Inspection of
Environment, Safety,
and Health Programs
at the

Lawrence Livermore National Laboratory

May 2007

Office of Independent Oversight
Office of Health, Safety and Security
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OVERSIGHT

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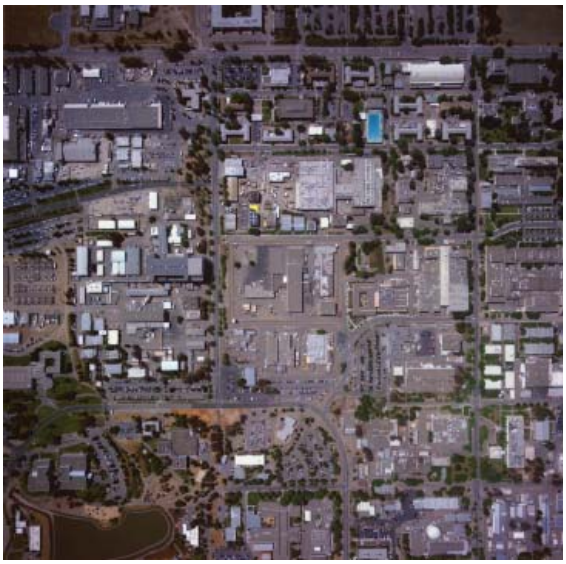
Abbreviations Used in This Report

AEID	Applied Engineering Infrastructure Division
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
EMS	Environmental Management System
ES&H	Environment, Safety, and Health
HEPA	High Efficiency Particulate Air
ISM	Integrated Safety Management
ISO	International Organization for Standardization
IWS	Integration Work Sheet
LLNL	Lawrence Livermore National Laboratory
LSO	Livermore Site Office
NMTP	Nuclear Material Technology Program
NNSA	National Nuclear Security Administration
PPE	Personal Protective Equipment

1.0 Introduction

The U.S. Department of Energy (DOE) Office of Independent Oversight, within the Office of Health, Safety and Security (HSS), conducted an inspection of environment, safety, and health (ES&H) programs at the DOE Lawrence Livermore National Laboratory (LLNL) during January and February 2007. The inspection was performed by Independent Oversight's Office of Environment, Safety and Health Evaluations.



Aerial View of LLNL

The DOE National Nuclear Security Administration (NNSA) provides funding for and has Headquarters line management responsibility for LLNL. At the site level, the Manager of the Livermore Site Office (LSO) has DOE line management responsibility for LLNL activities. Under a contract to DOE, the University of California manages and operates LLNL.[1] LLNL uses subcontractors for certain activities, such as construction.

The LLNL contract is currently up for competitive bid for the first time since LLNL was established in the 1952. An award decision is expected in the spring of 2007, followed by a transition period. The new contract will entail a number of important changes from historical operations. For example, there will be more emphasis on performance objectives, the contractor assurance system, and application of operation expertise to research and support activities. LSO has deferred full implementation of DOE Order 226.1, *Implementation of Department of Energy Oversight Policy*, until the new contract is in place.

LLNL's primary mission is research and development in support of national security. As a nuclear weapons design laboratory, LLNL has responsibilities in nuclear stockpile stewardship that include ensuring that U.S. nuclear weapons remain safe, secure, and reliable. LLNL also applies its expertise to prevent the spread and use of weapons of mass destruction and strengthen homeland security. Other major research and development program areas at LLNL include advanced defense technologies, energy, environment, biosciences, and basic science. In addition to NNSA funding, LLNL receives funding for specific projects from other DOE program offices, various other government agencies, and various commercial organizations.

The purpose of this Independent Oversight inspection was to assess the effectiveness of ES&H programs at LLNL as implemented by the University of California under the direction of NNSA/LSO. Independent Oversight evaluated a sample of activities, including:

- Implementation of the core functions of integrated safety management (ISM) for selected facilities and activities, focusing on work planning and control systems at the activity and facility level and their application to the following organizations and activities:
  - o Operations and research and development at selected Superblock facilities (principally

[1] Consistent with common practice, the term "LLNL" is used to refer to both the physical facility and the onsite contractor management. The term "University of California" is used to refer to the University of California corporate management, which provides corporate direction to the onsite LLNL management team and performs corporate line management and evaluation functions for activities at LLNL.

the plutonium and tritium facilities) performed by the Nuclear Materials Technology Program

- Operations and research and development at the Site 300 801 complex, performed by B Division of the Defense and Nuclear Technologies Directorate

- Biological-hazard-related activities at the Chemistry, Materials, and Life Sciences facilities

- Manufacturing activities performed by the Applied Engineering Infrastructure Division (AEID)

- Maintenance activities performed by the Plant Engineering Department

- Construction and decontamination and decommissioning activities, performed by the Plant Engineering Department and various subcontractors.

- Essential safety system functionality of the safety-related glovebox ventilation and fire suppression systems at the Plutonium Building (Building 332), including a review of engineering and configuration management; surveillance, testing, maintenance, and operations; and feedback and improvement of safety systems.

- NNSA, LSO, and LLNL effectiveness in managing and implementing selected aspects of the ES&H program that Independent Oversight has identified as focus areas, including environmental management system (EMS) implementation, workplace monitoring of non-radiological hazards, and safety system component procurement. Although these topics are not individually rated, the results of focus area reviews are integrated with or considered in the evaluation of ISM core functions.

- NNSA, LSO, and LLNL feedback and continuous improvement systems.

Sections 2 and 3 discuss the key positive attributes and weaknesses, respectively, identified during this review. Section 4 provides a summary assessment of the effectiveness of the major ISM elements that were reviewed. Section 5 provides Independent Oversight's conclusions regarding the overall effectiveness of NNSA, LSO, and LLNL management of ES&H programs, and Section 6 presents the ratings assigned during this review. Detailed results and opportunities for improvement were provided to LSO for consideration by NNSA, LSO, and LLNL site management. Appendix A provides supplemental information, including team composition, and Appendix B presents the findings identified during this Independent Oversight inspection.

In accordance with DOE Order 470.2B, *Independent Oversight and Performance Assurance Program*, NNSA must develop a corrective action plan that addresses each of the findings identified in Appendix B. In most cases, the findings listed in Appendix B were derived from multiple individual weaknesses and supporting examples that have been described in the detailed results provided to LSO. NNSA, LSO, and LLNL need to ensure that the corrective action plan for the Appendix B findings addresses the individual weaknesses and supporting examples. In addition, the causal analysis, corrective actions, and recurrence controls developed in response to the findings in Appendix B need to fully consider the individual weaknesses and supporting examples. The findings are referenced at one or more places in Section 3 or 4 of this report. The weaknesses in Section 3 provide a management-level summary of the findings; the weaknesses do not need to be separately addressed in the NNSA corrective action plan because the findings encompass the scope of the weaknesses.

2.0 Positive Attributes

Positive attributes were identified in ES&H programs in such areas as waste management, Superblock work control processes, recycling, and team assessments.

LSO has taken some effective actions to enhance its oversight of LLNL. There is significant LSO senior management commitment to improve safety, as evidenced by the use of outside expertise to evaluate ES&H responsibilities and performance. LSO has performed a number of effective self-assessments and identified issues, and has a number of ongoing corrective actions to enhance its ES&H oversight. For example, there have been significant improvements in the LSO Facility Representative program. LSO also enhanced its oversight of LLNL biological research activities that support recent expansions of national defense-related programs. In 2005, following a select agent packaging incident in Building 365, LSO decided to establish a formal program to oversee LLNL biological research and enhance operational awareness. The LSO efforts have contributed to the effective controls for biohazard at LLNL facilities evaluated during this inspection.

LLNL has instituted a structured and effective process for annual team assessments of ISM implementation through work control document evaluations and work observations. The process includes direct involvement of senior managers, and has resulted in identification of numerous deficiencies and issues in work control documents and work activities and improved management awareness of ISM implementation problems and performance. Although continued improvement is warranted (e.g., more consistent implementation and self-critical approach across LLNL), this mandatory, structured, well-defined process has resulted in significant improvement in work control documents and the identification of numerous deficiencies, systemic issues, and opportunities to improve work control documents at LLNL.

Superblock has an effective and well-defined work control process that systematically categorizes all work and specifies how hazards associated with each work type are to be identified and controlled. Work control requirements and expectations are effectively communicated to workers at Superblock using a formal and systematic process. Specific requirements associated with control of all work in Superblock are well defined in the "Plutonium Facility – Building 332 Work Control/Design Control Change Process Manual" and the "Category 3 Nuclear Facilities and Superblock Yard Work Control Manual." These documents apply an appropriate graded approach in specifying work planning requirements for all individual activities. The approach addresses routine and low-hazard activities defined and mitigated by facility safety plan requirements, operational and programmatic activities defined and mitigated by operational safety plan requirements, and non-routine or specialized operations, maintenance, or programmatic work defined and mitigated by specific work permits prepared for each activity. Further, all workers are required to be periodically trained and tested on their respective facility and operational safety plans to ensure understanding of requirements and accountability for performance. ES&H Team 1 personnel assigned to Superblock are highly qualified and are visibly engaged with workers, engineers, and support personnel, including attendance at and input to work request, work permit, and pre-job meetings, as well as in review and approval of work permits and safety plans.

