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Management of Facility Design and Construction

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Management of Facility Design and Construction

1.0 Introduction

Accomplishing facility design and construction successfully and safely is essential to the success of any LLNL endeavor. Inadequate design considerations can have adverse financial impact and can even cause programmatic failure, as well as personnel injury or even loss of life. DOE directives require environment, safety, and health (ES&H) hazard analyses as part of the project documentation for new construction, modifications to existing buildings, and upgrades to utilities. Therefore, design and construction hazards are managed in a graded and formal manner. "Good engineering practice" may be a commonly understood and accepted term, but only careful management will make it a reality.

This document contains requirements and guidance for LLNL project planners and authorizing organizations in managing the facility design and construction process, as well as implementing the first three functions of Integrated Safety Management (ISM). See Document 2.2, "Managing ES&H for LLNL Work," in the *ES&H Manual* for more details about the ISM process.

Some of the items covered in the previous version of this document have been omitted. See Appendix A for a list of the items and pointers to the documents containing related guidance. This document covers the following:

- Management of facility design and construction activities at LLNL, including modification to existing facilities and equipment, from the conceptual design through the construction stage.
- Flowdown of ES&H requirements to facility design and construction subcontracts.
- Hazard identification and risk assessment in facility design and construction.
- Facility design considerations that are unique to LLNL.
- Facility equipment specification considerations.
- Safety notes.

Plant Engineering is generally responsible for the management of conventional facility design and construction at LLNL. The task of ES&H personnel assigned to a project is to assess hazards and conduct safety analyses and ensure that the results of these are addressed by facility design and that construction activities are conducted safely.

The activity of design as described in this document corresponds to the engineered controls defined in Document 2.2. Although all applicable Work Smart Standards (WSSs) shall be applied to facility design and construction, the term "WSS" should not be used in subcontracts. See Section 3.0 for guidance on this and other special design and construction subcontract flowdowns.

2.0 Facility Design Practice at LLNL

Hazard identification and risk assessment are in general conducted early in the design process, in the Pre-Title I and Title I phases. (The four phases are defined below.) In these phases, involvement by institutional team members (i.e., the Hazards Control Environmental Protection, and Safeguards and Security Departments and others specified in Section 2.2) with the designers is crucial to ensure that hazard and risk assessments are timely and correctly conceived. In the Title II phase, ES&H involvement consists of reviewing the unfolding design to ensure it conforms to earlier ES&H assessments.

2.1 Phases of Design and Construction

Facility design and construction projects comprise four phases of work:

- Pre-Title I—Conceptual design.
- Title I—Preliminary design.
- Title II—Design.
- Title III—Construction.

Table 1 shows the documents and governing procedures for each of the four phases of design and construction, which are discussed in detail in the following subsections.

2.1.1 Pre-Title I (Conceptual Design)

Conceptual design describes the intended result of a project. It incorporates the programmatic client's functional criteria for the facility, the results of discussions from the authorizing organization and project team, the designation of safety analyses, National Environmental Policy Act (NEPA) process or evaluation required for the facility, and proposed design approaches for the facility. Preliminary hazard identification and risk assessment are conducted in this phase. Conceptual design activity may result in the preparation of a conceptual design report (which essentially is a technical funding proposal) and may also result in the preparation of a formal basis-of-design document, which may be used as a benchmark in building commissioning.

Table 1. Documents and governing requirements for the phases of design and construction.

Phase	Governing requirements	Example Documents
All phases	Work Management Plan (WMP) for Title I, II, and III Project Reviews in Plant Engineering (Rev. 1)	Safety analysis/screening document
Pre-Title I (conceptual design)	Document 3.1, "Safety Analysis Program," in the <i>ES&H Manual</i> Document 3.5, "Environmental Planning," in the <i>ES&H Manual</i> Relevant WSSs and standards of good practice not in the WSS set	Environmental documents: National Environmental Policy Act and California Environmental Quality Act review, categorical exclusions (CXs), Environmental Assessment, Environmental Impact Report, and permits Basis of design Conceptual design report
Title I (preliminary design)	Relevant WSSs DOE Order 420.1	Design criteria Fire hazards analysis
Title II (design)	Use of Standards at LLNL [Plant Engineering Management Policy Memorandum (MPM) 26] Signatures on Drawings and Specifications (Plant Engineering MPM 28)	Design drawings Construction specifications Equipment specifications
Title III (construction)	Document 2.4, "Construction Subcontractor ES&H Program," in the <i>ES&H Manual</i> Document 2.5, "Procured Services Subcontractor ES&H Program," in the <i>ES&H Manual</i>	As-built drawings and specifications Integration Work Sheet (IWS) Subcontractor corporate safety plan, Project Safety Plan, Task Identification Process (TIP) List Task-specific safety plan
Facility acceptance, placing in Operation	Document 2.2 Document 3.3, "Operational and Facility Safety Plans," in the <i>ES&H Manual</i>	Project closeout documents (e.g., warranties and maintenance and operations manuals) Authorization Basis Documents, Facility Safety Plans (FSPs), and Operational Safety Plans (OSPs)

2.1.2 Title I (Preliminary Design)

Preliminary design in general consists of the development of formal design criteria, which divides the proposed design work by engineering discipline and states the technical criteria by which the design work is to proceed and be evaluated. Hazard identification and risk analysis, including development of the Fire Hazards Analysis (FHA), may continue during this phase; preliminary safety analyses prepared during the Pre-Title I phase may also be fine-tuned during the Title I phase. Design criteria that are prepared for use by outside architectural engineering firms also contain contractual requirements (e.g., proposed schedules, design review milestones, and acceptance criteria for deliverables).

