Independent Oversight Review of the Fire Protection Program at Lawrence Livermore National Laboratory

September 2013

Office of Safety and Emergency Management Evaluations
Office of Enforcement and Oversight
Office of Health, Safety and Security
U. S. Department of Energy

Table of Contents

Acronyms

ACFD	Alameda County Fire Department
AHJ	Authority Having Jurisdiction
BNA	Baseline Needs Assessment
CFR	Code of Federal Regulations
CDNS	NNSA Chief of Defense Nuclear Safety
CRAD	Criteria, Review, and Approach Document
DAP	Discipline Action Plan
DOE	U.S. Department of Energy
DSA	Documented Safety Analysis
ES&H	Environment, Safety, and Health
FHA	Fire Hazard Analysis
FPA	Fire Protection Assessment
FPE	Fire Protection Engineer
FPP	Fire Protection Program
FR	Facility Representative
FSP	Facility Safety Procedure
HEAF	High Explosives Application Facility
HEPA	High Efficiency Particulate Air
HSS	Office of Health, Safety, and Security
ITM	Inspection, Testing, and Maintenance
ITS	Issues Tracking System
LANL	Los Alamos National Laboratory
LFO	Livermore Field Office
LLNL	Lawrence Livermore National Laboratory
LLNS	Lawrence Livermore National Security, LLC
MPFL	Maximum Possible Fire Loss
MUSD	Maintenance and Utilities Services Department
NFPA	National Fire Protection Association
NMTP	LLNL Nuclear Materials Technology Program
NNSA	National Nuclear Security Administration
OFI	Opportunity for Improvement
PIV	Post Indicator Valve
PVC	Polyvinyl Chloride
RMA	Radioactive Materials Area
SDD	System Design Description
SME	Subject Matter Expert
SMPDD	Safety Management Program Description Document
SSC	Structures, Systems, and Components
STD	Standard
TSR	Technical Safety Requirement

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1.0 PURPOSE

The U.S. Department of Energy (DOE) Office of Enforcement and Oversight (Independent Oversight), within the Office of Health, Safety and Security (HSS), conducted an independent review of the fire protection program (FPP) at Lawrence Livermore National Laboratory (LLNL). The review was one part of a targeted assessment of fire protection at nuclear facilities across the DOE complex, including National Nuclear Security Administration (NNSA) sites.

The purpose of the Independent Oversight targeted assessment was to evaluate implementation of program requirements that are intended to ensure that adequate controls have been implemented to reduce the risk associated with events resulting from a fire or explosion at nuclear facilities. Existing HSS criteria, review, and approach documents (CRADs) were adapted to establish a focused set of inspection criteria, activities, and lines of inquiry for the targeted assessment. The independent review of LLNL is designed to evaluate the core fire protection elements and provide the site and responsible NNSA line management organizations with information for benchmarking their program effectiveness. This independent review also provides data for an ongoing HSS effectiveness review of the Department's implementation of Commitment #16 of the DOE implementation plan for Defense Nuclear Facilities Safety Board Recommendation 2004-1 regarding verification of Federal nuclear safety assurance capability.

This independent review was performed concurrently with an NNSA Livermore Field Office (LFO) surveillance at the LLNL Plutonium Facility and High Explosives Application Facility (HEAF) during the period of June 10-21, 2013. This report discusses the background, scope, methodology, results, and conclusions of the review, as well as findings and opportunities for improvement (OFIs) identified during the review.

2.0 BACKGROUND

LFO oversees LLNL and is responsible for administering the performance-based contract, executing assigned NNSA and DOE programs, and conducting oversight of work performed at LLNL in support of NNSA requirements and priorities. The mission of the LLNL Plutonium Facility is currently in transition following the completion of removal of most special nuclear materials. The HEAF is a DOE/NNSA complex-wide center for high-explosives research and development in support of the NNSA stockpile stewardship program at the LLNL.

The Independent Oversight program is designed to enhance DOE safety and security programs by providing DOE and contractor managers, Congress, and other stakeholders with an independent evaluation of the adequacy of DOE policy and requirements, and the effectiveness of DOE and contractor line management performance in safety and security and other critical functions as directed by the Secretary of Energy. The program is described in and governed by DOE Order 227.1, *Independent Oversight Program*, and a comprehensive set of internal protocols, operating practices, inspection guides, and process guides.

Fire protection was identified as an Independent Oversight targeted review area for 2013 in a HSS memorandum from the Chief Health, Safety and Security Officer to DOE senior line management,

Independent Oversight of Nuclear Safety – Targeted Review Areas Starting in FY 2013, dated November 6, 2012. This review is further described in the *Plan for the Independent Oversight Targeted Review of the Fire Protection Program at Lawrence Livermore National Laboratory*, dated April 26, 2013, which defines the specific focus at LLNL for this targeted review area.

3.0 SCOPE

Independent Oversight reviewed and assessed the effectiveness of the LLNL FPP and its implementation, with specific attention to program implementation at the Plutonium Facility and HEAF. The review included evaluation of key FPP elements, including the baseline needs assessments (BNA), fire pre-plans, exemption and equivalency process, alarms impairment process, hot work permits, combustible control, fire hazard analysis (FHA), and the National Fire Protection Association (NFPA) inspection, testing, and maintenance (ITM) program. The assessment also evaluated FHA/documented safety analysis (DSA) integration and technical safety requirement (TSR) surveillance and testing for the Plutonium Facility, and LLNL and LFO self-assessment.

4.0 METHODOLOGY

The Independent Oversight review of the LLNL FPP included reviews of documents and site walkdowns of selected LLNL facilities and the fire suppression safety systems. The review considered the requirements of 10 CFR 851, *Worker Safety and Health Program*; DOE Order 420.1B, *Facility Safety*; and NFPA codes and standards.

The following sections of HSS CRAD 45-34, Revision 1, were used for the targeted assessment:

- Section I, Programmatic Elements, FP-1, Program Documentation
- Section I, Programmatic Elements, FP-2, Program Implementation - Fire and Related Safety Hazards
- Section I, Programmatic Elements, FP-3, Program Implementation - Fire Prevention and Protection
- Section II, FHA/DSA Integration, FP-4
- Section IV, TSR Surveillance and Testing, FP-6.

5.0 RESULTS

5.1 Program Documentation

A documented fire safety program exists as required by applicable safety criteria. (DOE Order 420.1B, DOE-STD-1066-99)

A baseline needs assessment (BNA) of the fire protection emergency response organization has been documented and updated every 3 years. The plan should describe in sufficient detail fire-fighting operations for the respective facilities. (10 CFR 851, DOE Order 420.1B, DOE-STD-1066-99)

LLNL has a documented fire safety program as required by applicable DOE Order 420.1B criteria. The Emergency Management Department, under the Facilities and Infrastructure Directorate, is divided into three separate divisions: the Alarms Division, the Fire Protection Division, and the Emergency Programs Division. The Fire Protection Division of Emergency Management Department is responsible for implementing the LLNL FPP. The FPP manual and LLNL Fire Protection Engineering Standard 1.2,

Fire Protection Program Criteria, Revision 4, describe the implementation and define the major roles and responsibilities. The Fire Protection Division is represented by qualified fire protection engineers (FPEs), fire protection technicians (identified as fire inspectors), and the LLNL Fire Marshal, who is the division leader and has been delegated limited Authority Having Jurisdiction (AHJ). The Emergency Programs Division includes the fire department, whose services are based on a subcontract agreement with the Alameda County Fire Department (ACFD).