Waste management and cleanup activities at the 801 complex for post-shot beryllium and low-level radioactive wastes are comprehensive and effective. The complex uses engineering processes (facility systems for washing down the Contained Firing Facility room) and manual Contained Firing Facility chamber rinses and cleaning to transfer loose beryllium particulates and radiological contamination to the drain system and to ensure that all larger debris removed from the chamber meets housekeeping standards for beryllium particulate contamination. All particulates are removed by wash water and are then filtered out by a water purification

A CFF Chamber after an Explosive Test

system that recycles most of the water for future washes. Consequently, wastewater from the facility is minimized, and the only solid beryllium waste products classified as California combined waste are the polishing filters from the water cleaning system, which contain both hazardous beryllium particulate and radioactive waste. The remainder of the solid waste leaves the Contained Firing Facility chamber as low-level radioactive waste. The cleanup process is effective enough to result in a Contained Firing Facility chamber essentially free of removable beryllium and radioactive contamination (as determined by extensive sampling following previous cleanups), thereby significantly reducing the exposure potential to workers and allowing the majority of the setup activities for the next shot to be performed without respiratory protection.

LLNL has an aggressive recycling program that has resulted in numerous awards from DOE and an external regulatory agency. In addition to LLNL's extensive Pollution Prevention/Waste Minimization Program that includes recycling of paper, cardboard, universal waste lamps/batteries, and scrap metals, the site is currently constructing an E85 (85% ethanol—a bio-based, renewable fuel—and 15% unleaded gasoline) fueling station. Recycling is also being aggressively pursued in several line organizations, such as in the fleet maintenance's use of an aqueous-based brake washer machine and the recycling of automotive fluids and lead batteries. Projects to demolish old structures use a noteworthy practice that includes extensive recovery processes using thorough characterization to find and remove lead paint and other hazardous constituents to allow more metal items to be recycled. Also, as discussed above, the 801 complex has been extremely effective in minimizing the amount of California Combined waste containing beryllium particulates. LLNL has received several awards for its pollution prevention efforts, such as the EPA Region 9 Champions of Green Government Award for innovative strategy to use contractual mechanisms to eliminate waste streams and increase reuse of materials, the NNSA 2006 Pollution Prevention Program Best-In-Class Award for Space Action Team Assets for Value Contracts, and the NNSA 2006 Pollution Prevention Environmental Stewardship Award for the Particulate Capture and Water Recycling at the Site 300 Contained Firing Facility.

3.0 Weaknesses

Although some aspects of ES&H management are effective, there are weaknesses in various aspects of ISM programs at LLNL, most significantly work planning and control in some LLNL facilities, feedback and continuous improvement processes, and certain aspects of engineered safety systems at Building 332.

LLNL and LSO have not adequately addressed some previously identified deficiencies in the Building 332 safety systems, and there are a number of deficiencies in the reviewed safety systems' engineering design and authorization basis. Deficiencies were identified in several specific systems and components. First, in response to a concern identified in the 2004 Independent Oversight inspection, a nitrogen skid was upgraded from defense-in-depth to safety-class; however, the required commercial dedication of parts/components was not performed, the installation records were not reviewed to ensure that the rigor of design control/work control documents for this installation was commensurate with its safety class designation, the associated seismic analysis (which inherently relies on the use of certified quality parts and a level of rigor commensurate with the safety class installation requirements) did not address the potential interactions with adjacent non-seismic equipment, and subsequent modifications were outside of the site design change process. Second, the finding about the potential for high efficiency particulate air (HEPA) filter plugging during evaluation basis fires remains open from the 2004 Independent Oversight inspection, and adequate compensatory measures have not been defined and implemented. It is noted that current restrictions on hydride operations are reducing the dose consequences during evaluation basis fires; however, these restrictions do not satisfy the evaluation guide limits in some cases. A current and correct evaluation of safety is needed to clearly establish the needed conditions for continued operations. (See Section 4.2.) Third, LLNL and LSO have been slow in identifying and resolving a design deficiency in a fusible link damper. A malfunction of this damper during normal operation could have caused a radiological event, and during an event could prevent the room and glovebox exhaust systems from performing their confinement functions. This damper was subsequently removed by LLNL to address the concern. Fourth, there are inadequacies in the calculations used to support the volume requirements for a safety-class fire water storage tank, and there is no calculation for a safety-significant fire water storage tank. Fifth, fire suppression system pressure control valve testing was performed without established acceptance criteria for valve opening. As a result of these deficiencies, LLNL has not adequately demonstrated that some of the Building 332 safety systems in their current state will perform as required in accident conditions (e.g., design basis accidents such as fires and earthquakes). In addition, the effectiveness of LLNL safety system configuration management is hindered by inadequate and/or inconsistent quality and control of critical facility drawings. In some cases, adequate compensatory measures were not taken while long-term corrective actions were underway. (See Findings E-1, E-2, E-3, and E-4.)

Glovebox Work in the Superblock

Deficiencies in certain aspects of maintenance and procurement of safety system components reduce the assurance that safety systems will function with a high degree of reliability. The Maintenance Implementation Plan (MIP) for Building 332 does not identify DOE Order 433.1, *Maintenance Management Program for DOE Nuclear Facilities*, requirements that cannot be met in its present maintenance program, including pertinent elements of the configuration management and system engineer programs that are not yet fully implemented. The LLNL Nuclear Material Technology Program (NMTP)

process for evaluating and selecting suppliers for quality-significant orders does not have sufficiently detailed criteria and formality, and NMTP has not performed a formal, comprehensive self-assessment of its procurement process and implementing procedures. (See Findings E-5 and E-6.)

Institutional work control processes have not been adequately implemented for some manufacturing, maintenance, and construction activities. Within AEID, formal, documented hazards analyses have not been performed or documented on some of the hazards in the 321A Main Bay, the 321C Special Materials Machining Facility, or the 322 Plating Shop, and some hazard controls, such as personal protective equipment (PPE), are not identified, or are not sufficiently described such that the worker can identify and implement the appropriate control. LLNL Plant Engineering trade/service integration work sheets (IWSs) and bridging documents do not sufficiently identify and analyze hazards at the activity level to ensure that the appropriate hazards and requisite controls can be identified clearly. Although LLNL has taken significant steps to include work smart standards requirements in construction subcontracts, additional effort is needed to assure that these requirements are incorporated into site-specific safety plans and enforced by construction managers, particularly for small subcontractors with less LLNL work experience. (See Findings C-2, C-3, C-4, and C-5.)

Radiological hazards associated with the use of thoriated welding electrodes at LLNL have not been adequately evaluated to determine appropriate radiological controls. Thoriated welding electrodes are exempted from the LLNL Radiation Protection Program based on their availability as consumer products. These items are specifically exempted from Nuclear Regulatory Commission licensing requirements. 10 CFR 835 also contains a provision to exempt consumer products from occupational radiation protection requirements. However, thoriated welding electrodes contain up to several percent thorium (Th)-232 and therefore present a potential airborne radiological hazard and contamination hazard. Limits for radiological contamination and airborne radioactivity from Th-232 are presented in Part 835 for occupational uses of Th-232, and concerns associated with radiological hazards and needed controls are well documented in scientific literature, material safety data sheets and industry standards published by the American Welding Society. While exposure scenarios and potential hazards associated with the use of these items may vary widely depending on exposure conditions and durations, LLNL has not conducted sufficient hazards analysis to establish a basis for the lack of any radiological controls. (See Finding C-1.)

LLNL has not adequately addressed known systemic hoisting and rigging deficiencies and issues within the various program directorates and does not have an adequate program for ensuring that hoisting and rigging equipment is inspected and safe for use. Some hoisting and rigging equipment in service at LLNL has not been inspected annually as required by the LLNL ES&H Manual, and some equipment was damaged or defective. However, such equipment was available for use. LLNL does not have a comprehensive and systematic process for performing required annual inspections of rigging gear, and required annual inspections on hoisting and rigging equipment, including cranes, slings, and hoists, have not been performed by some LLNL organizations. Similar concerns were documented in numerous LSO surveillance activity reports and were self-identified during previous LLNL self-assessments (there were over 70 deficiencies and issues from 39 assessment activities in 2005 and 2006 in the LLNL issues tracking database from at least four different directorates); approximately half of the deficiencies were for gear that had no evidence of the required annual inspections. However, analysis and corrective actions for these deficiencies have not been timely and were often not rigorous or comprehensive at the directorate level or the institution level. For example, the Engineering Directorate identified the hoisting and rigging annual inspection issue in 2003, but the corrective actions for this issue were not effective, and the issue was again identified in 2005. Further, no compensatory measures, interim corrective actions, or documented justifications were established to ensure that the failure to conduct annual inspections did not jeopardize worker safety during lifting operations. In addition, LSO and LLNL have not identified the systemic aspects of the hoisting and rigging deficiencies identified and documented by LSO and LLNL as programmatic issues to be addressed at the institutional level. The subject matter expert for the hoisting and rigging Work Smart Standard was not aware of the LSO reports and was aware of only some of the issues in the issue tracking system. The deficiencies in addressing hoisting and rigging deficiencies is a symptom of a broader concern with issues management at LLNL, at both the directorate and institutional level. A contributing factor is that LLNL has not adequately established formal responsibilities

or requirements, at the institutional or directorate level, to perform assessments of this program or other safety programs. (See Finding D-5.)