2.1.3 Title II (Design)

Design activity "fleshes out" the preliminary design into a set of detailed specifications and drawings that describe the proposed facility in sufficient detail for actual construction. ES&H activity is in general confined to ensuring that the detailed design incorporates the results of earlier safety analyses.

2.1.4 Title III (Construction)

Construction activity uses the facility design to build the facility. Because no design can address all the contingencies that may arise during construction, a certain amount of design activity usually occurs during construction, in general in the form of addressing a contractor's requests for information or clarification or evaluating proposed changes to the original design that may arise as construction progresses. Changes to the original design are recorded as they occur and, at the end of construction, are incorporated into a set of revised drawings and specifications called "as-builts." Integration Work Sheets (IWSs) need to be prepared before construction activities begin.

ES&H activity in this phase is complex and is thoroughly described in Document 2.4, "Construction Subcontractor Environment, Safety, and Health Program," and Document 2.5, "Procured Services Subcontractor Environment, Safety, and Health Program," in the *ES&H Manual*.

2.2 Roles and Responsibilities for Management of Facility Design and Construction

Facility design at LLNL is a collaborative effort that involves the authorizing organization requesting the design, facility design professionals in several engineering disciplines, health and safety specialists and analysts, environmental protection analysts, and safeguards and security specialists. The roles and responsibilities of each member of the project team are detailed in the Work Management Plan (WMP) for Title I, II, and III Project Reviews in Plant Engineering. Roles and responsibilities in general applicable to ES&H are specified in Section 8.0. In a typical project, the design professionals produce a design, and the analysts critique the design in their respective areas during design reviews.

Because facility design is a collaborative effort, project management is essential to its success. A designated project manager takes responsibility for assuring that all team members meet at scheduled times to discuss design issues and that all comments are resolved. Procedures for issue resolution and change control in the project environment are detailed in the WMP. A project execution plan is prepared to further detail roles and responsibilities. For large, complex projects, a dedicated project manager from the Plant

Engineering Department or the directorate is essential. For small projects, the role of project manager may be assumed by the project's lead engineer.

Variables in project management that influence the rigor of the management process are:

- Number and special credentials of team members.
- Number and frequency of design review meetings.
- Quality and formality of design review packages.

Project management is implemented at LLNL in accordance with DOE O 413.3, *Program and Project Management for the Acquisition of Capital Assets*. The complex project management interface between LLNL, DOE, and the University of California is beyond the scope of this document. For more information, refer to the *Project Management Procedures Manual*, a Plant Engineering document intended for project managers and available at the following Internet address:

http://www-r.llnl.gov/plant_eng/pe-library/library.html

2.2.1 Authorities Having Jurisdiction

Authorities having jurisdiction (AHJs) for facilities are personnel who are authorized as final arbiters of design issues in their respective departments. Conflicts that arise during the design process and that cannot be resolved between the project team and their respective line management shall be referred to the appropriate AHJ for resolution. Facility AHJs reside in the Plant Engineering and Hazards Control Departments. For AHJ issues associated with programmatic electrical equipment, see Document 16.3, "LLNL Authority Having Jurisdiction Requirements for Approving Electrical Equipment, Installations, and Work," in the *ES&H Manual*.

2.3 Management of Design

All facility design shall be conducted by experienced, qualified design professionals. Plant Engineering management ensures that the design staff has the expertise and experience (e.g., in exhaust ventilation, fire suppression, electrical work, and pressure) with the codes and standards that govern the work of their discipline. Compliance with the standards and codes (which address health and safety issues) and reducing the life cycle costs are often as important as a designer's technical competency in designing safe facilities.

Designers on facility projects are in general under dual management, i.e., under the direction of both a project manager (who sees that the objectives of the project are met) and the Design and Construction (D&C) Division of the Plant Engineering Department.

2.3.1 Use of Standards in Design

Design practice is increasingly governed by national and international codes and consensus standards. In addition, as part of government's general cost-reduction efforts in the 1990s, DOE promoted the use of voluntary consensus standards and codes and other government agency standards (when existing) in lieu of DOE-generated standards. The use of standards at LLNL is addressed in Plant Engineering Management Policy Memoranda (MPM) 26, "Use of Standards at LLNL."

LLNL Work Smart Standards. LLNL's WSS set contains many standards and codes that have a bearing on facility design. Use of such standards, as applicable, is made mandatory by the University of California's (UC's) contract with DOE. However, many other standards that are routinely used in facility design are not specified in the WSS set. Because of the large number of such standards and the time-consuming task of selecting the appropriate standards for each project, the Plant Engineering Department maintains resources that save the designer time and ensure consistency from project to project. These resources are found in the *LLNL Facilities Specification* and LLNL Facilities Standards, discussed below.

LLNL Facilities Specification. The *LLNL Facilities Specification* is a set of approximately 200 specification sections for use in construction subcontracts. The sections are contract "boilerplate" that need to be tailored by qualified design professionals before being used in an actual construction subcontract. The *LLNL Facilities Specification* references approximately 300 national and international consensus standards and codes and is LLNL's definitive list of standards typically cited in facility construction work.

