# Volume II
# Technical Appendices

Independent Oversight
Inspection of
Environment, Safety,
and Health Programs
at the

# Sandia National Laboratories

ISM

DEPARTMENT OF ENERGY · UNITED STATES OF AMERICA

May 2005

SSA
*Office of Security and Safety Performance Assurance*

Office of Independent Oversight and Performance Assurance
Office of Security and Safety Performance Assurance
Office of the Secretary of Energy

# INDEPENDENT OVERSIGHT
# INSPECTION OF
# ENVIRONMENT, SAFETY, AND HEALTH PROGRAMS
# AT
# SANDIA NATIONAL LABORATORIES

## VOLUME II
## TECHNICAL APPENDICES

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## Volume II
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### Table of Contents

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# Acronyms

| | |
|---|---|
| ACGIH | American Conference of Governmental Industrial Hygienists |
| ACRR | Annular Core Research Reactor |
| AIHA | American Industrial Hygiene Association |
| AM | Assistant Manager |
| ANSI | American National Standards Institute |
| CAIRS | Computerized Accident/Incident Reporting System |
| CAP | Corrective Action Plan |
| CBDPP | Chronic Beryllium Disease Prevention Program |
| CFR | Code of Federal Regulations |
| CINT | Center for Integrated Nanotechnologies |
| CPR | Corporate Process Requirement |
| CSE | Cognizant System Engineer |
| CY | Calendar Year |
| D&D | Decontamination and Decommissioning |
| DBA | Design Basis Accident |
| DART | Days Away, Restricted, or Transferred |
| DIN | Do It Now |
| DNFSB | Defense Nuclear Facilities Safety Board |
| DOE | U.S. Department of Energy |
| DSA | Documented Safety Analysis |
| ECP | Employee Concerns Program |
| EMS | Environmental Management System |
| ES&H | Environment, Safety, and Health |
| ESF | Essential System Functionality |
| FEOSH | Federal Employee Occupational Safety and Health |
| FMOC | Facilities Management and Operations Center |
| FR | Facility Representative |
| FRAM | Functions, Responsibilities, and Authorities Manual |
| FY | Fiscal Year |
| GIF | Gamma Irradiation Facility |
| ICE | Isentropic Compression Experiment |
| IHIR | Industrial Hygiene Investigation Report |
| ISM | Integrated Safety Management |
| ISMS | Integrated Safety Management System |
| ISO | International Organization for Standardization |
| JHA | Job Hazards Analysis |
| JHE | Job Hazard Evaluation |
| JSA | Job Safety Analysis |
| JSHE | Job Site Hazard Evaluation |
| KIMS | Kirtland Issues Management System |
| LDRD | Laboratory Directed Research and Development |
| MESA | Microsystems and Engineering Sciences Applications |
| MITL | Magnetically Insulated Transmission Line |
| MSDS | Material Safety Data Sheet |
| MSHA | Mine Safety and Health Administration |
| MSR | Maintenance Service Request |

## Acronyms (continued)

| | |
|---|---|
| NEPA | National Environmental Policy Act |
| NIOSH | National Institute of Occupational Safety and Health |
| NNSA | National Nuclear Security Administration |
| NOTES | Non-Occurrence Trackable Events |
| NTS | Noncompliance Tracking System |
| NWSMU | Nuclear Weapon Strategic Management Unit |
| OA | Office of Independent Oversight and Performance Assurance |
| OEL | Occupational Exposure Limit |
| ORPS | Occurrence Reporting and Processing System |
| OSHA | Occupational Safety and Health Administration |
| P2 | Pollution Prevention |
| PAAA | Price-Anderson Amendments Act |
| PALD | Portable Automotive Lifting Device |
| PCB | Polychlorinated Biphenyl |
| PEP | Performance Evaluation Plan |
| PER | Performance Evaluation Report |
| PETL | Processing and Environmental Technology Laboratory |
| PPE | Personal Protective Equipment |
| PHS | Primary Hazard Screening |
| PISA | Potentially Inadequate Safety Analysis |
| R&D | Research and Development |
| RAM | Radiation Area Monitor |
| RCRA | Resource Conservation and Recovery Act |
| RCSC | Radiological and Criticality Safety Committee |
| RCT | Radiological Control Technician |
| RPPM | Radiation Protection Program Manual |
| RWP | Radiation Work Permit |
| SAD | Safety Assessment Document |
| SAP | Satellite Accumulation Point |
| SAR | Safety Analysis Report |
| SDD | System Design Description |
| SNL | Sandia National Laboratories |
| SNL-NM | Sandia National Laboratories/New Mexico |
| SME | Subject Matter Expert |
| SOP | Standard Operating Procedure |
| SPO | Security Police Officer |
| SSCs | Structures, Systems, and/or Components |
| SSO | Sandia Site Office |
| STD | Standard |
| TA | Technical Area |
| TIG | Tungsten Inert Gas |
| TLD | Thermoluminescent Dosimeter |
| TLV | Threshold Limit Value |
| TTC | Thermal Test Complex |
| TQP | Technical Qualification Program |
| TSR | Technical Safety Requirement |
| TWA | Time Weighted Average |
| TWD | Technical Work Document |

## Acronyms (continued)

| | |
|---|---|
| USQ | Unreviewed Safety Question |
| USQD | Unreviewed Safety Question Determination |
| UV | Ultraviolet |
| WIF | Weapons Integration Facility |
| Z Machine | Z Pulsed Power Accelerator |

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# APPENDIX C

# Core Function Implementation (Core Functions 1-4)

## C.1 INTRODUCTION

The U.S. Department of Energy (DOE) Office of Independent Oversight and Performance Assurance (OA) evaluated work planning and control processes and implementation of the first four core functions of integrated safety management (ISM) for selected Sandia National Laboratories (SNL) activities. The OA review of the ISM core functions focused on environment, safety, and health (ES&H) programs as applied to selected aspects of SNL activities:

- Processing and Environmental Technology Laboratory (PETL) (see Section C.2.1)
- Z Pulsed Power Accelerator (Z Machine) (see Section C.2.2)
- Gamma Irradiation Facility (GIF) (see Section C.2.3)
- Maintenance (see Section C.2.4)
- Subcontractor construction (see Section C.2.5).

The sampling approach provides for a review of a representative sample of SNL organizations, facilities, programmatic activities, and work activities/tasks[1] at SNL, including programmatic research and development, facilities operations, maintenance, and construction. For all the above areas, OA reviewed procedures, observed ongoing operations, toured work areas, observed equipment operations, conducted technical discussions and interviews with managers and technical staff, reviewed interfaces with ES&H staff, reviewed ES&H documentation (e.g., plant standards, permits, and safety analyses), and examined waste management activities. Specific processes in each area and OA team activities are discussed further in the respective results sections.

## C.2 RESULTS

In addition to evaluating the selected SNL activities, OA also evaluated the collective results of the application of Core Functions 1-4 in the selected activities to identify commonalities and factors that contribute to the identified deficiencies. As discussed below, the evaluation of the collective results provides perspectives on the sitewide work control processes.

The Sandia Site Office (SSO) and SNL have a system of institutional policies, standards, and procedures to implement many aspects of the SNL ISM system. In most respects, the primary facility hazards, such as hazards associated with operation of accelerators and large radiation sources, are well understood and effectively controlled. Similarly, generally adequate controls are in place for hazards that have received higher levels of visibility and management attention, such as beryllium.

However, the 2003 OA inspection and other oversight activities, such as recent SSO assessments, identified systemic deficiencies in the implementation of institutional processes across SNL facilities and activities, particularly as they apply to threats to worker safety from standard industrial hazards and exposure to certain chemical and toxic substances. Such deficiencies were identified in fundamental ISM

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[1] In this report, the terms "activity" and "activities" are used in a manner consistent with DOE Policy 450.4, *Safety Management System*, to include programmatic activities, such as operation of the Z Machine, and all lower-tier work activities and tasks, such as specific laboratory activities or tasks performed by researchers or maintenance personnel.

work control elements, such as communicating ES&H performance expectations, implementing work control processes for work activity-level hazards, and implementation of safety controls.

In the two years since the 2003 OA inspection, SNL has generally continued to implement effective controls for the primary facility hazards and other visible hazards, and has made progress in some areas related to worker safety. For example, maintenance personnel have begun to use formal processes, such as primary hazard screenings (PHSs) and job site hazard evaluations (JSHEs), to analyze hazards and establish controls for maintenance activities. However, for many identified deficiencies, limited progress has been made or corrective actions have not been effective in addressing the root causes and preventing recurrences of deficiencies. As a result, a number of aspects of worker safety are still not adequate to provide a level of assurance consistent with DOE ISM expectations. The injury and illness rates at SNL are among the highest of the 27 DOE contractors performing research related activities. For example, in calendar year (CY) 2004, Sandia's Total Recordable rate of 2.5 was the second highest rate for recordable injuries among the 27 contractors at DOE national laboratories. Furthermore, Sandia's CY 2004 DART[2] case rate of 0.8 was exceeded by only four other DOE contractors. Further, because of weaknesses in developing and verifying corrective actions (see Appendix D), most of the 2003 OA findings were closed before the effectiveness of the corrective actions was validated and verified.