LLNL Fire Protection Division

The FPP manual documents the mission, policies, and procedures necessary to meet DOE Order 420.1B requirements. The LLNL FPP's policy is to implement 10 CFR 851, DOE Order 420.1B, and all other DOE-prescribed fire protection codes and standards that are applicable to LLNL, including the mandatory NFPA standards that flows from the Order, the latter of which is identified in the Lawrence Livermore National Security, LLC (LLNS) contract. The process for flowing these program elements down to the facility level is further described in the LLNL Environment, Safety and Health (ES&H) Manual Volume II Document 22.5, *Fire*, Revision 12. At the time of the assessment, LLNL was updating the program to comply with DOE Order 420.1C, which was recently included in the LLNS contract, including re-delegation of LLNL AHJ roles and responsibilities as allowed by DOE Order 420.1C.

The ES&H Manual provides an overview of the requirements and documents the key fire protection administrative procedures that are intended to minimize the risk and consequence of fire and maintain a Highly Protected Risk status at the LLNL. The ES&H Manual also identifies key roles and responsibilities that contribute to implementing a comprehensive fire protection program. Key program elements described in the ES&H Manual include safe handling of combustibles, hot work, life safety and fire protection reviews, fire protection equipment, means of egress, and fire department activities. The FPEs who are responsible for implementing the FPP requirements do so primarily by participating as members of the ES&H teams, which are key implementing mechanisms for the FPP.

Each ES&H team has at least one FPE assigned who provides fire protection engineering support. ES&H Team 1 supports both the Plutonium Facility and HEAF. The FPEs are also integrated into the LLNL Institution-Wide Work Planning and Control process described in ES&H Manual Document 2.2 through the review of integration work sheets. FPEs also review design plans for construction, perform triennial fire protection assessments, and maintain technical baseline documentation, such as the FHAs (e.g., for nuclear facilities) and the fire protection assessments (FPAs) and surveys for non-nuclear facilities.

The fire inspectors perform several key fire protection functions, including issuing hot work permits, performing water based suppression system impairments, and conducting monthly inspections of fire extinguishers, water suppression system valves, certain battery-powered emergency lights, and automated external defibrillators (AEDs). The ACFD performs fire department operations and the LLNL contracts with the ACFD to provide a resident emergency response capability. The fire department is responsible for initial response to all non-security emergencies on or adjacent to LLNL property. Services also include pre-incident planning, assigned fire prevention activities, emergency medical service, hazardous materials emergency response, maintenance and testing of fire department equipment, personnel training, and performing required drills.

Independent Oversight previously evaluated the processes for identifying emergency response capabilities and maintaining them is a state of readiness in case of a severe natural phenomena event, and identified several areas in which the LLNL emergency plan and implementing procedures do not accurately define the concept of operations used by the ACFD and LLNS, which may result in

unnecessary delays and an ad hoc response to a time-urgent event. Independent Oversight concluded that LLNL needed to better integrate and coordinate planning with local, state, and DOE assets for response to a severe NPE (see *Independent Oversight Review of Preparedness for Severe Natural Phenomena Events at LLNL, July 2013*)

Independent Oversight reviewed the ES&H Team 1 interaction relative to the Plutonium Facility. The Team 1 FPE is relied on to provide timely and accurate expertise regarding FPP implementation. The ES&H Manual, Volume II, Document 22.5, *Fire* guides the Team 1 FPE responsible for nuclear facilities, with regard to fire safety criteria. These criteria flow down to the Plutonium Facility in the form of a Discipline Action Plan (DAP), which captures the principal objectives of the program and delineates the principal roles and responsibilities of the FPE. The DAPs are facility-specific and describe the necessary Emergency Management and ES&H Department personnel actions to meet the objectives of the comprehensive LLNL FPP. Independent Oversight concluded that the implementation of the LLNL FPP, this unique DAP process, and the associated administrative implementation procedures for control of combustibles, and monitoring the integrity of fire barriers in the Plutonium Facility, and in some cases exceeds, the requirements stated in the FPP.

Baseline Needs Assessment

DOE Order 420.1B requires that each site establish its capabilities to provide timely and effective fire fighting response with sufficient staffing, apparatus, facilities, and equipment and document these capabilities in a BNA that reflects applicable NFPA codes and standards and is updated every three years. Responsive to this requirement, the LLNL Fire Marshall prepared and maintains a BNA comprising two parts: a Requirements Document and a Compliance Assessment. The Requirements Document is based on requirements established in NFPA 1710 but additionally considers other NFPA codes and standards and other requirements and guidance documents addressing emergency response, customized to meet LLNL's unique needs. The Compliance Assessment documents the minimum performance criteria necessary to meet the mandatory requirements set out in the Requirements Document and to determine whether each criterion has been met; it also considers the subcontract with the ACFD and the associated personnel and equipment. Independent Oversight confirmed that the minimum fire department staffing, apparatus, equipment, and procedures meet NFPA requirements and concluded that the BNA is well documented, current, and comprehensive.

A comprehensive FPP depends upon key programs and administrative controls that reduce the risk and minimize the consequence of a fire. The Independent Oversight team identified the following processes as representative of the LLNL FPP: fire pre-plans, exemption and equivalences process, alarm impairment process, hot work permit process, and control of combustibles, further discussed below. Additionally, the FHA, life safety measures, NFPA ITM of fire systems, and self-assessment processes are discussed in Sections 5.2, 5.3, and 5.6, respectively.

Although the FPP Manual and the ES&H Manual provided a limited level of information specific to roles and responsibilities and the flowdown of these requirements and information was not consistently well supported by the LLNL Fire Protection Division implementing policies, procedures and standards reviewed, Independent Oversight observed many of the LLNL FPP processes were adequately implemented based on interviews, document reviews, and facility walkdowns. For example, the Hot Work Permit – Fire Watch Duties/Responsibilities documented the scope and defined the key responsibilities for implementation of the respective requirements, and field observations and discussions with FPEs demonstrated a strong understanding of their roles and responsibilities. Although implementation was adequate, LLNL Fire Protection Division policies, procedures, and engineering standards and procedures did not fully address current FPP organizational and individual roles, responsibilities, authorities, and accountabilities (see **OFI-1**). Examples of FPP documents that could be

strengthened include:

- Review of Fire Hazards Analysis, Policy 5.3.1, rev. 4.0
- Fire Protection Engineering Facility Survey, Policy 5.8, rev. 5
- Fire Protection and Life Safety Equipment Inspection Program, Policy 400.00, rev. 1
- Estimating Building Values, Policy 5.6, rev. 7
- Fire Barrier/Fire Wall Inspection Procedure, Policy 9.5, rev. 0
- Exemption and Equivalency Tracking, Policy 1.1.1, rev 0
- Fire Protection Engineering Facility Survey, Policy 5.8, rev 5.0
- Fire Door Inspection and Functional Testing, Policy, 9.4, rev. 0
- Emergency Lighting, Policy 4.3, rev. 0

Fire Pre-Plans (RunCards)

The LLNL Building and Trailer Runcards Policy 30.103, describes how the ACFD implements fire pre-plans and oversees the development and maintenance of RunCards. Independent Oversight interviewed the fire captain responsible for implementing this program to gain an understanding of the program requirements and verify roles and responsibilities, and also reviewed the RunCards for the Plutonium Facility and HEAF. The Plutonium Facility information was up to date and accurate, and the Special Information sheet documented in the RunCard is provided quarterly by the ES&H technicians. However, the information for the HEAF RunCard was not consistent with the Facility Safety Procedure (FSP), and it did not reflect the physical conditions observed in the facility. For example, the HEAF RunCard had not been updated to incorporate facility changes since the last revision in 2004 (see **Finding F-1**):

- Sprinkler system modifications: The deluge sprinkler system has been converted to a wet pipe system.
- Gunpowder storage was not identified on the RunCard.
- Chemical storage rooms were not identified or consistent with the FSP. The FSP indicated the largest number and variety of chemicals and explosives to be in the synthesis laboratories.

Interviews with Fire Department personnel revealed that the RunCard process is based primarily on changes marked on paper copies and time consuming (see **OFI-2**).