LLNL Facilities Standards. LLNL Facilities Standards are a set of approximately 50 design standards that define current facility design practice in several technical areas, i.e., civil, structural, architectural, mechanical, electrical, and industrial electronic. LLNL Facilities Standards are intended to provide design guidance to qualified design professionals. The documents are maintained by the Plant Engineering Department but are actually consensus standards that receive a wide LLNL institutional review prior to acceptance. The consensus process for review and approval of LLNL Facilities Standards is detailed in the Quality Assurance Plan for LLNL Facilities Standards.

2.3.2 Design Review

In design review, the work of design professionals is submitted to the other members of the project team for their evaluation. Design reviews give health and safety analysts,

environmental analysts, and security specialists the opportunity to verify that the design complies with the requirements of safety analysis documents (i.e., Screening Reports, Hazard Analysis Reports, Safety Analysis Reports, and environmental regulations), the applicable WSSs, and other aspects of LLNL's safety program. The design review process is detailed in the WMP.

The number and rigor of design reviews may vary depending on a project's size and complexity. Most projects have a Title I review (at the stage of 30% completion) and a Title II review (at 90% completion); some projects may elect to have additional reviews at other stages of project development.

2.3.3 Design Authorization

When a completed design is reviewed, and all project team member comments are resolved, the design shall be authorized before being released for construction. Authorization of a design is represented by signatures on drawings and specifications. Procedures for design authorization and signoff are contained in Plant Engineering MPM 28, "Signatures on Drawings and Specifications." A design shall be authorized by the following:

Client. The client's (i.e., authorizing individual's) signature signifies that the design is acceptable from the standpoint of the requesting authorizing organization.

Project Management. The project manager's signature signifies that the design conforms to DOE and LLNL contractual requirements (i.e., that the design has been reviewed by all the project team members) and that all comments have been resolved.

Design. The design signature signifies that the design conforms to D&C Division procedures and has been checked.

2.4 Management of Construction

Construction is begun only after the design has been authorized. However, minor construction may not require design. Construction at LLNL may be performed by construction subcontractors, the LLNL labor-only contractor, or Plant Engineering crafts personnel. Construction that requires little or no design is typically performed by the labor-only contractor or Plant Engineering crafts personnel. (For more information about construction without design, see Section 2.4.1.)

Construction Subcontractors. Construction subcontractors are managed by the project team in the person of the assigned construction manager. Because the construction contract is essentially the entire description of the work, all relevant design and construction requirements, including subcontractor safety requirements, shall be

unambiguously stated in the contract. Design drawings and specifications therefore need to be clear, thorough, and technically correct. Portions of LLNL's ES&H requirements that are not found in referenced codes and standards shall be restated in binding contract language and placed in the construction subcontract. IWSs associated with construction subcontracts are generic documents; the safety provisions of the subcontract and the subcontractor's safety plan govern all work of the subcontract.

Labor-Only Contractor. The labor-only contractor is managed by the Plant Engineering Department in the persons of Plant Engineering project and construction coordinators.

LLNL Crafts. Plant Engineering crafts personnel are Laboratory employees, and their work is governed directly by the *ES&H Manual*. Personnel performing installation work (e.g., asbestos and lead abatement, work on pressurized units, and electrical work) that requires specialized experience and expertise shall have received the appropriate training, be experienced in the work, and work under trained and experienced supervisors.

2.4.1 Management of Construction Without Design

Small construction jobs are often performed by the LLNL labor-only contractor or LLNL crafts personnel without a design. The Plant Engineering Work Induction Board (WIB), in consultation with the Plant Engineering Advisory Review Board (ARB), determines whether a job introduced [either by whiz tag (i.e., short-term work request) or job order] to the Plant Engineering Department requires a design.

Jobs that do not require a design are managed by the Plant Engineering job manager. Because no design review process applies, the safety aspects of such jobs are formally addressed in the IWS. The Plant Engineering Department maintains generic IWSs for common construction work that may be submitted by the job manager in support of the prestart meeting or walkthrough. Non-generic IWSs are prepared by the job manager and the ES&H Team representative at a prestart meeting or walkthrough and subsequently submitted electronically to the ES&H Team for review. Changes in IWS assessment that arise during construction are reviewed and authorized by the Plant Engineering coordinator and Hazards Control representatives and are documented in a revised IWS.

2.5 Placing in Operation

Before any facility is occupied or any new or significantly modified project begins operation, the authorizing organization shall conduct a prestart review. The formality and rigor of the review varies depending on the type and complexity of the hazards involved. For example, the review might consist of a joint walkthrough (i.e., final inspection) by representatives of the occupying or operating program, Plant

Engineering, and ES&H Team representatives or a formal review modeled on DOE-STD-3006 and Document 2.2, Appendix K. Program or facility management shall coordinate with the ES&H Team leader to determine the appropriate level of readiness review.

3.0 Flowdown of ES&H Requirements in Design and Construction Subcontracts

Design and construction at LLNL are commonly subcontracted activities. Therefore, the work to be performed shall be defined in a construction or architectural-engineering (A-E) subcontract. ES&H requirements are normally passed on to LLNL employees through Contract 48, the *ES&H Manual*, and training. Because subcontractor employees are not LLNL employees, these ES&H requirements shall flow down (i.e., be passed on) through a construction or A-E subcontract.