This 2005 OA inspection identified three findings in work planning and control that warrant institutional-level attention because they are evident across multiple facilities and activities that were evaluated on this inspection and may occur at other SNL facilities and activities that were not included in the scope of this inspection. These three findings are presented below for easy reference and are briefly discussed. Additional observations contributing to these findings are discussed and referenced to the applicable finding in the results section for each of the five activities reviewed (Sections C.2.1 through C.2.5). The three institutional findings are similar in scope and nature to some of the findings from the 2003 OA inspection, further indicating that corrective actions have not been sufficiently comprehensive or effective.

The first institutional finding reflects weaknesses in work planning and in establishing and communicating adequate controls for protecting the health and safety of workers and the environment. The SNL work control processes did not ensure that systems are in place to identify, analyze, and document work activity/task-level hazards and ensure that adequate controls are identified and clearly communicated to the workforce. Although the PHS process is a useful tool for identifying activity hazards, additional lower-level analyses are often needed to adequately address task-level controls. In many cases, the selection and implementation of safety controls are left to the individual worker or researcher and rely on the knowledge and experience of individuals rather than clear safety standards and documented hazards and controls, as required by ISM. As discussed throughout this appendix, weaknesses are evident in the hazards analysis and controls processes as applied to worker safety elements, such as confined space, use of hazardous chemicals, lead, hazards communication, and some aspects of radiation protection. Some aspects of waste management, primarily waste segregation at the point of generation, had similar concerns.

**Finding #1. SNL has not sufficiently documented work descriptions, identification and analysis of hazards, and hazard controls at the work activity/task level to ensure that risks to workers and the environment have been adequately identified, analyzed, and controlled.**

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[2] A DART case is an injury or illness that resulted in days away from work or days of job restriction or transfer. DART was formerly referred to as the Lost Workday case rate.

The second institutional finding reflects the lack of a required comprehensive and effective exposure assessment program. SNL organizations have a number of processes for identifying, analyzing, and controlling workplace exposures to chemical, physical, biological, or ergonomic hazards. However, these processes are not comprehensive, integrated, and consistently applied, and do not adequately ensure that worker exposures are sufficiently analyzed, sampled/monitored, and documented based on risk and that the results are effectively communicated to line management and integrated into work documents. Specific concerns were identified in exposure assessments for laboratory chemicals, epoxy, ozone, welding fumes, ultraviolet (UV) radiation, lead, and noise.

**Finding #2. SNL line management has not defined an exposure assessment strategy or implemented a comprehensive exposure assessment program that utilizes recognized exposure assessment methodologies, as required by DOE Order 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*.**

The third institutional finding reflects the weaknesses in the SNL line management process for evaluating and implementing safety requirements. In a number of cases, line management organizations interpreted ES&H policies or requirements in a non-conservative manner or did not effectively implement a required ES&H control. In some cases, line management received relevant and valid recommendations from safety professionals on how to meet an ES&H requirement but did not adequately evaluate the recommendations or take action to implement the recommendations or suitable alternatives. There is no procedure, requirement, or mechanism to document a justification when safety professionals' recommendations are not to be implemented. Further, there are few controls, triggers, or thresholds that require line management to seek ES&H subject matter experts to evaluate a situation that has ES&H implications that might be beyond the expertise of line management organizations. In some cases, line management has not solicited ES&H input if it was not required, although the ES&H input might have resulted in a more accurate analysis of the hazard or a more appropriate selection of hazard controls. As a result, there were a number of situations where hazards to workers were not adequately identified, analyzed, and/or controlled in such activities as welding, cutting, laser operations, hoisting and rigging, confined space entries, construction, chemical use, and ozone protection. This finding is similar to a finding in the 2003 OA inspection, which has not been adequately addressed across SNL facilities and activities.

**Finding #3. SNL line management does not have an integrated process for soliciting and evaluating ES&H expertise, incorporating safety recommendations/requirements into work documents, and ensuring that safety controls fully meet ES&H requirements.**

The three findings above were evident in a wide range of SNL work activities, including facility operations, laboratory research, support activities, and maintenance, and were observed at several of the facilities reviewed on this OA inspection. Similar concerns are also evident in construction activities, which are typically performed by subcontractors using other work control processes (see Section C.2.5). Therefore, it is important that SSO and SNL evaluate and address the institutional findings at each applicable facility/activity and perform an extent-of-condition evaluation for the site. The corrective actions need to include both institutional and facility/activity-specific corrective actions and address all of the individual concerns that are referenced to a specific finding.

Because these three findings and some of the other activity-specific findings discussed in Sections C.2.1 through C.2.5 are similar in nature to 2003 OA findings, OA also collectively examined the findings to identify potential weaknesses in management systems that may contribute to their persistence and/or recurrence:

- There is still significant reliance on an expert-based approach to safety for work activities that affect worker safety, rather than on the ISM principle of clear standards and requirements. Some managers expressed a reluctance to implement formal and rigorous safety management processes because they believed that their personnel were capable of properly selecting and implementing safety controls. However, the deficiencies discussed in this section indicate that SNL personnel do not always have sufficient relevant safety expertise and do not always select appropriate controls.

- SNL assessments have not been consistently effective in identifying ES&H deficiencies, and when deficiencies are identified, issues management and corrective action processes are not adequate to ensure effective and comprehensive resolution (see Appendix D).

- SNL line management has not sufficiently implemented their responsibilities for ensuring that safety processes are clearly defined and effectively implemented. In some cases, line managers took non-conservative approaches to safety requirements (e.g., defining work as skill of the craft or skill of the researcher, when the hazards could be significant and non-routine) or relied on ES&H support personnel to address deficiencies that were more appropriately addressed by line managers who have the responsibility and authority to affect change.

- Processes and document hierarchies are not always sufficient to flow requirements down through the organization from institutional policies to the work activity/task level. In a few cases, there are some ambiguities in the high-level ES&H policies in the SNL ES&H Manual; more frequently, SNL line management does not have an adequate system (e.g., a defined requirements document hierarchy) for establishing and communicating ES&H requirements to the work activity/task level. In current practice, much of the communication is verbal or through electronic mail or other informal or non-controlled mechanisms.

The above information about management systems is intended to provide SSO and SNL management with an initial framework for evaluating causal factors and identifying comprehensive and effective corrective actions for the longstanding institutional and activity-specific findings in this appendix.

### C.2.1 Processing and Environmental Technology Laboratory

The PETL is one of five facilities that collectively comprise the Materials and Process Sciences Center (Center 1800) within SNL. The PETL facility, which is the largest of the five facilities, is a modern, state-of-the-art material sciences research laboratory that opened in CY 2000. Currently, Center 1800 is the principal occupant of the PETL facility and employs approximately 110 research and administrative staff. Material science research within PETL is diversified and includes materials analysis and forensics, materials aging and reliability, materials processing, materials synthesis, and materials properties and performance.

The varied hazards within PETL include thermal, chemical, pressure/vacuum, mechanical, electrical, and non-ionizing radiation hazards. ES&H support is provided by the Division 1000/2000 ES&H customer support team through a work agreement. Currently the Division 1000/2000 ES&H customer support team consists of safety engineers, industrial hygienists, environmental protection representatives, and a staff of health physicists and radiation control technicians. PETL line managers, researchers, and technologists have direct access to the ES&H customer support team; however, the primary interface is through the Center 1800 ES&H coordinator, who reports directly to the Director of Center 1800.

OA's evaluation of implementation of the first four core functions of ISM for PETL research activities focused on evaluation and sampling of safety performance across the Materials Synthesis and Processing

Group and the Materials Performance and Reliability Group. Work activities observed by the OA team included research being conducted in the surface analysis laboratory, metallography laboratory, chemical synthesis laboratory, facility for atmospheric corrosion testing, solder science and mechanical solder testing laboratories, mass spectrometry laboratory, and liquid and gas chromatography laboratories. PHS documents, technical work documents (including operating and administrative procedures), ES&H policies and procedures, laboratory work spaces, and administrative and engineering controls were also reviewed.

**Core Function #1: Define the Scope of Work**

The Sandia ES&H Manual (CPR 400.1.1) and the Sandia Integrated Safety Management Description (CPR 400.1.2) describe the overall work control and ISM processes that apply to all SNL work activities, including PETL research activities. Within PETL, defining the scope of work includes describing the work, identifying the work authorization chain, identifying the location of the work, and establishing the resources and priorities to perform the work.

For longer-duration research projects involving significant resources, research work is well-defined in research proposals and project plans. For example, a segment of the research conducted within PETL is funded through Laboratory Directed Research and Development (LDRD) Projects. Each LDRD project is defined in a research proposal, which describes the project, the resources required, estimated costs, and proposed project location(s). In addition, each LDRD proposal includes an ES&H checklist, which addresses National Environmental Policy Act (NEPA) documentation requirements, and safety and health considerations. LDRD projects are limited to three years and are reviewed annually. Approximately 60 percent of the longer-duration research and development work performed at PETL is conducted under multi-year Nuclear Weapon Strategic Management Unit (NWSMU) projects. The NWSMU process, like the LDRD process, is also well defined in program documentation. According to the NWSMU process description, “project work must be described in sufficient detail to ensure that appropriate processes and procedures are in place.” At minimum, a PHS and NEPA review are required before the start of each NWSMU project. The PHS is reviewed annually thereafter.