Exemption and Equivalency Process

Independent Oversight reviewed and evaluated the process for documenting equivalencies and exemptions under the FPP. LLNL recently implemented a method of developing generic equivalences, with the objective of reducing the time and effort for documenting equivalencies that do not merit an exemption. The process was found to be appropriate for identifying a large number of similar equivalencies expeditiously and efficiently. However, this generic equivalency process has not been formalized or incorporated into the LLNL Exemption and Equivalency Tracking Policy 1.1.1, Revision 0. (see **OFI-3**).

Alarms Impairment Process

The purpose of the Alarms Impairment Procedure, Policy Number 860.010, Revision 1, is to define the life safety systems and responsibilities relating to impairments including, but not limited to, fire detection, fire sprinkler, emergency paging, fire alarms, and hazardous material systems. The Independent Oversight team observed that LLNL had several active impairment procedures, including

the Permit and Impairment/Shutdown Procedure for Fire Sprinkler Systems and the Sprinkler System Impairment Control & Restorations. The impairment procedures were issued by different divisions and provided overlapping information. Independent Oversight identified this issue in a 2009 nuclear safety review, and an LFO fire protection functional area review in 2012 recommended that the LLNL impairment procedures be consolidated. Despite the procedural issues, interviews with the Fire Alarms Division manager and the Fire Marshal demonstrated adequate emphasis on the impairment process, and they have been working toward consolidating the impairment procedures.

Hot Work Permit Process

The LLNL Fire Watch Duties/Responsibilities Policy 1.5, Revision 0 describes the process for hot work permits. The Independent Oversight team evaluated this process by reviewing completed hot work permits and interviewing the fire inspectors. A hot work activity was evaluated at HEAF and all of the required controls for minimizing the potential for fire, including posted hot work permits, compensatory measures, restricting work activities, and impairing the active detection system, were completed satisfactorily. The Independent Oversight team noted during interviews that the fire inspectors were very knowledgeable of the hot work process, were well qualified, had many years of experience, and demonstrated a high level of ownership and responsibility.

Control of Combustibles

Programmatic combustible control requirements are established in LLNL ES&H Manual Volume II, Document 22.5, *Fire*, and serve as the basis for each facility's unique combustible control criteria. The facility-specific DAP further amplifies ES&H combustible control requirements unique to each facility, and facility administrative procedures provide further program implementation guidance, establish basic policy, set criteria for evaluation, and provide priorities for housekeeping and flammable and combustible material use and storage. The ES&H team fire protection engineer's work from the facility administrative procedure to perform facility walkdowns to ensure program compliance. For example, the DAP covering the Plutonium Facility is detailed and compliant with LLNL program requirements.

Independent Oversight accompanied the FPE on the bi-weekly housekeeping and combustible materials control walkdown at the Plutonium Facility using procedure ECMS No. CMU05-000066, entitled *B332 Housekeeping and Flammable/Combustible Material Control*. The FPE displayed a keen familiarity with the facility and the walkdown procedure requirements. The bi-weekly walkdown is a qualitative evaluation of combustibles; however, the FPE maintains and prepares a quantitative fire loading calculation consistent with NFPA Fire Protection Handbook guidelines to support the Plutonium Facility TSR fire loading limits. During this walkdown, the FPE also checked fire doors and fire penetrations. The general housekeeping and combustible materials control walkdown procedure generally provides sufficient criteria and appropriate rigor regarding combustible loading. During a bi-weekly walkdown, Independent Oversight observed transient combustibles accumulated in a room being fit-out with new equipment. The FPE documented the observation and took appropriate action consistent with the walkdown procedure. However, control of transient combustibles could be enhanced in the work planning and control process to address transient combustibles (see **OFI-4**).

5.2 Fire and Related Safety Hazards

Fire Hazard Analyses (FHA) have been prepared for each nuclear facility and the results coordinated and integrated into the Documented Safety Analysis as required. (DOE Order 420.1B, DOE STD-1066-99, DOE-HDBK-1163, NFPA 801)

Fire and related safety hazards on site (or within the facility) have been identified and evaluated in conjunction with a current and comprehensive FHA and self-assessment. (DOE Order 420.1B)

The FHA and self-assessments address all essential elements for a complete analysis as delineated in DOE Order 420.1 and its implementation guide. (DOE Order 420.1B and DOE Guide 420.1-3)

The information contained in the FHA and assessment is accurate, as required by applicable fire safety criteria. (DOE Order 420.1B)

Plutonium Facility

The LLNL FPP provides for preparation of a detailed FHA to assess the risk of fire within individual fire areas through implementation of LLNL Fire Protection Engineering Standard 5.3, *Fire Hazard Analysis*, Revision 11. This standard was used as the basis for development of the most recent Plutonium Facility FHA, issued in May 2013, which addresses and corrects previous FHA deficiencies. LLNL Fire Protection Engineering Standard 5.3.1, *Review of Fire Hazards Analyses*, Revision 4 addresses the requirements for reviewing and revising the FHA. The Plutonium Facility FHA adequately describes the facility with regard to code construction type classification and building construction characteristics. Hazards unique to the facility are identified by type and location, fire rated area separations and barriers are identified and described in detail, and fire protection controls are described. The Plutonium Facility FHA generally contains the necessary attributes prescribed in DOE Order 420.1B and DOE Guide 420.1-3. Although these program standards and directives provide essential guidance for FHA development, the Plutonium Facility FHA was deficient in some areas (see **OFI-5**):

- In some cases, the FHA does not provide references to supporting documents that form the basis for statements in the FHA. For example, it does not list the design documentation and analyses that support Section 3.0, *Protection,* which describes safety structures, systems, and components (SSC) and performance.
- The FHA does not document codes of record dates to ensure facility-specific compliance and to facilitate development of SSC design modifications. Similarly, codes of record with issue dates are not clearly documented in the Plutonium Facility DSA or the Fire System Design Description (SDD) documents.
- The Maximum Possible Fire Loss (MPFL) documented in the Plutonium Facility FHA does not consider the cost of lost time (considered mission interruption costs) and environmental cleanup costs.

The FPE assigned to ES&H Team 1 provides expertise, review, and guidance to the Plutonium Facility and other nuclear facilities and ensures translation of fire program requirements to the facility operations as defined in ES&H Manual, Volume II, Document 22.5, *Fire.* The FPE's program responsibilities are found in the DAP for the Plutonium Facility. The facility fire program is additionally enforced and amplified by the facility system engineering staff as defined by the System Engineering Program Manual ECMS No. CMU09-00052. These two programs address compliance with the baseline hazard controls identified in the safety basis and with SSC configuration management. Furthermore, the FPE assists in preparation and review of programmatic safety documents, bi-weekly combustible loading and housekeeping surveys, review of the work permit process, and review of selected facility maintenance and testing activities. Interviews and walkdowns with the FPE assigned to the Plutonium Facility ES&H Team 1 demonstrated detailed knowledge of and active involvement in Plutonium Facility review of proposed work activities, development and review of the Plutonium Facility DSA updates, preparation of the Plutonium Facility FHA, and review of the ongoing fire water tank design modification.

High Explosives Application Facility

The Independent Oversight team evaluated the implementation of the FPP at the facility level by conducting a walkdown of the HEAF and reviewing documentation describing the specific processes and programs supporting the facility fire protection program. The HEAF facility assessment was recently downgraded from requiring a FHA to an FPA, which describe the controls and risks associated with fire and explosives. Like the Plutonium Facility FHA, the HEAF analysis did not consider interruption costs when determining the MPFL values. In addition, the superseded FHA for the HEAF identified the facility as mission critical with high value equipment, but the latest FPA does not recognize the HEAF as being mission critical. An interview with the FPE responsible for HEAF revealed that he could not explain why. The Independent Oversight team observed that based on the HEAF's mission and explosive hazards, the HEAF may represent a unique fire risk and require an FHA, as documented in DOE-Order 420.1B. Interviews with the Fire Marshal and the HEAF FPE revealed that the term "unique fire risk" was not consistently understood or applied. The Fire Protection Engineering Facility Survey Program Procedure 5.8, Revision 5 does not define the process for downgrading an FHA to an FPA (see **OFI-6**).