LLNL has not fully implemented an integrated exposure assessment program, and some workplace exposure assessments and baseline hazard surveys or periodic resurveys are not being performed and/or documented as required by DOE Order 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees.* Although LLNL has a number of effective elements of a workplace exposure program in place, these elements have not been integrated into a comprehensive workplace exposure assessment process, resulting in gaps and deficiencies in the performance, documentation, and communication of workplace exposure assessments. Some workplace exposure assessment implementing procedures for meeting the requirements of DOE Order 440.1A are outdated, and guidance is insufficient to ensure effective implementation and documentation of industrial hygiene evaluations. Workplace exposure assessments and/or exposure monitoring for chemical, biological, or physical hazards have not been conducted on an established frequency based on risk for some of the facilities and/or operations inspected by the Independent Oversight team. As a result of these program weaknesses, a number of workplace exposures were not identified, evaluated, and/or documented for such hazards as welding fumes, ozone, hexavalent chromium, oil mists, cleaning and lubrication chemicals, lead solder, tin lead brazing, noise, asphalt fumes, ergonomic stress (e.g., hand-arm vibration), chemicals in pressure treated and painted lumber and dust from recycling landscape and wood waste, and airborne silica. In some cases, known workplace hazards have not been evaluated for over 10 years, and the basis for such a long interval between exposure assessments based on risk is not documented. (See Finding F-1.)

LSO and LLNL feedback and improvement programs have not been sufficiently effective to ensure that deficiencies in ES&H programs are effectively identified and addressed to prevent recurrences. LSO and LLNL have made some improvements in their feedback and improvement programs since the 2004 Independent Oversight inspection, but process and performance deficiencies hinder the effectiveness of the programs. LSO does not have an adequate process for tracking and trending issues and operational awareness data, its safety system oversight of engineered safety systems is in the early stages of implementation, and LSO does not have adequate technical resources to provide detailed oversight of engineering design, authorization bases, and configuration management. LSO does, however, have ongoing and planned corrective actions for some of these weaknesses, including the planned implementation of the Pegasus system for managing issues. There are various weaknesses in LLNL feedback and improvement processes, particularly in the areas of self-assessments, issues management, and injury/illness investigation processes. (See Findings D-1, D-3, D-4, D-6, and E-7.)

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4.0 Results

The following paragraphs provide a summary assessment of the NNSA, LSO, and LLNL activities that Independent Oversight evaluated during this inspection.

4.1 Work Planning and Control Processes

LLNL's institutional work planning and control process allows significant flexibility to individual directorates and departments. Some organizations, such as NMTP, use processes that are designed specifically for their activities. Other LLNL organizations use the site process and tailor it to their needs.

Nuclear Materials Technology Program

Independent Oversight's evaluation of work control within LLNL's Superblock focused on evaluation of safety performance of laboratory and support activities in Buildings 332 and 331, which represent a significant portion of NMTP's ongoing work activities at LLNL's Superblock. The LLNL institutional work control process does not apply at Superblock because NMTP has a separate DOE authorized work control process, which pre-dates the LLNL institutional system and was made part of the authorization basis for operation. Programmatic work in Building 331 was not evaluated because the facility is currently undergoing major renovations and upgrades to the tritium processing areas.

The scope of work within Superblock facilities is adequately described in facility safety, operations, and work permit documentation.

Most hazards associated with Superblock work are appropriately identified and analyzed by facility safety plans, operational safety plans, and work permits. Although a few work permits did not contain complete hazard information, indicating inattention to detail in following work control requirements, most work permits were adequate, and the deficiencies appear to be isolated instances in an otherwise effective process. However, institutional expectations regarding the identification of hazards have not been adequately delineated, and hazards associated with exposures to thorium from welding activities have not been sufficiently analyzed to ensure adequacy of controls. Although these concerns were identified at Building 331, similar conditions exist across the site, indicating a systemic concern with institutional requirements management and policy rather than facility-specific work control. (See Finding C-1.)

Hazard controls for Superblock work are generally effective. There is extensive involvement and integration of ES&H professionals in work planning processes at Superblock, which enhances operational safety. In some cases, details of controls and their implementation have not been specified, indicating some lack of rigor and inattention to detail in implementing requirements. However, these deficiencies were not widespread enough to be considered systemic failures in an otherwise effective and mature system.

Readiness to perform work is ensured through a series of systematic processes, including daily activity meetings, room and operator rounds and checks, and health and safety technician rounds. Workers performed work safely and demonstrated good awareness of requirements, proper glovebox techniques, and stop/pause work requirements.

Overall, although hazards associated with radioactivity from the use of thoriated welding electrodes and ozone from plasma arc cutting have not been fully addressed, work control processes at Superblock are generally effective. Workers are experienced and knowledgeable, and they performed work safely within the bounds of identified controls. Although the overall program is effective, improvements to the level of rigor and attention to detail is warranted to ensure better clarity and specificity of controls, especially those contained in work permits.

Site 300 801 Complex

The Site 300 801 complex consists of the Contained Firing Facility, the Flash X-Ray (FXR) Accelerator, and other associated support and diagnostic facilities. The 801 complex is a test facility that was modified in 2001 to perform high explosive experiments inside the Contained

Firing Facility chamber, thereby significantly reducing emissions to the environment. Although the facility performs explosive tests as part of the nuclear weapons program, special nuclear material is not present at the site. Many aspects of the work at the 801 complex are performed in accordance with procedures that are driven by explosive safety requirements.

Existing facility and activity level work documents adequately define the scope of work for current 801 complex operations.

B Division processes adequately identify and analyze hazards at the Site 300 801 complex. The Site 300 safety analysis report provides an adequate accident analysis for the 801 complex, and such processes as experiment review and IWS effectively identify and analyze activity-level hazards.

Appropriate and effective ES&H controls are established and implemented for most 801 complex hazards. Management of post-shot waste is particularly effective. In a few cases, the extensive attention to the strict controls needed for major hazards, such as explosives or particulate beryllium, may have overshadowed the need for attention to chemical or radiological hazards with less perceived risk. However, B Division management is aware of these problems and is taking actions to correct them.

In most cases, 801 complex work observed by the Independent Oversight team was appropriately authorized and verified ready, and was performed within established controls. Workers were knowledgeable of

Facilities at the CFF

the work instructions and controls and indicated that they felt empowered to stop work if safety concerns arose.

Overall, implementation of work planning and control in the 801 complex is effective. In a few cases, the extensive attention to the strict controls needed for such major hazards as explosives or particulate beryllium may have overshadowed the need for strict attention to chemical or radiological hazards with less potential risk; however, appropriate and effective controls are established and implemented for most 801 complex hazards, and management of post-shot waste is particularly effective.

Biological Work

LLNL performs work involving biological hazards for a variety of national agencies. All biological work activities currently conducted at multiple LLNL facilities are classified at the Biosafety 2 level or lower. Work with select agents, also at the Biosafety 2 level, is conducted only at Building 365, which can accommodate the safety and security requirements necessary to operate within agency (e.g., Centers for Disease Control and Prevention) permits. For this inspection, Independent Oversight reviewed work activities in Buildings 241, 361, and 364. These activities involve a wide variety of equipment and materials, including ventilated hoods, biological safety cabinets, robotic analyzers, chemicals, micro-curries of radioactive tracers, and potentially biohazardous waste streams.

The scopes of work for biological research and associated laboratory activities are well defined. Before starting any biological research or related activity at LLNL, researchers must provide clear and explicit documentation to the Institutional Biological Safety Committee, which evaluates many factors, including compliance with laboratory requirements and external regulations, biological hazard levels, risk classification, and facility limitations. In parallel, work is defined in IWSs, facility safety plan modifications, hazard assessment and control forms, and procedures. Work performed by subcontractors (used by LLNL to perform maintenance) is also well defined. As part of the work control system for subcontractors, subcontractors submit safety plans, protocols, and certifications that define the scope of work to be performed.

The IWS and subcontractor work control system documents associated with the activities in Buildings 241, 361, and 364 demonstrate that hazards have been identified and sufficiently analyzed to establish controls. Laboratory hazards are sufficiently identified and described in the relevant work control documents. One instance was identified in which the team industrial hygienist was not consulted concerning the use of a new chemical. The IWS broadly authorizes the use of toxic chemicals and provides general controls.

Although the researcher obtained the material safety data sheet, consulted with the ES&H team technician, and used the correct controls, a more complete review that included the industrial hygienist involvement was not performed.

