the hazard(s) introduced by the proposed change (or discovered inadequacy) that exceed the LSI classification limit.

In the case of a positive finding of the Change Control Form, complete additional safety basis documentation required for the new hazard(s) exceeding LSI criteria. The new documentation shall be approved at the level as determined in the Residual Risk Matrix.

3.4.4.2 Changes to Low, Moderate, or High Hazard Facilities. For Low, Moderate, or High hazard facilities, the change control process is similar. The Change Control Form requires a description of the proposed change (or noted discrepancy in actual inventory/operation from that described in existing documentation). Compare the proposed change to the classification criteria in Table 6 to establish whether or not the proposed change will increase the hazard classification. Note any increase in hazard classification on the Change Control Form.

Next, the proposed change is evaluated against the following criteria to determine if more analysis, controls, or higher risk acceptance levels are required:

1. Could the proposed change (or other change control entry condition) shift a previously analyzed event to a higher risk bin (Figure 3) due to an increased probability and/or consequence?

2. Could the proposed change (or other change control entry condition) create the possibility of a new credible event not previously analyzed?

3. Could the new proposed change compromise a credited control or require a new credited control?

If all answers are “no,” then a negative finding is concluded and no further evaluation is required. The review is documented and facility management approves the Change Control Form and files it with the facility SBD.

If the responses to criteria #1 or #2 are “yes,” then the analyst shall describe the condition and perform the hazard analysis for the change. The analyst shall compare the event probability and unmitigated consequences of this scenario against the Analysis Level Matrix. Here, the analyst determines to what bin the new scenario applies, as compared to the highest risk event in the existing SBD. If the final ranking is in hazard analysis space, the following considerations apply:

A. If the new scenario lands in the same or lower bin than the highest risk event of all hazard types previously analyzed, facility management may approve the Change Control Form, because the risk level has not increased beyond what was approved by the Facility AD.

B. If the risk bin will increase due to a new hazard condition, but still falls within hazard analysis space on the Analysis Level Matrix, attach the analysis and submit to the Facility AD for approval (because Facility ADs approve SBDs with the highest residual risk in the hazard analysis space). Because the risk level has increased, this is considered a positive finding.

If the Analysis Level Matrix indicates a need for accident analysis, then compare probability and consequences against the Residual Risk Matrix. If the approval level for both the hazard type and facility does not increase, then the original signatory shall approve the change. If the approval level does increase, or a credited control may be compromised by the proposed change, or a new credited control is required (response to criteria #3 above is “yes”), then either one of the following two options is permissible:

- Perform accident analysis. Analyze credited controls sufficient to restore original approval level and check mitigated impact on nearby facilities per Section 4.0. Attach all analyses and have document approved at same level of authority, or

- Resubmit revised SBD to higher authority, as indicated on Residual Risk Matrix, with justification.

Any additional required controls shall also be fully implemented through the facility’s implementation plans (e.g., FSP) and training materials.

Since the change control analysis includes all information typically required in a Tier 2 or Tier 3 document (depending on the level of analysis required), no further safety basis documentation

is needed. The Change Control Form serves as an addendum to the SBD, and its contents are incorporated into the SBD during the next triennial update.

The Change Control Form is distributed as discussed in Section 3.4.3 of this document.

4.0 Communication

Facility management is required to communicate:

- Information about significant potential accident impacts on other LLNL facilities to the management of those facilities.
- The purpose and function of required controls to the workers who must understand and implement those controls.

Communication of hazards identified through safety analysis to facility workers is not included in this document, but is an element of the program described in Document 10.2, “LLNL Health Hazard Communication Program,” in the *ES&H Manual*.

4.1 Notification Facilities

Notification facilities are facilities potentially subject to a level of exposure from a Low, Moderate, or High hazard facility that could create irreversible injuries or illnesses to workers, or cause the workers’ inability to take protective action. Management of hazard-ranked facilities shall communicate with the management of all facilities that might be subject to such potentially serious exposures. Even Low hazard facilities may have notification facilities within the standard 100 m facility distance.

When the notification facility is also a hazard-ranked facility, and the source facility analysis has identified a potential for impact, one of the issues may be the effect of an event on safety systems operability and the control of hazards in the notification facility. The notification facility management is responsible for determining if any action is required to protect its facility safety basis. Institutional contributors and reviewers of the safety analysis are also responsible for considering these kinds of impact.

4.1.1 Criteria for Selecting Facilities for Notification

A Tier 2 or Tier 3 SBD contains a section that discusses impacts on nearby facilities (See outlines in Section 3.1). This section may state: “No notifications are required because the maximum impact of a mitigated event is expected to be no more than recoverable injury or illness.” If, after applying consequence-mitigating controls, a credible event described in that SBD still has the potential for causing irreversible injury or illness or an inability to take protective action (e.g., where TEEL-2 may be exceeded) or damage to safety equipment in a nearby facility, then the management of the source facility shall notify the management of the nearby facility. Facilities within a 100 m radius of Low hazard facilities may require notification.

Facilities at greater distances from Moderate or High hazard facilities may also be notification facilities. Facilities requiring notification shall be determined for each source facility classified as Low hazard or above, and a current list of those facilities shall be attached to the source facility's SBD.

Facility management shall evaluate the estimated impact of all types of hazards, based on their potential for irreversible injury or illness or workers' inability to take protective action, and notify management of nearby facilities as appropriate.

4.1.2 The Communication Process

When a source facility's safety analysis shows a potential mitigated hazard release high enough to meet notification criteria, notify in writing each notification facility's points-of-contact (FPOC) and Assurance Manager (AM). This should occur early in the control development process, since information about the notification facility may affect the selection of controls to be designed into the source facility operations.

The chosen method of notification (e.g., e-mail messages, official memos with analysis attached, meeting minutes) shall be recorded within the source facility's SBDs. In addition to notifying the affected facilities, the source facility's management shall provide Space & Site Planning (S&SP) with the list of notification facilities. It shall be S&SP's responsibility to notify the source facility management that a new facility or trailer will be moved into the area, or that the ownership of a notified facility is being changed. The source facility management shall then carry out the notification process, as necessary, and shall update its notification facility listing.

4.2 Communication to Workers

Controls identified in the safety analysis process need to be operable when the hazards they control are present. Some of these controls may be credited controls, and the failure to have them in operation when required may be a reportable occurrence. Controls may have a safety control function for more than one hazard, so they need to be appropriately operated and maintained.

Facility management responsible for implementing facility safety-basis-identified controls shall be familiar with:

- All hazardous events that a control mitigates or prevents.
- When the control is required.
- How the control functions to provide the protection.
- What maintenance activities or oversight are required to ensure the control's operability.

Those programmatic line managers responsible for ensuring that programmatic controls are implemented when needed and are adequately maintained shall also be familiar with control functions, purposes, and maintenance.

This information shall be included in the facility safety plans, but may also be included in other documents such as Integration Work Sheets/Safety Plans (IWS/SPs), engineering safety notes, operating procedures, and ES&H Team discipline action plans, as appropriate.

Facility and programmatic managers shall ensure that the control's purposes and functions are communicated to all applicable workers, so that operability is not impaired through inadvertent changes to the control function (e.g., use of a replacement part of a material incompatible with the hazard, unreviewed change in a procedure, or change in interlock logic) or improper scheduling of maintenance (e.g., exceeding the surveillance period, or shutting down for maintenance when the hazard is present).

5.0 Roles and Responsibilities

This section describes individual roles and responsibilities pertinent to this process.

5.1 Worker

Workers are responsible for:

- Reporting deviations from required procedures or operating conditions specified in SPs to a supervisor, RI, or other manager.
- Understanding the function and use of controls identified in SPs relevant to their responsibilities.
- Implementing controls identified in SPs, as required.

5.2 Supervisor, Responsible Individual, or Other Manager

Supervisors, RIs or other managers are responsible for:

- Informing facility management of reported deviations from procedures or operating conditions required by the facility safety basis and specified in SPs.
- Ensuring that programmatic controls are implemented in activity-level documents and that work practices are within the approved SBE.

5.3 Programmatic Line Management

Programmatic line management is responsible for:

- Understanding the function, use, and maintenance of programmatic safety-basis-identified controls and communicating this information to the workers who must implement or could impact the controls' operability.
- Providing input to the safety basis on current and planned operations to ensure that the information is correct and complete and accurately reflects the work hazards.
- Ensuring that programmatic operations are performed within the facility safety basis envelope, including maintaining and operating programmatic safety basis controls and performing operations only when facility safety basis controls are operational.
- Reporting SBE non-compliances to facility management.

5.4 Facility Management

Facility management is responsible for:

- Defining the facility (i.e., identifying the operation, building, building segment, or building complex), and, if segmentation is adopted, documenting that it meets segmentation criteria.
- Designating those structures meeting the criteria of Table 1 as Office facilities.
- Screening and classifying all non-Office facilities in Facility Screening Reports.
- Providing input to safety analysts concerning inventory and programmatic operations, inventories, equipment, facilities, and procedures for hazard classification and safety analysis documents.
- Preparing and maintaining the safety analysis documentation and assuring that the information about the programmatic operation is correct and complete, so that it accurately reflects the work hazards.
- Obtaining required LLNL approvals and concurrences.
- Ensuring that assumptions used in the analysis are documented and that supporting documents (e.g., calculations, engineering notes, signature pages, references, and all current SBDs are retrievable).
- Understanding the function, use, and maintenance of safety-basis-identified controls and communicating this information to workers who may have an impact on the controls operability.
- Developing, or reviewing and concurring on, all facility documents that cover the implementation of safety basis assumptions and controls (e.g., OSRs, FSPs, SPs, facility procedures, IWSs).

- Assuring that work in the facility is performed in accordance with the approved safety basis. This assurance activity includes periodic verification of Office classification, and assuring inventory levels are below approved limits.
- Ensuring the integrity of building segmentation.
- Ensuring that the change control process is completed and approved prior to making a change (see Section 3.4.4).
- Responding to a discovered noncompliance by:
  - Returning the facility to a safe condition,
  - Making the operation conform to a compliant condition or revising the safety basis, and
  - Filing any required reports of the incident.
- Developing and maintaining a list of notification facilities, notifying managers of those facilities in accordance with Section 4.1, and recording the method of notification. Providing Space & Site Planning (S&SP) with a copy of the list.
- Maintaining the required facility safety systems under a configuration management program in accordance with the *ES&H Manual* and ensuring that those systems are operable when required by operations within the facility.
- Distributing the SBDs and Office listing in accordance with Sections 3.4.3 (for SBDs) and 2.2 (Office Listing).
- Maintaining the facility safety basis documentation for the lifetime of the facility.

5.5 Plant Engineering

Plant Engineering is responsible, at facility management's request, for:

- Repairing and maintaining Office facilities and equipment in accordance with ISMS requirements for Office facilities.
- Performing required maintenance on credited controls in accordance with the governing OSRs.

5.6 Space & Site Planning

Space & Site Planning is responsible for:

- Notifying source-facility management when a notification facility changes ownership, or when a new facility is to be placed in the same area.

5.7 Environmental Protection Department

The Environmental Protection Department is responsible for:

- Maintaining an institutional chemical inventory system, including an annual chemical reconciliation process.
- Reviewing the safety basis to verify its agreement with the Sitewide Environmental Impact Statement.
- Working with the Hazards Control Department to integrate hazard analyses with NEPA analyses.

5.8 Hazards Control Department

The Hazards Control Department's management is responsible for:

- Identifying Subject Matter Experts (SME) with the responsibility to interpret rules, Contract 48 requirements, and the LLNL *ES&H Manual* as they apply to WSSs or specific operations at LLNL.
- Providing ES&H Team support for the development and review of SBDs.

Through its AB Section personnel, Hazards Control Department management is also responsible for:

- Supplying trained safety analysts to help in the development and maintenance of facility SBDs.
- Supporting the DDO and ADs, as requested, in institutional reviews of SBDs or risk acceptance decisions.
- Reviewing SBDs for technical accuracy and consistency in format and content and providing concurrence signature.
- Providing institutional guidance for compliance with this document, including internal policies and procedures approved through LLNL's standard mechanisms.
- Developing methodology for generating inventory limit tables and maintaining the tables generated.
- Representing LLNL as an institution with NNSA regarding the LLNL facility safety basis program.
- Maintaining a database (electronic library) of the hazard classification and status of each facility's safety basis at the Livermore site and at Site 300.
- Maintaining copies of SBDs for all LLNL facilities.

- Reviewing the integration of the hazard analysis for the safety basis with NEPA, fire hazard, and emergency planning analyses.
- Developing detailed procedures necessary for safety analysts to produce consistent safety analyses in accordance with the nonnuclear safety analysis standard.
- Preparing training for the safety analysis process.