Independent Oversight conducted a facility walkthrough of HEAF and identified several non-compliant fire safety conditions (see **Finding F-2**):

- Restricted egress: A wooden pallet had been left on the floor of the high bay area, restricting the route to an emergency exit.
- Obstructed fire extinguisher in the high bay area: This condition was corrected during the walkthrough.
- Unsecured hydrogen gas bottle in the high bay area: This condition was corrected during the walkthrough.
- Flammable liquids not properly stored (small quantities of acetone, ethyl alcohol, and other solvents): This condition was corrected during the walkthrough.
- Sprinkler riser placard not updated to reflect the actual sprinkler systems that the riser supplied: NFPA 13.3.3 states that each control valve shall be identified and have a sign indicating the system or portion of the system it controls.

LLNL conducted an extent-of-condition review for the rest of the HEAF facility and found a number of other experimental areas where flammable liquids were improperly stored. Subsequently, the contractor placed an order to procure additional flammable storage cabinets that will be placed in several experimental areas to fully address the concern.

Overall, the FPP controls for reducing the risk associated with fire at HEAF are well established and implemented. The designated FPE was found to be actively involved in completing the necessary fire protection assessments and was integrated into the review and approval of the facility DAP. The facility management team demonstrated a high level of knowledge regarding the inherent fire risks associated with the HEAF during the facility walkdown, and they were responsive in correcting identified deficiencies.

5.3 Fire Prevention and Protection

A complete spectrum of fire prevention controls and procedures are in existence and have been implemented as required by applicable fire safety criteria. (DOE Order 420.1B, Site & Facility DSA)

All fixed fire protection features (appropriate construction types, fire barriers, fire alarm and signaling systems, manual and automatic fire suppression systems, etc.), that are required by authorization basis documents and fire hazards analyses, have been installed and are tested and maintained, as required by applicable fire safety criteria. (DOE Order 420.1B, Site & Facility DSA)

A process exists to assure that all fire prevention and protection features are reviewed and approved by a qualified fire protection engineer. (DOE Order 420.1B)

Water Supply

Independent Oversight reviewed the fire protection water supply for the LLNL Site 200 area main underground piping grid. Water is gravity fed from three tanks located on the hills situated on the adjoining Sandia National Laboratory property through redundant 14-inch pipes to the LLNL grid. These tanks have a capacity of 1.5 million gallons total and are supplied with water from the San Francisco Hetch-Hetchy Aqueduct. The tanks supply both fire fighting and domestic water to the main Site 200 and are the primary source of water. If the Hetch-Hetchy primary water supply quantity or quality becomes inadequate, a normally open crosstie from the Alameda County Flood and Water Conservation District Zone 7 to the grid is used as a backup, along with a pumping station adjacent to the crosstie. Other normally closed crossties that connect to the Livermore municipal water supply also exist. The grid infrastructure throughout the LLNL Site 200 area has numerous zone sectional valves to facilitate piping isolation for routine or emergency maintenance to service areas. Additionally, post indicator valves (PIVs) exist at pipe routing into individual facilities from the main branch piping.

Much of the underground piping and valves were installed over 40 years ago and are aging. Independent Oversight performed a walkdown of portions of the grid infrastructure, the pumping station, and crossties, and interviewed utilities department personnel. Due to budget and manpower constraints, the LLNL Maintenance and Utilities Services Department (MUSD) ceased routine exercising of zone isolation valves and extended the Zone 7 diesel and electric pump start testing frequency from weekly, as required by NFPA, to monthly. ITM of the Zone 7 pumps and the grid sectional control valves are no longer performed in accordance with NFPA requirements but rather by requirements established by the American Water Works Association. This action was as a result of the LLNL Fire Marshall, who is the delegated AHJ, designating the Zone 7 pumps as "water pumps" and not "fire pumps." Much of the buried piping consists of transite pipe, an asbestos-cement material. Other installed piping is largely black steel welded, epoxy lined steel, and galvanized. The newest installed piping is C900 PVC pipe. The grid cross ties consist of backflow preventers and two rising stem isolation valves; these devices are inspected and maintained annually but visually exhibited poor external condition during the Independent Oversight Team's walkdown.

A piping condition assessment was performed by a subcontractor (V&A), dated November 2012, and concluded that the piping loop system exhibited moderate risk of deterioration and that the current condition was uncertain. The actual service life of transite piping depends largely on pipe condition and working environment. Over time, buried transite and steel pipe can undergo gradual degradation in the form of corrosion that can lead to reduction in effective cross-section, which results in loss of mechanical strength. Accordingly, as the water distribution system ages, the number of pipe failures increases with time. At LLNL, steel pipe is predominately in fire service mains, and there have been no catastrophic mechanical failures documented due to loss of strength. Transite pipe failures have been due to external point loads such as settling of electrical duct banks/bond beams on transite piping or movement due to tree roots deflecting a joint beyond permissible angles. Based on the report conclusions, Independent Oversight could not find any evidence of a formal plan in place to address the results of the report.

The LLNL FPP Manual identified MUSD's responsibilities as maintaining and testing the standpipe and manual water spray systems, tank water supply system and fire service mains for flow. Interviews with the MUSD's supervisor revealed that this information was not accurate and that their responsibilities were limited to maintaining the underground water supply and associated infrastructure. In actuality, Emergency Management and ACFD are responsible for the system from a single supervised/locked valve that would impair fire elements directly to those elements. MUSD flushes lines for water quality per AWWA guidelines rather than to check fire flow. The ACFD's responsibilities included the ITM of auxiliary valves for fire hydrants, flushing of hydrants and maintenance of the water pumps and associated isolating valves (see **OFI-7**). The Independent Oversight Team was informed by MUSD that the auxiliary valves for fire hydrants were not being inspected or tested, and the frequencies for flushing of hydrants has been extended beyond the NFPA required frequencies (see **Finding F-3**).

Overall, the Independent Oversight team observed that at the time of this assessment, there was not adequate priority or attention being given to the underground water supply. Based on the findings documented in the subcontractor (V&A) report, the recent reduction and/or elimination of ITM on fire water components such as valves and hydrants, and extending pump test frequencies, Independent Oversight is concerned that actions taken to date by MUSD have not yet been sufficiently coordinated and/or evaluated from a FPP perspective to ensure that a reliable supply of water for fire protection is maintained. Furthermore, there was no formal plan in place to address MUSD's response to unplanned events such as a water main break or identifying key water supply valves that would need to be isolated to minimize the impact and duration of emergency impairments (see **OFI-11**).

Interim Fire Protection or Life Safety Measures

The objective of the Interim Fire Protection or Life Safety Measures, Policy 1.6, Revision 0, is to provide compensatory measures for situations where reductions in required fire protection or life safety controls occur. The procedure requires either an equivalency or interim life safety measures for building requirements of the Life Safety Code. An LLNL self-assessment, completed in July 2010, evaluated the implementation of this standard and the interim measures used to compensate for reduced levels of fire protection or life safety. The examples of interim compensatory measures noted in this report included cessation of certain activities, providing a fire watch, and notification of facility occupants.

The Independent Oversight team reviewed LLNL's recent efforts to address a self-identified sitewide issue associated with emergency lighting deficiencies, as well as the corrective actions that had been implemented or were in progress. All of the corrective actions and path forward to resolving the deficiencies were considered appropriate. The LFO has been monitoring progress and completed a functional area review assessment, *Status Review Programmatic Noncompliance Related to Emergency Lighting and Illuminated Exit Signs,* in January 2011 to determine the status of LLNL's corrective actions associated with the emergency lighting. The LFO assessment concluded that although several corrective actions were still in progress, LLNL's actions and progress met expectations. In addition, a formal root cause analysis, *LLNL Root Cause Analysis Report - Failed Emergency Light Units*, provides a detailed description of the programmatic gaps, which include undefined responsibilities for testing emergency lights and applying life safety requirements.

