Site Visit Report
Review of the Lawrence Livermore National Laboratory
Fire Protection Design Review Process – May 2010

This site visit report documents the results of the Office of Health, Safety and Security's review of the Lawrence Livermore National Laboratory (LLNL) Fire Protection Design Review Process. This review, conducted on March 24 through April 2, 2010, was sponsored by the U.S. Department of Energy (DOE) Livermore Site Office (LSO) and conducted jointly with LSO staff.

The review identified a number of observations and one weakness, which should be further evaluated by LSO in accordance with LSO Work Instruction (WI) 226.1.1, *Writing and Managing Contractor Assessments, Issues and Corrective Action Plans in Pegasus*, dated June 6, 2009. Consistent with WI 226.1.1, observations are minor problems or conditions that are of concern to the inspector and may or may not involve a failure to meet a DOE, contractual, or regulatory requirement. These observations are not deemed significant, but should be communicated to the contractor to facilitate correction, if required, and to contribute to continuous process improvement. A weakness is an apparent failure to meet a DOE, contractual, or regulatory requirement, or a significant management issue that must be corrected by the contractor.

BACKGROUND:

The objective for this review was to verify that the LLNL design review process has been established, implemented, and maintained in accordance with DOE Order 420.1B, *Facility Safety*, Contractor Requirements Document, Chapter II, Section 3.b.(3) and (4).

Understanding the institutional requirements for completing design reviews, starting from the site management policies as they flow down to implementing procedures, was a necessary element for performing this assessment. To gain an understanding of the requirements and process, several meetings were held with the numerous stakeholders including: LLNL Facilities and Infrastructure Directorate; Design Standards Department; Environment, Safety, and Health (ES&H) Directorate; Fire Protection Engineering Department; and Maintenance Utility Service Division. In addition, various LLNL management policies, department manuals, and procedures were reviewed. A diagram depicting the flowdown of these requirements is provided in Appendix A.

To evaluate performance, several projects, including buildings B111, B581, B490, B391, B153, and B381, were selected for review. These projects represented a broad range of phases of project execution, from design through construction.

A functional area Criteria Review and Approach Document (CRAD) was developed by LSO for this assessment. The LSO CRAD included the following specific evaluation criteria and is included in its entirety in Appendix B:

- LLNL's Design Review Process ensures fire protection program requirements, including compliance with building codes, fire safety standards, and established engineering principles, are documented and incorporated into plans and specifications for new facilities and significant modifications to existing facilities.
- Plans, specifications, procedures, and acceptance tests are being reviewed by a qualified fire protection engineer (FPE), and the reviews are being documented.
- A redundant fire system should be considered for safety-class systems and equipment that are vulnerable to fire damage.

RESULTS:

Fire Protection Design Reviews

The fire engineering staff were aware of their roles with regard to performing project design reviews and were actively engaged with ongoing project work, which can be attributed to good internal communication within the department and the experience level of the staff fire engineers, who work independently with minimal oversight. Design Review Comment Sheets, supplemented with emails, were the established means for communicating with project managers and other team members.

The requirement for performing design reviews was implemented by the ES&H Manual, Document 22.5, Fire, Section 4.8 which states that "all new facilities and modifications to existing facilities are required to receive a mandatory life safety and fire protection code review prior to design acceptance, in which all facility life safety and fire protection elements are considered and appropriately addressed in the facility design." The LLNL Fire Protection Engineering Standards support these reviews by referencing the codes and standards for developing specifications and acceptance test criteria.

Updating the fire hazard analysis (FHA) and run cards is based on the scope and complexity of the project. If the facility qualifies for an FHA, high-value property protection is specifically evaluated and the fire protection program depends on the LLNL scientific programs to identify high-value or mission-important equipment. Revising the run cards is the responsibility of the Fire Department (Policy No. 30.103) and is required to be reviewed and updated on an annual basis.

The LLNL requirement for performing fire protection design reviews was being met. The roles and responsibilities for completing fire protection design reviews were managed differently between nuclear and non-nuclear facilities, and implemented by the respective work control programs. Non-nuclear facilities function under the LLNL Institution-Wide Work Control Process (LLNL-AM-409863), and nuclear facilities are covered by the Superblock Work Control Manual (LLNL-AR-409585). The Facilities and Infrastructure Directorate provides the lower-tier implementing procedures for applying engineering project management resources and submitting engineering documents, such as drawings and specifications.