At the laboratory level, each PETL laboratory has a PHS, which includes a “description” of the general type of activities conducted in the laboratory. PHS descriptions, such as the PHS for the surface analysis laboratory, provide an overall description of typical operations and equipment in the laboratory, as well as a discussion of routine maintenance operations. In some cases, the PHS work description is supplemented by one or more technical work documents (TWDs). Most TWDs in PETL laboratories are operation and maintenance manuals provided by the supplier of commercially purchased equipment, such as the focused ion beam scanning electron microscope in laboratory room 1212B.

At the research task or bench experiment level, a “job card” is typically used to describe the work task for short-term sample analysis projects, in which the customer provides a material sample for a specific customer-defined analysis. For example, for metallography sample preparation in laboratory room 1327B, individual work tasks are defined through the customer preparation of a job card. The job card identifies the work requested, as well as general hazard and material information. Because the job card is used for “production-like” material analysis tasks, the use of the job card is limited in application and is currently used by one Center 1800 department in the PETL facility.

Other bench-level research projects are of higher variability and cannot be considered “production-like.” A number of these research activities have not been documented at the experiment or bench level to a degree that all hazards and controls can be identified and analyzed. For these projects, management expectations have not been clarified to describe when and how research experiments are to be documented (based on risk) so that the hazards can be analyzed and the appropriate controls can be documented. For example, the preparation of metallographic samples within laboratory room 1327B routinely requires the use of concentrated hydrofluoric acid (HF) as well as other acids and bases. However, the PHS does not describe the overall process for etching metallographic samples, and a TWD has not been developed for this activity to document the research activity so that the appropriate hazards and controls can be identified. The "skill-of-the-researcher" is relied upon to identify the work scope, analyze the hazards, and define the hazard controls. The resultant conclusions and hazard controls are seldom documented. For example, depending on the work process, the potential hazards in using HF may be significant and could require specific controls, such as special personal protective equipment (PPE) (e.g., gloves, chemical apron, face shield), HF training, an industrial hygiene exposure assessment, the availability of calcium gluconate for emergency response, prohibitions to working alone, and medical surveillance; however, none of these have been documented in a PHS, TWD, or elsewhere.

For bench-level research activities, such as chemical synthesis, the research activity is often defined informally through a variety of mechanisms. In some cases, experimental tasks are communicated by the department manager through notes recorded in a laboratory notebook, electronic mail, or most often through verbal communications. In other cases, the research activity is defined by the researcher performing the work; it may be documented in the researcher's laboratory notebook, but only to the extent as needed by the researcher. TWDs, other than equipment operating manuals, are seldom used to define research at the experiment level. Neither SNL nor Center 1800 has defined expectations for how experiments are to be defined at the experiment level so that higher-risk hazards and controls can be identified and documented. In a February 2005 Work Control Assessment Report issued by the National Nuclear Security Administration, SSO also noted in Appendix H, "Research and Development," that in general, there were no formalized or documented work control processes for research and development organizations. (See Finding #1.)

**Summary.** For longer-duration research projects involving significant resources, research work at the project level is well defined in research proposals and project plans. Similarly, at the laboratory level, each PETL laboratory has a PHS that provides an overall description of the type of research being conducted in the laboratory. At the research task or bench experiment level, the definition of work scope varies and is often informal and expert-based, even for higher-risk research activities.

**Core Function #2: Analyze the Hazards**

In general, the PETL research staff has considerable experience in working with the hazards in their workplace. The PETL research staff are also cognizant of the risks involved with their research and are knowledgeable of the hazard controls required to reduce the risk.

At the laboratory level, the PHS process has been an effective tool for identifying, analyzing, and documenting types or categories of hazards (e.g., solvents, carcinogens) present within a laboratory. For the ten PETL laboratories evaluated by the OA team, the laboratory PHSs correctly identified the categories of hazards present in the laboratory (e.g., corrosives, lasers, thermal hazards, electrical hazards).

In some cases, however, the laboratory PHS lacks sufficient detail to identify hazards at the experiment, task, or bench level, and often PETL has no other mechanisms (e.g., TWDs and procedures) that supplement the PHS to meet this requirement. Chapter 21, "Technical Work Documents," and Chapter 6E, "Chemical Hygiene Plan," of the ES&H Manual require activity- or experiment-level TWDs to describe the hazards and controls. Because of the high variability of much of the research conducted within PETL, SNL management has determined that developing TWDs for each research experiment is impractical, even for higher-risk experiments and laboratories such as Laboratory 2214, where the use of hazardous chemicals is extensive. The PHS is limited to defining classes of chemicals present (e.g., acids, bases, variety of organic solvents, chemical carcinogens, and corrosives). Within each chemical classification, some chemicals are significantly more hazardous than others (e.g., HF or methylene chloride), although these chemicals, their use, and their unique hazards are not identified in either the PHS or a TWD. As discussed under Core Function #1, for a specific research experiment, the identification of hazards is the responsibility of the researcher as a skill-of-the-worker activity, the results of which are seldom documented. Currently, there is no graded approach at the bench level for documenting experiment-level hazards based on risk. (See Finding #1.)

When workplace assessments are required by the PHS process for hazards identified in the PHS (e.g., chemicals, thermal, and electrical), the workplace hazards assessment is not sufficiently documented. The PHS requires a workplace hazards assessment for chemical, pressure, and thermal hazards. A TWD may also serve as a workplace hazards assessment. An informative and useful Center 1800 procedure on working with hazardous chemicals has been developed for use within all PETL laboratories to serve as a PETL-wide workplace hazards assessment; however, the procedure does not address hazards for any specific laboratory or experiment and does not meet the requirements of a TWD as described in the ES&H Manual. TWDs are seldom developed for individual laboratories, and in some cases, researchers have incorrectly assumed that if a workplace hazards assessment is required by a PHS, it need not be documented. (See Finding #1.)

Another concern with the PHS as a hazard identification and analysis tool is the lack of guidance for involving SNL waste disposal organization subject matter experts in the preparation, review, and/or approval of a PHS or related TWDs. For example, the PHS process has questions for analyzing waste, but there is no specific requirement that SNL hazardous waste management subject matter experts be contacted to ensure that a path for disposal is available before the waste is generated. The PHS process contains drop-down questions, so if waste is expected, the PHS directs the workers to ES&H Manual Chapter 19A, "Hazardous Waste Management," for identifying the appropriate controls. During the development of a PHS, the wastes to be generated are compared to existing waste profiles to determine whether there is an established path for disposal. Informally, if the waste does not fit an existing profile, an additional review may be conducted. However, until the waste has been generated and a request for disposal is initiated, the SNL waste disposal organization is not formally contacted. As a result, a waste without a path for disposal may be generated without the required prior DOE approval and without sufficient time for the disposal of the waste. The SNL hazardous waste facility is permitted to store waste for only one year, and if the time required to identify a disposal path and waste vendor exceeds this period, the site could exceed the waste storage period, which would require a formal notification to the state. (See Findings #1 and #3.)

In a related concern, industrial hygiene subject matter experts have not been sufficiently involved in the performance of exposure assessments to ensure that potential worker exposures to some chemical, physical, biological, and ergonomic hazards have been identified and quantified based on risk to workers, as required by DOE Order 440.1A. With the exception of lasers, biological hazards, and chemical asphyxiates, there are no well-documented risk thresholds or criteria for involving industrial hygiene in the evaluation of research activities at PETL. DOE Order 440.1A requires initial or baseline surveys of all work areas or operations to identify and evaluate potential worker health risks, and periodic resurveys and/or exposure monitoring as appropriate. In addition, DOE Order 440.1A requires documented exposure assessments for chemical, physical, and biological agents and ergonomic stressors using recognized exposure assessment methodologies. SNL lacks a well-documented exposure assessment strategy that explains how these DOE Order 440.1A requirements are to be implemented. The current SNL program does not meet some DOE expectations for conducting and documenting exposure assessment using recognized exposure methodologies as described in DOE Guide 440.1-3, *Occupational Exposure Assessment;* DOE-STD-6005-2001, *Industrial Hygiene Practices;* or the American Industrial Hygiene Association (AIHA) publication entitled "A Strategy for Assessing and Managing Occupational

Exposures."  For example, although SNL Industrial Hygiene has developed two robust procedures for conducting air and surface contaminant sampling and documenting the results in an Industrial Hygiene Investigation Report (IHIR), these work practices do not provide for a comprehensive exposure assessment program as described in the DOE or AIHA guidance documents.  Specific elements of the SNL program that lack the rigor described in recognized exposure methodologies include initial or baseline industrial hygiene surveys, periodic reassessments, exposure assessment documentation, a technical description of the exposure assessment strategy, identification of recommended and additional control measures, and linkage of exposure assessment performance and sampling/monitoring to estimated risk.  Overall, the current Industrial Hygiene work practices lack sufficient guidance or thresholds that describe when or how an exposure assessment or sampling/monitoring for workplace contaminants should be conducted and documented.  This situation was also evident in the 2003 OA inspection, and a similar concern was identified by SSO in a 2004 assessment of the Sandia Industrial Hygiene occupational exposure assessment program.  (See Finding #2.)