To protect workers, the public, and the environment from biological hazards, LLNL has established specific requirements within the laboratory ES&H manual to ensure the safe handling and use of biological materials. Specifically, Part 13 of the ES&H manual outlines the process for all biological-related activities to follow before any actual work begins. The LLNL Institutional Biological Safety Committee has primary responsibility for accurately classifying and verifying that the hazard level of research activities is identified accurately and that appropriate controls are in place. In addition, the Committee implements the laboratory best practice principles, which demand conservative classification of hazards so that controls are more rigorous than laboratory standards.

Work observed in Buildings 241, 361, and 364 was performed within established controls. The personnel have been properly trained and supervised for the work tasks they are expected to perform, and hazardous and non-hazardous biological waste streams were handled and processed in accordance with established protocols and the requirements of the ES&H Manual.

Overall, LLNL has established and implemented effective work control processes for biological hazards and related activities. LLNL has appropriately adopted and conservatively implemented national guidelines for establishing controls for biological hazards. Work control processes have been implemented effectively, and the resulting work documents and controls are effective, with the isolated exception of the documentation and controls for use of a new chemical. The robust Institutional Biological Safety Committee and safety team ensure that hazards and controls for biological research are identified and controlled as specified by Federal requirements and guidelines.

Applied Engineering Infrastructure Division

Within AEID, the Manufacturing Group provides other LLNL directorates (i.e., clients) with a wide variety of manufacturing capabilities, such as chemical and electrochemical plating of plastics and metals, plastic and metal machining of large and small components, machine tool services, laser processing, welding, and machining of special materials (e.g., depleted uranium and beryllium).

Most of the work performed within the Manufacturing Group is conducted with experienced machinists, platers, electricians, and mechanics under broad IWSs that address individual training requirements and general area controls. However, these IWSs seldom define specific work activities, such that the hazards and controls unique to those activities can be identified, documented, and evaluated by line management or ES&H subject matter experts. As a result, opportunities for the identification of hazards that are outside the knowledge and experience of the worker performing the activity may be missed (e.g., machine guarding and exposure assessment requirements).

At the facility level, hazards for the 321 complex are well documented and analyzed in facility safety plans and hazards assessments. At the work activity level, potential area hazards to which each worker could be exposed are identified globally in the IWS under which work is authorized. For higher potential hazards, some IWSs provide an additional description of the hazards or a safety plan is prepared. However, formal documented hazards analyses have not been performed or documented on some of the hazards in the 321A Main Bay, the 321C Special Materials Machining Facility, or the 322 Plating Shop. The hazards associated with a specific work activity, such as operating a lathe in the 321A Main Bay, are not documented, but instead are communicated to workers informally or in some cases through training. As a result, hazards that are outside the knowledge and experience of the worker may be missed, as well as opportunities for hazard identification by ES&H subject matter experts, line management, and other workers. In a number of examples, worker exposure hazards have not been sufficiently identified and/or analyzed. (See Finding C-2.)

Facility-level hazard controls are well defined in facility-level hazards analysis documents. Most workers in the 321/322 complex are experienced and skilled in their crafts. The ES&H Discipline Action Plans and activity-specific IWSs are effective hazard control documents when properly designed and implemented. However, some hazard controls (e.g., PPE) are not identified, or are not sufficiently described such that the worker can identify and implement the appropriate control. Some environmental engineering and administrative controls have not been implemented effectively in the Plating Shop. Radiological controls associated with 321C machining operations are not well defined through the IWS process but instead are informally implemented. IWSs controlling work in

321C lack relevant information about radiological hazards and controls required for the work, and as a result do not meet minimum DOE expectations for controlling radiological work authorization. A number of the 321/322 complex IWSs are designed from a global perspective and do not identify activity-level hazard controls (such as with radiological controls), or the IWS has deficiencies such that the worker cannot determine the expected hazard control. For some hazards, only worker training is used to identify hazard controls, although this application of skill-of-the craft in lieu of well-defined activity-level controls is not described in LLNL institutional work control processes. (See Findings C-2 and C-3.)

Readiness to perform work is achieved though both formal and informal processes (e.g., IWS, and meetings and discussions between line mangers and their workers, respectively). For well-defined activities, this process is effective, but for more global activities, in which a work envelope is established, readiness to perform work is the responsibility of the worker. Although most work observed by the Independent Oversight team in the 321/322 complex was performed in accordance with established controls, some work was authorized under an IWS for activities in which the hazards had not been analyzed and the controls had not been adequately identified.

Overall, at the facility level, hazards and controls are well documented and analyzed for the 321 complex in facility safety plans and hazards assessments. However, activity-level hazards are not always adequately identified and controlled and rely too much on individual expertise and training. As a result, opportunities for the identification of hazards and controls that are outside the knowledge and experience of the worker performing the activity may be missed, as well as opportunities for hazard identification by ES&H disciplines, line management, and other workers.

LLNL Maintenance (Plant Engineering)

Maintenance at LLNL is conducted primarily by the Plant Engineering Department. ISM is implemented primarily through trade/service IWSs, bridging documents, and pre-task hazards analyses. Plant Engineering has 30 trade/service IWSs that are used to analyze the general types of craft and shop work performed in connection with maintenance. The bridging documents are then used to connect the trade/service IWS to the specific facility hazards and tasks associated with an individual work request. This system is described and implemented through a series of maintenance operating procedures, which derive from and reference LLNL policies and standards. LLNL has taken a number of actions to improve the trade/service IWSs since the 2004 Independent Oversight inspection, such as clarifying responsibilities.

Most work definitions are adequate for the activities and potential hazards. The work definition process incorporates input from Plant Engineering supervision and/or craft personnel to ensure that enough detail is provided to allow appropriate hazards analysis.

Hazards analyses performed in connection with IWSs, bridging documents, and facility point-of-contact interfaces have gaps where hazards can be missed. The use of trade/service IWSs rather than activity-specific IWSs places too much emphasis on the individual worker's knowledge and skill, often

Decontamination and Waste Treatment Facility

without the benefit of input from Hazard Control Team ES&H disciplines or LLNL subject matter experts. As a result, some hazards are not identified or analyzed for such areas as chemicals, lead, noise, welding fumes, asphalt fumes, and hazardous wastes. Although Hazard Control Team ES&H disciplines are required to help develop and concur with the various IWSs, many of these reviews have not been sufficiently effective. For example, weld shop supervision is not aware of any Industrial Hygiene survey or exposure assessments of welding fumes since 1994, yet weld shop personnel work with such materials as stainless steel and welding rods containing chromium (the Occupational Safety and Health Administration standard and limits for such materials as hexavalent chromium have become more stringent since 1994). Some hazards have not been identified or analyzed for such areas as chemicals, lead, noise, welding fumes, asphalt fumes, and hazardous wastes. For example, a maintenance task involving a chiller replacement required Freon recovery, but hazards and environmental controls for this recovery were not adequately identified in either

the work request or the IWS. The work description was only "remove old chiller; install new chiller," with no mention of the Freon recovery that is required by California environmental regulations. (See Finding C-4.)

The use of broad trade/service IWSs and vague bridging documents for the performance of work has resulted in a system where workers are expected to choose the controls they believe are applicable, rather than providing them with a set of specific controls that must be implemented. In addition, the process relies on workers to seek assistance from Hazard Control teams in establishment of controls, assuming that craft personnel are sufficiently cognizant of the hazards and available controls to know what questions to ask. These process weaknesses have resulted in some hazards not being adequately controlled for activities involving such hazards as noise, welding fumes, falls, and electrical sources. (See Finding C-4.)

The work control process currently used by Plant Engineering relies heavily on the individual workers' knowledge at the time of work, rather than written instructions that supplement individual knowledge and skills. This creates a risk that the necessary controls for the work to be performed will not be implemented adequately or followed during the course of work. In the work observed by Independent Oversight, workers typically followed controls when controls were clearly established, but in some cases workers were either unaware or confused with regard to the hazard controls. The absence of clear, documented hazards and controls creates potential safety vulnerability in such areas as fall protection, and increases the potential for environmental violations. (See Finding C-4.)

Overall, most Plant Engineering maintenance activities observed by Independent Oversight were performed safely, but the IWS process has not been applied effectively, and some hazards have not been adequately identified, analyzed, and controlled. Although LLNL has made some improvements in work planning and control for maintenance activities at LLNL since the 2004 Independent Oversight inspection, the application of the IWS system for maintenance activities is not sufficiently effective, primarily because work is not analyzed adequately through the "generic" trade/service IWSs, and too much reliance is placed on workers to select appropriate controls for each job, which may entail unique hazards that workers are not sufficiently experienced and trained to evaluate.

Construction

The Independent Oversight team assessed the effectiveness of processes used to control construction work managed by the LLNL Plant Engineering organization, including work performed by LLNL craft employees, a dedicated onsite contractor (GSE), and various offsite contractors. The work control processes used to plan and control the work differ based upon the organization performing the work.

The scope of work is adequately defined in job planning documents, and performance in this area has improved since the 2004 Independent Oversight inspection. The pre-task hazards analysis process has been extended to all construction subcontractors, improving the definition of tasks to be performed in carrying out this scope of work.