5.9 Associate Directors

Associate Directors are responsible for:

- Ensuring that all operations in their assigned facilities are performed within the facilities' SBEs.
- Developing, obtaining required approvals and concurrences prior to beginning operations, implementing, and maintaining the safety basis for each facility.
- Ensuring compliance with the Safety Analysis program as outlined in this document.
- Requesting support, if necessary, from the Hazards Control Department in a timely manner so that staffing and schedules can be properly adjusted.
- Funding the safety analysis effort.
- Justifying requests for DDO or NNSA/LSO acceptance of risk, when required.
- Reporting noncompliance with safety basis requirements, as required.
- Obtaining DDO and LSO approval of the preliminary SBD and task plan, if required.

Associate Directors may establish organizational structures and delegate authority within those structures for compliance with these requirements, including approval authority for LSI and Office facilities.

The facility AD is specifically responsible for providing LLNL approval of the SBD for all hazard-ranked facilities. (Some SBDs require final approval by NNSA/LSO.)

5.10 Deputy Director for Operations

In cases where the residual risk identified in a facility SBD cannot be reasonably reduced to AD authorization levels, the DDO is responsible to the Director for providing an institutional review in order to accept risk.

In cases where institutional review is required, the DDO shall:

- Ensure that experts and knowledgeable managers agree that the risk acceptance is justified based on identified operations and controls.
- Ensure that the justification of concurrence is documented.
- Concur as a signatory on the SBD.

5.11 Director

LLNL's Director is responsible for:

- Applying the safety analysis process to all LLNL facilities and operations.
- Implementing the resulting hazard classifications and risk acceptance delegated by NNSA.

5.12 Delegation of Approval Authority to Operate Nonnuclear Hazard Facilities

The DOE and NNSA are the primary authorizing agencies for all facilities covered by the nonnuclear hazard standard. This authority is executed through the NNSA Livermore Site Office (NNSA/LSO) and may be formally delegated to LLNL. Note that at any time, and for any LLNL facility, NNSA/LSO may choose to rescind its delegation of approval authority. In addition, NNSA/LSO always retains the right to object to the conclusions of any safety analysis document prepared by LLNL, if LLNL is not following the requirements of Work Smart Standard UCRL-ID-150214, rev. 1 and this *ES&H Manual* document. Any facility for which approval authority has not been delegated requires submittal of its SBD to LSO for approval. For these facilities, LSO must be notified if a change in operations (e.g., reduction of inventory, addition of a new control) lowers the risk level to a point for which approval authority has been delegated.

LSO also coordinates the effort involved in operational readiness reviews required for the startup or restart of accelerator facilities.

6.0 Training

This section describes the required training.

6.1 Facility Management and Support Workers

This section is applicable to facility management, ES&H Team Leaders and their deputies, Assurance Managers, and additional personnel as designated by facility management. In general, all workers with roles and responsibilities for generating, maintaining, and ensuring compliance with SBDs for nonnuclear facilities as specified in directorate level documentation (e.g., ISMS Implementation Plan, Training Plan, Quality Assurance Plan), require adequate

training to obtain a working-level knowledge of this document. In conjunction with reviewing this document, the following course offered by the Hazards Control Department shall be taken:

- **HS8050: Overview of *ES&H Manual* Document 3.1.** This course is required one time only, unless there are major changes to Document 3.1, at which point a refresher course shall be issued and required. Satisfaction of requirement shall be documented in LTRAIN.

In addition, workers with the roles and responsibilities specified above shall obtain a facility-specific working-level awareness of the contents and controls of the facility safety basis and the process of document implementation, (e.g., through required reading, on-the-job training, or briefing). The training should include a review of the following:

- Classification level of each facility.
- The type of SBD associated with each facility and where to obtain a copy.
- Roles, responsibilities, and authority for maintaining and implementing the safety basis.
- Safety basis controls and the associated QA requirements needed to maintain them.
- The control implementation documents (e.g., FSP, SP, SOPs).
- Reporting requirements.
- Change control process.
- Configuration management as relevant to maintaining facility safety systems to ensure risk reduction and segmentation requirements (see Section 3.4).
- What to do in case of a control nonconformance.

Facility management shall document the satisfaction of this requirement. Training material should be provided for participants' future reference. Facility specific awareness training does not apply to Directorate Assurance Managers and ES&H Team Leaders and their deputies. The repeat frequency of this facility specific training is at the discretion of directorate facility management.

In addition, workers responsible for completing LLNL Facility Screening Reports (Tier 1 documents) are required to obtain adequate training by taking the following:

- **HS8051: Preparing Facility Screening Reports.** This course is required one time only. The prerequisite for this course is HS8050. Satisfaction of this requirement shall be documented in LTRAIN upon completion of the training.

6.2 Safety Analysts

Safety analysts are defined as those performing hazards or accident analyses or reviewing these analyses for AB Section concurrence. They may also be defined as those individuals preparing Tier 2 or Tier 3 documents. Safety analysts require a level of training adequate to obtain:

- An expert-level knowledge of this document and are required to take the following courses in the order listed:

  1. HS8050: Overview of *ES&H Manual* Document 3.1.
  2. HS8051: Preparing Facility Screening Reports.
  3. HS8060: Nonnuclear Safety Analyses. This course is required one time only. The training topics include hazard analysis, accident analysis, control selection, and OSR methodology.

  Satisfaction of these requirements shall be documented in LTRAIN upon completion of the courses.

- In addition, safety analysts shall obtain an awareness-level knowledge of the applicable facility safety basis. This can usually be satisfied by attending a briefing from the safety basis owner and reading the SBDs. Satisfaction of this requirement shall be documented.

Training schedules for safety analysts are established by Hazards Control Department management. Other individuals interested in attending these courses should consult the Hazards Control Department's Training Section for more information.

6.3 Workers

Workers, defined as those who perform operations and activities within a facility, require no specific training on the facility SBDs, but are required to follow their facility documents and procedures that implement any SBD requirements. Facility management and RIs shall familiarize workers on their activity-specific implementing documents.

7.0 Noncompliances

7.1 Discovery of Noncompliance and Inadequacies

The facility Safety Basis Envelope (SBE) is the authorized aggregate of a facility's activities. It is delineated in the facility's SBDs and is presumed for Office facilities. The facility's operations are expected to remain within the SBE at all times.

Facility activities are considered outside of the facility SBE and in noncompliance if:

- New activities are added, or existing ones are changed so that authorized limits are exceeded without proper authorization and possibly without analysis.
- Credited controls (see Section 2.5.2) fail, and the resulting condition of the facility is not covered by an action statement documented in an OSR. (Action statements describe the steps to be taken to recover from a control failure and assign a time scale to the actions. The steps may include establishing temporary controls to allow continued operation. If the steps of an action statement are initiated, the facility is still compliant with the SBE.)
- The underlying assumptions regarding safety used to define the SBE prove invalid. These assumptions include initial conditions such as physical properties of a hazardous material and structural properties of the building, analysis methodology such as the model used to calculate release consequences, and effectiveness of a credited control.

Facility management is responsible for reestablishing the facility operations to within the SBE. When a noncompliance is clear, facility management shall, using its best judgment, return the facility to compliance in a safe and expeditious manner, either by suspending operations or taking other action. Under some conditions it may be unclear if the facility's activities exceed its SBE. In these cases, facility management shall use its best judgment to return operations to within the facility's SBE level. The AB Section personnel may be available to aid in these evaluations.

Flowcharts located in this section describe the process of recovery from a reported noncompliance.

7.2 Facility Management Initial Response Process

When informed of a potential SBE issue, facility management shall determine if the facility operations exceed the SBE. If operations do exceed the envelope, or if a determination cannot be made, then facility management shall return the facility operations to a level within the documented SBE. This may require establishing of temporary controls. The initial review of the issue shall take place expeditiously. Restoration may occur in stages: first, ensuring a given suite of activities to be inside the envelope, followed by permitting additional activities as they are proven to be within the SBE. In such cases the first stage shall be implemented expeditiously while subsequent stages can be delayed (see Boxes 1–3, Figure 5).

The actions necessary to restore activities immediately to within the SBE may not be clear, particularly if the noncompliance determination is incomplete. Facility management shall take actions that, in its best judgment, will return the operation to within the SBE. If, at anytime, evidence suggests that compliance was not restored, facility management shall take such further action as it deems necessary.

In rare cases, facility management may be unable to restore operations immediately to within the SBE. For example, an inventory limit may be exceeded and the excess cannot be removed to another facility within a short period of time. In such cases, after careful review by Subject Matter Experts and a determination of safe limits, some operations may be allowed to resume, perhaps with new controls. Approval for resumption shall be at the AD level, or higher if the residual risk requires higher approval levels. Establishing a revised safety basis will follow the change control process in Section 3.4.4. If the revised safety basis involves a higher risk or more cumbersome controls, management may use it to augment the documented safety basis only temporarily. Once the facility reverts to a condition described by the non-augmented safety basis, the temporary revision of the SBE may be dropped.

Facility management's final step is to communicate the facility status if appropriate. If the SBE has not been exceeded, then no communication is required. If the envelope was exceeded or judgment suggests it may have been exceeded, then facility management shall communicate as required by LLNL policy. This may include a formal occurrence report. If temporary restrictions were implemented to mitigate risks, facility management shall inform the AB Section (see Box 5, Figure 5). In addition, if temporary hazards are authorized that, after mitigation, may impact nearby facilities at a new level, then facility management shall inform the management of those notification facilities (see Section 4.1).

Note: Facility management may have established administrative controls that do not permit operating at the limits of the documented SBE, (i.e., provide margin between limits for operations and limits established by safety analysis). Under such conditions, violating a control does not necessarily imply exceeding the SBE.

7.3 Facility Management Process for Final Disposition

After the initial response to an observed noncompliance or unsafe condition, facility management shall determine if the SBE or SBD needs revision to permit additional activities, to continue existing activities, or to exclude previously authorized activities. A decision to change the SBE or the documentation leads to the change control process described in Section 3.4.4 (see Boxes 6, 7, and 8 in Figure 6).

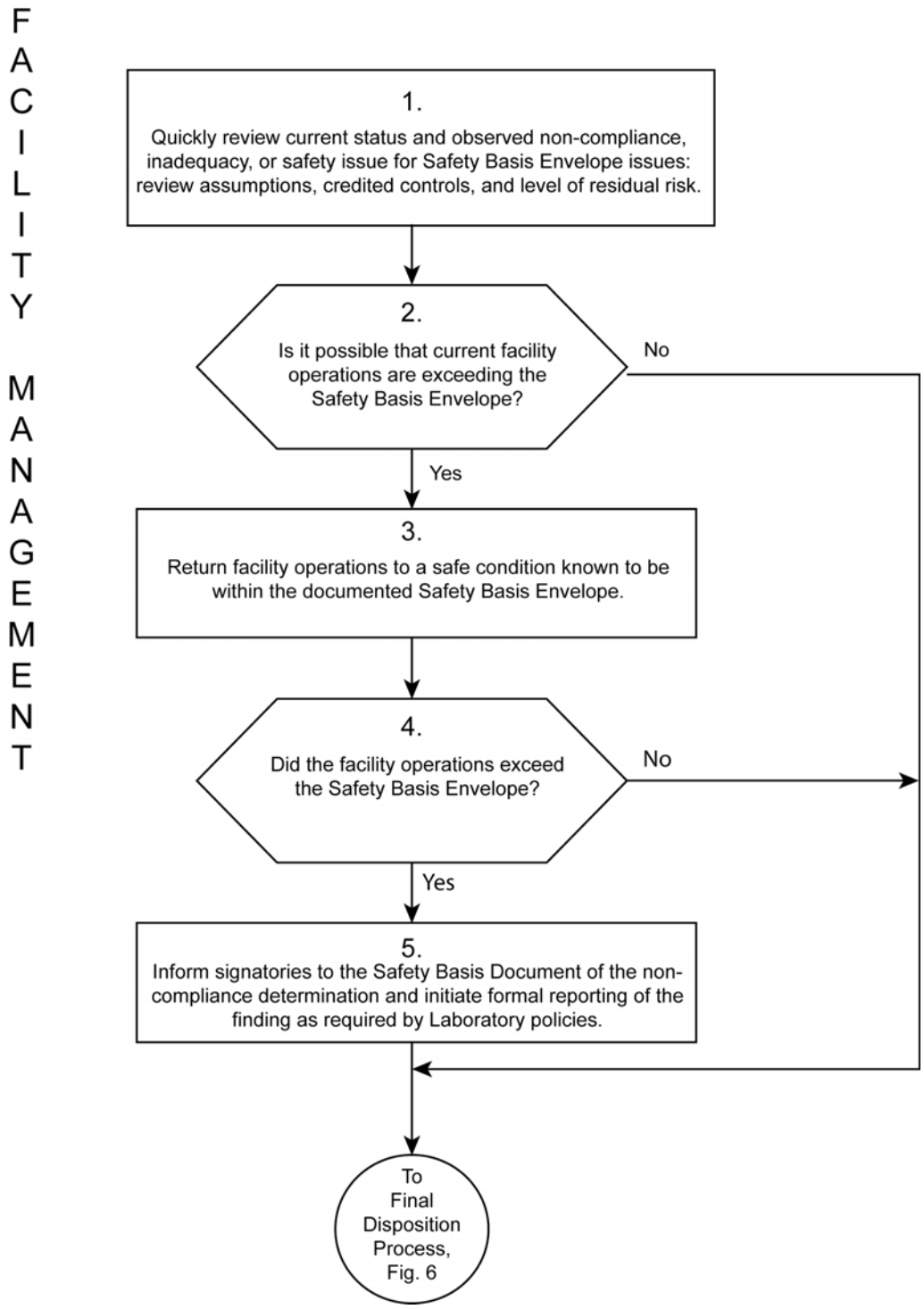


Figure 5. Facility Management Initial Response Process.