Because SNL does not have comprehensive institutional exposure assessment requirements and processes, line management has not adequately involved industrial hygiene in assessing some potential PETL research hazards.  For example, within the metallography laboratory (Room 1327B), specimen encapsulates using epoxy resins are routinely prepared on the benchtop without local ventilation. Although some of the epoxy hardeners present significant health hazards (e.g., National Fire Protection Association health rating of 3), their use in this application has not been evaluated by Industrial Hygiene or documented in an IHIR.  In the focused ion beam microscope laboratory (Room 1212B), the ion pump associated with the equipment produces a magnetic field in excess of 5 Gauss, and therefore may require additional controls (i.e., door postings) according to Chapter 6J of the ES&H Manual.  However, Industrial Hygiene has not performed an exposure assessment to quantify the magnitude of the hazard.  In another example, the non-ionizing radiation exposure potential from the UV source associated with the mercury xenon lamp in the chromatography laboratory (Room 2212) has not been evaluated and/or documented by Industrial Hygiene in an IHIR.  As a result, the appropriate hazard controls are uncertain. (See Finding #2.)

**Summary.**  The PHS process has been an effective tool for identifying laboratory hazards and establishing and defining a safety envelope for individual research laboratories.  However, there is no comparable graded-approach tool for identifying and analyzing hazards at the experiment, task, or bench level and for documenting the results based on risk.  In addition, exposure assessments have not been uniformly and consistently performed to ensure that all significant risks are adequately evaluated as required by DOE Order 440.1A.

### Core Function #3:  Identify and Implement Controls

The ISM work process at SNL, as described in the SNL Integrated Safety Management Description, provides expectations for developing and implementing hazard controls for research facilities, such as those operated by the Materials and Process Sciences Center at PETL.  At the institutional level, the SNL contract and management systems have delineated a set of management standards and requirements as defined in the SNL standards/requirements identification document.  The SNL ES&H Manual establishes the controls for implementing the ES&H safety standards and requirements.

Most engineered controls within PETL facilities are well designed and sufficiently maintained.  Because the PETL facility is less than five years old, the facility was designed with state-of-the-art engineering controls, including computer-controlled fume hoods, a central corridor for movement of chemicals, once-through ventilation, and office spaces that are external to the laboratory spaces.  Ventilation systems, fume hoods, and eyewash stations were adequately maintained and are inspected on a regular basis.

Most institutional SNL training requirements are well defined in PHSs and other TWDs. The PHS process is a useful mechanism for defining training requirements and identifying requirements for administrative procedures based on requirements in the SNL ES&H Manual. Some SNL Centers, such as Center 1800, have developed a TWD that defines supplemental ES&H training requirements for such activities as hazardous waste management and chemical operations training.

Hazard postings within the PETL laboratories effectively communicate the dominant types of hazards within the laboratory. Hazard postings on laboratory doors are current and accurate. Designated areas for particularly hazardous chemicals within the PETL spaces are appropriately posted.

The chemical inventory system has been an effective measure for identifying and controlling the inventory of hazardous chemicals within the PETL facilities. Chemicals throughout the various laboratories are appropriately labeled and bar coded. Chemical inventory system listings of hazardous chemicals in individual laboratories are current and easily accessible.

Although the engineering and administrative controls within the PETL research spaces have a number of positive attributes, the work control process for research and development at the experiment or laboratory bench level is not well documented. As a result, the expectations for how the core functions of ISM are to be implemented are unclear. Neither the Sandia Integrated Safety Management Description nor the SNL ES&H Manual provides specific guidance for how the five core functions of ISM are to be implemented for research and development work activities at the experiment or bench level. Guidance is particularly lacking for how research work activities/tasks are to be defined, controls documented, work authorized, and feedback and improvement conducted. As indicated previously, this concern was also identified by a recent SSO Work Control Assessment Report. (See Finding #1.)

Within PETL spaces, there are no effective and/or consistent criteria for documenting hazard controls—PPE or administrative controls—based on risk. The PHS does not adequately document hazard controls for hazards that are below the SNL low hazard risk classification (at either the laboratory or experiment level), and TWDs are not routinely prepared to document hazard controls. As a result, the identification and application of hazard controls relies upon the researcher, and the selection of hazard controls for a particular experiment is seldom documented. (See Finding #1.)

In some cases, the selection of controls implemented by researchers is neither documented nor appropriate. For example, the mixing of epoxy resins in the PETL metallography laboratory (Room 1327B) is performed on the bench, without local ventilation and without using nitrile gloves. However, the material safety data sheets (MSDSs) for the resin and hardener used to prepare the epoxy specify a polypropylene, ethylene vinyl alcohol glove for the resin and a neoprene glove for the hardener. Furthermore, the supplier of the nitrile glove, which is currently in use, does not recommend the use of the nitrile glove in this application. In addition, the manufacturer of the hardener also recommends the use of a local exhaust, which is not present in the laboratory. Although an exposure assessment for a comparable research activity was performed in 1994 for a different SNL building, the exposure assessment assumed the activity was performed beneath a canopy fume hood. (See Finding #1.)

In another example, hazard controls have not been documented for working with lead in the solder science and testing laboratories (Rooms 2323 and 1210). Solder in use in these laboratories contains more than 35 percent lead. Neither of the PHSs for these two laboratories addresses hazard controls associated with working with lead. There are no TWDs for these two laboratories that address hazards and controls for the lead research. Specific lead hazard controls that have not been documented include: identification and use of the appropriate protective gloves, ensuring that lead operations are performed at low temperatures (i.e., below 343 degrees Celsius to preclude lead fume generation), a housekeeping plan to ensure that all work surfaces are maintained as free as possible of lead, periodic exposure assessments and sampling, and notification to the medical unit of all personnel who routinely work with lead. The most recent exposure assessment, which was performed in 1991, identified lead dust levels well in excess of the established Department of Housing and Urban Development guideline of 21.5 micrograms (µg)/100 square centimeters ($cm^2$), and recommended a housekeeping plan. The housekeeping plan has not been formalized, and no additional lead exposure assessments have been conducted during the past 14 years or for similar operations in the new PETL building. Furthermore, the SNL medical unit was unaware of any researchers working with lead in these laboratories, and as a result the opportunity for a lead baseline was missed. (See Finding #2.)

In another example, hazard controls have not been documented for the non-ionizing radiation source (UV radiation) associated with the mercury xenon lamp in the chromatography laboratory (Room 2212). Although a separate PHS has been prepared for the use of this lamp, the associated hazard controls (i.e., door posting and the need for UV-filtered safety glasses), which were identified by the researcher, have not been documented in either the PHS or a TWD. The PHS, however, states that "a site specific TWD detailing administrative exposure control(s) shall be developed." In addition, ES&H Manual Chapter 6J recommends a TWD where non-ionizing radiation sources could expose workers to non-ionizing radiation at levels approaching exposure limits; the TWD should provide the details of the administrative controls. There is no record of an exposure assessment (i.e., IHIR) having been conducted for this UV source, as previously discussed. (See Findings #1 and #2.)

At the laboratory level, some ES&H training programs do not have guidance for consistent and adequate implementation at the laboratory level. The Occupational Safety and Health Administration (OSHA) requirements for hazardous chemical training for laboratory workers (29 CFR 1910.1450) and the SNL ES&H Manual require that employees be trained at the time of initial assignment, when new physical or health hazards are introduced to the work area, and prior to assignments involving new exposure situations. For PETL staff who work with hazardous chemicals, a sampling of individual training records confirms that these workers had initial hazardous chemical training as required by the OSHA standard. However, there is no well established process to ensure that laboratory workers receive additional work-area-specific training when a new chemical hazard is introduced or when laboratory workers change assignments or locations (and thus may encounter different chemical hazards). In addition, several of the training courses that may be intended to satisfy the area-specific hazardous chemical training are either outdated or too generic to satisfy the requirement that the training be task-specific and address the hazards and controls of the task in which the worker is involved. (See Finding #3.)

In some cases, the SNL ES&H Manual does not provide sufficient guidance to ensure that the hazard is evaluated by ES&H subject matter experts and that the appropriate exposure controls can be readily and consistently identified and implemented by line management. For example, according to the SNL Laser Safety Officer, there is a potential safety hazard for high irradiance Class 3a lasers if they are used with any optical collection device (e.g., telescope) in which the beam becomes concentrated. However, other than a recommendation for training, no hazard controls or precautions associated with Class 3a lasers are noted in ES&H Manual Chapter 6G, "Lasers and Intense Light." Although this potential hazard is discussed in the SNL laser safety training class, the class is not required for users of Class 3a lasers. While a number of Class 3a lasers are in use in the PETL spaces, this hazard control is not identified or well known because of the limited guidance provided in the ES&H Manual and may not be implemented. (See Finding #3.)

In another example, ES&H Manual Chapter 6J, "Non-ionizing Radiation," requires managers to ensure that warning signs and symbols are posted around devices that emit UV energy into occupied or potentially occupied areas. Furthermore the ES&H Manual instructs managers that postings must comply with American National Standards Institute (ANSI) Z53.1-1979, and that exposure to the workforce must be less than the exposure limits in the 1997 American Conference of Governmental Industrial Hygienists

(ACGIH) threshold limit values book. Without requesting an analysis of the UV light frequencies and obtaining the cited references, which are out of print, the manager cannot readily identify the appropriate hazard controls. At PETL, for example, all the appropriate hazard controls for the UV light source (Room 2212) may not have been implemented. (See Finding #3.)