LLNL has established appropriate processes for hazard identification and analysis, and implementation of these processes has been generally effective. Exposure monitoring requirements have been added to construction subcontracts and exposure monitoring has improved, but additional LLNL support and oversight are needed to achieve consistent compliance with these requirements. (See Finding C-5.)

Appropriate controls were established for most of the construction work observed during this inspection. The work control process for work performed by LLNL ensures that required controls are adequately addressed in the ES&H Manual and an IWS safety plan, and that workers are trained on these requirements. The process for work performed by subcontractors is adequate, but was not always implemented with sufficient rigor to ensure that workers were informed of applicable requirements. The subcontractor process requires that applicable controls be included in site-specific safety plans that are prepared by subcontractors and approved by LLNL. LLNL has included appropriate controls in construction subcontracts but has not assured that these requirements are consistently incorporated into site-specific safety plans. For example, fire hazard controls that were established for the re-roofing of Building 231 were not adequate. A tar kettle was being operated at temperatures in excess of specified limits, combustible materials were located near the kettle, the kettle thermometer was inoperable, the fire watch was assigned distracting duties, and the required number of fire extinguishers was not available. The process for assuring adequate control of hazards associated with subcontracted construction work relies heavily on the

development of adequate site-specific safety plans and permits, but these documents do not include specific requirements for hazard controls that apply to the scope of the work. In addition, most plans do not contain any hoisting and rigging requirements, and some plans do not provide instructions for implementing contract requirements for exposure assessment and do not reference the appropriate threshold limit values. Nonetheless, most subcontractors understand the safety requirements and expectations and comply with them. However, when applicable requirements were not included in the safety plan for a small roofing company with limited LLNL work experience, employees of this company were not aware of some fire safety requirements, and fire hazards were not adequately controlled. (See Finding C-5.)

LLNL has established formal processes for ensuring that hazards are analyzed and controls are in place before authorizing construction work to begin. Processes require review and approval by appropriate LLNL and contractor representatives before work is authorized to proceed. These processes were implemented effectively for most construction work observed during this inspection. Workers consistently followed established fall protection requirements, PPE requirements for electrical work were strictly followed, hearing protection, hard hats, and safety glasses were worn when required, and waste management and pollution prevention requirements were implemented. The two identified examples of failure to follow hot work permit requirements indicate that corrective actions for previously identified deficiencies were not sufficiently effective. Notwithstanding the isolated deficiency in hot work permit conformance, most work was performed safely and in accordance with requirements.

Overall, appropriate work control processes have been established and most work is performed within established controls. However, LLNL has not applied its work control processes with sufficient rigor to ensure effective flowdown of some Work Smart Standards requirements to construction subcontractors. Appropriate requirements have been added to construction subcontracts, but these requirements are not always conveyed to the subcontractors' workers. The LLNL work control process for subcontracted construction requires that hazard controls be specified in site-specific safety plans and requires workers to be trained on these plans, but this requirement has not been consistently met (i.e., required controls are not always incorporated in safety plans, and some workers do not have sufficient knowledge of safety requirements). This problem was most evident during the re-roofing of Building 231 by a contractor that had little prior LLNL work experience and thus limited knowledge of LLNL safety requirements and expectations. In this case, required controls were not incorporated into the subcontractor's safety plan and were not enforced by the LLNL construction manager, thus workers were not aware of the requirements, and fire hazards were not adequately controlled. Most construction work was performed safely by contractors with more LLNL experience and knowledge of LLNL requirements.

Overall Perspectives on Work Planning and Control

LLNL has improved processes and performance in several aspects of work planning and control, such as construction subcontracts, radiation protection, and control of chemicals. However, implementation of work planning and control processes varied considerably across the evaluated site organizations. The organizations with high hazard activities, such as nuclear operations, high explosives, and biohazards, had developed and implemented generally effective work planning control processes. Other organizations did not effectively tailor and implement the site work control process to their activities and were not consistently effective in ensuring a high degree of worker safety, primarily in such areas as shop activities, maintenance, and construction.

4.2 Essential System Functionality

In the review of essential system functionality, Independent Oversight evaluated the effectiveness of the LLNL NMTP processes for engineering and configuration management to determine whether selected Building 332 safety systems are capable of performing their safety functions with a high level of confidence, commensurate with their importance to safety. The programs and processes evaluated included configuration management, the unreviewed safety question process, maintenance, testing, and operations. The team also reviewed the progress on correcting findings resulting from the 2004 Independent Oversight inspection at Building 332. Subsequent to that inspection, site management stood down Building 332 operations and implemented a number of improvement actions to enhance nuclear safety.

Configuration Management and Supporting Processes

NMTP continues to improve elements of its configuration management program, but improvements in system drawings are progressing slowly. Most Building 332 facility safety systems, structures, and components, including utility and support systems, are documented, graded, and maintained on the Master Equipment List, which is a formally controlled document. NMTP is developing system design descriptions for the two safety systems selected for review. Although the descriptions are still in draft form, they follow appropriate DOE guidance for summarizing the requirements and physical configuration of the systems. The configuration of safety systems is managed through a process defined by the Work Control/Design Change Control Process Manual. The process ensures that any changes made to the safety systems, structures, and components, such as through modification or maintenance activities, are appropriately incorporated into the system management files in the configuration management program. LLNL has made adequate progress on improving the unreviewed safety question program, although a few additional improvements are needed in isolated aspects of the sitewide unreviewed safety question procedure. Although significant efforts have been expended on updating system drawings, there are still weakness in their quality, standards for production, control, and completion schedule. High-quality design drawings are essential to an effective configuration management program; drawings must include accurate information and be readily available so that NMTP personnel (e.g., operations, engineering, and the authorization basis group) can perform their daily work correctly and maintain the systems in the correct configuration. (See Finding E-1.)

Engineering Design and Authorization Basis

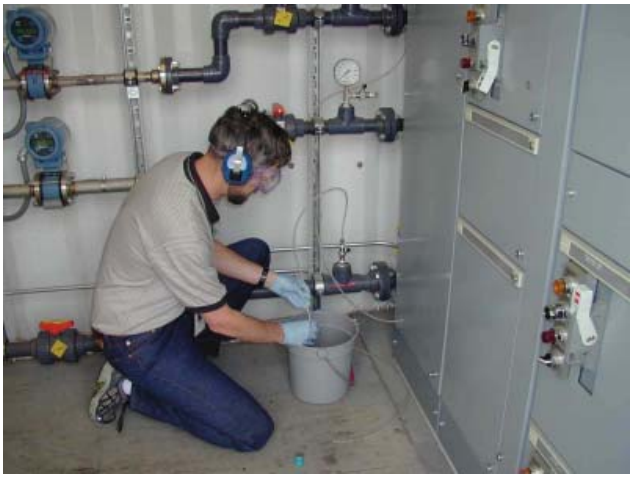
Facility engineering and safety basis personnel are generally knowledgeable about the facility, its systems, and the supporting design and safety bases. They also are experienced, well-educated, motivated, and capable. The systems reviewed by Independent Oversight are generally well designed and robust with respect to their normal operating functions. However, the quality of the documented safety analysis and technical safety requirements at LLNL do not fully meet DOE requirements for a nuclear facility. Further, for the systems reviewed by Independent Oversight, there were significant weaknesses in system design, in the analyses of accident-related safety functions, and in the related safety bases. The following list summarizes the deficiencies identified during this Independent Oversight inspection (see Findings E-2, E-3, E-4, and E-7):

- Inadequate or non-existent supporting analyses for a documented safety analysis for the required time frame for fire suppression system water tanks flow
- Untimely resolution of an inaccessible fire damper with high risk failure mode for the room ventilation exhaust system
- Inadequate nitrogen skid corrective actions for its safety classification
- Lack of test procedure acceptance criteria for fire suppression system pressure control valves
- Inadequate analyses of ability of confinement exhaust systems' HEPA filters to survive evaluation basis room fires and inadequate identification and implementation of compensatory actions (see below for further discussion)
- Non-conservative new technical safety requirement final HEPA filter operating differential pressure limit
- Inconsistent new technical safety requirement for HEPA filter changeout
- Safety class check valve was not included in new technical safety requirements
- Improper safety classification downgrade of fire suppression system components in the new DSA, which led to an exclusion of the safety-significant check valve from the new technical safety requirements
- Inconsistent technical safety requirements surveillance acceptance criterion for fire suppression system pressure control valves.

Weaknesses in the area of engineering design and authorization basis, discussed below, raise questions about the ability of certain safety systems to perform

their safety functions in accident conditions and thus warrant priority and timely management attention, as discussed below.

The 2004 Independent Oversight inspection identified a concern with the ability of the Building 332 room exhaust system safety class HEPA filters to perform their safety functions for evaluation basis fires. The HEPA filters' ability to survive this event as a result of combustion product accumulation and differential pressure increase to, in some cases, a level above the rated value (10 inches water column) was not demonstrated. The HEPA filter could rupture, exposing



Work at LLNL

workers and the public to doses above the values reported in the safety analysis report. In response to this concern in 2004, LLNL generated and submitted to LSO a potentially inadequate safety analysis, an unreviewed safety question determination, and an "Evaluation of Safety" that concluded that "...smoke conditions produced by fires present a low risk to the worker, the public, and the environment..." and that "...continued operations are safe."