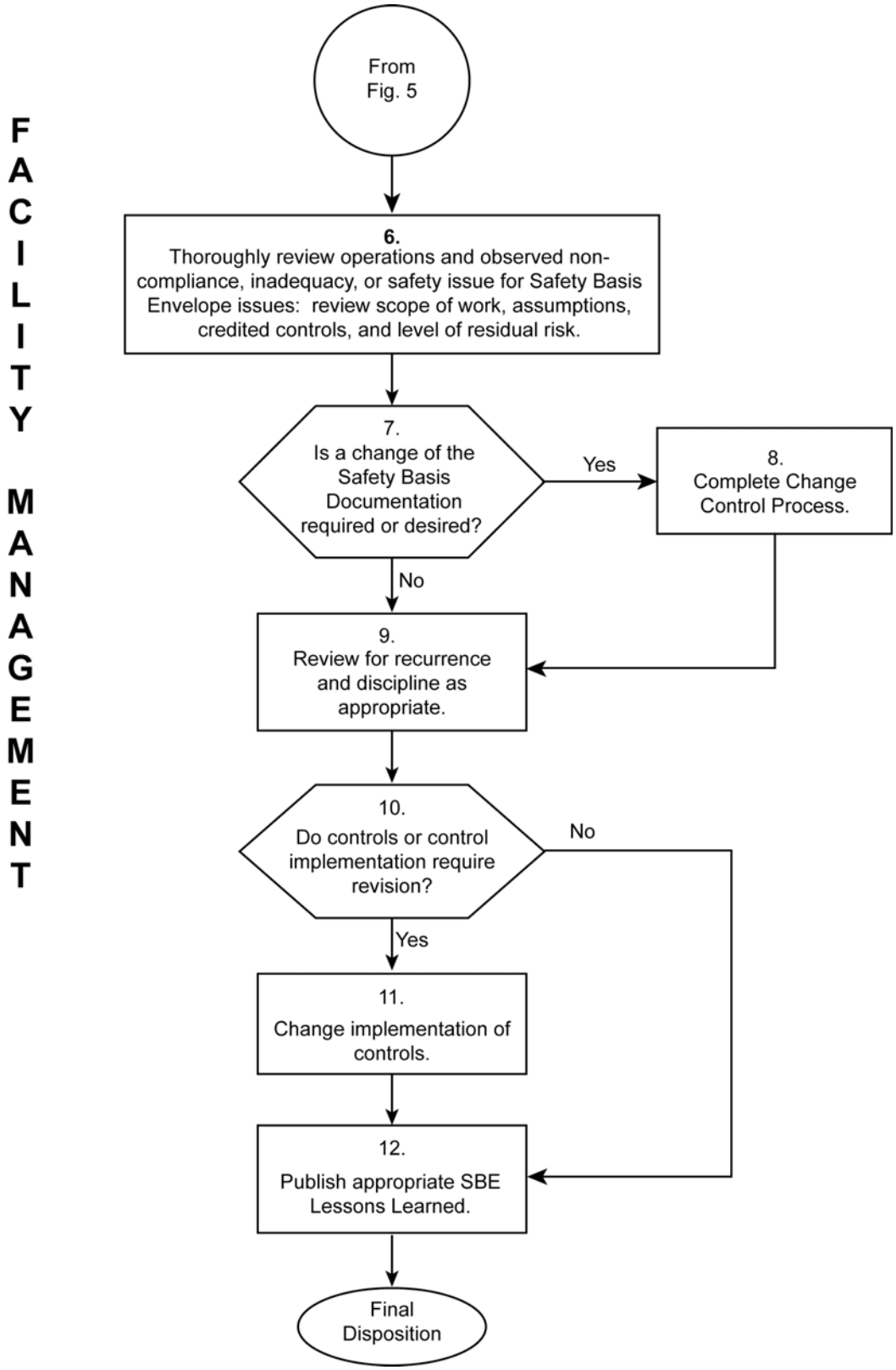


Figure 6. Facility Management Process for Final Disposition.

If the SBE was exceeded, facility management shall review the occurrence and revise current processes as needed to prevent recurrence. Disciplinary action may also be appropriate if existing controls and procedures were not followed. (see Box 9, Figure 6).

If no change is required in the SBE or documentation, then facility management may still decide, based on the observed safety issue implications, to implement changes in the safety requirements governing facility operations. These changes may be selected to add to the margin of safety and are the consequence of the need to continuously improve the safety of facility operations (see Boxes 10 and 11, Figure 6).

Finally, facility management shall have the safety observation and subsequent activities analyzed to identify, and formally publish, improvements to safety basis processes and techniques that should be shared with others at LLNL (see Box 12, Figure 6).

This long-term process begins with a thorough review. This review may be more extensive than the initial analysis activity that established the SBE. For example, in the case of new hazards to be analyzed for inclusion in the envelope, a review of new hazards serves the same purpose as the initial review and shall be as complete. But not all observations will lead to extensive analysis. Even serious safety violations (e.g., operating machinery with shields removed) may have no implications regarding the facility safety basis. Facility management is responsible for deciding what activities are necessary to constitute a proper review. (In the case of serious safety violations as exampled here, parallel review activities address operational safety issues.)

8.0 Work Standards

The standards required for the work performed at LLNL are codified in Appendix F of the contract between DOE/NNSA and UC (Contract 48). As new or updated requirements are added to Appendix F through the Change Control Board process, new standards appear and old ones show new revision numbers and publication dates. For this reason, only the standard number and title are listed in Section 8.1. Appendix F shall be checked for current accepted standards and dates as necessary. Note that newer standards (e.g., DOE Orders), may be listed on the Internet that are not LLNL standards, because they have not been accepted into Contract 48.

8.1 Work Smart Standards

10 CFR 830, “Nuclear Safety Management, Subpart B,” “Safety Basis Requirements.”

10 CFR 835, “Occupational Radiation Protection/Radiation Protection Program (RPP).”

29 CFR 1910.119, “Process Safety Management of Highly Hazardous Chemicals.”

42 CFR 73, “Possession, Use, and Transfer of Select Agents for Humans.”

DOE Manual 440.1-1, DOE Explosives Safety Manual (including DOE Explosives Safety Committee approved changes through December 2001).

DOE Order 420.2A, Safety of Accelerator Facilities (November 5, 1998), including Sections 1-3 (excluding Sections 4-5 and additional exclusions in 5/01/02 memo to the CCB); including Contractor Requirements Document, Sections 1-4, (excluding Sections 5-8).

DOE O 440.1A, Worker Protection Management for DOE Federal and Contractor Employees, Attachment 2 (Sections 1-11, 13-17, 18 [except 18.a], 19 [except 19.d.3], and 20).

DOE-Standard-1091-96, Firearms Safety.

UCRL-ID-150214, Rev. 2, "Safety Basis Requirements for Nonnuclear Facilities at Lawrence Livermore National Laboratory" (February 2003).

9.0 Resources for More Information

9.1 LLNL Sources

- *Environment, Safety & Health (ES&H) Manual.*
- Environment, Safety, and Health (ES&H) Teams.
- Hazards Control Department, Safety Program Division.
- Directorate Assurance Manager.

9.2 Other Sources

40 CFR 302.4, "Designation Reportable Quantities and Notification Requirements."

49 CFR 173.469, "Tests for special form Class 7 (radioactive) materials."

Craig, Douglas et. al., *ERPGs and TEELS for Chemicals of Concern*, WSMS-SAE-02-0171, latest edition.

http://tis-hq.eh.doe.gov/web/chem_safety/teel.html

DOE O 413.3, Program and Project Management for the Acquisition of Capital Assets.

DOE O 430.1, Life Cycle Asset Management.

DOE-STD-3009-94, Change 1, Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports.

DOE Standard 1027-92 (CH 1), Hazard Classification and Accident Analysis Techniques for Compliance with DOE O 5480.23, Nuclear Safety Analysis Reports, Sections 2-4 and Attachment 1 (except for the requirement for Certificates of Compliance for Type B containers) (September 1997).

DPST-CFRP-111, *Component Failure Rate Data with Potential Applicability to Plutonium Facilities,* E.I. DuPont de Nemours & Co., Savannah River Laboratory, 1980.

Homann, S., *Emergency Prediction Information Code (EPI Code)*, Homann Associates.

Miles, J.B., *Applicability Of PSM Standard To Explosive And Pyrotechnic Manufacturing*, Directorate of Compliance Programs, Occupational Safety and Health Administration, Department of Labor.

http://www.osha.gov/pls/oshaweb/owadisp.
show_document?p_table=INTERPRETATIONS&p_id=22524

NUREG/CR-1278, *Handbook of Human Reliability with Emphasis on Nuclear Power Plant Applications*, A.D. Swain, H.E. Guttman, August 1983.

NUREG/CR-4639, Nuclear Computerized Library for Assessing Reactor Reliability (NUCLARR), U.S. NRC, December 1980.

U.S. Department of HHS, Public Health Service, *Biosafety in Microbiological and Biomedical Laboratories*, HHS Publication No. (CDC) 93-8395, May 1999, 4th edition.

Appendix A

Terms and Definitions

Accident analysis (AA)	The estimation of the expected consequence and probability of potential accidents selected for inclusion in a facility Safety Basis Document (SBD)
Accident	An unplanned sequence of events that results in undesirable consequences.
Ammunition	For purposes of this standard, explosives (i.e., bullets) used in rifles, handguns, shotguns, machine guns, and similar devices designed to be carried and operated by one person. Unloaded firearms are excluded from concern in safety basis hazards identification and analysis.
Authorization Basis (AB) Section	A section of the Hazards Control Department's Support and Policy Division responsible for recording the LLNL Safety Basis, maintaining the standards upon which it is based, and aiding in the development of documents compliant with those standards.
Biosafety level (BSL)	There are four levels of containment required to perform biohazardous operations safely. Work practices and techniques, safety equipment, and laboratory facilities appropriate for the operations are based on the potential hazards imposed by the agents used and the laboratory function and activities. BSL levels are addressed in Document 13.6, "Safe Handling and Use of Biological Research Materials," in the *ES&H Manual*.
Change control negative finding	The change control review concludes that the proposed changes are already covered within the SBD, and therefore no additional analysis is required.
Change control positive finding	The change control review concludes that the proposed change is not covered within the SBD, and therefore additional action is required (e.g., elimination of proposed change, additional analysis, additional controls).
Colocated workers	People outside a facility under consideration but within the LLNL fence line. When calculating material dispersions, a minimum distance of 100 m is used due to code limitations.

Committed Effective Dose Equivalent (CEDE)	A measure of the impact of the uptake of any radioactive material into the body.
Consequence	The result or effect of the release of a hazard (radiological, chemical, biological, explosive, or industrial).
Conservative	Biased toward safer conditions.
Credible	Plausible. A credible event in this standard corresponds to an event whose probability is marginal.
Credited controls	Control(s), identified through hazard or accident analysis, that are required to reduce the residual risk acceptance level (see Figure 3).
Event	An unplanned occurrence, sequence of occurrences, or phenomena that may result in a release of hazardous material (e.g., radiological, chemical) or energy.
Expected event	Event could be expected to occur once during the facility or operation lifetime.
Facility management	That set of persons, delegated by the Facility Associate Director owning the facility, that is responsible for operation of the facility within the envelope established by the approved safety basis. See Section 5.4 of Roles and Responsibilities.
Facility	A Laboratory operation, building, group of buildings, or building or operation segment that will neither initiate an accident in, nor have an accident initiated by, another facility. All buildings listed in the LLNL Facility Information Management System database are included in one or more LLNL “facilities.”
Hazard analysis	A comprehensive assessment of facility hazards and associated (and primarily unmitigated) accident scenarios that could produce undesirable consequences for the onsite population, the public, or the environment. Included in the analysis are consequence and probability estimation and hazard evaluation.
Hazard identification	A step in the screening process that pinpoints material, system, and process/activity characteristics that can produce undesirable consequences.