The primary means for flowing down the requirements is the *LLNL Facilities Specification* and the General Provisions of a subcontract. Division 1 of the *LLNL Facilities Specification* contains many provisions that directly flow down the ISM Clause (i.e., Clause 6.7) of Contract 48. In addition, a subcontract's Schedule of Articles, which is attached to every construction subcontract bid package, contains Clause 6.7 of Contract 48 in language suitable for inclusion in a subcontract. Applicable WSSs are specifically referenced in the *LLNL Facilities Specification*, as well. For detailed information on contractual flowdown of ISM requirements, contact the Plant Engineering Department.

4.0 Hazard Identification and Risk Assessment for Facility Design and Construction

Facility hazard identification and risk assessment are covered in Document 2.2 and in Document 3.1, "Safety Analysis Program," in the *ES&H Manual*. A facility's classification influences a design and how rigorously the design needs to be managed. Safety analysis documents, the facility hazard classification, and environmental regulatory requirements [e.g., NEPA, the California Environmental Quality Act (CEQA), and air, water, or waste permits] drive the performance criteria for design elements, e.g., seismic and wind design, ventilation, and egress. Special or unusual performance requirements (e.g., handling biological, toxic, radioactive, or explosive materials) also influence the makeup of the project team that will take the design through to construction.

If no special requirements are indicated in the safety analysis, FHA, environmental documents, or the hazard classification, then the prevailing building and life safety codes govern design. Relevant codes for design and construction are cited throughout the design documents and include the Uniform Building Code; the International

Building Code; the National Fire Protection Association (NFPA) codes; electrical, mechanical, plumbing, and life safety codes; and many others.

Hazard identification and risk assessment for construction is a collaborative effort. For construction subcontracts, the process is defined in Document 2.4. For LLNL crafts construction, IWSs are used to identify hazards and controls, and the ES&H Team monitors the work to ensure that safe conditions prevail.

4.1 Hazard Identification and Risk Assessment as Part of the Design Process

Hazard identification and risk assessment should be conducted as early as possible in the design process, in general during Pre-Title I and Title I. At this stage, involvement by Hazards Control and Environmental Protection team members is crucial to ensure that hazard and risk assessments are identified and addressed. During Title II, ES&H involvement consists of ensuring, through review, that the unfolding design conforms to earlier ES&H assessments and includes additional hazards that have been identified.

4.2 Special Hazards Information

Special hazards can have a large impact on design and construction. See Document 3.1 for information on hazards analysis for a range of special hazards.

4.3 Environmental Documentation

LLNL is required by NEPA and CEQA to incorporate measures into the planning and design of any project to identify and mitigate impacts to the environment (see Part 30, "General Environmental Controls," and Document 3.6, "Environmental Planning," in the *ES&H Manual*). Such measures are specified in "Mitigation Monitoring and Reporting Program for Continued Operation of Lawrence Livermore National Laboratory" and in the 1997 Environmental Impact Report Addendum for Continued Operations of Lawrence Livermore National Laboratory (see Section 9.3).

To ensure that sensitive resources are protected and managed appropriately, the Environmental Protection Department conducts cultural and biological resource surveys as part of early project planning.

If an Environmental Impact Statement or Environmental Assessment is determined to be needed, the program is required by DOE to provide the necessary planning and funding. The Environmental Protection Department can provide guidance and assistance in preparing the documents. Lower-level NEPA documents [e.g., for categorical exclusions (CXs)] are in general prepared by the Environmental Protection Department at no additional cost to the program (see Part 30 of the *ES&H Manual*).

Sources of pollution shall be controlled to protect the environment, as prescribed by applicable federal, state, and local environmental protection laws. Standard measures for controlling pollution that results from construction activities are part of every construction subcontract and are contained in Division 1 of the *LLNL Facilities Specification*.

4.4 Prohibited Materials

Use of certain building construction materials and compounds is prohibited at LLNL. Such materials include asbestos, lead (for certain applications), polychlorinated biphenyls (PCBs), and chlorinated fluorocarbons (CFCs). The following materials and operations can be used with the agreement of the ES&H Team during the predesign process if the use locations are noted in the design plans.

- Polyurethane paints or coatings.
- Epoxy paints or coatings.
- Chromate paints or primers.
- Lead-containing solders.
- Cadmium-containing brazing alloys.
- Any operation that is reasonably expected to result in overexposures to air contaminants.

Contact the ES&H Team for guidance. The *LLNL Facilities Specification* contains approved materials for most applications, as well as notice of blanket prohibitions.

5.0 Design and Construction Requirements Unique to LLNL

This section is intended to illustrate the areas in which facility design and construction at LLNL deviate from common construction industry practice. The requirements discussed here include only those requirements that would be passed on to outside architectural or engineering firms or construction subcontractors performing work at LLNL sites. This section does not cover special internal LLNL operations or programmatic requirements that would normally affect only employees of LLNL or DOE. Such internal requirements are covered elsewhere in the *ES&H Manual*.

Most design and construction requirements at LLNL are common industry practice. Facilities with high hazard classifications may have very stringent performance requirements that, although not common to commercial construction, are nevertheless common at DOE facilities or in the nuclear and chemical industries. Such special requirements are to be given detailed attention in the safety analyses, environmental

documents, and conceptual design documents. However, there remain a number of other requirements that are largely unique to LLNL and that outside architectural or engineering firms and construction subcontractors cannot be expected to know. Such requirements are detailed in the following tables:

Table 2—Outlines the various domains to which design and construction requirements apply.