LLNL's HEPA filter Evaluation of Safety incorrectly assumed that the HEPA filters will survive a differential pressure of up to 13 inches water column, when the filters are rated for only 10 inches water column, and that the filters would remain dry. The Evaluation of Safety cited test data supporting a higher differential pressure capability as support for the LLNL assertion that the filters could withstand differential pressure greater than 10 inches water column. However, this data was for a different type of dry filters than those installed in the facility. In addition, the Evaluation of Safety incorrectly stated that "…a vault fire and the associated failure of the room exhaust system have an event frequency of less than 10^{-6}/year." However, the failure stated in the safety analysis report is based, in part, on random exhaust fan failure due to power loss, not flow stoppage as a direct result of the fire. The correct frequency, which would not include the random fan failure component, would be on the order of 10^{-4}/year, per the documented safety analysis, for the evaluation basis fire alone. Therefore, the conclusion that this condition would not significantly increase the consequences of an evaluation basis fire was incorrect.

According to LSO management, LLNL's Evaluation of Safety was not accepted, and the basis for current operations in relation to the unreviewed safety question is an LSO Condition of Approval on hydride operations that reduces the allowable material at risk and thus the potential consequences from evaluation basis fires, and an observation that combustible fire loading in the vault area is low. In addition, LSO management directed LLNL to submit proposed changes to the documented safety analysis to support completion of the high HEPA filter differential pressure exhaust fan trip modification. These actions were deemed appropriate to return to a reduced operations condition. However, consequences for a vault fire scenario coupled with a HEPA filter rupture could exceed the site boundary evaluation guide for the public, and other scenarios could result in significant increases in the potential exposure to collocated workers. The potential increase to collocated workers has not been addressed. As a result, the limit on hydride operation does not adequately address the HEPA filter loading unreviewed safety question.

Overall, LSO and LLNL have not established an authorization basis that defines conditions for current operations based on analysis of the unreviewed safety question regarding HEPA filter loading.

Surveillance and Testing

New and recently issued surveillance procedures are well written. While older procedures have some deficiencies, LLNL is in the process of upgrading its older surveillance procedures and is on schedule on this effort. All surveillance procedures are adequately controlled. The surveillances are performed in accordance with the established schedules and are generally performed in a rigorous manner. The staff members who perform the surveillances are knowledgeable of the associated safety systems and the test procedures.

Maintenance

Maintenance activities for the selected Building 332 safety systems are performed in accordance with improved procedures, which call for more rigor and discipline. LLNL Plant Engineering provides sound and well-managed preventive and predictive maintenance support. They also have an excellent Condition Assessment Survey process for DOE-required facility lifecycle management. However, the Building 332 Maintenance Implementation Plan does not have sufficient detail and does not identify the gaps and deficiencies in meeting DOE Order 433.1 requirements, which calls for DOE to ensure that maintenance requirements that cannot be met are appropriately documented and acknowledged, and that sufficient resources are budgeted to accomplish the maintenance program's objective of providing highest confidence in the reliable performance of mission-critical safety systems, structures, and components through proactive maintenance practices. For example, the Maintenance Implementation Plan, does not identify and address the gaps in the configuration management and system engineer programs that are required by DOE Order 433.1. LSO has not provided an adequate review of the Maintenance Implementation Plan. (See Finding E-5.)

Operations

Operational and alarm procedures are generally well written, and the procedures and their performance are adequately controlled. Operators are well prepared to monitor and operate systems and associated support systems and take appropriate action in emergencies. Although some deficiencies exist in training, safety system component labeling, and operator aids, these deficiencies are isolated instances in an otherwise effective program for operations.

Overall, LLNL has made good progress in addressing deficiencies in the operations, surveillance, and testing areas and has effective processes in these areas. Improvements also have been made in maintenance and procurement, although deficiencies in these areas warrant increased management attention. LLNL/NMTP and LSO have taken extensive measures to improve the safety status of the safety-related systems at Building 332. However, the progress made in the areas of configuration management, engineering design, and authorization basis has been limited and/or not sufficiently effective. Most of the 2004 Independent Oversight findings related to engineering design were improperly closed without careful verification that the corrective actions were adequate and properly implemented. In some cases, adequate compensatory actions were not put in place while awaiting the implementation of corrective actions. The safety systems that were identified as deficient (fire water tanks, nitrogen skid, and HEPA filters) and that are required in various accident conditions may not perform as required in the safety analysis report and/or new documented safety analysis/technical safety requirements. Significant work remains and timely management attention is needed to address the current deficiencies in the areas of configuration management, engineering design, and authorization basis.

LLNL and LSO have recently made progress in establishing their respective systems engineer and safety system oversight programs, and these efforts have the potential to drive continuous improvement. However, these programs are in their early stages of implementation, and their intended benefits have not yet been realized.

4.3 Focus Areas

Safety Component Procurement

NMTP has implemented an improved process for procuring quality-significant items and services. The review of receipt inspection packages for quality-significant orders showed that technical and quality requirements for procurement were clearly specified and that the received items were adequately inspected and tested to meet the specified requirements. However, certain aspects of the procurement process need to be further defined and formalized. In particular, there is little documentation supporting the evaluation and selection of suppliers of quality-significant items against specified criteria. LSO has conducted adequate oversight reviews of selected aspects of the NMTP procurement process and the LLNL suspect/counterfeit items program. (See Finding E-6.)

Environmental Management System and Pollution Prevention Program

In accordance with DOE Order 450.1, *Environmental Protection Program*, LLNL was required to establish an EMS by December 2005. As allowed by the order, LLNL chose to use ISO 14001 as the basis for the EMS in the Work Smart Standards.

LSO adequately implemented its responsibilities for evaluating the LLNL EMS program before LLNL

self-certified establishment of its EMS. Also, LSO has been actively engaged in evaluating environmental performance and monitoring progress in achieving corrective actions, and has established ISO 14001-related performance measures to ensure LLNL's continued focus on achieving an effective EMS. LLNL has appropriately incorporated an EMS within the site's ISM system to ensure that environmental hazards are analyzed and that appropriate controls are implemented effectively. LLNL self-certified its EMS in accordance with the established requirements and milestones, and recognizes that corrective actions for non-conformances must be completed to ensure that EMS implementation is fully effective. In addition, pollution prevention has been aggressively pursued in several line organizations, which has resulted in numerous awards. However, deficiencies in work planning and control in several line organizations hinder effective implementation of activity-specific environmental controls. In addition, environmental activities for significant aspects are only in the early stage of implementation in several line organizations, and therefore specific controls to enhance pollution prevention and ensure effective environmental stewardship have not been identified or implemented in all cases by several line organizations. These organizations' limited implementation of environmental management programs that identify objectives, targets, and environmental activities for significant aspects indicates that increased LLNL and LSO attention is warranted to ensure that the LLNL EMS continues to mature and fully meets DOE expectations.

Workplace Monitoring

DOE Order 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*, requires line management to ensure that workplace monitoring is effectively implemented for Federal and contractor workers, including subcontractors. During this inspection, the Independent Oversight team reviewed a number of work activities associated with construction, maintenance, production support, and engineering in which workers were potentially exposed to chemical, physical, and ergonomic hazards, and reviewed the current state of the LLNL non-radiological worker exposure program as defined in procedures, instructions, and various presentations.

DOE Order 440.1A establishes the basis and requirements for an effective workplace monitoring and exposure assessment process. Although LLNL has implemented a number of the elements of an effective exposure assessment process, they have not been integrated into a comprehensive program to ensure that all workplace exposure hazards are evaluated, documented, and monitored based on potential risk to the worker. The Industrial Hygiene Surveillance Program under development, if prioritized and fully developed, can meet this need. However, currently, there are gaps and inadequacies in the performance documentation and communication of workplace exposure assessments. A number of workplace hazards have not been identified, evaluated, and/or documented, and in some cases the baseline hazards survey and periodic resurvey requirements of DOE Order 440.1A are not being met. Similar concerns were also identified by the LSO industrial hygienist in recent LSO surveillances. (See Finding F-1.)

4.4 Feedback and Improvement Systems

NNSA

NNSA has an adequate process to maintain operational awareness. However, NNSA has not used its expertise and technical resources to support LSO in areas where LSO currently has important ongoing activities and gaps in technical staff capabilities. For example, LSO has important responsibilities and ongoing efforts in overseeing the LLNL efforts to address deficiencies in nuclear safety systems and authorization bases documents, but the LSO Senior Nuclear Safety Advisor position has been vacant for over a year; this position is intended for someone who would be responsible for providing advice and guidance to LSO senior management regarding issues associated with the safe operation and authorization basis of nuclear facilities. In addition, NNSA has not completed some of the actions necessary to fully implement their programs for meeting the requirements of DOE Order 226.1, *Implementation of Department of Energy Oversight Policy.* NNSA has identified gaps and established an implementation plan, but they have not met the deliverables specified in their implementation plan in such areas as development of a Contractor Assurance System policy and performance expectations, development of an NNSA Headquarters Annual Assessment Schedule, definition of an NNSA Headquarters Lessons Learned Program, and development of a Headquarters issues management system. (See Finding D-1.)