Hazard	A source of danger (i.e., material, energy source, or operation) with the potential to cause illness, injury, or death to workers; damage to a facility; or damage to the environment (without regard for the likelihood or credibility of accident scenarios or consequence mitigation).
Hazard ranked facility	Facilities that are ranked either Low, Moderate, or High hazard.
Initial conditions (Also “intrinsic aspects of operation”)	Specific assumptions regarding a facility and its operations that are included in unmitigated evaluation. Initial conditions are generally those passive practical limits set by the description of the activity and which are resistant to change by simple human error.
Major modification	Construction that would result in changes to the structural design basis of the facility or to controls credited for segmentation.
Marginal event	Event is not expected to occur, but may occur during the facility or operation lifetime.
Mitigated risk	The estimated risk of an operation when credited controls are operable.
Mitigative control	Reduces the potential event’s consequence (impact).
Nonnuclear facility	For the purpose of this standard, a nonnuclear facility is defined as any LLNL-operated building, group of buildings, building segment, or segmented operation that is assigned a unique facility number through the LLNL Facility Information Management System database with the following exception: nuclear facilities categorized as 1, 2, or 3 per 10 CFR 830.
Notification facilities	Notification facilities are facilities potentially subject to a level of exposure from a Low, Moderate, or High hazard facility that could create irreversible injuries or illnesses to workers, or cause the workers’ inability to take protective action.
Offsite public	All individuals outside of the DOE site boundary.
Operable	A control is operable if it is capable of performing the safety function assumed in the SBD’s assessment of residual risk.

Operational Safety Requirements (OSR)	A document that describes the function and maintenance of credited controls in the form of equipment and administrative controls. OSRs define the minimum conditions necessary to ensure safe operations with respect to colocated workers and the public at a distance removed from the immediate facility. They may include operating limits, testing requirements, administrative controls, use and application provisions, and design features.
Operational-use quantity	The quantity of ammunition assigned to a duly authorized Protective Service Officer for a daily assignment.
Preventive control	Reduces a potential event's frequency (likelihood).
Primary Explosive	UNO Class 1 material listed in Table B.1 of Document 17.1, "Explosives," in the *ES&H Manual* as a primary explosive.
Probable event	Event is likely to occur several times during the facility or operation lifetime.
Process Safety Management (PSM)	Additional safety requirements for facilities whose hazardous materials inventories exceed the quantities listed in 29 CFR 1910.119, Appendix A.
Q List	The Chemical Quantity List contains the Q values used to classify facilities where hazardous chemicals are used. The list is based on the Temporary Emergency Exposure Limit (TEEL) values that are posted on the DOE's Chemical Safety Office website.
Q value	Quantities of each chemical that would cause exposures equal to each of the chemical's TEEL values at specific distances from the point of release, based on standard source term assumptions and using the EPI Code for dispersion calculations under defined atmospheric conditions.
Quantity-Distance (QD)	A process for determining permitted explosives inventory at a location. Required by the DOE Explosives Safety Manual and based on type of explosive, the structure of the facility containing the inventory, and the type of structure that might be impacted by an explosion (e.g., inhabited building, road, power line).

Radiological hazards	Radionuclides in quantities that fall below the thresholds in DOE-STD-1027-92 for Hazard Category 3 nuclear facilities. These hazards, while not required to meet 10 CFR 830 Subpart B, shall meet the requirements of 10 CFR 830 Subpart A and 10 CFR 835, and the requirements of this document.
Residual risk	The operational risk that remains when all credited controls are operable.
Risk binning	The process of categorizing the relative risk of events by assigning the events a “bin” on a frequency-consequence matrix (see Section 2.4.3.1, Risk Evaluation). Risk binning is used as an aid in selecting accidents for further evaluation. It is also part of implementing the graded-approach concept.
Risk Group	A system [developed by the Centers for Disease Control (CDC) and the National Institutes of Health (NIH)] for classifying biological agents by the degree of hazard. There are four risk groups: a larger RG number indicates a higher level of hazard.
Safety analysis	A systematic process to identify and analyze the hazards of an operation, the associated potential consequences and risk of accidents, and the adequacy of measures taken to eliminate, control, or mitigate the hazards, and to document this information.
Safety Basis Document (documentation)	Written documents that establish the safety basis for the facility. Includes initial documentation and changes. Does not include reviews of operations that do not result in changes to the Safety Basis Envelope (SBE).
Safety Basis Envelope (SBE)	The aggregate of activities and hazardous inventories in a facility as analyzed and permitted by the approved safety basis documentation.
Screen-out	Does not require further analysis.
Secondary explosive	UNO Class 1 material listed in Table B.1 of Document 17.1, but not shown as a primary explosive.

Select Agent	A microorganism (virus, bacterium, fungus, rickettsia) or toxin listed in Appendix A of 42 CFR 72, “Additional Requirements for Facilities Transferring or Receiving Select Agents.” The term also includes recombinant organisms/molecules that are one of the following: (1) Genetically modified microorganisms or genetic elements from organisms in Appendix B shown to produce or encode for a factor associated with a disease. (2) Genetically modified microorganisms or genetic elements that contain nucleic acid sequences coding for any of the toxins in Appendix B or their toxic subunits.
Standard Industrial Hazards (SIH)	Hazard sources (material or energy) routinely encountered by the general public, or in general industry and construction, for which national consensus codes and/or standards exist to govern handling or use without the need for special analysis to define safety design and/or operational parameters.
Temporary emergency exposure limits (TEELs)	Four levels (0-3) of limits as defined below. When a TEEL level is referred to in this document, it is assumed that the impacts are no greater than the maximum impact allowed for that level. **TEEL 0:** The maximum concentration in air below which most people would experience no appreciable risk of health effects. **TEEL 1:** The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing anything other than mild transient adverse health effects or perceiving a clearly defined objectionable odor. **TEEL 2:** The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action. **TEEL 3:** The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing life-threatening health effects.
United Nations Organization (UNO)	The UN has developed a world-wide standard for labeling dangerous materials.

Unmitigated risk	The risk involved with a facility and its associated operations, assuming there are no credited controls. Only initial conditions and the basic physical realities of a given operation are considered.
Workers	Individuals either immediately adjacent to or within the occupied area of hazard, or outside the occupied area of hazard but within the site boundary. Colocated workers are a subset of the latter group.

Appendix B
Form for Recording the Results of a Facility Screening

LLNL Facility Screening Report (SCR)	
Lead Preparer:	Date Performed:
Facility Description	
Briefly describe facility location, structure and attach a building layout:	
Define facility type: Check: ☐ Single Structure or Area: (B/Tr/A)_____ ☐ Complex of Buildings: Designation _____ ☐ Segment* of Bldg or Complex: _____ Seg.# __ *Attach justification for segmentation	**Owner Organization:** Directorate: _____ Facility AD:_____
Final Facility Classification: (Check) ☐ LSI ☐ Low ☐ Moderate ☐ High ☐ Nuclear Facility ☐ Accelerator	
Concurrence Signatures: Lead Preparer:_____ Date:_____ AB Section Leader or designee:_____ Date:_____ ES&H Team Leader or designee:_____ Date:_____	
Approval Signature: Facility Management:_____ Date:_____	
Supporting Documentation Appended Check as appropriate: ☐ Justification for Segmentation ☐ Chemical Hazard List ☐ Radiological Hazard List ☐ Explosive Hazard List ☐ Building Layout	Comments:

Identification of Operations, Inventories, and Hazards

List key operations that are conducted within the facility:

Did Facility Management receive any notifications of credible external threats from nearby facilities? yes ☐ no ☐

If yes, list the following for each notification:

Source Facility: Facility Contact(s): Phone # (s):

Describe Hazard(s):

Hazard Identification Table

Check the hazard types found in the facility.

Not Found	Found		
☐	☐	Biological Hazards	Complete block I, below
☐	☐	Chemical Hazards	Complete block II, below
☐	☐	Explosive Hazards	Complete block III, below
☐	☐	Radiological Hazards	Complete block IV, below
☐	☐	Industrial Hazards	Complete block V, below

I. Biological Hazards

Check BioHazard Type

☐ **Non-Select Agents**

Check highest group in facility:

- ☐ RG1 Agents
- ☐ RG2 Agents
- ☐ RG3 Agents

☐ **Select Agents**

Select highest group in facility:

- ☐ RG1 Agents
- ☐ RG2 Agents
- ☐ RG3 Agents

☐ Other BioHazards (e.g., Blood, nucleic acid, lab animals, contaminated needles/sharps, animal/human tissues)

Biological Safety Level (BSL)

Circle highest level in facility:

N/A BSL-1 BSL-2 BSL-3

II. Chemical Hazards

Check ChemHazard Type

- ☐ Flammable, volatile or fuming
- ☐ Toxic materials (acutely toxic, toxic, systemic toxin, toxic gases)
- ☐ Corrosives/irritants
- ☐ Reactive materials (e.g., air/water sensitive; pyrophoric; thermally, shock, or friction sensitive; perchlorate)
- ☐ Carcinogens, mutagens, reproductive hazards
- ☐ Pesticides
- ☐ Beryllium
- ☐ Materials of special concern (e.g., alkali metals, fluorine, asbestos, lead, mercury, PCB)
- ☐ Other regulated metals (e.g., chromium, copper, nickel, zinc)
- ☐ Other:_____

For chemicals that exceed LSI classification, attach maximally planned chemical inventory listing.

Listing attached? ☐ YES ☐ NO

III. Explosive Hazards

Check

- ☐ Primary High Explosives
- ☐ Secondary High Explosives
- ☐ Propellants/Low Explosives
- ☐ Firearms Ammunition

Do any of the explosive types checked above have any of the following associated hazards?

- ☐ Fragmentation Hazards (Primary Fragments)
- ☐ Group L Explosives

Attach maximally planned inventory listing for each explosive type checked.

IV. Radiological Hazards

Check Sum of Ratio

- ☐ <1 of RQ thresholds (40 CFR 302.4 Appendix B)
- ☐ >1 of RQ thresholds < Cat. 3 Thresholds (DOE-STD-1027-92, Table A.1)
- ☐ >Cat. 3 Thresholds (DOE-STD-1027-92, Table A.1) < Cat. 2 Thresholds (DOE-STD-1027-92, Table A.1)

Does facility contain the following?

Radiation Generating Devices:

- ☐ Radiation generating devices not covered by DOE O 420.2A (e.g., X-rays, Electron Beams, Radiography Equipment): class___
- ☐ Radiation generating devices covered by DOE O 420.2A (Accelerators).

Exempted materials:

- ☐ Radioactive Certified Sealed Sources
- ☐ Rad. In Type B Containers with current certificates of compliance
- ☐ Either in quantities>Cat. 3 thresholds (DOE-STD-1027-92, Table A.1)

Attach listing of maximally planned radiological materials inventory.

V. Industrial Hazards

Check if hazard present	Industrial Hazard	Examples of industrial hazard(s) for each general category. (Circle Industrial Hazards found unless majority are present, then circle entire category and cross off items that don't apply.)	List industrial hazard(s) that could directly impact the public (fence-line) or colocated worker (100 m).
	Electrical	Battery banks, cable runs, diesel generators, electrical equipment, heaters, high voltage (> 600V), motors, power tools, pumps, service outlets, fittings, switchgear, transformers, capacitors, magnetic fields, transmission lines, wiring/underground wiring, other:_____.	
	Thermal	Boilers, bunsen burner/hot plates, electrical equipment, electrical wiring, engine exhaust, furnaces, heaters, lasers, steam lines, welding surfaces, welding torch, other:_____	
	Kinetic	Acceleration/deceleration, bearings, belts, carts/dollies, centrifuges, crane loads (in motion), drills, fans, firearm discharge, fork lifts, gears, grinders, motors, power tools, presses/shears, saws, vehicles, airplane, vibration, other:_____	
	Potential (pressure)	Autoclaves, boilers, coiled springs, furnaces, gas bottles, gas receivers, pressure vessels, vacuum vessels, pressurized system (e.g., air), steam header and lines, stressed members, other:_____	
	Potential (height/mass)	Cranes/hoists, elevated doors, elevated work surfaces, elevators, lifts, loading docks, mezzanines, floor pits, scaffolds and ladders, stacked material, stairs, other:_____	
	Internal Flooding Sources	Domestic water, fire suppression piping, process water, other:_____	

Hazard Classification

Circle the appropriate hazard level:

Biological	**Not found**	**LSI**	**Low**		
Chemical	**Not found**	**LSI**	**Low**	**Moderate**	**High**
Explosive	**Not found**	**LSI**	**Low**	**Moderate**	**High**
Radiological materials	**Not found**	**LSI**	**Low**	**Nuclear**	
Radiation generators	**Not found**	**LSI**	**Acc**		
Industrial	**Not found**	**LSI**	**Low**	**Moderate**	**High**

Controls for LSI classified facilities: (Low, Moderate and High facility controls are addressed in Tier 2 or Tier 3 SBDs.)