Throughout the year, some undergraduate and graduate students, as well as postdoctoral researchers, are routinely involved in research activities at PETL. Because these individuals have a wide variety of skills and experiences, the selection, documentation, and communication of hazard controls are particularly essential to avoid injury or illnesses for this group of researchers see Finding #1).

**Summary.** Engineering controls are well designed, implemented, and used within the PETL research spaces to reduce researchers' risk of exposure. In general, hazard postings are adequate, and the chemical labeling and inventory system has been effective. However, at the laboratory and experiment level, there is no effective mechanism for identifying and documenting some hazard controls. The identification of hazard controls is often at the discretion of the researcher, and is seldom documented. In some cases, the expert-based selection of hazard controls is incorrect or incomplete. In addition, some ES&H training programs and sections of the ES&H Manual lack sufficient guidance to be readily implemented by line managers.

**Core Function #4: Perform Work Within Controls**

In general, most work activities observed by the OA team within PETL were performed safely and within the controls established though postings and the PHS. Hazard controls posted on laboratory doors were followed. Workers were generally in compliance with the requirements stated in the applicable PHSs. The PETL research staff was conscientious with respect to their work activities and followed the identified hazard controls. In most cases, housekeeping was good.

Hazardous waste operations in Centers 1700 and 1800 are being performed in accordance with SNL and state hazardous waste requirements. The labels are on the containers, and the containers are kept closed. The satellite accumulation points (SAPs) are under the control of the operator, and information is recorded for use in characterization of the waste based on process knowledge. Personnel responsible for the SAPs are knowledgeable of the requirements.

During the past few years, injury and illness rates for Center 1800 research and development activities have decreased. For example, since CY 2002, recordable injury rates have decreased from 4.54 to 2.03. Days Away case rates and Lost Workday case rates have also decreased from 1.13 and 2.27 to 0 and 1.01, respectively.

At the experiment level, some research was not performed in accordance with recommended controls, as discussed previously. For example, a few research experiments did not fully implement the PPE requirements or local ventilation requirements as described in the MSDSs for the chemicals that were in use. For the period of CY 2002-2004, 23 percent of the PETL injuries and/or illnesses were caused by potential chemical exposures, and an additional 6 percent of the injuries were caused by burns. In some cases, since the hazard controls for the research were not documented, performance of work within controls could not be audited. (See Findings #1 and #3.)

**Summary.** Observed work activities were performed safely. In most cases, the research staff was knowledgeable of the hazards and the expected controls associated with their experiments, and they performed work in accordance with those controls. Laboratory hazard postings were followed, and engineering controls were used as designed.

### C.2.2 Z Pulsed Power Accelerator

At Z Machine, observed work activities included facility preparations and readiness verifications for several machine "shots," pre- and post-shot activities (including center section and Z backlighter laser loading and unloading), magnetically insulated transmission line refurbishment work, and program support activities, such as welding operations, equipment inspections, and crane operations.

**Core Function #1: Define the Scope of Work**

The scope of work activities at Z Machine is generally well defined. The Z Machine PHS bounds the scope of work at the facility level. Routine and programmatic work activities are defined though TWDs (i.e., operating procedures and safety work plans) and the experiment descriptions. These documents define the work sufficiently to allow the applicable hazards to be identified.

**Summary.** In general, SNL has defined the scope of work activities in sufficient detail to permit adequate identification and analysis of the hazards to workers, the public, and the environment.

**Core Function #2: Analyze the Hazards**

Hazards for most work at Z Machine are adequately identified and analyzed through formal hazards analysis processes (see exceptions below). Depending on the type of activity, SNL uses one of four primary processes for hazards analysis for work at Z Machine. At the facility level, most Z Machine hazards are identified in a PHS. In some cases, complex hazards are more extensively characterized to supplement information in the PHS. For example, while Z Machine beryllium contamination is identified in the PHS, additional characterization of the hazard has been performed and documented in IHIRs. During the 2003 OA inspection, Z Machine facility-level hazards were also analyzed in an accelerator safety assessment document (SAD). Since the last assessment, SNL determined that a SAD was not required for the Z Machine and no longer maintains the SAD as the facility safety envelope. However, some of the SAD analyses are still valid and used in the hazards assessment portion of the PHS. Hazards unique to Z Machine major routine maintenance and operational activities are generally well analyzed through the Z Machine procedure review and approval process. The safety approval form process provides an adequate mechanism for experimenters to provide information to facility operations on hazards unique to the experiment and each individual shot. The facility then evaluates whether the shot hazards are covered by existing controls or whether further mitigating actions are needed. Safety work plans are developed for "tasks or activities that may contain hazards that are not fully controlled through a high level PHS." They are governed by a center-level administrative procedure, "Planning for Safety." Although this administrative procedure needs revising to address organizational changes, the process, if followed as written, provides an acceptable method to perform a work activity/task-level hazards analysis and identify appropriate controls for major, non-routine tasks that are not otherwise covered by procedures.

Although most hazards are adequately analyzed, some deficiencies were identified in the areas of chemical, noise, and radiological hazards analyses and with the implementation of an administrative procedure addressing hazards analysis. These deficiencies are further described below.

Z Machine line management does not ensure that adequate hazard exposure assessments are performed as required by DOE Order 440.1A for some skill-of-the-craft or other routine activities. The OA team observed or identified several work activities with inadequate or non-existent industrial and chemical hazards analyses. Examples include:

- Welding activities in the Z Machine welding shop have never been sampled for fumes specific to the welding wire currently in use. The MSDS for the current welding wire reduces the maximum total fume exposure guideline from 5 to 1.5 milligrams per cubic meter based on the manganese content of the wire and subsequent contribution to the total fume content; however, this restriction has never been addressed by an exposure assessment.

- Although the inside of the pulse forming section of the machine is a permitted confined space, welding activities in this confined space are occasionally performed but have never had an exposure assessment.

- Many machining activities in Z Machine welding and machining shops are loud, including hand tool work that traditionally exceeds hearing protection limits and excessive impact noise from hammering on large aluminum parts. Workers performing observed activities used hearing protection and offered observers hearing protection. However, no hearing protection requirements had been established for the area, and there was no record that a noise exposure assessment that would determine appropriate hearing protection had ever been performed for the area.

- A Z Machine shot generates a significant static discharge within the building, creating the potential for significant ozone generation; however, an exposure assessment addressing workers' exposure to ozone when entering the area immediately following a shot has never been performed.

- Exposure assessment plans for routine activities at Z Machine have not been identified, developed, or implemented.

- The Z Machine PHS identifies welding/cutting operations as an additional type of hazard, but it only lists the potential hazards for these activities as fires and burns. It does not list exposure to chemical fumes or excessive noise exposure as potential hazards, even though workers are routinely exposed to these hazards. In addition, the PHS system uses incorrect terminology in that welding/cutting operations are activities, not hazards, and fires and burns are potential consequences, not potential hazards.

Inadequate exposure assessments are a continuing problem that was previously identified in the 2003 OA inspection and later in a 2004 SSO work planning inspection. Line management attention in this area has not been sufficient to ensure that the minimum hazards analyses necessary to protect the workers have been performed. (See Finding #2.)

As discussed above, safety work plans are used to analyze planned non-routine work activities; however, in some cases, Z Machine personnel do not follow all administrative procedure requirements applicable to their development. As a result, controls are not clearly linked to the hazards, and hazards and controls can be missed. For example, in seven of the nine safety work plans approved since 2002, controls are not listed on the hazard identification list as required by the administrative procedure. Controls unique to the activity are only listed in the discussion section, but not all hazards are specifically addressed in this section, and specific controls are not linked to specific hazards. Without more attention to detail in the hazard identification list, some hazards and controls are missed. In the latest approved safety work plan (Marx Annex Move), the failure to follow the administrative requirements resulted in several deficiencies. The directions on the hazard identification list form were changed without revising the associated administrative procedure; hazards are identified for solvents but no controls are listed; and one of the work performance steps requires moving 55-gallon drums of hexane (a highly flammable liquid), even though the hazard identification list indicates that there are no flammable liquids, and no controls are provided. (See Finding #3.)

The OA team noted important failures in the area of radiological hazards analysis that are needed to support the adequacy of Z Machine radiological controls and practices and to demonstrate compliance with institutional radiological requirements. Specifically, the radiological hazards associated with the different types of Z Machine shots have not been analyzed in a formal or systematic manner, resulting in potentially inadequate controls. Specific concerns are discussed below.

First, neither the PHS nor other documents discusses or distinguishes between the different radiation hazards that may be present during and following the various types of shots performed at Z Machine; this information is needed to form the basis for appropriate radiological controls. The four basic shot types are isentropic compression experiment (ICE) shots, ICE shots with radioactive material targets, standard wire array shots, and neutron-producing shots. The facility SAD indicates the potential for activation of components during all types of Z Machine operations. However, current radiological controls are based on the assumption that activation is not possible during ICE shots without a radioactive material target. The basis for these conclusions is not documented. Further, the radiological hazards posed by photons, neutrons, and activation products produced during the other shot types have not been formally addressed through hazards analysis processes. (See Finding #1.)