Table 3—Explains the organization of the special requirements matrix shown in Table 4.

Table 4—Details the special requirements themselves.

Table 2. The domain of LLNL's special requirements.

Requirements subdomain	Description of subdomain
UC/DOE Contract 48 (includes WSSs)	As LLNL's prime operations contract, this document contains all DOE-specific requirements for LLNL operations. The requirements are in general enumerated in the other documents listed in this table. Exceptions are shown in Table 4.
UC/LLNL construction contracts, including the Terms and Conditions, General Requirements, and Special Requirements.	Nearly all ES&H and reporting requirements that pertain to construction are contained here. See Table 4 for specifics.
LLNL Facilities Design Standards and the <i>LLNL Facilities Specification</i>	The requirements of these documents do not typically deviate from industry practice. The documents define the subset of industry practice that LLNL has adopted as a site-specific standardization measure.
The LLNL <i>ES&H Manual</i>	The <i>ES&H Manual</i> is essentially an operations manual for the LLNL sites and is written for employees of LLNL. <i>ES&H Manual</i> operational requirements that are also contractor requirements but that are not addressed by codes in general appear in LLNL design standards and construction contracts. See Table 4 for specifics.
Safeguards and security requirements	Safeguards and security requirements almost universally derive from DOE orders specified in UC/DOE Contract 48. Many of the requirements have design and construction implications and are referenced in LLNL construction contracts and design standards. LLNL's primary source for safeguards and security requirements is DOE-M-5632.1C-1, "Manual for Protection and Control of Safeguards and Security Interests." See Table 4 for specific references to the documents.

Table 3. Column descriptions and abbreviations for Table 4.

Column heading	Description
Category	One of the following requirement categories: contractual, environmental, health, safety, security, or special design.
Requirement	Description of the special requirement.
Where cited	A list of the documents in which the requirement is cited. The following abbreviations are used: Document = <i>ES&H Manual</i> Document DOE STD = Department of Energy Standard LLNL FS = <i>LLNL Facilities Specification</i> PEL = LLNL Facilities Standards
Relevant reviews	A list of the LLNL interest areas that govern approval of the special requirement. The following interest areas are addressed: Environmental Protection, Hazards Control, Health Services, Material Management, Plant Engineering, Procurement, Security, and UC Legal.

Table 4. LLNL special requirements matrix.

Category	Requirement	Where cited	Relevant reviews
Contractual	Use of LLNL Special Requirements in Contracts UC/DOE contractual provisions are contained in the subcontract Terms and Conditions, the specification General Requirements, and the specification Special Requirements. All specifications written by outside A-E contractors shall include the language of these sections. In particular, the specification Special Requirements contain all special environmental, health, and safety requirements that LLNL passes on to its construction subcontractors.	LLNL FS, Division 1	UC Legal Procurement Environmental Protection Hazards Control Plant Engineering
Environmental	Protection of Historical Resources Provisions for the protection of historic resources are contained in the Special Requirements of the <i>LLNL Facilities Specification</i> .	LLNL FS 01010	Environmental Protection
Environmental	Storm Water Pollution Prevention Plan (SWPPP) LLNL has two site-specific SWPPPs (one for the Livermore site and one for Site 300) that are approved by the California Department of Water Resources. Provisions of the plans relevant to facilities construction are contained in the cited sources.	LLNL FS 01010	Plant Engineering Environmental Protection

Table 4. LLNL special requirements matrix. (cont'd)

Category	Requirement	Where cited	Relevant reviews
Environmental	Tracking Hazardous Materials Onsite LLNL has special requirements for tracking hazardous materials that are used in the performance of work at the LLNL Livermore site and Site 300. The requirements are contained in the Special Requirements of the <i>LLNL Facilities Specification</i> .	LLNL FS 01010	Environmental Protection Materials Management
Health	Warning Contractors of San Joaquin Valley Fever—Site 300 San Joaquin Valley fever is a potentially deadly disease caused by dust-borne fungus. The fungus is present in many of the soils of the San Joaquin valley and has been found at Site 300.	LLNL FS 01200	Hazards Control Health Services
Safety	Beryllium Handling	Document 14.4	Hazards Control
Safety	Construction Safety Construction safety at LLNL in general follows California and federal OSHA requirements. Further requirements are contained in cited sections of the <i>LLNL Facilities Specification</i> . LLNL requires all subcontractors to prepare and submit a safety plan prior to performing work. Requirements for construction subcontractor safety are contained in Document 2.4.	Document 2.4 LLNL FS 01200	Plant Engineering Hazards Control
Safety	Explosives	Document 17.1 <i>DOE Explosives Safety Manual</i>	Hazards Control
Security	Barrier and Delay Systems Doors, windows, unattended openings, walls, ceilings, floors, fences may be construed to be security barrier and delay systems and thus governed by LLNL security design provisions contained in DOE-M-5632.1C-1, which also contains relevant criteria.	DOE-M-5632.1C-1	Safeguards and Security Plant Engineering
Security	Door Locks LLNL has special security requirements for its door locks that are contained in the referenced documents.	PEL-A-2 LLNL FS 08712	Safeguards and Security Plant Engineering
Security	Lighting All designs for lighting systems shall comply to the provisions of the LLNL Security Lighting Plan.	LLNL Security Lighting Plan, Rev. 2	Safeguards and Security Plant Engineering