Briefly describe controls developed to assure that facility operations do not exceed the facility classification:

Other controls?
Briefly describe:

List what document(s) through which the controls will be implemented:

Instructions for Completing Hazard Identification Table in Facility Screening Form

(Three pages, not part of screening form)

1. **Conduct a walk-through of the facility to verify information gathered (ensure no hazards overlooked), identify inconsistencies, and become familiar with operations and hazards.**

2. For chemical hazards:
   a. Review the chemical listing and summarize the general categories of chemicals in the attached Hazard Identification Table (e.g., acid, base, flammable).
   b. Determine the appropriate Q Value for each chemical.
   c. List all chemicals that exceed LSI criteria and attach.
   d. Determine if chemical inventories exceed the threshold quantity specified in 29 CFR 1910.119 (Process Safety Management); TQ threshold values. If above, follow requirements per this CFR 1910.119. (LLNL facilities typically establish thresholds well below these thresholds.)

3. For explosives hazards:

   Identify explosive inventory in terms of total quantities of each type respective to the United Nations Organization (UNO) Hazard Class/Division. This may include powder-actuated tools and ammunition used or stored at the facility.

4. For radiological hazards:
   a. Review the radiological listing and perform a sum-of-ratio calculation of the radionuclides to the following listings:
      i. 40 CFR 302.4, Appendix B
      ii. DOE-STD-1027-92 (Change 1), Table A.1, Category 3 thresholds
   b. If radiation generation devices (RGDs) are present, determine whether or not these meet the criteria for accelerators. Determine class of each RGD per Document 20.3, “LLNL Radiological Safety Program for Radiation-Generating Devices,” in the *ES&H Manual*.
   c. Check whether exempted radiological materials are present within the facility.

5. For biological hazards:
   a. Determine the desired maximum categories of biological agents within the facility (i.e., Select Agents, non-Select Agents and highest risk group agents associated with each).
   b. Determine if other biohazards are present or anticipated (e.g. blood, recombinant DNA, lab animals, contaminated needles/sharps, animal/human tissues).
   c. BSL level of labs within the facility, and the highest BSL permitted per the IBC.
   d. If Select Agents are present, then attach the Select Agent listing to this form.

6. For industrial hazard types:

   Review facility operational documentation and consult facility representatives to determine the industrial hazards present or anticipated.

   List industrial hazard(s) that could directly impact the public (fence-line) or colocated worker (100 m) or could serve as initiators to an event. See guidance below:

Industrial Hazard	Guidance for Screening SIH[1]
Household chemicals	Household products used in household quantities can be screened out.
X-Ray Equipment	Screen out (i.e., disregard for further analysis) those facilities with X-ray equipment or simple accelerators that are commercially available, conform to appropriate national codes and standards (e.g., ANS N537/NBS123 for X-ray equipment or ANS 43.1 for accelerators), and have not been modified with regard to safety-related design and operating features, such as voltage and shielding. If the X-ray system does not conform to the appropriate national code standard or the accelerator is considered "complex," it shall be identified for further HA. (See Section 2.6.2.3.2 of ANS 43.1, Complex Accelerators, for the definition of simple and complex accelerators.)
Flammable Materials	Considered as a contributor/initiator for fire events.
Lasers	Screen out Class 1 and 2 lasers and Class 3 lasers with enclosed beams (per ANSI Z136.1) because they do not represent a significant health threat. However, if these Class 1, 2, and 3 laser systems do not conform to the appropriate national standard, they shall be identified for further HA. Class 3 lasers with non-enclosed beams and Class 4 lasers are to be identified for further analysis. Gas supplies that are an integral part of an unmodified, sealed, purchased system do not have to be treated separately. However, gas supplies that are not sealed in a purchased system or systems that have been modified shall be considered separately (i.e., toxic material criteria). Replacing integral gas cylinders is not considered a modification.
Electrical	Screen out standard electrical hazards, but retain for further analysis those that represent special safety concerns. Systems to be retained are (1) those with 600 volts or more and 25 milli-amperes or more output, and (2) stored-energy systems with 50J or more stored energy and terminal-to-terminal voltage of 600 volts or more. The National Electric Code (NEC) 70-1990 identifies these as systems requiring special consideration.
Kinetic Energy	Many high kinetic energy systems are capable of causing worker injury. However, most of these (e.g., cars, trucks, forklifts, cranes) are standard industrial hazards (SIH) unless an initiator for another significant event. Unique systems (e.g., high energy flywheels, large centrifuges) are not considered SIH and are subject to analysis.

Industrial Hazard	Guidance for Screening SIH[1]
Pressure	High hydraulic pressures and pressurized gas bottles are SIH. Large volumes of compressed gases are not routine and cannot be screened out: Stored energy <0.1 LB, TNT Pressure > 3000 psig.
Temperature	Screen out high-temperature systems of which the only consequence is a contact burn. Keep for further analysis those systems that could result in a strong overpressure if a coolant or other fluid contacted the high-temperature mass, could cause toxic products if materials in the area were exposed to the high temperature, or could cause a fire that would spread radioactive or toxic materials. High temperature systems are SIH, but an evaluation is required if the temperature could result in an overpressure, create toxic products, or cause a fire. Temperatures that could act as an initiator cannot be screened out.
Asphyxiants	Asphyxiants do not have Threshold Limit Values (TLVs) and, therefore, cannot be handled as toxic materials and are considered SIH unless the following considerations apply. Identify for further analysis (1) areas that could entrap asphyxiants, (2) cylinders of compressed asphyxiants, and (3) situations in which the oxygen level would be less than 18% due to increased asphyxiant gas concentration.
Biohazards	Screen out common sources of biohazards (e.g., cooling towers), but facilities containing biohazards that require special industrial hygiene controls (e.g., protective clothing, breathing apparatus, special warning placards) should be retained for further analysis.

1 The criteria in this table are provided to facilitate screening of obvious SIHs. Failure to satisfy these criteria does not rule out ultimately identifying a given hazard or sub-hazard as an SIH.

7. Use the information gathered and recorded in, or attached to, the Hazard Identification Table to compare with the classification criteria in Table 5, and determine the classification of each hazard and the overall facility classification.

Appendix C

Content Requirements for Accelerator Safety Assessment Documents

Descriptive information in the Safety Assessment Document must include the following elements:

- A statement of the accelerator type (e.g., linear induction traveling wave) and basic principle of operation, including the type(s) and maximum intensity of radiation that will be produced.
- The location of the accelerator and facility relative to co-located workers, LLNL facilities, the site boundary, and the public.
- Identification of radiation hazards created due to beam activation and/or material contamination.
- The application and use of the accelerator (e.g., radiography, particle physics research) and the facility function, if different.
- A description of the major facility features related to accelerator operation (e.g., dedicated accelerator bay, target areas, shielding, interlocks, normally manned and unmanned areas).
- A generalized description of the line management and support organization structure for operation of the accelerator.
- A generalized description of how accelerator operations are conducted.

The hazard analysis must meet the process and content requirements described in section 2.4, with the following additions:

- Hazards must include those with adverse impacts to workers in addition to co-located workers and the public.
- Control selection must consider consequences to workers in addition to co-located workers and the public.
- Consequences mitigated by the credited controls shall be used for assessing risk.

Consequences and probabilities from the hazard analysis related to the public and co-located workers shall be compared to the residual risk matrix (Figure 4) to ensure acceptable risk. The risk to workers shall be derived from the hazard analysis and qualitatively described.

While there is no specific requirement for accident analysis for accelerators, it is possible that accident analysis will be necessary to support probability estimates that are based on control effectiveness information.

Accelerator Safety Envelope

The Accelerator Safety Envelope (ASE) should normally include a maximum allowable dose over time, or dose rate, for occupied areas while the accelerator is being operated. In addition, it should include credited controls and identifiable accelerator configurations or parameters that are controlled to ensure that the expected maximum radiation intensity is not exceeded. Violation of the ASE is equivalent to violation of an Operational Safety Requirement for other hazards.

All controls identified through the analysis process shall be summarized and identified as credited accelerator facility controls in the document. These controls are equivalent to the credited controls associated with other hazards in this document. These controls must be included and implemented for operations through the use of safety plans. Note that, by definition, accelerators are Class IV Radiation Generating Devices (RGDs) and require a safety plan per Document 20.3. The process of implementing accelerator controls though safety plans particular to the facility/activity involved should be described.

Note: All accelerator safety assessment documents currently require NNSA/LSO approval.

Suggested Format for Accelerator Safety Assessment Documents

The following outline provides a format for organizing the content of a Safety Assessment Document if no other hazard types classified above LSI are present in the facility. If other hazard types do exceed LSI, then this assessment shall be addressed within the appropriate tier-level document as an appendix. (The accelerator is considered to have a Low hazard classification.)

Chapter 1 Summary

- 1.1 Purpose and Scope
- 1.2 Facility Mission
- 1.3 Accelerator Operations Summary
- 1.4 Summary of Results
- 1.5 Conclusion

Chapter 2 Descriptions

- 2.1 Site Description
- 2.2 Facility Description
  - 2.2.1 General Facility/Accelerator Layout
  - 2.2.2 Accelerator Details
  - 2.2.3 Historical Activation and Contamination
- 2.3 Engineered Features
- 2.4 Management Structure

2.5 Description of Operations

Chapter 3 Safety Analysis

3.1 Hazard Identification and Event Tables

3.2 Normal Operations

3.3 Accident Conditions

3.4 Risk Assessment

3.4.1 Public and Collocated Workers

3.4.2 Qualitative Worker Risk Description

Chapter 4 Controls for Accelerator Safety

4.1 Accelerator Safety Envelope

4.2 Accelerator Facility Controls

4.2.1 Engineered Controls

4.2.2 Administrative Controls

4.3 Applicable Safety Programs

4.4 Implementation of Controls through Safety Plans

Appendix D

De Minimis List

This appendix lists highly hazardous chemicals assigned a de minimis value less than 1 kg. Chemicals are placed on this low de minimis list when the Q(1,100m) value calculated on the standard Q tables for Site 200 or Site 300 is < 20 kg. The appropriate de minimis value is the Q (0,100) value calculated divided by a factor of twenty, down to a generic minimum of 10 grams. Calculated Q values are available at the following website: https://www-esh.llnl.gov/nsahtml/NSAFrameset.htm

SUBSTANCE NAME	CAS #
ACETYL CHLORIDE	75-36-5
ACROLEIN	107-02-8
ALPHA-PINENE	80-56-8
ALUMINON	569-58-4
ARSINE	7784-42-1
BERYLLIUM	7440-41-7
BORON TRICHLORIDE	10294-34-5
BORON TRIFLUORIDE	7637-07-2
BROMINE	7726-95-6
CARBOXYLIC ACID SODIUM SALT	16550-39-3
CHLORINE	7782-50-5
CHLORINE DIOXIDE	10049-04-4
CHLORINE TRIFLUORIDE	7790-91-2
CYANOGEN CHLORIDE	506-77-4
DIAZOMETHANE	334-88-3
DIBORANE	19287-45-7
DICHLOROACETYLENE	7572-29-4
DICHLOROMETHYL ETHER; (BIS[CHLOROMETHYL]ETHER)	542-88-1
DIMETHYL SULFIDE; (2-THIOPROPANE)	75-18-3
DIMETHYLHYDRAZINE, 1,1-	57-14-7
DIOXINE; (TCDD; 2,3,6,7-TETRACHLORODIBENZO-P-DIOXIN)	1746-01-6
EPIBATADINE (NICOTINE-LIKE)	Z-0031