Specific work control procedures and methods to manage change control have been documented. The expectations that exist internally, within the Fire Protection Engineering Department, for performing design reviews are based on technical skills and competencies. For example, life safety design reviews are managed by the Fire Marshal, while the remainder of the FPE staff supports design that involves suppression or special hazards. The Alarms Group performs the alarm and signaling design work and then forwards the respective project documentation to the Fire Marshal for final review and approval. This process is not formally documented and is, to a large degree, based on the level of knowledge of the individuals.

Interviews with ES&H management revealed that ES&H personnel understand their responsibility to coordinate with fire engineers prior to the design phase of a project, and then to seek comments from FPEs through the course of the design effort.

Observation: Consider developing an internal procedure or guidance document for performing design reviews. Such a document could better define and document the roles and responsibilities for performing design reviews within the Alarms Group and Fire Protection Engineering Department.

Implementation and Flowdown of LLNL Requirements

The documentation review for this assessment indicated that the design review process was not well defined. Many of the key documents were not referenced, procedures and policies were not updated to reflect organizational changes, and specific controls had not been implemented. For example, many procedures still incorrectly refer to the Plant Engineering organization (which no longer performs the functions), including the Management of Facility Design and Construction (Document 42.1). Specific documents for performing fire design reviews, including the Design Review Comment Sheet, Emergency Alarm and Voice System Permit, and the Fire Alarm System Record of Completion, were implemented, but had not been integrated into the respective procedures. For example, according to the Alarms Group, the intended function of the Emergency Alarm and Voice System Permit was to prevent projects from bypassing the Alarms Group's design input; however, the wording on the permit limits their involvement to the pre-construction phase by stating, "site inspection required prior to beginning of work." As a result, the input required from the Alarms Group would not occur at the intended design phase of the project.

Observation: Consider improving the implementation of the specific documents that are used when performing fire design reviews.

Design reviews for nuclear facilities were driven from the work control program (Superblock Work Control Manual, LLNL-AR-409585). A process flow chart within this manual described the change control process and key steps when design input was required for minor and significant changes. The design reviews for non-nuclear facilities were less formalized and managed through the work control/work release process (Work Control Manual, MAN–GWM-0003). In general, the requirements flowed down from the Facilities and Infrastructure Directorate policy statements to the ES&H Manual and then to the respective work control programs for field implementation.

In some cases, project controls were not applied to small projects. For example, for the building B111 project, the activity was released as "Minor Work," which required only craft resources to fabricate sprinkler piping even though design changes were made. For this activity, a "Form 1" should have been required to process work involving design but was not submitted, and the design changes were documented on a sketch without going through the project controls for an approved signed-off engineering drawing, in accordance with Project Reviews (PLAN-GWM-0001).

Observation: Consider briefing the FPE staff on project management procedures to enhance their understanding of project controls and to reduce the risk of inadequate design control for small projects.

Fire Protection Design Approval

The Alarms Group and Fire Engineering Department designated engineers to be responsible for completing in-house design. Although the engineers appear to be qualified, their qualifications were not well documented. Personnel, who sign off on FPE drawings as the Record Engineer, take on a significant amount of responsibility. The minimum competencies for designing fire suppression and alarm systems should be integrated into the respective training and qualification records.

Weakness: There is a lack of documentation to verify that the engineers who review/approve fire protection design and sign-off engineering drawings, within the Facilities and Infrastructure Directorate, are qualified to perform this role, as invoked by DOE Order 420.1B and required by the National Fire Protection Association codes and standards.

Configuration Management for Fire Systems

Completed fire protection design drawings exist for B490 and B111. However, the design drawings were not easy to retrieve from the database that was managed by Plant Engineering. Even though some documented guidance was provided (Engineering Drawings Policy, ENG-0002), the process for managing this database was not well defined and did not clearly identify roles and responsibilities. Discussions with personnel within the Engineering Standards Department indicated that not all project managers adhere to the guidelines for submitting drawings. Currently, more than one database is used for archiving fire protection drawings, including the one maintained by the Alarms Group. Not all of the LLNL fire alarm drawings have been archived and updated. The Alarms Group discovered inconsistencies with the record drawings while performing routine facility maintenance, resulting in a backlog of red-lined drawings that need to be addressed.