Table 4. LLNL special requirements matrix. (cont'd)

Category	Requirement	Where cited	Relevant reviews
Security	<p>Security Access Doors [single-door portal systems and controlled access by individual number (CAIN) booths]</p> <p>CAIN booths and similar secure entries are unique to facilities like LLNL. LLNL has developed special criteria for the construction of such entries that are contained in the referenced documents.</p>	LLNL FS 08318	Safeguards and Security Plant Engineering
Security	<p>Site Access Provisions</p> <p>Because of the presence of classified information and nuclear materials at the LLNL site, special security and site-access provisions apply to personnel working onsite. Site-access classifications are contained in DOE-M-5632.1C-1.</p> <p>Contractor access provisions are contained in the access provisions of the <i>LLNL Facilities Specification</i>.</p>	LLNL FS 01100 LLNL FS 01110 LLNL FS 01120 LLNL FS 01130 LLNL FS 01140 LLNL FS 01150	Safeguards and Security
Special Design	<p>Cathodic Protection</p> <p>Many underground mechanical utility systems at LLNL are protected from corrosion by a site-wide cathodic protection system, which should be considered in design. A description of the LLNL cathodic protection system is contained in design standards.</p>	PEL-M-02666	Plant Engineering
Special Design	<p>Design Standards and Master Specifications</p> <p>LLNL Facilities Standards and the <i>LLNL Facilities Specification</i> are prepared to identify the industry standards and codes adopted for use in LLNL facility design. Use of the standards and codes is required in design because they ensure conformity and cost effectiveness in subsequent facility maintenance, repair, and operation.</p>	All PELs All LLNL FS	Plant Engineering
Special Design	<p>Backup Power Systems</p> <p>All design for backup power systems shall be approved by the Plant Engineering Custom Power Group.</p>	PEL-E-16620	Plant Engineering

Table 4. LLNL special requirements matrix. (cont'd)

Category	Requirement	Where cited	Relevant reviews
Special Design	High-Pressure Systems Installation of high-pressure systems and containment vessels at LLNL is subject to review by the Hazards Control Department. Comprehensive guidance for the design of pressure vessels is contained in Document 18.2, "Pressure Vessel and System Design," and Document 18.3, "Pressure Testing," in the <i>ES&H Manual</i> .	Document 18.1 Document 18.2 Document 18.3	Hazards Control Plant Engineering
Special Design	Low Conductivity Water (LCW) System LLNL maintains a LCW system for use by programs to fulfill mission requirements. Requirements for the system are defined in the referenced LLNL design standards.	PEL-M-15484	Plant Engineering
Special Design	Maintaining Project and Facility Document Archives DOE requires that certain project documentation be archived for the life of the project and other documentation for the life of the facility. Brief criteria for document retention are contained in the Plant Engineering Project Filing System Guide, which is based on more-extensive criteria contained in DOE O 200.	DOE O 200.1	Plant Engineering
Special Design	Natural Phenomena Hazards Criteria DOE has established natural phenomena hazards criteria for use in determining the hazard rating of a facility. The hazards criteria in turn may determine the criteria to which a building is designed.	DOE STD 1020 94	Hazards Control Plant Engineering
Special Design	Panelboard and Circuit Numbering Panelboard schedules that are to be provided by subcontractors shall meet the provisions of PEL-E-16061A.	PEL-E-16061A	Plant Engineering
Special Design	Room Numbering System LLNL requirements for room numbering within a building are contained in PEL-A-01088.	PEL-A-01088	Plant Engineering
Special Design	Space and Site Planning All facility design involving siting of buildings, roads, or landscaping shall conform to provisions of the latest LLNL Site Master Plan.	1995 Site Development Plan	Plant Engineering

6.0 Equipment Specification Considerations

Design of special programmatic equipment is not covered in this document. This section contains guidance for LLNL purchases of equipment for conventional facilities that may require special performance specifications. For guidance on the design of programmatic equipment, contact the appropriate department in the Engineering Directorate.

Equipment performance specifications, even if prepared separately from construction subcontracts, requires collaborative efforts and discussions among the authorizing organization, designers, and ES&H personnel involved in design, fabrication, installation, and (possibly) maintenance. Special considerations in specifying equipment may include the following:

- The equipment may be unique or nearly so, and therefore no applicable design standards exist.
- The design may be the work of a single subject-matter expert with few peers qualified to review the work.
- Acceptance of custom fabricated equipment may require developing and conducting custom test procedures.

In general, equipment specifications should follow common industry practice and consensus codes and standards whenever such exist. Equipment should be procured instead of being fabricated whenever possible. Acceptance test procedures for equipment are often available from consensus standards organizations (e.g., the National Electrical Manufacturers Association and the Sheet Metal and Air Conditioning Contractors' National Association) and eliminate the need to write custom procedures.

LLNL organizations that commonly write equipment specifications (e.g., the Mechanical Engineering, Electrical Engineering, and Plant Engineering Departments) maintain libraries of successful specifications for future reuse. Master equipment specifications are often written for commonly purchased or fabricated items, and such "boilerplate" specifications can greatly increase the reliability of purchased or fabricated equipment.

Equipment that is purchased as a long-lead item often needs to be designed and specified before the bulk of the facility design is complete. The project team therefore shall take special care to ensure that the emerging facility design does not conflict with the requirements of the equipment specifications.