Current radiological practices date back a number of years and are based primarily on information informally communicated between various personnel. Such practices have not been analyzed for the current Z Machine operating parameters, which have changed over the years with increasing power output and neutron production capability. For example, Z Machine personnel assume that standard wire array shots produce gamma radiation and charged particles such as protons, which result in charged particle activation of components in close proximity to the blast shield. Because of the relatively short range of the charged particles in matter, personnel believe that activation would be mainly confined to the area in close proximity to the inner blast shield, and any activity found outside this area would come from fragments of contamination spread from activated material located within the blast shield. However, neutron-producing shots will produce neutron activation at greater distances in areas outside the blast shield, with different radiological characteristics. In both types of shots, there is the potential for photoactivation resulting from high-energy bremsstrahlung radiation interactions with structural components anywhere in the center section. In none of these examples is there any documented assessment discussing these concepts or, more importantly, the key radiological hazards associated with the various shot types. Information about expected activation products, decay times, and radiation energies is necessary to establish, verify, and/or alter the basis for current radiological practices and monitoring methods. For example, the current practice of using surface contamination limits for release of materials located outside the blast shield is questionable because it dates back to a time when neutron-producing shots were not common and there was much less potential for activation of components located outside the blast shield. (See Finding #1.)

Z Machine also does not maintain a documented technical basis for the selection and use of specific radiological measuring instruments in use at the facility as required by the DOE Radiation Protection Program Manual (RPPM). The lack of such documentation may be caused or exacerbated by a lack of the needed formal radiological hazards analysis information. Specific deficiencies include an inability to demonstrate that existing equipment and dosimetry (e.g., survey meters and thermoluminescent dosimeters) are appropriate for the types, levels, and energies of the expected radiation; that existing equipment and dosimetry are adequate to ensure compliance with regulations; and that radiological readings are valid for the types, levels, and energies of the expected radiation. The ability to demonstrate the adequacy of these parameters is required by institutional requirements and DOE regulations. While most radiations can likely be reliably detected with the instrumentation in use, some low-energy radionuclides that may be formed during activation cannot be properly detected with the survey instruments in use at Z Machine. Other isotopes that can be detected are often present in conjunction with these materials, but the lack of documented information on activation products makes use of such a scaling comparison impossible. Similarly, the response and accuracy of thermoluminescent dosimeters to measure external radiation exposure cannot be evaluated because the energy spectrum of the penetrating radiation produced during the shots has not been assessed or defined. (See Findings #1 and #3.)

**Summary.** For most work, Z Machine hazards are adequately identified and analyzed through formal hazard control processes; however, some standard industrial activities are not adequately analyzed, and some radiological hazards analyses are not detailed or documented sufficiently to meet institutional requirements and ensure appropriate controls. Unnecessary worker exposure to industrial hazards is a longstanding deficiency, and previous feedback mechanisms, such as the 2003 OA assessment, last year's SSO assessment, and some Sandia self-assessments, have not been effective at rectifying this deficiency. Increased management attention is needed to ensure that these hazards are adequately addressed. (See Appendix D and Finding #15.)

**Core Function #3: Identify and Implement Controls**

Z Machine uses an appropriate combination of engineered controls, administrative controls, and PPE to effectively control most hazards. Engineered controls, such as computerized area access control and keylock switches for equipment lockout, are extensively used to protect personnel from radiological, electrical, and other hazards directly associated with a machine shot. Administrative controls, such as procedures, permits, and training, complement the engineering controls and are effective in most cases, although some deficiencies were observed (as discussed below).

In general, the primary hazards analysis processes discussed in the previous section also provide adequate processes for establishing administrative hazard controls for most work activities. In addition, processes for use of such permits as hot work permits, confined space permits, and radiological work permits are in place and generally effective (exceptions are discussed below). Technical procedures and other technical work documents are generally well written and provide an adequate level of detail to ensure that tasks can be performed safely. Prerequisites, notes, and cautions are appropriately used to convey most hazard controls not otherwise covered by permits. For example, electrical hazard controls, such as grounding instructions and lockout/tagout, are extensively addressed by technical procedures.

Z Machine activities involve frequent use of cranes and rigging equipment in production and general lifts, and appropriate administrative controls, such as procedures, checklists, and operator aids, have been developed. For example, crane inspections are required by procedure, and inspection checklists are laminated and approved as operator aids so that the inspection steps can be marked in erasable marker each day and subsequently verified by any qualified crane operator. Operating procedures provide the appropriate steps to effectively control production lifts. Controls for general lifts include the previously mentioned inspections and training. In most cases, these controls are adequate; however, in one case, appropriate controls for a general lift involving an elevated work surface were not provided (see the discussion of fall protection later in this section).

Z Machine operations also involve extensive coordination between different technical and ES&H disciplines and organizations. To better facilitate necessary communications, Z Machine uses a text paging system to send out notices concerning operational status and timing for upcoming shots. This system ensures that all responsible individuals are informed of important events and can make appropriate arrangements to perform their required duties. The system is administered by Z Machine Operations personnel and activates several times each day to advise personnel of important milestones and activities in preparation for or following each shot. In this manner, radiological control technicians (RCTs), workers, and support personnel are informed of the current timeline and can execute their responsibilities appropriately. For example, text pages are sent out to advise personnel of 15-minute high bay lockdowns and before pre-unload briefings that workers and RCTs must attend.

Although many hazard controls at Z Machine are robust, deficiencies in certain aspects of radiological, industrial safety, and industrial hygiene controls were identified, as discussed below. Concerns about waste management were also identified.

In the area of radiological controls, Z Machine does not have an appropriate mechanism to ensure compliance with RPPM requirements related to control of activated materials. As discussed under Core Function #2, Z Machine relies on an undocumented and unproven assumption that activation of materials in the center section occurs only within the confines of the blast shield and that any radiation detected on components outside the blast shield result from radioactive contamination and not activation. The accuracy of this assumption is important because control of surface-contaminated items is not required below certain measurement thresholds, while activated (volume-contaminated) materials must be controlled if any detectable radioactivity is present. The RPPM defines "controlled material" as items or material that is activated or volume-contaminated; it is subject to more stringent radiological requirements than low-level surface-contaminated items. Existing practices at Z Machine do not address RPPM activated material requirements and allow items from outside the blast shield to be released based solely on surface contamination levels, without regard to the potential for fixed or induced radioactivity within the material itself. Consequently, controlled radioactive material from Z Machine may be improperly controlled, managed, or released. (See Findings #1 and #3.)

Z Machine also has no documented basis for the lack of routine RCT coverage and surveys following ICE shots. Limited radiological survey data taken after ICE shots shows the presence of components with detectable radioactivity. Site personnel speculate that this activation is the result of the re-use of parts that were activated during earlier non-ICE shots. However, some of the documented direct readings would exceed total contamination guidelines for surface contamination and the materials would therefore require labeling and continued control, even under the less stringent surface-contamination criteria. The potential presence of activated material, coupled with RPPM requirements that work with “controlled material” be subject to survey and technical work documentation, calls into question the existing practices that do not require radiation protection support during ICE shots. (See Findings #1 and #3.)

Some radiological controls implemented at Z Machine are not specified in radiation work permits (RWPs) or TWDs as required by the ES&H Manual. Recent efforts to simplify RWPs at Z Machine have resulted in RWPs that contain only the information that the worker must know, not the specific controls that RCTs must implement. RCT radiological practices and protocols, which were included in previous versions of RWPs, are not currently documented in a TWD as required. The ES&H customer support team is developing RCT guidelines for use by the RCTs, but the draft guidelines do not meet the rigor and formality of TWDs. (See Finding #3.)

In addition, radiological information presented in the current Z Machine Unload RWP does not meet site requirements (i.e., RPO 06-605) for content and format. Deficiencies include:

- Anticipated radiological conditions are not provided for airborne radiation, contamination, and radiation levels.
- Required PPE is not defined but left to the discretion of the RCT.
- Respiratory protection requirements are vague and/or left to the discretion of the RCT.
- Extremity dosimetry and lapel air sampling are not defined but left to the discretion of the RCT.

- When pause-work or stop-work conditions are encountered, additional radiological controls are not defined but left to the discretion of the RCT. (See Finding #3.)

In the area of industrial safety and hygiene, deficiencies were identified with confined space controls, implementation of exposure assessment recommendations, and implementation of the Z Machine Chronic Beryllium Disease Prevention Program (CBDPP) implementation plan and fall protection. These concerns are addressed in the following paragraphs.

Z Machine does not comply with some OSHA and SNL program requirements for confined space controls. The confined space permits and the observed confined space entries showed numerous deficiencies, including failure to meet all OSHA requirements for worker safety. The following deficiencies were identified with two confined space permits being used for the same space by different Z Machine organizations:

- The ES&H Manual requires that supervisors authorizing entry determine the appropriate retrieval equipment and methods; however, neither of the confined space permits for the Z Machine center section (prepared by different supervisors) included any provisions for use of retrieval gear, and no retrieval gear was worn. The supervisors marked that retrieval gear was not applicable but provided no justification for that decision. When the center section cover is on, the top area is only accessible by a manhole on the top cover and has no forced ventilation, making the retrieval capability essential to safe operations. The practice of not providing retrieval capability has been accepted for years; no one in the line management or industrial hygiene review of completed permits recognized the deficiency.

- PPE requirements on one permit were not consistent with beryllium PPE requirements as to the type of coveralls.

- One permit listed possible hazardous environments including lead, welding fumes, plasma cutting, nickel, and tin, but there was no testing for these constituents.

- The atmospheric hazards block on one permit was marked N/A when oxygen deficiency was, in fact, possible.