The Independent Oversight team determined that LLNL's corrective actions which included the replacement of batteries in the existing emergency lights and path forward were adequate, but that additional compensatory measures we not considered. For example, facility managers had not heightened their building occupants' awareness of life safety deficiencies and the risks associated with inoperable emergency lights. An action or response plan describing how each facility would respond during a loss of power was not considered. Interim life safety controls such as a response plan and

raising the awareness of the occupants should have been implemented and remained in effect until the building emergency lighting systems had been adequately tested and validated to be functional, as required by the LLNL Fire Protection Engineering Standard, Policy 4.3, *Emergency Lighting*, Revision 3 (see **Finding F-4**).

Plutonium Facility

Independent Oversight reviewed credited fire protection systems at the Plutonium Facility to confirm that an appropriate ITM program for fire protection features is being conducted. The requirements of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, NFPA 72, *National Fire Alarm Code*, and other applicable NFPA standards and codes related to ITM requirements have been integrated into the facility TSR surveillance testing program. A combustible control program has been implemented, and the associated ITM requirements have been integrated as a specific administrative control and validated by bi-weekly facility walkdowns (see Section 5.5).

High Explosives Application Facility

Independent Oversight's review of LLNL's fire protection test records for the HEAF coupled with an interview with the supervisor of the Alarms Division revealed that the PIVs were being tested in accordance with NFPA 25. The current LLNL test method includes a tension verification or "Spring Test," consisting of giving the valve handle a quarter turn to ensure that it is still connected to the stem (for semi-annual tests) and cycling the valve fully open and closed (for the annual test). Documenting the number of turns when completing the annual test verifies that there is no blockage in the valve, but this step had not been incorporated into the test procedures (see **OFI-8**).

5.4 FHA/DSA Integration

Within the scope of the review, the FHA conclusions shall be incorporated into the safety authorization (preliminary safety design review, preliminary DSA, or DSA, as appropriate) and demonstrate the adequacy of controls provided by the system to eliminate, limit, or mitigate identified hazards, and define the process for maintaining the controls and controlling their use

The safety authorization basis is consistent with the fire hazards analysis; demonstrates the adequacy of controls provided by the system to eliminate, limit, or mitigate identified hazards; and defines the processes for maintaining the controls current at all times and controlling their use

In accordance with DOE Order 420.1B, the conclusions of the FHA are to be incorporated in the DSA for Category 1, 2, or 3 nuclear facilities to provide consistency between fire accidents analyzed in the DSA and the actual fire hazards analyzed in the facility. The FHA for the Plutonium Facility, LLNL-MI-637895, was reviewed for consistency with the facility's DSA to determine the adequacy of the fire protection selected control set for the identified hazards. In determining the value of the MPFL, which is used in part to assess the need for fire protection systems, the basic assumption should be that there is no automatic or manual fire suppression; the FHA appropriately assumes the failure of both automatic fire suppression and manual fire-fighting efforts. It further states that none of the safety class fire protection system equipment would have a bearing on the MPFL determination. However, the absence of the safety class high efficiency particulate air (HEPA) filtration water spray could influence the MPFL; the DSA documents the hot gas temperature during a fire at a magnitude that would challenge the ventilation ducting and the final HEPA filtration. In addition, the FHA documents the MPFL based on a fire event in a specific room which is the largest radioactive materials area (RMA) laboratory in

the facility. However, based on discussions with the FHA author, in determining the MPFL, the damage potential associated with the DSA design basis fire scenario was not considered. This is contrary to the guidance defined in DOE-G-420.1-3 that states that the damage potential MPFL as defined in DOE-STD-1066-99 and the DSA design basis fire scenario should be considered. The DSA design basis fire is postulated to occur in a different room and assumes a different combustible loading than considered in the FHA analysis (see **OFI-5**).

The facility FHA comprehensively and qualitatively identifies the fire hazards and assesses the risk from fire within individual fire areas in the facility. A concise description of building construction is provided as required, and fire rated area separations are identified. Where fire areas are defined, they are bounded by fire rated construction with openings protected by equivalently rated fire doors and penetration seals. Where penetrations are made in the structure, fire retardant material approved by Underwriters Laboratories (UL) is installed to preserve the fire resistance rating of the structure consistent with the DSA. The facility DSA defines the scope of work that is performed in the facility, identifies and analyzes the hazards associated with the work, and establishes the hazard controls on which the contractor relies to ensure adequate protection of workers, the public, and the environment. Independent Oversight determined that for Building 332, the hazards identified in the FHA and the associated controls are consistent with those evaluated in the DSA.

5.5 TSR Surveillance and Testing

Surveillance and testing of the system demonstrates that the system is capable of accomplishing its safety functions and continues to meet applicable system requirements and performance criteria

Surveillance and test procedures confirm that key operating parameters for the overall system and its major components remain within safety basis, NFPA, and applicable consensus standards operating limits

The acceptance criteria from the surveillance tests used to confirm system operability are consistent with the safety basis

Instrumentation and test equipment for the system are calibrated and maintained

A review of the safety basis documents showed that TSR safety system surveillance testing adequately confirms the adequacy of safety SSC credited controls performance requirements. Surveillance and testing of the fire suppression system generally demonstrates that the system is capable of accomplishing its safety functions and continues to meet applicable system requirements and performance criteria. All surveillance and test procedures confirm that key operating parameters for the overall system and its major components remain within safety basis, NFPA, and applicable consensus standard operating limits, and the acceptance criteria from the surveillance tests used to confirm system operability are consistent with the safety basis. At the Plutonium Facility, the required NFPA ITM is integrated into the facility TSR surveillance testing procedures. The requirements of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, NFPA 72, *National Fire Alarm Code*, and other applicable NFPA standards and code ITM requirements are integrated into the facility TSR surveillance testing program. Independent Oversight reviewed surveillance test procedures and confirmed that safety basis attributes of the testing were not adversely influenced by preconditioning in order to accomplish the NFPA-required ITM. Internal inspections of the safety class fire water storage tank and safety class check valves are integrated to the surveillance test procedures and performed at a five-year interval as required by NFPA. Additionally, all other required NFPA ITM is covered by existing surveillance procedures.

5.6 Fire Protection Self-Assessment Program

A documented comprehensive self-assessment of the fire protection program is performed by the DOE site office and the facility contractor at least every 3 years, or at a frequency with appropriate justification approved by the DOE head of field element. (DOE Order 420.1B)

Proper controls are incorporated to prioritize and monitor the status of the fire protection assessments and associated findings until final resolution

Lawrence Livermore National Laboratory

LLNL has a formally documented and implemented fire protection self-assessment program, described in LLNL Fire Protection Engineering Standard 1.4, *Assessment of Fire Protection Program.* LLNL has completed two self–assessments, including the *Lawrence Livermore National Laboratory Fire Protection Self Assessment, January 15, 2010* and the *LLNL Fire Protection Program Annual Limited Self Assessment, July 29, 2010.* These assessments and respective conclusions were reviewed by the Independent Oversight team, which concluded that the reports were appropriately self-critical and considered results from external assessments, such as the *Independent Oversight Review of Nuclear Safety at Lawrence Livermore National Laboratory,* dated December 2009. More recently, Los Alamos National Laboratory (LANL) and LLNL established a joint agreement to perform mutual assessments of their respective FPPs. Independent Oversight reviewed the report *LANL review of the LLNL FPP*, dated September 2012, and concluded that using an assessment team independent of the LLNL program and organization added value by providing different perspectives. Some items identified during the LANL review, such as greatly underestimated MFPL values, needed improvements in some FPP documentation, and centralized and strong implementation of FPP elements from the LLNL Alarms Division, were consistent with Independent Oversight's current observations. The results of the three assessments were appropriately entered into the LLNL Issues Tracking System (ITS) for LLNL management review, corrective action development, and tracking of actions to closure.