Equipment shall be tested and listed or labeled by a nationally recognized testing laboratory (NRTL) recognized by the Occupational Safety and Health Administration (OSHA) under 29 CFR 1910.7. Such NRTLs include, but are not limited to, Underwriters

Laboratories and Factory Mutual Research Corporation. If a vendor cannot supply NRTL-listed equipment, the Procurement and Materiel Department informs the equipment supervisor that the equipment shall be inspected by the AHJ before use.

7.0 Safety Notes

An LLNL safety note is a management-approved document that describes the anticipated hazards associated with a piece of equipment or a process, as well as the responsible engineer's approach, analysis, and rationale used to assure the design safety of the equipment, system, or process. A safety note:

- Identifies the significant hazards associated with the equipment or process.
- Identifies the standards, codes, or specifications that govern design and testing.
- Defines the inspection and testing requirements necessary to ensure that design products are in conformance with the safety note.
- Supplies additional information necessary to properly identify, operate, and maintain the equipment or process.
- Documents a management-approved design approach.
- Defines the testing, inspection, and maintenance requirements.

A safety note for equipment shall be prepared if the equipment:

- Is considered custom hardware.
- Is (or was originally) commercial but
 - Has been modified in some way that could affect its safety.
 - Has design factors that are known or suspected to be inadequate.
 - Is known or suspected to have been inadequately proof tested.
 - Is to be used in a nonstandard mode or environment.

Safety notes shall be prepared according to the procedures of the organization that authors the note. For example, the Engineering Directorate maintains procedures for generating various Engineering Safety Notes (ESNs), whereas other directorates' safety notes are identified as Lawrence Livermore Safety Notes (LLSNs). LLSN numbers may be obtained from the Engineering Directorate's Engineering Record Center (ERC) at the following Internet address:

<http://ercu.llnl.gov/>

LLSNs may be archived in the ERC for permanent retention.

8.0 Responsibilities

General responsibilities for all workers are described in Document 2.1, "Laboratory and ES&H Policies, General Worker Responsibilities, and Integrated Safety Management," in the *ES&H Manual*. This section gives responsibilities for participants in the design and construction process. For responsibilities exclusively related to the construction process, see Document 2.4.

8.1 Authorizing Organization

The authorizing organization:

- Is responsible and accountable for completing a project on behalf of its program.
- Ensures that adequate funding is available for the project.
- Ensures that prestart reviews are conducted.
- Authorizes final acceptance of the project.

8.2 Plant Engineering Department

This section specifies the responsibilities of Plant Engineering Department personnel.

8.2.1 Line Management

Line management:

- Ensures that design teams are adequately staffed.
- Ensures that conflicts between the design team, the authorizing organization, and other project team representatives are adequately resolved.
- Ensures that competent, qualified personnel are assigned to the project.

8.2.2 Project Manager

The project manager:

- Assembles the project team and obtains adequate support. The project team consists of
 - The client, the project manager, the design manager, and the construction manager.

- Representatives from the Plant Engineering Department's Design and Construction Division, Maintenance and Operations Division, and Space and Site Planning Office, and from the Hazards Control, Environmental Protection, and Safeguards and Security Departments.
- Ensures that the objectives of a specific project are achieved.
- Is accountable both to the authorizing organization and to Plant Engineering line management.
- Assures that all team members meet at scheduled times to discuss design issues and that all comments, including ES&H issues, are resolved. Procedures for conflict resolution and change control in the project environment are detailed in the WMP.

8.2.3 Construction Manager

The construction manager:

- Ensures that all project construction is carried out in accordance with the requirements of the drawings and specifications.
- Is accountable to the project manager. See Document 2.4 for construction manager responsibilities in the ES&H Team during construction.
- Reviews all Title III documents.
- Initiates and coordinates review comments, requirements for information, and change orders.
- Ensures that ES&H issues are identified and addressed.
- Ensures that construction workers use approved work practices to produce a quality product that meets design specifications.

8.2.4 Design Manager

The design manager:

- Ensures that all design work is carried out in accordance with the project's objective.
- Is accountable to the project manager.
- Coordinates the work of project designers and ensures that their design work is portrayed in the drawings and specifications accurately and consistently.
- Reviews all Pre-Title I, Title I, and Title II documents. Ensures that ES&H issues pertinent to a project are accurately translated into the design drawings and specifications.

8.2.5 Designer

The designer:

- Designs all of aspects of a facility (i.e., civil, architectural, structural, mechanical, electrical, and industrial electronic) in accordance with good engineering practice (see Document 41.1, "LLNL Quality Assurance Program," Section 2.3.2, Criterion 6, in the *ES&H Manual*).
- Follows all applicable codes and standards (including those specified in the WSS set), analyzes projects for credible hazards, and incorporates controls using the graded approach to eliminate or reduce hazards to an acceptable level.
- Contacts the ES&H Team for assistance in evaluating unusual hazards associated with operating a facility or piece of equipment.

8.3 Hazards Control Department

The Hazards Control Department:

- Ensures that the design team addresses all pertinent health and safety issues that may result from equipment, processes, or hazardous materials used on the job site or in the facility.
- Reviews construction safety plans.
- Performs preoccupancy walkthroughs and ongoing safety inspections during construction.