Observation: Consider allocating the necessary resources to complete the as-built for the red-lined fire alarm engineering drawings in order to establish record drawings that can be retrieved from the site engineering database. A performance metric should be developed to demonstrate the ongoing progress, with a target date for completion.

Observation: Consider consolidating the multiple databases and eliminating the redundancy that exists for engineering drawing databases to improve efficiency and reliability.

During the contract transition, an effort was made to establish some level of priority for maintaining configuration control for the LLNL fire systems. The Configuration Management Plan (Ref. PLAN-CM-0001) was intended to provide a higher level of configuration control for fire systems that were designed for life safety purposes. The procedure provided a change control process to ensure that the list of the life safety fire suppression and detection/alarm systems conformed to the configuration management class 3, as defined in the ES&H Manual (Document 41.2, Configuration Management Program Description). The Configuration Management Plan was referenced in the ES&H Manual (Document 22.5, Fire), but had not been updated or fully implemented.

Observation: Consider strengthening implementation of the Configuration Management Plan. Evaluate other fire systems (in addition to life safety) that could be mission sensitive, such as the site fire alarm system that currently does have as-built drawings and the limited number of high voltage alarm/detection systems.

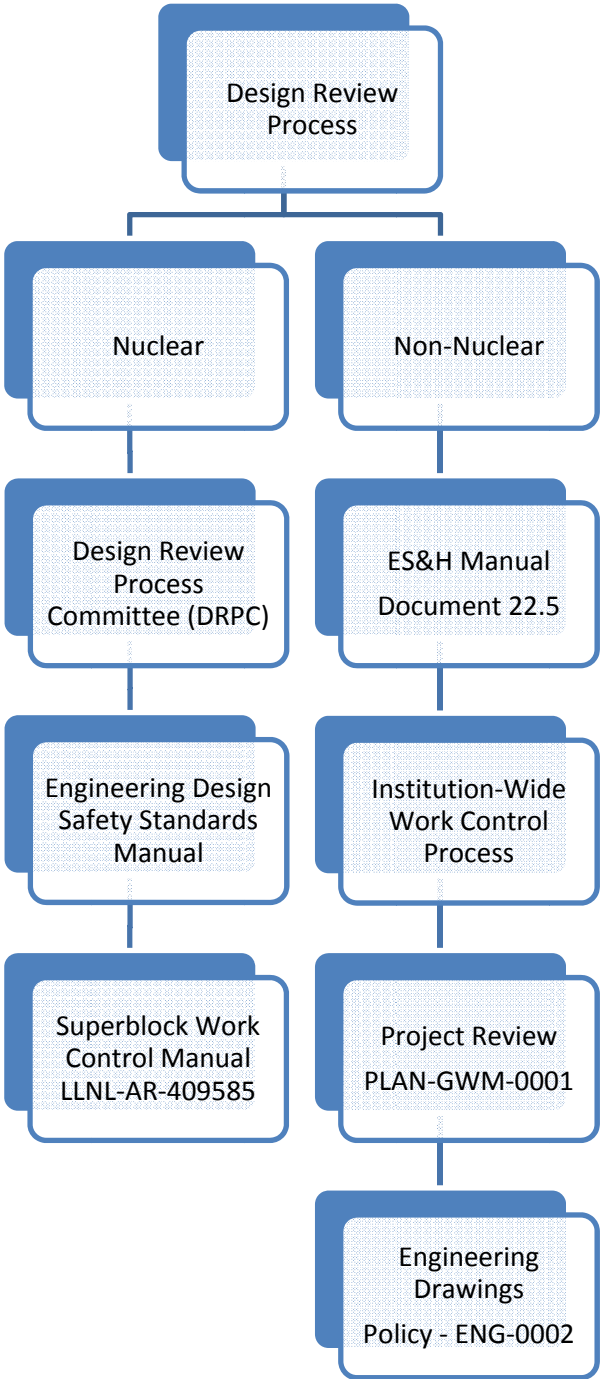
CONCLUSIONS:

Overall, the design review process was observed to be effective and the LLNL programs for performing these reviews were being implemented. Many aspects of the process are effective, and the personnel who implement it are knowledgeable and experienced.

This review identified only one shortcoming that rose to the level of a weakness (i.e., an apparent failure to meet a requirement). Specifically, the training qualifications for personnel who sign off on FPE drawings as the Record Engineer are not documented in the respective training records. Although this situation needs to be addressed, the concern relates to the lack of documentation because the engineers appear to be qualified.