The three assessments described above focused primarily on ensuring that adequate programs had been established and a framework for flowdown of FPP requirements existed. However, the assessments consisted primarily of a review of the program documentation and policies, with only limited reviews of the effectiveness or implementation of key aspects of the FPP or the interfaces among the key individuals and organizations responsible for implementation of FPP measures at the facility level (see **OFI-9**).

In addition to the institutional assessments described above, LLNL Nuclear Materials Technology Program (NMTP) personnel and LFO performed a joint management self-assessment of the NMTP fire protection program in March 2013, focusing on NMTP nuclear facilities. The purpose of the joint assessment was to determine whether nuclear facility safety basis fire evaluations were properly implemented within the FPP. For this limited scope, the depth and breadth of the assessment were adequate. Several deficiencies were identified and entered into the ITS system. Independent Oversight found the corrective actions to be acceptable. The Plutonium Facility Assurance Manager stated that future NMTP management self-assessments would include focus on a specific FPP element to allow a more detailed and though review.

Livermore Field Office

The LFO FPP is documented in LFO *Safety Management Program Description Document (SMPDD) Oversight of the Fire Protection Program (FPP), FY 2013.* The SMPDD describes the LFO master assessment plan oversight FPP elements, oversight scope and approach, and LFO's process for evaluation of LLNL FPP performance. The SMPDD appendices address a number of key products resulting from

LFO FPP oversight activities, including prior fiscal year evaluation of FPP program performance, issues and corrective actions requiring follow-up, and the current fiscal year master assessment plan and assessment schedule. LFO strategy for FPP oversight is based on several factors, with the highest priority on risk and hazard classification of facilities using the emergency planning hazard assessment criteria, DOE requirements, and performance concerns. The Plutonium Facility and HEAF are identified in the SMPDD Strategic Plan for LFO FPP oversight. Although DOE Order 420.1C shifted the focus of field elements to approval and evaluation of the contractor's FPP rather than maintaining a separate, formally documented FPP for LFO, the LFO FPE and FPE-in-Training stated that they will continue to maintain the SMPDD to support the LFO oversight strategy and planning for assessments of the LLNL FPP.

The LFO continues to maintain sufficient staff and assigned personnel with adequate technical competence to oversee the LLNL FPP. LFO has one qualified fire protection subject matter expert (SME) providing oversight of the LLNL FPP and explosives safety program. The fire protection SME is supported by the LFO fire safety engineer-in-training, who recently graduated from a Fire Protection Masters Program and continues to make progress towards meeting the prerequisites for the Technical Qualification Program fire protection qualification standard. LFO oversight of the LLNL FPP also is supported by two qualified safety system oversight personnel who oversee safety class and other fire protection systems.

The LFO's assessment records for the Plutonium Facility provide adequate objective evidence of periodic walkthroughs, document reviews, and observations of ITM implementation, combustible controls, impairments, postings, housekeeping, life safety, FPP equipment and system status, and the fire water tank modification in progress. The LFO identified issues involving lack of flowdown of LLNL institutional requirements for fire system impairments, RunCard maintenance, and discrepancies in fire sprinkler system as-built drawings. These issues were appropriately communicated to the contractor and are tracked in the LLNL ITS. To date, LFO assessments have concluded that the FPP ITM program is adequately implemented in accordance with DOE Order 420.1B, Change 1, and NFPA requirements; this conclusion is consistent with the results of this Independent Oversight review.

In addition, the LFO has been conducting walkthroughs and observations of work activities and facility conditions through the assigned LFO Facility Representative (FR) and LFO fire protection SME at the HEAF; however, most were focused on various aspects of explosives safety operations. Housekeeping and combustible control practices were typically checked, and minor discrepancies were noted occasionally. The last detailed, documented surveillance that focused on key aspects of FPP implementation at HEAF was in July 2009, when the LFO reviewed the FHA and fire protection systems with support from the NNSA Service Center. Fire pre-plans (i.e., RunCards), control of flammables and explosive formulations, and the facility FHA were found to be adequate at that time. The LFO was also involved in monitoring contractor actions to investigate the April 30, 2013 HEAF smoke detector activation event. Follow-on discussions with the LFO FR assigned to HEAF and the LFO fire protection engineer SME indicated that, due to the nature of hazards in HEAF, oversight activities focused primarily on explosives operations. Based on the results of this review, Independent Oversight concluded that while the overall level of LFO resources being applied to oversee HEAF operations is appropriate, increased emphasis on some aspects of FPP implementation should be integrated into LFO's ongoing, routine, scheduled oversight activities (see **OFI-10**).

The LFO has conducted oversight of the LLNL water supply system for fire protection to determine the reliability and adequacy of the water supply and distribution system for fire suppression. The LFO conducted a detailed surveillance in February 2008 and several more surveillances in June 2012 to observe testing and maintenance of electric and diesel water pumps. The focus of these surveillances was primarily on above-ground components, and no major concerns were identified. However, a number of important observations were made, including a need for: the water master plan to evaluate the

underground system piping due to its age; the development of an emergency water system impairment recovery plan in the event of pipe breaks; and the development of a water isolation valve exercise program for exercising all critical isolation valves in the water system within a specified time period. The LFO did not require a formal response and corrective action from the contractor to address these observations. In light of the recent information (e.g., the material condition of the underground fire protection piping, the recent reduction and/or elimination of ITM on fire water components such as valves and hydrants, and extending pump test frequencies), the LFO should re-evaluate the past observations to determine whether they should be reemphasized to the contractor and/or elevated as recommendations or issues and included in the ITS for tracking and resolution (see **OFI-11**).

LFO's oversight of the LLNL FPP was most recently reviewed by the NNSA Office of the Chief of Defense Nuclear Safety (CDNS) in October 2011. The CDNS review concluded that although there were two issues with the Plutonium Facility FHA (e.g., an issue with flowdown of AHJ requirements, and closure of one previous NNSA review weakness). The LFO had documented and implemented an effective program for oversight of the FPP. Independent Oversight reviewed the status and closure documentation for the three CDNS findings and one weakness cited in the CDNS report. Although LFO had not yet performed its own validation of closure for the CDNS's fire protection findings associated with the contractor, there was sufficient objective evidence to demonstrate adequate closure. With the issuance and recent inclusion of DOE Order 420.1C in the LLNL contract, LFO and LLNL have taken additional actions to clarify AHJ roles and responsibilities.

The Independent Oversight team also reviewed the actions and response to recommendations from Independent Oversight's 2009 nuclear safety review of the LLNL. A number of recommendations focused on strengthening the LLNL FPP documents. The LLNL planned to incorporate the associated improvements in the next revision. Although some improvements had been made, resource constraints have kept the program documents at a low priority. For other recommendations, LLNL deemed the current program to be adequate, in the absence of any prior performance issues, and concluded that no further actions were required. Other than the lengthy delay in improving the program documentation, Independent Oversight has no concerns regarding the disposition of recommendations.

6.0 CONCLUSIONS

Overall, most of the LLNL FPP processes reviewed are well-defined and implemented. The BNA for LLNL is well documented, current, and comprehensive. NFPA ITM requirements for fire systems are adequately implemented for the Plutonium Facility and HEAF. In addition, safety basis required TSR surveillances adequately confirmed the performance of safety SSC credited controls. Although some improvements could be made, the FHA for the Plutonium Facility and FPA for HEAF have been adequately prepared and maintained. For the Plutonium Facility, the FHA results are appropriately integrated into the DSA, as required. The implementation of the LLNL FPP through the facility-specific DAPs and the associated administrative implementation procedures at the Plutonium Facility is effective.