8.4 Environmental Protection Department

The Environmental Protection Department:

- Conducts surveys and assessments to determine the type and level of environmental documents and permits that are needed. For general or specific environmental requirements for project planning, design, and construction, refer to Volume III of the *ES&H Manual*, or contact your ES&H Team.
- Prepares the environmental analyses for Plant Engineering to be included in the conceptual design report and the preliminary proposal.
- Reviews construction design drawings and the Storm Water Pollution Prevention Plan and submits comments to the Plant Engineering Department. Resolution of the comments is then incorporated into the design.

- Ensures that the design team addresses all issues relating to environmental protection and regulatory permitting requirements.

8.5 Safeguards and Security Department

The Safeguards and Security Department ensures that the design team addresses all pertinent security issues in their design.

9.0 Work Standards

9.1 Work Smart Standards

DOE O 414.1A, "Quality Assurance," Attachment 1, "Contractor Requirements Document."

DOE O 420.1 Chg. 3, "Facility Safety," Attachment 2, "Contractor Requirements Document," Paragraph 4, except 4.1.2 and 4.1.3 and excluding the invocation of ANS 8.9, ANS 8.10, and ANS 8.17.

DOE O 430.1A, "Life Cycle Assessment Asset Management," Attachment 2, "Contractor Requirements Documents." [DOE Order 413.3 cancelled paragraphs 6e(7), 7b(11)(14), 7c(4), (6), (7), (11), (16), 7d(4) and (8), 7e(3), (10), and (17); Attachment 1, Definitions (items 30, 42, 48), Attachment 2 CRD paragraph 1d.]

9.2 Other Requirements

DOE-M-5632.1C-1, "Manual for Protection and Control of Safeguards and Security Interests."

http://www.fas.org/irp/doddir/doe/m5632_1c-1/index.html

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

10.0 Resources for More Information

10.1 LLNL Contacts

For more information about the topics discussed in this document, contact the following as necessary:

- Area ES&H Team.
- Plant Engineering Design and Construction Division.

- Plant Engineering Projects Division.
- Plant Engineering Standards and Documentation Group.

10.2 Lessons Learned

For lessons learned applicable to design and construction, refer to the following Internet address:

http://www-r.llnl.gov/es_and_h/lessons/lessons.shtml

10.3 Other Sources

Design Safety Standards Manual, Chg. 3, Mechanical Engineering Department, September 1995 (M-012).

DOE-STD-3006, "Planning and Conduct of Operational Readiness Review (ORR)."

Environmental Impact Report Addendum for the Continued Operation of Lawrence Livermore National Laboratory, Lawrence Livermore National Laboratory, October 1996 (UCRL-CR-125546).

LLNL Facilities Specification, Plant Engineering Department.

LLNL Facilities Standards, Plant Engineering Department.

"Mitigation Monitoring and Reporting Program for Continued Operation of Lawrence Livermore National Laboratory," University of California, Berkeley, CA, August 1992 (SCH90030847).

MPM 26, "Use of Standards at LLNL," Plant Engineering Department.

MPM 28, "Signatures on Drawings and Specifications," Plant Engineering Department.

Project Management Procedures Manual, Plant Engineering Department (January 2001).

Available at the following Internet address:

http://www-r.llnl.gov/plant_eng/pe-library/library.html

Quality Assurance Plan for LLNL Facilities Standards, Plant Engineering Department.

Work Management Plan for Title I, II, and III Project Reviews in Plant Engineering, Plant Engineering Department.

Appendix A

Additional Topics and Sources of Information

Listed in the table below are sources of guidance for topics not addressed in this document. Contact your ES&H Team for additional information.

Topic	Where to Get Additional Information
Battery charging rooms	Contact your ES&H Team.
Boilers	LLNL Facilities Standard PEL-M-15620 / A.
Carpeting	<i>LLNL Facilities Specification</i> , Sections 09686, 09688, and 09690.
Change rooms	Contact your ES&H Team.
Elevators	<i>LLNL Facilities Specification</i> , Sections 14245 and 14250.
Emergency lighting	LLNL Facilities Standard PEL-E-16510. Document 11.2, "Hazards—General and Miscellaneous," in the <i>ES&H Manual</i> .
Explosives labs	DOE Explosives Safety Manual (DOE M 440.1). Document 17.1, "Explosives," in the <i>ES&H Manual</i> .
Eyewashes and emergency showers	LLNL Facilities Standard PEL-M-11610.
Fugitive dust emissions	<i>LLNL Facilities Specification</i> , Section 01500.
Laboratories	Contact your ES&H Team for special guidance on hazards associated with a specific laboratory.
Radiological facilities	The following <i>ES&H Manual</i> documents: Document 20.1, "Occupational Radiation Protection." Document 20.2, "LLNL Radiological Safety Program for Radioactive Materials." Document 20.4, "LLNL Occupational Radiation Protection ALARA Program."
Roofing materials	LLNL Facilities Standard PEL-A-07514 / A.
Seismic protection	For general guidelines, see Document 22.4 "Earthquakes," in the <i>ES&H Manual</i> . For shelving and cabinet seismic tie-downs, see LLNL Facilities Standard PEL-S-13082.
Trailers and temporary buildings	Plant Engineering Design and Construction Division.
Ventilation equipment	Document 12.2, "Ventilation," in the <i>ES&H Manual</i> .
Volatile Organic compound (VOC) emissions	For VOC emissions standards, refer to the applicable sections of the <i>LLNL Facilities Specification</i> . Contact the Plant Engineering Department for details.