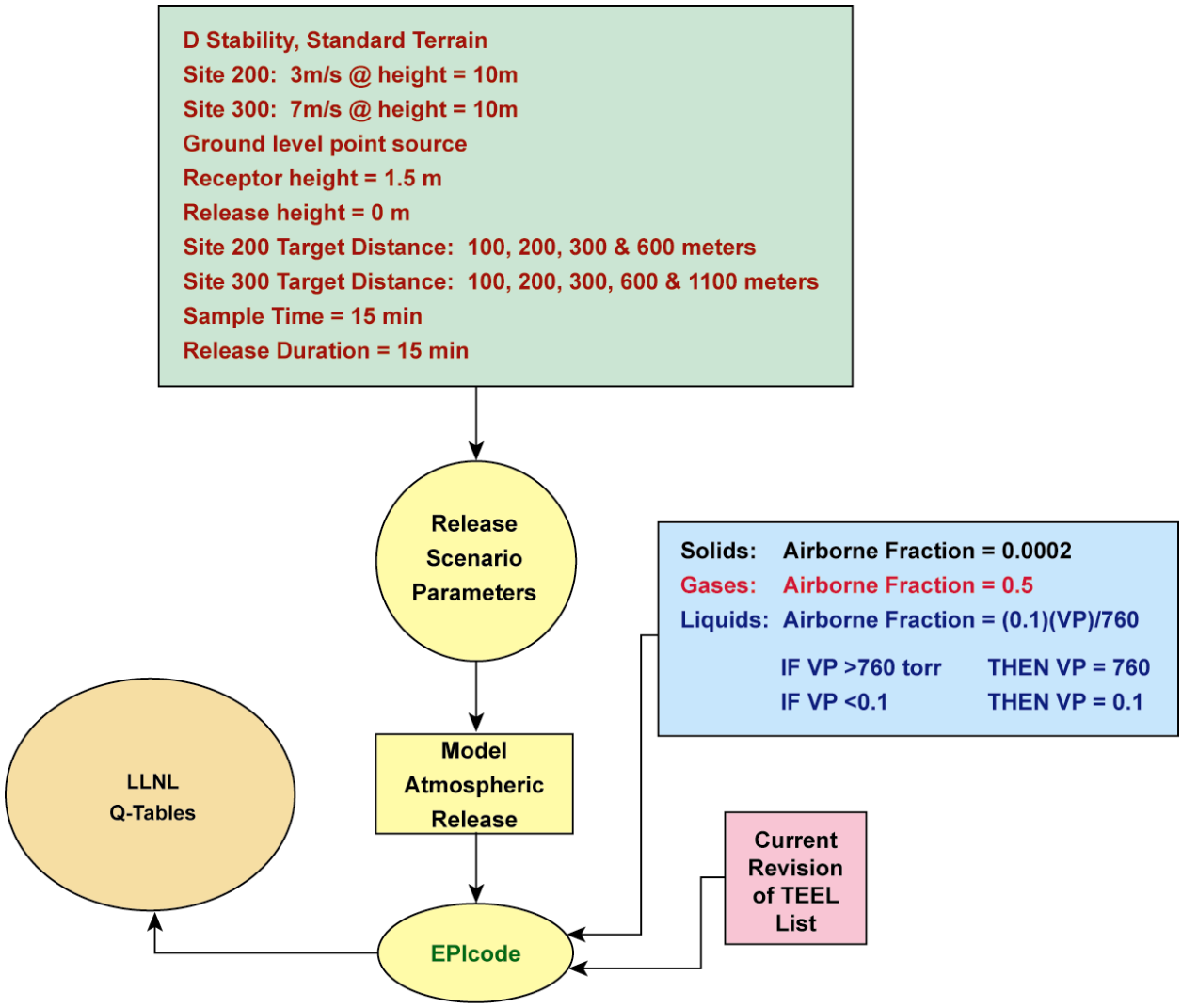
SUBSTANCE NAME	CAS #
ETHYL NITRITE	109-95-5
ETHYLENE FLUOROHYDRIN; (2-FLUOROETHANOL)	371-62-0
ETHYLENE OXIDE; (OXIRANE)	75-21-8
FLUORINE	7782-41-4
FORMALDEHYDE	50-00-0
FURAN	110-00-9
GERMANE; (GERMANIUM TETRAHYDRIDE)	7782-65-2
HEXACDD, 1,2,3,4,7,8-	39227-28-6
HEXACHLORODIBENZOFURAN, 1,2,3,6,7,8-	57117-44-9
HEXACHLORODIBENZOFURAN, 2,3,4,6,7,8-	60851-34-5
HYDRIODIC ACID 4 (AS IODINE)	10034-85-2
HYDROBROMIC ACID; (HYDROGEN BROMIDE)	10035-10-6
HYDROGEN CHLORIDE (GAS)	7647-01-0
HYDROGEN FLUORIDE; (GAS)	7664-39-3
HYDROGEN SELENIDE	7783-07-5
KEPONE; (CHLORDECONE)	143-50-0
KETENE; (CARBOMETHENE, ETHENONE)	463-51-4
METHYL CHLOROSILANE; (CHLOROMETHYLSILANE)	993-00-0
METHYL FLUORIDE; (FLUOROMETHANE)	593-53-3
METHYL ISOCYANATE	624-83-9
METHYL-1-PROPENE-1-ONE, 2-; (DIMETHYLKETENE)	598-26-5
NEODYMIUM (III) CHLORIDE	10024-93-8
NICKEL CARBONYL	13463-39-3
NITROGEN DIOXIDE	10102-44-0
NITROSYL CHLORIDE	2696-92-6
NORCHLOROFLUOROEPIBATIDINE	Z-0057
OXYGEN DIFLUORIDE; (FLUORINE MONOXIDE)	7783-41-7
OZONE	10028-15-6
PENTABORANE	19624-22-7
PENTACHLOROBENZO-P-DIOXIN, 1,2,3,7,8-	40321-76-4
PENTACHLORODIBENZOFURAN, 2,3,4,7,8-	57117-31-4
PHOSGENE	75-44-5
PHOSPHINE	7803-51-2
PROPARGYL BROMIDE	106-96-7

SUBSTANCE NAME	CAS #

SELENIUM HEXAFLUORIDE	7783-79-1
SOMAN; (3,3-DIMETHYL-2-BUTANOL METHYLPHOSPHONOFLUORIDATE, GD)	96-64-0
STIBINE	7803-52-3
SULFUR DIOXIDE	7446-09-5
SULFUR PENTAFLUORIDE	5714-22-7
SULFUR TETRAFLUORIDE	7783-60-0
TELLURIUM HEXAFLUORIDE	7783-80-4
TETRACHLORODIBENZOFURAN, 2.3.7.8-	51207-31-9
TETRAFLUOROHYDRAZINE	10036-47-2
THALLIUM(I) SULFATE; (SULFURIC ACID, DITHALLIUM(1+) SALT)	7446-18-6
TUNGSTEN HEXAFLUORIDE	7783-82-6
VINYL FLUORIDE	75-02-5
ZZDPD FREE CHLORINE REAGENT	Z-0127
ZZDPD TOTAL CHLORINE REAGENT	Z-0128