Although most aspects of the LLNL FPP were effective, some FPP procedures and standards that flow down and implement FPP requirements need to be strengthened. In addition, increased management attention is warranted to improve implementation of some FPP program elements, such as fire pre-plans and interim compensatory measures for some life safety deficiencies. Of particular significance, the recent changes to ITM requirements and new information on the material condition of the underground infrastructure for the LLNL Site 200 water supply warrant increased management attention.

LLNL and LFO have generally performed adequate assessments and issues management. However, increased focus by both LLNL and LFO on LLNL organizational interfaces responsible for implementation of key aspects of FPP, and on overall water system reliability is warranted, given the aging piping and infrastructure. In addition, LLNL self-assessments could be further improved by focusing more on performance and implementation of requirements at the facility level.

7.0 FINDINGS

Findings indicate significant deficiencies or safety issues that warrant a high level of attention from management. If left uncorrected, findings could adversely affect the DOE mission, the environment, the safety or health of workers and the public or national security. Findings may identify aspects of a program that do not meet the intent of DOE policy and requirements.

Finding F-1: The LLNL Pre-Fire Plan (i.e., RunCard) for the HEAF is inconsistent with the FSP and does not reflect the physical conditions observed in the facility.

Finding F-2: Several non-compliant fire safety conditions were identified during the HEAF walkdown/tour, including restricted egress, obstructed fire extinguishers, improperly stored flammable liquids, and an outdated placard.

Finding F-3: Inspection, Maintenance, and Testing of the fire water supply components are not in accordance with NFPA standards. Auxiliary valves for fire hydrants are not being inspected or tested, and the frequencies for flushing of hydrants had been extended beyond the NFPA required frequencies. Furthermore, based on the findings documented in the subcontractor (V&A) report, the recent reduction and/or elimination of ITM on fire water components such as sectional control valves and hydrants, and extending pump test frequencies, Independent Oversight is concerned that actions taken to date by MUSD have not yet been sufficiently coordinated and/or evaluated from a FPP perspective to ensure that a reliable supply of water for fire protection is maintained.

Finding F-4: Interim compensatory measures are insufficient at the facility level to ensure that the building occupants are aware of life safety deficiencies. Facility managers have not been directed to raise occupants' awareness of the risk associated with the lack of operable emergency lights in case of a loss of power. An action or response plan has not been prepared to describe how each facility would respond. These controls have not been implemented until the emergency lighting systems were adequately tested and validated to be functional as required by LLNL Fire Protection Engineering Standard, Policy 4.3, *Emergency Lighting*, Revision 3.

8.0 OPPORTUNITIES FOR IMPROVEMENT

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

Lawrence Livermore National Laboratory

OFI-1: Ensure that current FPP organizational and individual roles, responsibilities, authorities, and accountabilities are sufficiently documented during the next revision to LLNL Fire Protection Division policies, procedures, and engineering standards.

OFI-2: Given the challenges in maintaining the accuracy of LLNL pre-fire plans, re-evaluate the current process and mechanisms for maintaining RunCards, with an overall goal to improve consistency in maintaining RunCard accuracy, including working towards use of an electronic-based system to improve its maintainability for updating RunCards.

OFI-3: In the next revision of the *LLNL Exemption and Equivalency Tracking Policy* 1.1.1, consider addressing the process for developing and approving generic equivalencies.

OFI-4: Re-consider providing enhanced guidelines and acceptance criteria in the Plutonium Facility work planning and control process procedure for controlling transient combustibles as to quantity and allowable residence time.

OFI-5: In the next revision of the Plutonium Facility FHA, consider the following improvements:

- Provide references to the supporting documents that form the basis for statements in the FHA. For example, design documentation and analyses that support Section 3.0, *Protection*, describe safety SSC and performance but are not listed.
- Document the results of the ongoing Plutonium Facility fire tank modification Code of Record review in the Plutonium Facility FHA, DSA, and fire system SDD, as appropriate.
- In conjunction with the ongoing LLNL actions to address the greatly underestimated values that were used to calculate the MPFL (as identified in *LANL Assessment of the LLNL Fire Protection Program*, dated September 2012), ensure that the update of the Plutonium Facility MPFL addresses the cost of lost time (considered mission interruption costs) and environmental cleanup costs. In addition, ensure that the MPFL analysis considers the damage potential MPFL, as defined in DOE-STD-1066 and the Plutonium Facility DSA for the design basis fire scenario.

OFI-6: Consider developing a standardized policy to document the process for downgrading from an FHA to an FPA.

OFI- 7: LLNL should update the FPP Manual to reflect current MUSD's responsibilities for the ITM of the underground fire water supply and related components. Appropriate direction and guidance should be provided from the Fire Protection Division to MUSD personnel on implementing the respective ITM requirements and ensuring compliance with NFPA codes and standards.

OFI-8: Consider adding a step to the annual Fire Alarms Division PIV test procedure to document the number of turns during the test to ensure that the valve is returned to its proper position following testing.

OFI-9: Consider improving the LLNL self-assessment program by identifying specific program elements for future self-assessments to allow a more detailed assessment of the effectiveness of implementation of key elements of the FPP at the facility level.

Livermore Field Office

OFI-10: Consider more fully integrating FPP implementation aspects, specifically life safety/facility condition, into routine walkthroughs and other scheduled LFO oversight activities. For example, provide additional training and checklists to FRs to strengthen facility walkthroughs, and conduct some FP SME monthly walkthroughs concurrent with LLNL ES&H Team Technician Supervisors to further increase operational awareness, knowledge and perspectives of workplace conditions at the facility level.

OFI-11: In coordination with LLNL, consider re-evaluating several of the observations identified in February 2008 LFO surveillance, such as development of a water isolation valve exercise program and development of an emergency water system impairment recovery plan to determine if they should be reemphasized to the contractor and/or elevated as recommendations or issues warranting increased priority.

9.0 ITEMS FOR FOLLOW-UP

Through the site lead program, Independent Oversight will continue to follow up periodically on actions taken to address the findings identified in this report, in particular actions taken to ensure that the site maintain a reliable fire water supply.

Appendix A
Supplemental Information

Dates of Review

Onsite Review: June 11-20, 2013

Office of Health, Safety and Security Management

Glenn S. Podonsky, Chief Health, Safety and Security Officer
William A. Eckroade, Principal Deputy Chief for Mission Support Operations
John S. Boulden III, Director, Office of Enforcement and Oversight
Thomas R. Staker, Deputy Director for Oversight
William E. Miller, Deputy Director, Office of Safety and Emergency Management Evaluations

Quality Review Board

William Eckroade
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Thomas Staker
William Miller
Michael Kilpatrick

Independent Oversight Site Lead

Robert Freeman

Independent Oversight Reviewers

Robert Freeman – Lead
Jeffrey L. Robinson
Joseph Panchison

Appendix B
Documents Reviewed, Interviews, and Observations

Documents Reviewed:

- LLNL Fire Protection Engineering Standard, Emergency Lighting, Rev. 3.0, 9-2011
- LLNL Root Cause Analysis Report- Failed Emergency Light Units, 3-2011
- ES&H Manual 11.2 Hazards – General and Miscellaneous, 12-2011
- UCRL-AM-133867, ES&H Manual Volume II Document 22.5 Fire, Revision 12
- LLNL Emergency Management Department (EMD), Emergency Light Building Priority List, 2-2012
- LLNL EMD, Building Requiring Emergency Lights (Spreadsheet), Provided by Fire Marshal, 5-2012
- BSS-SBK-B33, B331 Annual Wet Pipe Sprinkler Test Procedure, 8-26-2008
- Alarms Impairment Procedure, Policy No 860.010, rev 1, 4-2009
- Permit and Impairment/Shutdown Procedure for Fire Sprinkler Systems, Policy No 850.046, rev 1, 10-2012
- Sprinkler System Impairment Control & Restorations, Policy 430.00, rev 2, 7-2010
- HEAF Fire Protection Assessment Checklist, rev o, 11-2009
- Fire Hazards Analysis Building 191, rev 4, 8-2009
- LLNL Building and Trailer Runcards, Policy 30.103, 10-2008
- Fire Department Runcard, HEAF, 3-2004
- LLNL-TR-559076, Fire Protection Program Manual, rev 3.0, April 2012
- Impairment Control of Critical Health and Safety Systems, Policy No. 100, 5-2012
- LLNL Fire Protection Program Criteria, Policy 1.2, rev 4, 9-2011
- Fire Protection 2013 Disciplined Action Plan for HEAF, rev. 7.5, 1-2013
- UCRL-AM-133867, ES&H Manual Document 55.1, Documented Safety Analysis Program Plan, 9-2009
- Organization & Management Plan for Alarms Division, rev 1, 10-2012
- Review of Fire Hazards Analysis, Policy 5.3.1, rev 4.0, 4-2012
- Fire Barriers/Fire Wall Inspection Procedure, Policy 9.5, rev 0, 12-2011
- PEL-M-1430, Fire Sprinkler Riser, Rev H, 10-1992
- Hot Work Permit-Fire Watch Duties/Responsibilities, Policy 1.5, rev 0, 9-2011
- Fire Protection and Life Safety Equipment Program, Policy No. 400.00, 12-2012
- Fire Protection Engineering Facility Survey program, Policy 5.8, rev 5, 9-2011
- Estimating Building Values, Policy 5.6, rev 7, 4-2012
- Fire Alarm Systems – Notification Appliances, Policy 6.3, rev 2, 4-2012
- PROC-OPS-0002, Building Fire Sprinkler System Outage Permits, rev 0, 11-2005
- LLNL Baseline Needs Assessment (Requirements), LLNL-TR-609134
- LLNL Baseline Needs Assessment (Compliance), LLNL-TR-609473
- LLNL Water Piping Condition Assessment Methodology Evaluation Report, V&A 12-0273
- LLNL NMTP Note, Reliability of Plutonium Facility Firewater Sources, EN02-332-001
- Functional Area Review of the LLNL Water Supply System, ASRP-TS-7.15.2009-99364
- Joint Management Self-Assessment, ITS #34913
- ES&H Manual, DSA Program Plan, Document 51.1
- Fire Protection Program Manual, LLNL-TR-559076
- Plutonium Facility Run Card

- ES&H Team 1 Discipline Action Plan (DAP)
- NMTP Superblock System Engineering Program Manual
- Superblock Administrative Control Procedure, Housekeeping & Combustible Materials Control
- Superblock Administrative Control Procedure, Monitoring Integrity of 2 Hr Fire Barriers in RMA
- Fire Hazards Analysis, Building 332
- LLNL Fire Protection Engineering Standard 5.3, FHA, LLNL-AM-521911
- LLNL Fire Protection Engineering Standard 5.3.1, Review of Fire Hazards Analyses
- LLNL Fire Protection Engineering Standard 5.6, Estimating Building Values
- Documented Safety Analysis (DSA), Plutonium Facility
- Technical Safety Requirements (TSR), Plutonium Facility
- TSR Fire Protection Surveillance Testing Procedures, Plutonium Facility, (w/data)
- System Design Description, Fire Suppression System, Plutonium Facility
- Preventive Maintenance Procedures- Plutonium Facility Fire Protection (Various)
- Livermore Field Office Policy 226.2, Operations Teams, dated 3/26/2013
- Livermore Field Office Work Instruction 226.1.3, Performing Oversight, dated 1/28/2013
- Livermore Field Office Work Instruction 414.9.1, Writing and Managing Assessments of the Livermore Field Office, Issues and Corrective Action Plans in ePegasus, dated 4/16/2013
- Livermore Site Office Work Instruction 414.9.2, Performing Self-Assessments, dated 3/2/2011
- Livermore Site Office Work Instruction 226.1.2, Oversight Planning, dated 8/3/2011
- LLNL Fire Protection Program Self Assessment, dated 1/15/2010
- LLNL Fire Protection Program Annual Limited Self-Assessment, dated 7/29/2010
- LANL Assessment of the LLNL Fire Protection Program, dated 9/2012
- NNSA Headquarters Biennial Review of Site Nuclear Safety Performance, Livermore Site Office, dated October 2011
- LFO Safety Management Program Description Document Oversight of the Fire Protection Program Fiscal Year 2013, Revision 1
- LFO Fire Protection Master Assessment Plan, 2/27/2012
- LFO Fire Protection Master Assessment Plan, Fiscal Year 2013
- LFO/LLNL Alarms Group Bi-Weekly Meeting Minutes (various)
- LFO/LLNL Fire Marshall Bi-Weekly Meeting Minutes (various)
- LFO/LLNL Fire Protection Engineer Bi-Weekly Meeting Minutes (various)
- ePegasus Records
  - ASM-TS-10.5-2010-292839
  - ASRP-ESH-12.28-2011-408188
  - ASRP-ESH-4.23.2012-434307
  - ASRP-ESH-12.28.2012-487443
  - ASRP-FO-3.4.2013-497807
  - ASM-SI-10.18-2012-474286
  - ASRP-SI-12-10-2012-484497
  - ASM-TS-7-15-2008-92278
  - ASM-ESH-10.27.2011-394688
  - ASRP-TS-7.15.2009-99364
  - ASRP-TS-7.15.2009-98971
  - ASRP-TS-7.15.2009-99032
  - ASRP-ESH-7.23.2012-453899
  - ASM-TS-7.15.2009-94085
  - ASRP-FO-2.17.2012-419204
  - ASRP-FO-5.21.2013-512582
  - ASRP-ESH-6.4.2012-443780

- ASRP-ESH-8.4.2011-368753
- ASRP-TS-5.5.2011-345771
- ASRP-TS-7.6.2010-265872
- ASRP-TS-7.15-2009-99339
- ASRP-TS-7.15.2009-99504
- ASRP-TS-9.30.2010-287833
- ASRP-SI-6.26.2012-448790
- ASRP-ESH-9.2.2011-375528
- ISS-ESH-9.2.2011-375538
- ISS-TS-11.9.2009-212198
- ISS-ESH-9.2.2011-375530
- ASM-TS-10.15-2010-292839
- ASRP-ESH-12.5-2011-403153
- ISS-ESH-12.6.2011-403449
- ISS-ESH-12.6.2011-403298
- ASRP-MO-11.22.2011-401155
- ACT-TS-7.15.2009-77457
- ACT-TS-7.15.2009-77460
- ACT-ESH-2.3.2012-415982
- ASM-TS-7.15.2009-92438
- ASRP-TS-7.15.2009-99383
- ASM-ESH-10.11.2012-472361
- COR-TS-8.20.2008-13051
- COR-TS-9[1].18.2009-135442

Interviews:

- LFO Facility Representative Plutonium Facility
- LFO Facility Representative HEAF
- LFO Fire Protection Subject Matter Expert
- LFO Fire Protection Engineer
- LLNL Fire Marshal
- LLNL Fire Protection Engineer Plutonium Facility
- LLNL Fire Protection Engineer HEAF
- LLNL Fire Captain – Alameda Fire Department Liaison
- LLNL Fire Alarms Division Supervisor
- LLNL Fire Alarms Division Manager
- LLNL Fire Inspector
- LLNL Maintenance and Utilities Services Department Manager
- LLNL Maintenance and Utilities Services Department Supervisor
- LLNL Fire Protection System Engineer

Observations:

- LLNL HEAF Facility Tour/Walkdown
- LLNL Plutonium Facility Fire Protection Surveillance
- LLNL/LFO Meeting: Status Water Tank Modification
- LLNL Water Supply Tour/Walkdown