Although a number of observations were identified for LLNL consideration, most of these are related to better documentation of the program expectations. The impact of these documentation issues is currently limited because of the experience and knowledge of the FPEs.

Appendix A
Design Review Process



Appendix B
Design Review Process
Criteria Review and Approach Document

Performance Objective

The Lawrence Livermore National Laboratory (LLNL) Fire Protection Design Review Process has been established, implemented, and maintained at the LLNL.

Requirement

DOE Order 420.1B, *Facility Safety*, Contractor Requirements Document, Chapter II, Section 3.b.(3) and (4)

Criteria

- LLNL's Design Review Process ensures fire protection program requirements, including compliance with building codes, fire safety standards, and established engineering principles, are documented and incorporated in plans and specifications for new facilities and significant modifications to existing facilities.
- Plans, specifications, procedures, and acceptance tests are being reviewed by a qualified fire protection engineer (FPE), and the reviews are being documented.
- A redundant fire system should be considered for safety-class systems and equipment that are vulnerable to fire damage.

Review Approach

- Inspection Activities - General
  - Review fire protection system design and defense-in-depth strategies.
  - Interview personnel, including FPEs, fire coordinators, fire system technicians, and fire department personnel.
  - Review policies, procedures, and corresponding documentation related to Integrated Safety Management core function and nuclear safety.

- Document Reviews
  - Review DOE-STD-1066-99, *Fire Protection Design Criteria*.
  - Check LLNL's flowdown of design criteria from the contractor's institutional Design Review Process to plans and specifications for new and significant modifications to existing facilities. Evaluate the effectiveness of the new Facility Management Department and Work Control Process for triggering the necessary design reviews.

- Review FPE staff qualifications.
- Review FPE's documented reviews of fire protection plans, specifications, fire emergency response procedures, and acceptance tests for quality. Evaluate the methodology and criteria established for managing significant projects versus modifications.
- Design documents, key plans, and drawings for newly built or significantly modified facilities, with changes, and before and after specifications as applicable. (Specifically, ES&H Manual, Document 42.1, and associated standards including LLNL FPE Standard 1.0, 1.2, and 5.1.)
- Ensure any impacts to the documented safety analysis, technical safety requirement, or fire hazard analysis (FHA), have been analyzed.
- Update run cards.

- Interviews
  - Interview FPE reviewer for design review methodology, and how he/she keeps aware of needed design reviews.
  - Interview Fire Marshal about Design Review Process.
  - Interview some Facility Managers of new or significantly modified facilities.

- Walkthroughs
  - Conduct walkthrough of a sample of new and modified facilities.

- Analysis
  - Review effectiveness of order compliance in meeting design review goals.

Interview Questions

- For FPEs
  1. How do you maintain awareness of significant modifications to facilities?
  2. Can you please walk me through your design review process and your role in the process?
  3. Are your reviews documented and how?
  4. May I have a copy of your latest review document?
  5. How are plans, specifications, procedures, and acceptance tests influenced by your reviews, and how do you determine the most up-to-date criteria?
  6. Please describe what follows if your review impacts a documented safety analysis or FHA, and is this process documented?
  7. What about impacts to run cards?

8. Can you describe the process for the commissioning of newly installed or modified fire systems?

- For Fire Marshal
  1. Design Review Process
     a. Institutionally, how is the design review process managed?
     b. Can you demonstrate how facilities and modifications meet the fire protection codes and standards in effect when a facility design criteria is approved, otherwise known as the Code of Record? Do they remain in effect for the life of the facility?
     c. Are other provisions (i.e., updated codes and standards) applied to existing facilities when a construction modification takes place, and is there a process that ensures this has been completed? What about when a potential for immediate risk to life safety or health has been identified through either the facility assessment or FHA review process, or during the construction review or permitting process?
  2. FPE qualifications
     a. How do the FPEs become technically qualified for their respective facilities?
     b. How is continuing training managed and documented?
     c. May I have a copy of the FPE's qualifications?

- For Facility Manager
  1. Can you please walk me through your process that controls how changes are implemented during new construction or major modifications at your facility?
  2. How do you manage design changes? Specifically, how do you ensure that the appropriate groups are notified?
  3. Is there a signature block for the FPE group for approval of major modifications or another means that denotes their review/approval?