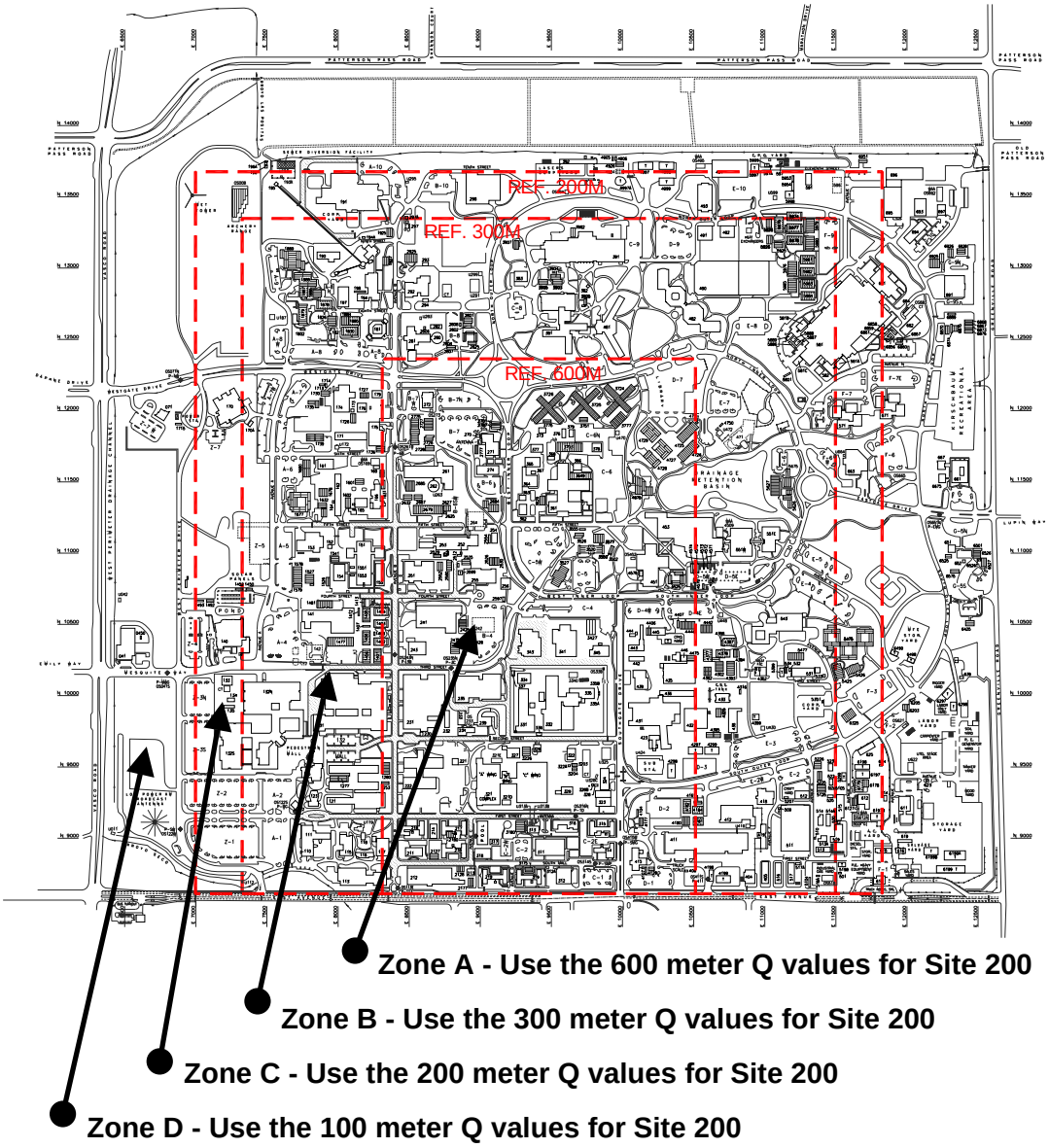
Appendix E

Parameters Used to Calculate the Chemical Inventory Quantity (Q) Table

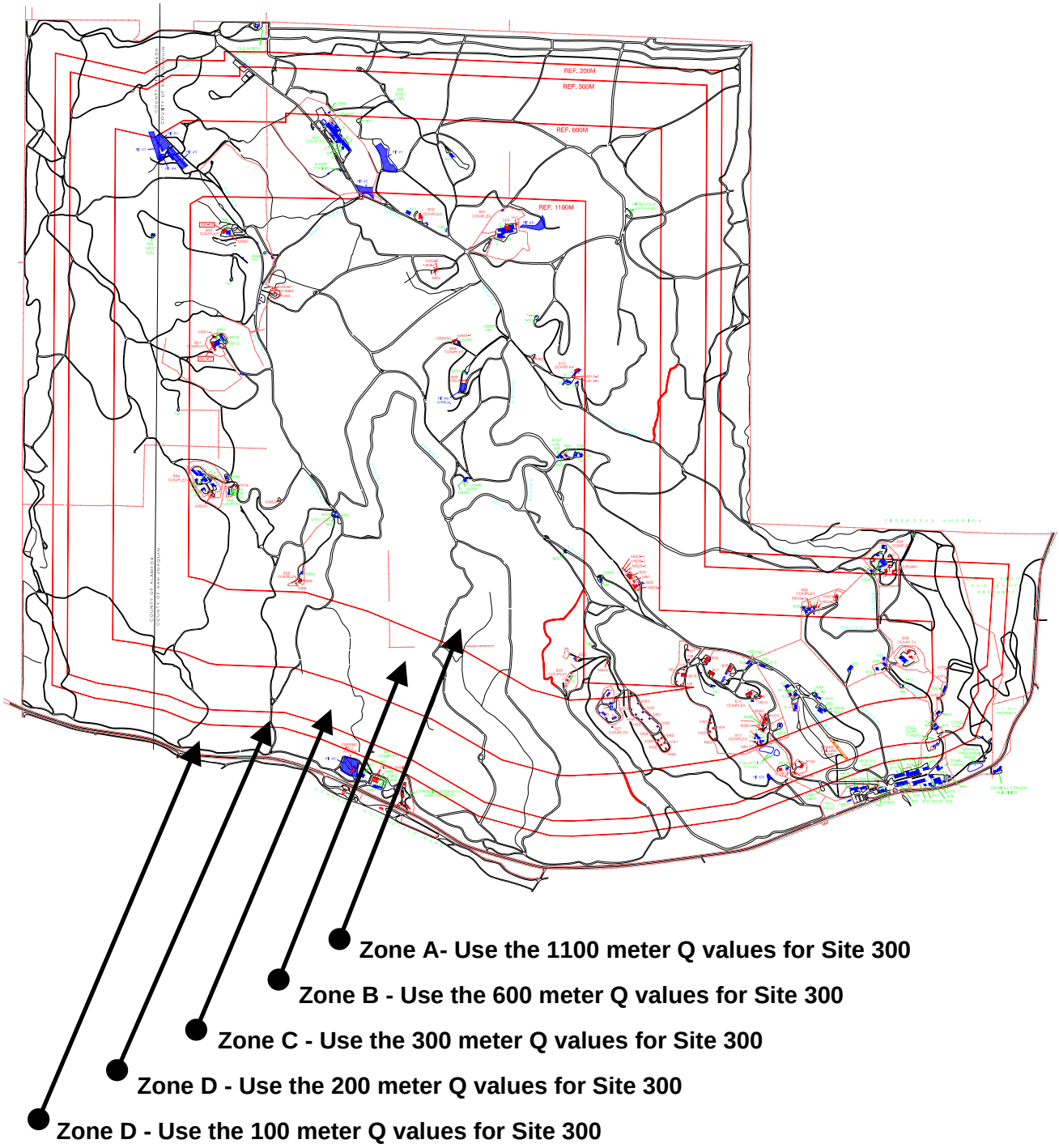


Appendix F

Zone Maps



Site 200 Zone Map to Determine Default Distances for Q Values



Zone A- Use the 1100 meter Q values for Site 300

Zone B - Use the 600 meter Q values for Site 300

Zone C - Use the 300 meter Q values for Site 300

Zone D - Use the 200 meter Q values for Site 300

Zone D - Use the 100 meter Q values for Site 300

Site 300 Zone Map to Determine Default Distances for Q Values

Appendix G

Examples of Completed Hazard Evaluation Table

Note: These are only examples. Other formats are equally acceptable. The only requirement is to capture, in an easily understood form, the following information:

- Event number [designators may include an alphanumeric indicator for event category (e.g., spill, fire, explosion, earthquake) to assist in subsequent sorting].
- Hazards involved.
- Location.
- Postulated event description.
- Causes/Initiators (e.g., failure, error, operational/environmental condition that initiated event).
- Unmitigated risks (no barriers or controls to reduce the consequences).
- Preventative design and administrative features.
- Mitigative design and administrative feature.
- Qualitative probabilities/frequency estimates.

Example of a Hazard Evaluation Table

Hazard Summary					Controls		Event Rankings			Notes
Event	**Location**	**Hazard**	**Scenario**	**Cause**	**Preventive Features**	**Mitigative Features**	**Consequence**	**Frequency**	**Unmitigated Risk Conclusion**	
S-1	Room A-17, Analytical chemistry lab	Chemical (acid)	Nitric acid tank spill	Seismic event, vehicle impact	**Design:** Steel vessel Seismic mounting Cement barriers **Administrative:** Procedures, trained personnel, PPE	**Design:** Building ventilation to an elevated stack **Administrative:** Emergency response procedures, emergency response training, PPE	**Colocated Worker** Potentially C based on generic F at 1 m/sec Q-list **Public** Potentially C based on generic F at 1 m/sec Q-list	Marginal	Accident analysis is not required	
F-1	Outside Storage Shed C	Chemical (acid)	Fire in combustible building housing 300 kg of acid solution	Electrical short; thermal energy from electrical equipment, human error; unknown ignition source	**Design:** Electrical equipment design code, NFPA standard **Administrative:** Combustible material control, procedures, trained personnel	**Design:** None **Administrative:** Fire Department response, emergency operating procedures, trained personnel	**Colocated Worker** Potentially B based on generic F at 1 m/sec Q-list **Public** Potentially A based on generic F at 1 m/sec Q-list	Expected	Accident analysis is required	Thermal plume may produce acceptable risk results in accident analysis. Legacy inventory. Facility management preparing to remove most material.

Event CHEM-3: Spill of HCl containers throughout the facility due to a seismic event

Causes:	1. Natural Phenomena—seismic or wind event resulting in the direct or indirect application of mechanical energy.
Preventive Features:	**Design:** • Facility structure resistant to seismic and wind stresses. • Use of floor-mounted acid storage cabinets for hydrochloric acid. **Administrative:** • Operations consistent with the requirements of Part 14, "Chemicals," in the *ES&H Manual.* • Chemical hygiene plan as one specific element of Part 14. • Current inventory tracking via the ChemTrack system.
Mitigating Features:	**Design:** • Building ventilation provides for significant dilution of any airborne release both internally and by directing the release to a 38 m elevated stack. • Building shell provides a significant dilution and deposition volume for any airborne release after loss of power (e.g., seismic event). • Fire suppression system limits potential for fire growth and propagation. Administrative: • Facility and institutional emergency response plans.
Unmitigated consequences:	Per *ES&H Manual* Document 3.1, the overall facility quantities have the potential to exceed generic Q-list values. Therefore, the event is forwarded directly to accident analysis without ranking in the Analysis Level Matrix.
Probability:	Expected for an event doing little damage. Marginal or less for an event doing severe damage. **Note:** Facility seismic design, in current terms, generally correlates to Performance Category 2.
Comments:	Accident analysis is required.

Appendix H

Use and Application of Operational Safety Requirements

This appendix provides generic OSR materials. Specifically, it provides an example Use and Application Section (H.1-H.3), specifies generic MFRs and TRs to be used if MFRS are applicable (H.4-H.6), and states the administrative control required for deviations from OSRs (H.7).

The Use and Application section is the first section in OSRs that utilize MFR controls. It contains basic information and instructions for using and applying the information found in the OSRs. The following minimum elements shown in the examples of this Appendix (H.1-H.3) must be addressed: (1) definitions, (2) operational modes, and (3) frequency notation.

The MFR/TR section is the second section in OSRs that utilize MFR controls. When MFRS are assigned, they are preceded by a standard set of generic MFRs and TRs that define the logical framework within which the facility-specific MFRs and TRs operate. The language for generic MFRs and TRs is standardized as cited in Sections H.5 and H.6.

The Administrative Control section is the third section in OSRs that utilizes MFR controls of those noted in the first section that do not. The first Administrative Control is always Z.1 (H.7 in this appendix), which generically defines the requirements for what constitutes an OSR violation and what must be done in response to such violations. The language for this control is also standardized.

As noted above, a Use and Application section, modified per a given facility's needs, and the generic MFRs and TRs need only be included in OSRs if MFRs are assigned as controls. The provisions for deviations from OSRs are applicable to all OSRs. However, they may simply be referenced in the OSRs for a specific facility as opposed to verbatim reproduction. Where this is done, the annotation "Per ES&H Manual Document 3.1" is the only entry required under the heading "Z.1 Deviations from OSRs."

USE AND APPLICATION

H.1 Definitions

The definitions in Table H-1 are applicable to Building _____ OSRs. The defined terms appear in capitalized type.

TableH-1. Definitions of terms.

Term	Definition
ACTIONS	The steps listed in each requirement required to be performed when the specified MFR is not met.
ADMINISTRATIVE CONTROLS	OSR controls not establishing requirements for structures, systems, and components and maintained solely as a management function.
AUTHORIZATION BASIS	Those aspects of the facility design basis and operational requirements relied upon to authorize operation
COMPLETION TIME	The amount of time required to complete an action.
DESIGN FEATURE	Passive structures, systems, and components of a facility specified in the OSRs that, if altered or modified, would have a significant effect on safe operation.
EXPLOSIVES	Any chemical compound or mechanical mixture which is designed to function as an explosive, or a chemical compound which functions through self-reaction as an explosive and which, when subjected to heat, impact, friction, shock or other suitable initiation stimulus, undergoes a very rapid chemical change with the evolution of large volumes of highly heated gases that exert pressures in the surrounding medium. The term applies to materials that either detonate or deflagrate.
HAZARDOUS MATERIAL	Material which, if unconfined, could result in an unacceptable consequence to the onsite worker or the public. Hazardous Material has one or more of the following characteristics: (a) has a flash point below 140°F or is subject to spontaneous heating; (b) has a threshold limit value below 500 ppm for gases and vapors, below 500 mg/m^3 for fumes, and below 25 mp/ft^3 (million particles per cubic foot) for dusts; (c) has a single dose oral LD50 below 50 mg/kg; (d) is subject to polymerization with the release of large amounts of energy; (e) is a strong oxidizing or reducing agent; or (g) in the course of normal operations, may produce dusts, gases, fumes, vapors, mists, or smokes that have one or more of the above characteristics. Also included are substances that are carcinogens that damage the lungs, skin, eyes, or mucous membranes.
IMMEDIATELY	As a COMPLETION TIME, the minimal amount of time required to safely complete the activity, not to exceed 1 hour.

Table H-1. Definitions of terms (cont'd).

Term	Definition
MINIMUM FUNCTIONAL REQUIREMENTS (MFR)	The lowest functional capability or performance levels of equipment, restrictive parameters, or states required for safe operation of the facility.
MODE	Any facility condition specified in Section 1.2, Modes.
OPERABLE/OPERABILITY	A system, subsystem, train, component, or device is OPERABLE or has OPERABILITY when it is capable of performing its specified function(s) and when all necessary attendant instrumentation, controls, electrical power, cooling water, lubrication, or other auxiliary equipment required for the system, subsystem, train, component, or device to perform its function(s) are also capable of performing their related support function(s).
OPERATIONAL SAFETY REQUIREMENT (OSR)	A requirement that defines the bounding conditions for safe operation to reduce the potential risk to the public and co-located workers from facility hazards.
STORAGE	EXPLOSIVES, RADIOACTIVE and HAZARDOUS MATERIAL inventories are held stationary in authorized containers and locations. Limited periods of being held in place during an operation do not constitute storage.
RADIOACTIVE MATERIALS	Material that emits alpha, gamma, or neutron radiation and contains 1 nCi or more of radioactivity, or items with surface activity levels exceeding those specified in Appendix D of the LLNL *ES&H Manual*.
TESTING REQUIREMENT (TR)	Requirements relating to testing, calibration, or inspection to ensure that the necessary OPERABILITY of systems and components is maintained or that operations are within the specified MFRs.

H.2 Operational MODES

MODES serve as a means of categorizing the operational status of Building _____. Typical MODES defined are OPERATION and STANDBY. Specific definitions appropriate for a given facility would be provided in Section 1.1. More complex operations sometimes include additional MODES such as SHUTDOWN or MAINTENANCE. The use of a number of detailed MODES is not expected for most facilities covered by this document.

H.3 Frequency Notations

The standard frequencies for TRs are defined in Table H-2.

Table H-2. Surveillance frequency notations.

Notation	Frequency
Hourly (H)	At least once per 60 minutes
Shift (S)	At least once per 12 hours
Daily (D)	At least once per 24 hours
Weekly (W)	At least once per 7 days
Monthly (M)	At least once per 31 days
Quarterly (Q)	At least once per 92 days
Semiannually (SA)	At least once per 184 days
9 Months	At least once per 274 days
Annually (A)	At least once per 365 days
18 Months	At least once per 548 days
N.A.	Not applicable

H.4 MFRS AND SRS

H.5 Generic Minimum Functional Requirements

MFR 2.0.1	MFRs must be met during the MODES specified in the Applicability, except as provided in MFR 2.0.2. Completion of the required ACTIONS for the MODE is considered to be in compliance with the applicability of the MODE.
MFR 2.0.2	Upon discovery of a failure to meet an MFR, the associated ACTIONS must be met. If the MFR is restored before the specified COMPLETION TIME(S) expires, completion of the ACTION is not required, unless otherwise stated.
MFR 2.0.3	When an MFR is not met and the associated ACTIONS are not met, or when an associated ACTION is not provided, operations shall cease IMMEDIATELY and the facility shall be placed in the safest MODE for which the MFR is not applicable within 24 hours. Only those RADIOACTIVE, HAZARDOUS, OR EXPLOSIVES MATERIAL movements necessary to place or maintain the facility in a safe condition may occur. Any such movements or transfers must be approved by the Facility Manager. Where corrective measures are completed that permit operation in accordance with the MFR or ACTIONS, completion of the ACTIONS required by MFR 2.0.3 is not required. MFR 2.0.3 is applicable to the OPERATION MODE. Exceptions to MFR 2.0.3 may be stated in the individual MFRs.
MFR 2.0.4	Equipment removed from service or declared inoperable to comply with ACTIONS may be returned to service under administrative control solely to perform testing required to demonstrate its OPERABILITY, or the OPERABILITY of other equipment. This is an exception to MFR 2.0.2.
MFR 2.0.5	When a support system is inoperable and an MFR for that support system is specified in the TSRs, the supported system is not required to be declared inoperable due solely to the support system inoperability. Only the support system's ACTIONS are required to be entered. This is a clarification of the definition of OPERABILITY. MFR 2.0.2 is still applicable to the supported system.