- During an observed evolution, log entries for accountability of individual entry and exits from confined space were not accurately maintained. Personnel were shown on the log as being inside the space when they were not.

- One permit was filled out on an expired form. (See Core Function #3.)

Inadequate control of confined spaces is a continuing problem that was previously identified in the 2003 OA inspection and in a 2003 Sandia ES&H Center functional area self-assessment. Corrective actions and line management attention in this area have not been sufficient to ensure that the minimum controls necessary to protect the workers have been implemented. (See Finding #3 and Appendix D, Finding #15.)

Z Machine line management does not use a systematic process to evaluate and effectively implement, or justify not implementing, recommendations cited by industrial hygienists in IHIRs, thereby potentially unnecessarily exposing workers to excessive chemical hazards. In many cases, management uses verbal instructions or electronic mail to address recommendations and may not have adequately resolved identified problems, documented justifications for not following documented safety professional recommendations, or adequately involved Industrial Hygiene in resolving potential conflicts between the recommendations and production needs. As examples:

- A May 2004 IHIR recommended discontinuing use of center section fans to prevent the spread of beryllium contamination; however, these fans are still in use. Management's decision to continue use of the fans was informally based on this IHIR and a July 2004 IHIR determination that no potential for a hazardous beryllium atmosphere existed. However, no discussion or analysis for the potential spread of contamination has been documented.

- A May 1999 IHIR found that peak ozone concentrations within welders' breathing zones during aluminum tungsten inert gas (TIG) welding and aluminum torch cutting can be up to 50 times the threshold limit value–time weighted average (TLV-TWA) and recommended that local exhaust ventilation be implemented immediately for all indoor aluminum TIG welding and plasma torch welding operations and that confirmatory ozone measurements be taken to determine ventilation effectiveness. These recommendations were never implemented.

- An April 2003 IHIR led to monitoring of one aluminum welding activity and one aluminum plasma torch cutting activity, and determined that the activities did not expose the workers to ozone above the TLV-TWA. However, these monitoring activities were performed with the large bay doors open to the outside, allowing outside air to circulate in the work area. The IHIR recommended that future welding and cutting work be performed with the bay doors open in the absence of any local exhaust ventilation at this work site, and that future periodic monitoring be performed to assure that ozone exposures remain below the regulated limits. Line management informally implemented the door-open restriction for the specific equipment and work activity in process at the time of the measurements but not for other welding and cutting work. (See Finding #3.)

Beryllium hazards posed by Z Machine operations are currently addressed in the recently implemented CBDPP implementation plan. However, in some cases, beryllium controls identified in the plan are not adequately or effectively implemented. While the plan provides an adequate method of controlling beryllium, it does not provide an implementation timeframe to incorporate identified controls into TWDs. The plan also does not ensure verification of the feasibility of controls or an effective method for revising controls based on actual implementation. In implementing the plan for production work, the beryllium operational area boundary for the center section, as currently established, is not compatible with process operations. For example, during post-shot activities, workers disconnected diagnostic and process lines connected to the center section head (inside the boundary) and retracted them to outside the boundary. In addition, even though the handrails are normally intended to establish much of the boundary, the boundary is often not apparent because several handrails must be removed to accommodate process equipment for the shot (the connection for the Z backlighter laser). Inadequate accommodation of process activities in planning and establishing the boundary likely contributed to some of the contamination control events observed by the OA team. (See Finding #3 and Core Function #4.)

Inadequate fall protection controls were identified in two cases. In the first case, no fall protection controls were in place during center section operations when personnel were working adjacent to an unprotected elevated surface. On multiple occasions during the same type of evolution, an approximately 3 by 4 foot opening in the center section cover was exposed while a worker was rigging the center section cover for lifting. This opening was not protected by guardrail or covering, and the worker was not using a personal fall arrest system. Consequently, the worker was at risk of falling approximately 10 feet to the bottom of the center section, a permitted confined space with limited retrieval capability. This hazard has been present for years, but no one had recognized the fall hazard. In the second case, workers did not recognize that they were being exposed to a fall protection hazard while performing crane operations in the new building annex until an OA inspector pointed it out. In both cases, lack of hazard recognition during skill-of-the-craft activities contributed to the lack of hazard controls. (See Findings #1 and #3.)

In the area of waste management, regulated hazardous waste and non-regulated waste are not always appropriately segregated at the point of generation. This practice has the potential for unnecessarily violating regulatory requirements for hazardous waste disposal. For example, at Z Machine, red containers with hazardous waste labels marked for oily rags are used to collect oily rags (which are not necessarily hazardous waste) in accordance with the requirements of ES&H Manual, Chapter 19A. The contents of these red cans are then moved to the less-than-90-day storage area, where a Z Machine waste management representative visually ensures there is no free oil before placing the rags in a container that goes to disposal as non-Resource Conservation and Recovery Act (RCRA) waste at a public landfill. Using a container marked as hazardous waste could result in actual hazardous waste being placed in the container with the oily rags. Because the waste management representative is not the generator of this waste, this process relies on the training of the generator to properly segregate oily rags from hazardous waste and ensure that no actual hazardous waste is placed in the container. Within the same general area, solvent rags, which are in fact regulated hazardous waste, are placed in the same type of red can for disposal as hazardous waste, thereby increasing the potential for combining this hazardous waste with the non-hazardous oily rags. Controls at the point of generation are needed to assure that the generator is properly managing hazardous and non-hazardous waste. Most DOE sites use color-coded containers and labels for regulated hazardous waste and non-regulated waste and provide specific training for waste generators on the use of these segregated containers. (See Findings #1 and #3.)

**Summary.** SNL has identified the appropriate hazard controls for most work activities; however, several examples of inadequate implementation of controls in industrial safety, industrial hygiene, waste management, and radiation protection indicate that increased management attention is needed to ensure appropriate worker protection. In some of these cases, better utilization of ES&H professionals by line management in work planning and performance might have prevented the deficiencies. Line management's inadequate use of safety professionals in areas needing such expertise, along with the other examples of inadequate implementation of controls, indicates that line management has not fully assumed responsibility for safety. Involvement of ES&H in the work control process was identified as a weakness in the 2004 SSO assessment on work control, and these additional examples illustrate continuing problems in this area. (See Appendix D, Finding #15.)

**Core Function #4: Perform Work Within Controls**

Z Machine uses several methods to confirm readiness for program work. Experiment approval is formalized through the safety approval form process. Approval to perform a pulsed power shot is rigorous and ensures that appropriate safety precautions and systems are in place, including the use of checklists, process area evacuations, and confirmatory personnel sweeps. Although some readiness review requirements have not been implemented (see below), readiness confirmation for most activities is effective.

In most observed work activities, Z Machine work was performed safely and in accordance with controls. Z Machine workers are extremely knowledgeable of the equipment, processes, and associated requirements of the operations procedures. For unload activities requiring radiological coverage, RCTs are engaged with the work and appropriately perform radiological surveys of items being removed from the center section. (However, see the concern discussed above with respect to the technical basis and justification for current practices.) Survey forms generated during these evolutions were also well documented and complete.

Hoisting and rigging activities are generally performed safely and in accordance with procedures. Workers appropriately perform daily crane inspections and perform rigging equipment inspections before each use. Workers exercise proper control and don appropriate PPE when performing hoisting and rigging operations, and appropriate spotters are used during load movements. All workers in the vicinity or path of crane movement don hard hats and keep nonessential personnel away from suspended loads. With one exception discussed below, workers appear to be aware of the hazards associated with lifts.

The less-than-90-day waste storage area for the Z-Machine is operating in accordance with SNL and external requirements. The area has secondary containment that is under cover for storing liquid drums of hazardous waste. No containers had been in storage over 90 days. The required weekly inspections are performed, and spill contingency equipment is in place.

Although most work was found to be performed safely and in accordance with controls, a few readiness review and work performance deficiencies were observed. These are described below.

Readiness reviews at Z Machine are not always performed as required by the ES&H Manual. For example, the Z Machine operations department had no plans to perform a readiness review for the new building annex prior to beginning program activities because management had misinterpreted the readiness review requirements in the ES&H Manual. Another example involves the machine and weld shop area, which had been shut down for over a year because of suspected beryllium contamination. The ES&H Manual identifies activities shut down over a year, or because of safety reasons, as requiring a readiness review; however, a readiness review was not performed before this area was reopened for work. During this OA inspection, workers performed hot work in the weld shop even though all fire extinguisher inspections in the machine and weld shops expired in December 2003; the expiration would have likely been identified if a readiness assessment had been performed. In both examples, line management had not established a mechanism to ensure that program work would not start until the required readiness review was performed.

In a few cases, workers failed to recognize hazards during work activities or failed to follow established controls. In two cases, workers failed to recognize imminent-danger fall hazards. (See Core Function #3 for more details.) In the machine and welding shops, workers inadequately performed required hot work permit checks for operable fire extinguishers—they signed off that the fire extinguishers were operable but did not verify that the fire extinguishers inspections were current. (In fact, none of the monthly inspections for any of the extinguishers in the area had been performed in over a year.) Several different workers performed these inadequate hot work permit checks over the two-month period since operations resumed in the area.