LSO

LSO has made significant progress since the 2004 Independent Oversight inspection (e.g., enhancements to the Facility Representative program, establishment of the Quality Management Council, and completion of some constructive self-assessments). LSO is in the process of implementing an integrated software solution (Pegasus), that when fully implemented, has the potential to address a number of longstanding deficiencies (identified by both external and internal assessments) in correspondence management, issues management, corrective action tracking, and operational awareness documentation. In addition, the LSO safety system oversight program is in its early stages of implementation and has not yet adequately addressed LLNL performance deficiencies in safety bases and engineering design of essential safety systems. (See Findings D-2 and E-7.)

LLNL

LLNL has established and implemented the basic feedback and improvement elements that result in improvement in processes and performance. Assessment activities are performed; safety problems are identified; deficiencies are corrected; analyses are conducted and actions are taken when injuries and events occur; lessons learned are identified and applied; and workers have various methods to report and get resolution of safety concerns. Actions taken in response to the 2004 Independent Oversight inspection have resulted in some improvements in processes and performance.

However, LLNL has not effectively implemented many of the elements of these feedback and improvement systems, and process steps and requirements in governing documents need further strengthening. Directorates and subordinate organizations do not rigorously follow the requirements specified in institutional documents. There is insufficient institutional oversight and evaluation of implementation and overall program adequacy of safety functional areas, including management systems. LLNL line managers are not being sufficiently evaluated and held accountable for effective implementation of safety requirements and management expectations. The description and communication of management systems and requirements, primarily in ES&H manual "documents," often do not adequately communicate the requirements and process steps necessary to ensure effective and compliant performance.

In addition, the LLNL self-assessments, issues management, and injury/illness investigation processes have not been sufficiently effective to ensure that deficiencies in ES&H programs at LLNL are identified and corrected and that effective recurrence controls are implemented. There is considerable variability in performance among directorates, the LLNL self-assessment program lacks sufficient rigor in planning and execution to be fully effective in evaluating ES&H performance, and a number of weaknesses persist. The causal analysis, corrective actions, and recurrence controls in response to these inspections have not been effective in resolving many of the identified systemic deficiencies. Assessment process implementation requirements and expectations are not always adequately defined, some assessments lack sufficient depth and focus to effectively evaluate the adequacy of ISM implementation, and some required assessment activities are not being performed. In addition, there is insufficient senior management and institutional-level monitoring and oversight to ensure that the program is implemented effectively and that directorates are held accountable for performance. In addition, issues identified by LLNL assessment activities are not consistently and effectively evaluated and resolved. Specifically, the documentation, evaluation, and resolution of ES&H deficiencies and issues are still not managed in a consistent and effective manner that fully supports continuous improvement, and institutional issues are still not captured and managed in a rigorous and timely manner. For example, NMTP corrective action management processes for the 2004 Independent Oversight findings related to the safety systems were not sufficiently rigorous, did not sufficiently evaluate the extent of condition, did not include sufficient verification of effectiveness, and did not adequately address interfaces (e.g., incorporation of changes into safety bases, technical safety requirements, surveillances, and analysis), resulting in a number of findings that were not adequately addressed and/or were inappropriately closed. Implementation of the issues management program remains problematic and is inconsistent across the directorates. LLNL injury and illness program requirements are not implemented as specified in program documents, and investigations still lack sufficient rigor to ensure that causes are identified and appropriate, and that effective corrective and preventive actions are identified and implemented. Investigation reports continue to lack sufficient rigor in fully describing all aspects of the incidents and in the identification of proper causes, addressing ISM system elements, and establishing

appropriate corrective actions and recurrence controls. Concurrence/approval of completed reports by line supervisors, ES&H investigators, and directorate assurance managers is not timely, and monitoring and assessment by directorate assurance managers remains less than adequate. Actions to address a number of 2004 Independent Oversight inspection findings have not been timely or fully effective. LLNL methods and practices for holding Directorates accountable for effective implementation of and compliance with LLNL and DOE feedback and improvement system requirements have not been sufficient to achieve consistently effective performance.

Overall, the causal analysis, corrective actions, and recurrence controls implemented in response to the 2004 Independent Oversight inspection have not been effective in resolving many of the identified systemic deficiencies in feedback and improvement systems and their implementation. (See Findings D-3, D-4, and D-6.)

5.0 Conclusions

LSO has applied significant effort to improvement since the 2004 Independent Oversight inspection. LSO's oversight has matured, and operational awareness and assessments have improved in gathering data and identifying deficiencies. LSO management recognizes that data management needs improvement and recently initiated implementation of Pegasus, which will provide an improved mechanism for data and issues management. LSO also has performed a number of self-assessments and used external expertise to evaluate ES&H responsibilities and performance. As a result of these efforts, a number of initiatives are underway for further improvement, including development and implementation of a strengthened facility representative training program. For the most part, LSO initiatives are appropriate and should lead to further improvement. However, while significant effort has been applied and further initiatives are underway, the number of discrepancies identified in the areas of engineering design and authorization basis for Building 332 indicates that further management attention is warranted in these areas.

Although LLNL has made some improvements in the implementation of the core functions of ISM at the activity level and in feedback and improvement processes, weaknesses in the management of institutional processes have contributed to inconsistency in the effectiveness of implementation in the activities and organizations evaluated by Independent Oversight. In general, additional rigor has been applied to nuclear, explosive, and biohazard operations, but work control processes have not been consistently implemented adequately to assure that other hazards are appropriately controlled. Of particular concern is the lack of activity-based hazards analysis and the lack of specificity in the identification of controls, particularly in non-nuclear maintenance, construction, and support activities, indicating that increased attention is warranted in these areas.

LLNL has placed significant effort on improving safety for the plutonium facility. They have conducted a series of reviews and have implemented improvements in several important areas, including surveillance testing, maintenance, and the unreviewed safety question process. Other important improvement initiatives are underway as well, such as the development of system design documents. However, a number of deficiencies were identified in the safety bases and in the closure of previous inspection findings, indicating a need for increased management attention in some aspects of configuration management and maintenance, and significantly increased management attention in the area of engineering design and authorization basis. In addition, LLNL and LSO need to initiate prompt actions to resolve issues that could affect safety. Further, LLNL and LSO need to determine the extent of condition of the types of deficiencies identified by the Independent Oversight team.

Overall, NNSA, LSO, and LLNL have made improvements in a number of areas, but increased management attention is needed to enhance ES&H processes and performance. Areas of particular priority and emphasis should include:

- LSO and LLNL need to take timely action to ensure the adequacy of authorization basis requirements and implementation for some safety systems in Building 332.

- NNSA needs to ensure that appropriate compensatory measures are a priority; specifically, they need to ensure that adequate technical expertise is available to LSO to support resolution of nuclear safety issues, including the deficiencies in safety systems identified previously and on this Independent Oversight inspection, until the senior nuclear safety technical advisor position is filled.

- With the new contract, LSO and LLNL need to place greater emphasis on establishing and monitoring institutional management systems to ensure that LLNL line management organizations at the institutional and directorate levels are responsible and accountable for effective implementation of ES&H requirements and feedback and improvement processes, with a particular focus on issues management and corrective action management.

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6.0 Ratings

The ratings reflect the current status of the reviewed elements of LLNL ISM programs.

Work Planning and Control

ACTIVITY	CORE FUNCTION RATINGS			
	Core Function #1 – Define the Scope of Work	**Core Function #2 – Analyze the Hazards**	**Core Function #3 – Develop and Implement Controls**	**Core Function #4 – Perform Work Within Controls**
Nuclear Materials Technology Division – Superblock Operations	Effective Performance	Effective Performance	Effective Performance	Effective Performance
Defense and Nuclear Technologies – Site 300 801 Complex Operations	Effective Performance	Effective Performance	Effective Performance	Effective Performance
Chemistry, Materials. and Life Sciences – Facilities with Biological Work Operations	Effective Performance	Effective Performance	Effective Performance	Effective Performance
Applied Engineering Infrastructure Division – Manufacturing Activities	Effective Performance	Needs Improvement	Needs Improvement	Needs Improvement
Plant Engineering Department – Maintenance	Effective Performance	Needs Improvement	Needs Improvement	Needs Improvement
Plant Engineering Department and Subcontractors – Construction and Decontamination and Decommissioning	Effective Performance	Needs Improvement	Needs Improvement	Effective Performance

Essential System Functionality

Configuration Management Programs and Supporting Processes .....NEEDS IMPROVEMENT
Engineering Design and Authorization Basis ..... SIGNIFICANT WEAKNESS
Surveillance and Testing ..... EFFECTIVE PERFORMANCE
Maintenance .....NEEDS IMPROVEMENT
Operations ..... EFFECTIVE PERFORMANCE