H.6 Generic Testing Requirements

TR 3.0.1	TRs must be met during the operational MODES or other conditions specified for individual MFRs unless otherwise stated in the TR. Surveillances do not have to be performed on inoperable equipment or variables outside specified limits.
TR 3.0.2	Each TR shall be performed within the specified frequency. The specified frequency is considered met if the surveillance is performed within 1.25 times the interval specified in the frequency as measured from the previous performance or as measured from the time a specified condition of the frequency is met. Exceptions to TR 4.0.2 are stated in the individual TRs.
TR 3.0.3	If it is discovered that a surveillance was not performed within its specified frequency, compliance with the requirement to declare the MFR not met may be delayed from the time of discovery up to 24 hours, or up to the limit of the specified frequency, whichever is less. This delay period is permitted to allow performance of the surveillance. **Note:** The original failure to perform a TR within its specified frequency must still be reported as an OSR violation. If the surveillance is not performed within the delay period, or if it is performed and the surveillance is not met, the MFR shall IMMEDIATELY be declared not met, and the applicable ACTIONS shall be entered. The COMPLETION TIMES of the ACTIONS begin IMMEDIATELY on failure to meet the surveillance.
TR 3.0.4	Entry into an Operational Mode or other specified condition shall not be made unless the TRs associated with the MFRs have been performed within the stated surveillance interval or as otherwise specified.

H.7 Deviations from Operational Safety Requirements

The OSRs define the controls needed to ensure that the facility/operation remains within the AUTHORIZATION BASIS established. They shall be formally controlled with all changes requiring approval at the same level as the associated AUTHORIZATION BASIS document.

H.7.1 Compliance

The Facility Manager is responsible for ensuring that the OSR requirements are met. Compliance is demonstrated by:

- Maintaining facility operation within any MFRs, performing the associated TRs during their applicability, and taking any ACTIONS defined by the MFRs when required.
- Establishing, implementing, and maintaining the ACs identified in this document.

H.7.2 Violation

Violation of an OSR occurs as a result of three circumstances:

- Failure to complete an ACTION statement within the required time limit following failure to comply with an MFR;
- Failure to perform a TR within the required time limit; or

- Failure to comply with an AC statement.

Failure to comply with a specific AC constitutes an OSR violation. For programmatic ACs, violation occurs when the failure is of sufficient magnitude that the overall intent of the referenced program is not fulfilled.

H.7.3 Response to Violations

Response to an MFR Violation

If any MFR is violated, as stated above, proceed as follows:

1. Place the building in a safe condition by entering MFR 2.0.3.
2. Notify the AUTHORIZATION BASIS signature authority in accordance with applicable LLNL procedures.
3. Prepare an Occurrence Report Notification in accordance with applicable LLNL procedures.

Response to a TR Violation

If a STR has not been performed within the required frequency, proceed as follows:

1. Enter TR 3.0.3 and perform the TR within 24 hours.
   a. If the TR is successfully met, exit TR 3.0.3 and continue operation in a compliant condition. NOTE: Steps 2 and 3 below must still be completed.
   b. If the TR is not successfully met, enter the action of the applicable MFR.
2. Notify the AUTHORIZATION BASIS signature authority in accordance with applicable LLNL procedures.
3. Prepare an Occurrence Report Notification in accordance with applicable LLNL procedures.

Administrative Control Violation

If an Administrative Control is violated, proceed as follows:

1. Place the facility in a safe condition, and notify the AUTHORIZATION BASIS signature authority.
2. Prepare an Occurrence Report.
3. Prepare a recovery plan, if appropriate, describing the steps leading to compliance with the Administrative Control.
4. Perform and document a technical evaluation, if appropriate, of the Administrative Control violation to determine if any damage occurred.

H.7.4 Emergency Actions

Emergency actions may be taken that depart from a requirement in the OSR provided that:

- An emergency situation exists;
- These actions are needed immediately to protect health and safety; and
- No action consistent with the OSR can provide adequate or equivalent protection.

Such emergency actions shall be performed by personnel trained and qualified for the necessary equipment or systems. If an emergency action is taken, the AUTHORIZATION BASIS signature authority should be notified as soon as is practically possible.

Appendix I

Change Control Form for Safety Basis Documents

Facility name/number:	**Change control form number:** **Date:**
Preparer's name/ Signature:	**Telephone ext:**
Current classification of facility (check): **___LSI ___Low ___Moderate ___High hazard**	**Current classification of hazard type to be evaluated (check):** **___LSI ___Low ___Moderate ___High hazard**
Describe the proposed change (or other change control entry condition):	

Step 1 Check the change control entry condition that applies.

_____A proposed change in inventory or operations beyond that authorized in existing SBD.

_____The discovery that previous analyses were inadequate (e.g., a potential hazard was discovered but not identified or was incorrectly analyzed in the SBE document).

_____A modification of credited controls.

_____A change in the Work Smart Standard for the safety analysis of non-nuclear facilities or table entries upon which the analysis process is based in the various standards (DOE-S-1027, 40 CFR 302.4, TEEL tables, Q-D constants, BSL definitions).

_____The facility hazard classification is being reduced.

If none of these apply, a Change Control Form does not apply.

Step 2 Does the proposed change exceed the facility's current classification?

___Yes ___No

Does the proposed change exceed the current classification of the hazard type to be evaluated?

___Yes ___No

Is the facility classification being reduced?

___Yes ____No (If yes, submit this form to original signatory authority for approval of classification downgrade. Attach new SBD, as required.)

Step 3 For Low, Moderate, or High hazard types, go to step 5. For LSI hazard types:

If answers to all of the questions above are No, form complete. Go to Step 4.

If Yes, check option selected:

_____Revise proposed change to meet LSI classification, add new hazard to screening form and go to Step 4.

_____Update screening form and evaluate need for Tier 2 or 3 SBD. Approval authority per *ES&H Manual* Document 3.1, Table 9: Residual Risk Matrix.

Step 4. Submit form to facility management for approval.

Facility Management's Name/Title:

_____

Telephone ext:_____ **L-code:**_____

Signature:_____ **Date:**_____

This form shall be maintained in file with facility SBD.

Step 5 For low, moderate, or High hazard facilities:

Evaluate the proposed change (or other proposed change control entry condition), against the following criteria. Do any of the following apply?

☐ 1. Could the proposed change (or other change control entry condition) shift an event to a higher risk bin (Figure 3, Analysis Level Matrix) due to an increase in probability and/or consequence? **If yes, go to 5b**.

☐ 2. Could the proposed change (or other change control entry condition) create the possibility of a new credible event not previously analyzed? **If yes, go to 5b.**

☐ 3. Could proposed change compromise a credited control, or does it require a new control? **If yes, go to step 5d.2.**

5a. If all answers are no, then a negative finding is concluded, and no further evaluation is required. Go to Step 4.

5b. If answers to questions 1 or 2 are yes,

1. Describe scenarios:

2. **Estimate worst-case-scenario:**

Consequence:

Frequency:

(Attach analysis if more room needed)

5c. Compare against Analysis Level Matrix (*ES&H Manual* Document 3.1, Fig. X).

1. **If final ranking is in Hazard Analysis space:**

   A. If new hazard condition fits into the same or lesser risk bin than the original analysis for hazard type, then a negative finding is concluded. Go to Step 4.

   B. If risk bin has increased due to new hazard condition, check mitigated impact to nearby facilities per *ES&H Manual* Document 3.1, Section 4.0. Attach all analyses. Finding is positive: Go to step 6 for AD approval.

2. **If final rankings are in Accident Analysis space, go to 5d.**

5d. Compare to Residual Risk Matrix.

1. **If approval level for hazard type and facility does not increase, go to original signatory for approval. (Finding is positive since additional analysis was needed.)**

2. **If approval level does increase, complete one of the following:**

   A. Develop new credited controls to reduce the risk to original approval level and develop new or revised OSR(s). Check mitigated impact to nearby facilities per *ES&H Manual* Document 3.1, Section 4.0, and communicate as needed. Attach all analyses. Finding is positive: Go to step 6.

   B. Resubmit revised SBD to higher authority with justification.

Approval Level:_____

Attach all analyses to this form

Step 6. Submit form for approval.

Preparer signature:_____**Date:**_____

ES&H Team Leader (or Designee)_____**Date:**_____

AB Section Leader (or Designee)_____**Date:**_____

Facility Management Designee_____ **Date:**_____

AD Signature_____**Date:**_____

If higher level per 5d, item 2b:

Name/Title:_____

Signature:_____**Date:**_____

Name/Title:_____

Signature:_____**Date:**_____

Appendix J

Change Control Form for Accelerator Facilities

[Instructions for using form: All instructions in square brackets are to be removed from the final document. All italicized items are to be REPLACED by the appropriate facility or other information (and reformatted). Shaded parts of the form are to be used only if required by the content of the document and should be deleted if not required.]

BUILDING *XXX*

Unreviewed Safety Issue

USI No.: *BXXX-###—Yr*

Title of facility management organization

Date

☐ This issue does not constitute a safety issue **[**all answers are no**]**. The cognizant facility manager approves continued operation.

☐ This issue does constitute a safety issue **[**one or more yes answers**]**. The original authorizing office approves continued operation.

Prepared by: _____

Name, Title or Function Date
[e.g., Safety Analyst]

Operation
Approved by: _____

Name, Title or Function Date
[e.g., Facility Manager or Original Authorizing Office]

Part I Introduction

An unreviewed safety issue has been identified resulting from:

- ☐ A proposed change of inventory or operations.
- ☐ A newly noted potential safety hazard.
- ☐ A discovery that previous safety analyses were inadequate.

This evaluation of the safety issue is summarized in the following Parts II through V.

- ☐ See attachment for details of analysis and supporting documentation.
- ☐ No attachments.

1. Issue:

   Describe the information being evaluated and the operation that it affects.

2. References used to perform the safety evaluation:
   [Add or remove references as appropriate.]

LLNL EIS/EIR	
FSPs, OSPs	*optional*
Existing Safety Assessment	

Part II Impact on the Existing Operation

1. Controls and equipment that are affected:
   List existing controls and equipment that are affected by the new information. Identify any of these structures, systems, or components (SSCs) that are essential for protection of the public (required to protect the public or prevent adverse environmental effects) or workers (required to prevent acute worker fatality or serious injuries to workers).

2. New SSC failure modes:
   Describe how the new information changes understanding of the ways in which the existing controls and equipment might fail.

3. List the accidents in the existing safety basis that are controlled by affected SSCs:
   Identify any previously analyzed or considered accidents that are affected by the changed failure modes.

4. Effect of SSC failure on existing safety basis:
   Describe how these accidents are affected, including new means of initiation, changes in probability, and changes in consequence.

Part III Potential for a New Accident

1. Describe any possible new accidents:
   Identify each accident type with enough detail to suggest possible scenarios to be analyzed. Use the Analysis Level Matrix to determine if accident analysis is required.

2. Analysis of accident:
   Provide an appropriate analysis of the probability and consequence of the new accident. This may be the equivalent of a hazard analysis (as described in Section 2.4) or it may be an accident analysis (as described in Section 2.5). A short analysis may be entered here. For more detailed analysis, provide a summary here and append the details to this Form.

Part IV Impact on the Accelerator Safety Envelope

1. Affected Accelerator Safety Envelope (ASE) elements:
   List operating limits, access controls and other controls shown in the SAD to be essential to safety that are affected.

2. Compare the existing operating conditions to the ASE elements:
   Examples: Normal beam energy vs. limiting energy, radiation field intensity vs. shielding requirements and detector alarm settings.

3. Compare the new operating conditions to the ASE elements.
   Identify any in which the operating conditions have come significantly closer to their limits.

4. Required new ASEs:
   Examples: New radiation detectors, new shield configuration, longer cool-off after beam shutdown.

5. ASE changes:
   Describe changes to existing ASEs required to provide safety because of this safety issue.

Part V Summary and Conclusions

Summary Questions		Yes	No
Is the probability of a safety system malfunction higher than previously expected?	(Part II Item 2)	☐	☐
Are the probability or consequences of a previously analyzed accident increased?	(Part II Item 4)	☐	☐
Is there potential for a new type of accident?	(Part III)	☐	☐
Is the safety of operation decreased?	(Part IV Item 3)	☐	☐
Are any new ASEs needed?	(Part IV Item 4)	☐	☐
Are there any changes to the ASEs needed?	(Part IV Item 5)	☐	☐

☐ This issue does not constitute a safety issue (all answers are no). The cognizant facility manager approves continued operation.

☐ This issue does constitute a safety issue (one or more yes answers). The original authorizing office approves continued operation.