Feedback and Continuous Improvement - Core Function #5

NNSA and LSO Feedback and Continuous Improvement Processes .....NEEDS IMPROVEMENT
LLNL Feedback and Continuous Improvement Processes .....NEEDS IMPROVEMENT

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APPENDIX A
SUPPLEMENTAL INFORMATION

A.1 Dates of Review

Planning Visit	January 8-11, 2007
Onsite Inspection Visit	January 22 – February 1, 2007
Report Validation and Closeout	February 21-23, 2007

A.2 Management

Glenn S. Podonsky, Chief, Office of Health, Safety and Security
Michael A. Kilpatrick, Deputy Chief for Operations, Office of Health, Safety and Security
Bradley Peterson, Director, Office of Independent Oversight
Thomas Staker, Acting Director, Office of Environment, Safety and Health Evaluations

A.2.1 Quality Review Board

Michael Kilpatrick	Bradley Peterson	
Dean Hickman	Robert Nelson	Bill Sanders

A.2.2 Review Team

Thomas Staker, Team Leader
Bill Miller, Deputy Team Leader

Phil Aiken	Vic Crawford	Ivon Fergus	Marvin Mielke
Shivaji Seth	Robert Compton	Al Gibson	Ed Greenman
Joe Lischinsky	Jim Lockridge	Tim Martin	Jon Johnson
Joe Panchison	Don Prevatte	Michael Shlyamberg	Ed Stafford
Mario Vigliani			

A.2.3 Administrative Support

MaryAnne Sirk
Keiana Scott
Tom Davis

A.3 Ratings

The Office of Independent Oversight uses a three-tier rating system that is intended to provide line management with a tool for determining where resources might be applied toward improving environment, safety, and health. It is not intended to provide a relative rating between specific facilities or programs at different sites because of the many differences in missions, hazards, and facility lifecycles, and the fact that these reviews use a sampling technique to evaluate management systems and programs. The rating system helps to communicate performance information quickly and simply. The three ratings and the associated management responses are:

- **Significant Weakness (Red):** Indicates senior management needs to immediately focus attention and resources necessary to resolve management system or programmatic weaknesses identified. A Significant Weakness rating

would normally reflect a number of significant findings identified within a management system or program that degrade its overall effectiveness and/or that are longstanding deficiencies that have not been adequately addressed. A Significant Weakness rating would, in most cases, warrant immediate action and compensatory measures as appropriate.

- **Needs Improvement (Yellow):** Indicates a need for improvement and a significant increase in attention to a management system or program. This rating is anticipatory and provides an opportunity for line management to correct and improve performance before it results in a significant weakness.

- **Effective Performance (Green):** Indicates effective overall performance in a management system or program. There may be specific findings or deficiencies that require attention and resolution, but that do not degrade the overall effectiveness of the system or program.

APPENDIX B
SITE-SPECIFIC FINDINGS

Table B-1. Site-Specific Findings Requiring Corrective Action

	FINDING STATEMENTS
C-1	Radiological hazards associated with the use of thoriated welding electrodes at LLNL have not been formally evaluated within the framework of the LLNL ISM program as required by DOE Policy 450.4, *Safety Management System Policy,* to ensure evaluation and development of appropriate radiological controls.
C-2	Activity-level hazards and controls for machining and plating work activities in the 321/322 complex are not sufficiently identified, analyzed, or documented, as required by DOE Policy 450.4, *Safety Management System Policy*.
C-3	Line management has not ensured that radiological conditions and needed controls for radioactive material machining activities in Building 321C are adequately defined and conveyed to workers, as required by DOE Policy 450.4, *Safety Management System Policy.*
C-4	LLNL Plant Engineering trade/service IWSs and bridging documents do not sufficiently identify and analyze hazards or specify controls at the activity level to ensure that the appropriate hazards and adequate controls can be identified clearly, in accordance with DOE Policy 450.4, *Safety Management System Policy*.
C-5	LLNL has not applied its work control process to subcontracted construction work with sufficient rigor to assure effective flowdown and enforcement of ES&H requirements in accordance with DOE Policy 450.4, *Safety Management System Policy*.
D-1	NNSA has not met *NNSA HQ 226.1 Implementation Plan* deliverables for: a Contractor Assurance System policy and performance expectations; the NNSA Headquarters Annual Assessment Schedule; definition of an NNSA Headquarters Lessons Learned Program; and a Headquarters issues management system. These actions were identified to address gaps in the requirements of DOE Order 226.1, *Implementation of Department of Energy Oversight Policy*, which were to be fully implemented by September 15, 2006.
D-2	LSO has not developed and implemented a sufficiently effective process for tracking, trending, and analyzing operational awareness data to ensure that deficiencies are addressed and that LSO oversight efforts ("for cause" reviews, Facility Representative surveillance, and direction for contractor self-assessment) are focused on areas of weakness, in accordance with DOE Order 226.1, *Implementation of Department of Energy Oversight Policy.*
D-3	The LLNL self-assessment program lacks sufficient rigor in planning and execution to be fully effective in evaluating ES&H performance in accordance with DOE Order 226.1, *Implementation of Department of Energy Oversight Policy,* DOE Order 414.1C, *Quality Assurance,* and DOE Policy 450.4, *Safety Management System Policy.*
D-4	LLNL has not implemented an issues management program that is fully effective in documenting ES&H program and performance deficiencies and ensuring that effective corrective actions and recurrence controls are developed and tracked to timely completion in accordance with DOE Order 226.1, *Implementation of Department of Energy Oversight Policy,* DOE Order 414.1C, *Quality Assurance,* and DOE Policy 450.4, *Safety Management System Policy.*
D-5	LLNL has not adequately addressed known systemic hoisting and rigging deficiencies and issues, ensured that the hoisting and rigging program is adequate, or ensured that requirements are being implemented as specified in LLNL and DOE safety standards, in accordance with DOE Order 226.1, *Implementation of Department of Energy Oversight Policy,* DOE Order 414.1C, *Quality Assurance,* and DOE Policy 450.4, *Safety Management System Policy.*

Table B-1. Site-Specific Findings Requiring Corrective Action (continued)

	FINDING STATEMENTS
D-6	LLNL injury and illness program requirements are not being implemented as specified in program documents, and investigations lack sufficient rigor to ensure that causes are identified and appropriate and that effective corrective and preventive actions are identified and implemented, in accordance with DOE Order 226.1, *Implementation of Department of Energy Oversight Policy,* DOE Order 414.1C, *Quality Assurance*, and DOE Policy 450.4, *Safety Management System Policy.*
E-1	As documented in a previous Independent Oversight finding, LLNL has not developed and maintained adequate drawings (piping and instrumentation, electrical, and other drawings) for vital safety systems, and has not adequately controlled such drawings to ensure that they are not used inappropriately, as required by DOE Order 420.1A, *Facility Safety*, DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*, and 10 CFR 830, *Nuclear Safety Management*.
E-2	Safety fire suppression and mitigation systems have open design concerns (storage tanks and nitrogen skid), and open design findings from the previous Independent Oversight review (nitrogen skid) have not been adequately addressed by LLNL and LSO to ensure that the systems will perform as designed in accident conditions, as required by 10 CFR 830.
E-3	As documented in a previous Independent Oversight finding regarding the potential for failure of important-to-safety room and glovebox exhaust system HEPA filters due to loading resulting from evaluation basis fires, LLNL and LSO have failed to perform adequate evaluations of Building 332 facility safety and to identify and implement adequate compensatory measures, analyses, or safety controls as required by 10 CFR 830.
E-4	In several cases, LLNL has not verified the capabilities of Building 332 safety structures, systems, and components to fully perform their safety functions as described in the documented safety analysis/technical safety requirements and validated the adequacy of the documented safety analysis/technical safety requirements, as required by 10 CFR 830.
E-5	LLNL's Maintenance Implementation Plan for Building 332, which has been approved by LSO, does not include detail appropriate to a hazard category 2 nuclear facility and does not identify the gaps and deficiencies in the maintenance program relative to the requirements of DOE Order 433.1, *Maintenance Management Program for DOE Nuclear Facilities.*
E-6	NMTP's process for evaluating and selecting suppliers for quality-significant orders does not have sufficiently detailed criteria and the necessary formality to meet the requirements of DOE Order 414.1C, *Quality Assurance*.
E-7	LSO has not conducted adequate and timely oversight of system drawings, authorization bases, and the technical adequacy of Building 332 safety systems, including the fire suppression system water storage tanks, nitrogen skid and pressure control valves, fire damper, and the room exhaust and glovebox exhaust systems final HEPA filters, as required by 10 CFR 830, DOE Order 420.1B, *Facility Safety*, DOE Manual 426.1-1A, *Federal Technical Capability Manual*, and DOE Standard 1104-96, *Review and Approval of Nuclear Facility Safety Basis Documents.*
F-1	An integrated exposure assessment program has not been fully implemented, and as a result some workplace exposure assessments and baseline hazard surveys or periodic resurveys are not being performed and/or documented as required by DOE Order 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees.*