In some cases, workers demonstrated poor beryllium contamination control practices in potentially contaminated beryllium operations areas. Potentially contaminated hand tools were routinely passed from personnel within the contamination zone to individuals outside the zone without being wiped down or otherwise cleaned. In addition, respiratory protection was doffed and potentially contaminated beryllium gloves were in contact with facial areas, hair, and other body parts. In one work activity, workers not dressed in required PPE routinely reached over the boundary to remove residual gasket material from a potentially contaminated component.

**Summary.** At Z Machine, most work is performed safely and in accordance with established controls. Operations and RCT work activities for shot performance and associated crane movements are performed safely and within established controls. Workers are extremely knowledgeable of applicable operating procedures. Although most work is performed safely, a few deficiencies were observed in implementation of readiness review requirements and worker diligence in meeting beryllium contamination control requirements.

### C.2.3 Gamma Irradiation Facility

The assessment of core function implementation at GIF included a review of work planning documentation associated with previous and upcoming work activities and experiments, interviews with line management, and observation of work. GIF irradiation cells are used only a few times per month; only two work evolutions occurred during the inspection, and both were observed. The first involved a maintenance evolution to correct a problem with a source transfer cart, and the second involved a dose rate acceptance test while exposing approximately 200,000 curies of cobalt-60 in cell #3.

**Core Function #1: Define the Scope of Work**

The scope of work for GIF activities is generally well defined through a combination of mechanisms, including the facility PHS, GIF operating procedures, and individual experiment plans. The GIF PHS broadly defines the scope of work as dry irradiation operations conducted within irradiation cells located inside the facility. GIF standard operating procedures (SOPs) further define those infrastructure operations and activities necessary to run and maintain the GIF facility and the irradiation cells in support of client needs. Individual experimenters who want to use the irradiation cells for specific experiments are required to prepare a specific GIF experiment plan defining the nature of the experiment, including any additional hazards that may be introduced.

In some cases, the scope of work for a particular task is not fully addressed by individual operating procedures or experiment plans; the scope of work also may encompass portions of several operating procedures, or may require special instructions not included in existing operating procedures. This situation existed for the dose rate acceptance test witnessed during the OA inspection, which required an RWP, ozone measurements, and separate measurements of dose rates inside the cell using a remote detector. These additional parameters constituted conditions not specifically addressed by the SOPs for acceptance testing or cell operations. For such work conditions, GIF uses work control instructions to more clearly define the scope of work and implement hazard identification and control activities. While this process provides a mechanism to document additional detail and bounding of work scope, the work control procedure as currently written applies only to maintenance and modification work and is not intended for operations. SNL Department 6780 recognizes this anomaly and is revising the current work control procedure to better define its scope and application.

**Summary.** Current processes for defining the scope of work at GIF provide sufficient detail to ensure that hazards posed by operations can be identified and controlled. Although the scope of work is not fully addressed by the PHS or operating procedures for some operations, GIF has implemented compensatory measures by utilizing a maintenance work control process to bound the scope of work for these activities.

**Core Function #2: Analyze the Hazards**

Several mechanisms are used to perform hazards analysis at GIF, including the PHS, individual experiment plans, and facility operating procedures. Collectively, these processes provide an appropriate framework for identifying most activity/task-level hazards. For example, the radiological hazards associated with GIF operations have been appropriately analyzed through both the PHS and GIF SOPs. Other hazards, including electrical, noise, mechanical, and pressure hazards, were also identified through the PHS and SOP processes. Additional hazards that may be introduced by individual experiments, such as explosives or bringing additional radioactive material to the facility, are further evaluated through individual experiment plans prepared in accordance with GIF SOP 014, “Experiment Plan Procedure.”

For most work, the adequacy of hazards analysis efforts is the responsibility of GIF operators and managers, customers, and ES&H customer support team professionals. In addition, a graded approach to additional hazards analysis and the level of review required prior to allowing operations is provided through the Technical Area (TA)-V Radiological and Criticality Safety Committee (RCSC). The TA-V RCSC is an integral part of the Sandia Independent Review and Appraisal System and is responsible for reviewing all activities involving significant quantities of radioactive materials used at TA-V facilities, including GIF. Formal criteria requiring involvement and review by the RCSC are defined in the RCSC charter and used by line management to determine when additional reviews of proposed work are necessary. Review of work documents at GIF indicates conservative application of these requirements for GIF activities.

While most activity-level hazards at GIF have been properly identified, hazards associated with ozone production and removal have not been fully identified or analyzed for all cell configurations; consequently, appropriate controls were not incorporated into the SOP governing cell entry. The hazards associated with ozone production during cell irradiation activities have not been identified in the GIF PHS even though ozone hazards have been recognized and identified in the GIF safety analysis report (SAR) and several operating procedures governing GIF operations. The omission from the PHS may have occurred because the generic PHS question set does not specifically ask a question related to the potential for generation of hazardous substances during operations.

Exhaust ventilation is a key engineering control referenced in the SAR and operating procedures to mitigate ozone hazards. A March 2001 IHIR evaluated ozone levels in cell #3 for a certain source strength and ventilation rate and determined that a minimum waiting period of three minutes must elapse before allowing re-entry into the cell. The IHIR also recommended a reevaluation of ozone levels if there are any significant changes to the source strength or cell ventilation rates and also evaluation of ozone levels in cells #1 and #2 during initial use. However, characterization of these ozone hazards, including the length of time needed for exhaust ventilation to bring ozone levels down to acceptable levels before reentry into the cell, has not been determined for all possible source configurations in the cells. Line management has not properly implemented the industrial hygiene recommendations relating to ozone characterization when source and/or ventilation parameters have changed, or during initial use of cells #1 and #2, thereby potentially unnecessarily exposing workers to uncharacterized chemical hazards. For example, in October 2004, GIF conducted an acceptance test for cell #2 using 180,000 curies of cobalt-60, approximately ten times the level used during the cell #3 test in 2001, with no requirement for ozone measurements. The current SOP used to govern cell entry by facility and research personnel makes no mention of a time constraint following irradiations before re-entering cells. (See Finding #3.)

**Summary.** Most hazards associated with GIF operations are appropriately identified using the PHS, operating procedures, and individual experiment plans. However, hazards associated with ozone have not been accurately identified in the PHS, and the effectiveness of engineering controls in mitigating the ozone hazards has not been formally evaluated.

**Core Function #3: Identify and Implement Controls**

GIF appropriately relies on extensive use of engineering controls to mitigate potential radiological hazards posed by operations. The irradiation cells and pool are heavily shielded, and numerous engineering features, such as door interlocks, warning lights and sirens, ventilation systems, and radiation monitors, have limited the need for administrative controls and PPE during many GIF operations. While significant quantities of cobalt-60 are used to deliver very high dose rates in cell irradiation locations, extensive use of radiation shielding and engineered safety features significantly limits the potential for personnel to be exposed to external radiation in the GIF. Occupied areas of the GIF are designed so that dose rates in accessible areas will not exceed 0.5 millirem (mrem) per hour (hr) when the maximum quantity of cobalt-60 is exposed in each cell. (See Appendix E for further discussion of the engineered features.)

In addition to the engineered controls, some administrative controls, such as procedures, are used extensively at GIF. All routine operations are governed by SOPs that include a discussion of hazards and associated controls applicable to the work. The SOPs provide the appropriate level of detail for performing routine GIF operations and provide linkage to most controls needed to mitigate anticipated hazards (e.g., RWPs). As noted under Core Function #1, some operations are not adequately defined or covered by a single SOP or experiment plan, but line management uses alternative measures (such as work control instructions and facility work requests) that further define the hazards and controls.

In addition to engineering controls and procedures, some work activities/tasks at GIF require an RWP to specify the activity level radiological controls. Very few RWPs are used at GIF, and most operations requiring an RWP are performed under RWP 2375 for conducting experiments and performing radiation area monitor source checks. However, the scope and span of control for this RWP is too broad to consistently and accurately convey specific requirements for discrete job evolutions and ensure that controls are adequately tailored to the activity. The description of work does not address some of the activities where this RWP is relied upon to control work at GIF. For example, the authorized work description for RWP 2375 does not properly reflect any applicability to work involving handling of in-pool sources with remote handling tools. (See Finding #1.)

Because the scope of RWP 2375 allows for the conduct of multiple work activities/tasks with different hazards, controls, and expected radiological conditions, the specific controls needed for each activity are difficult to ascertain. For example, this RWP was chosen to cover a two-part maintenance evolution to rig a source transfer cart in preparation for the acceptance test. The first part involved standard in-pool source transfer work to remove sources from the cart, while the second part was to raise the empty source cart into cell #3 for hands-on work. This second portion also required a non-routine bypass of the cell door interlock to allow operator entry into the cell, with the elevator raised, to perform hands-on work on the empty source cart. Because the cart is normally located on the bottom of the pool housing cobalt-60 source arrays, there was a potential for stuck pins and/or contamination of the empty cart when it was raised. However, the RWP had no requirement for RCT presence or coverage for this portion of the work, and it is unclear whether such coverage was intended. RCTs were already present because of the in-pool source transfer portion of the work and performed surveys of the cart when it was raised into the cell; however, such actions were not mandated or driven by the RWP. (See Finding #1.)

RWP 2375 also contains conflicting information and insufficient detail as to expectations for some radiological controls. For example, the RWP requires a supplemental dosimeter when entering a high or very high radiation area. However, based on the RWP hold point suspension limit of 100 mrem/hr, entry into a high radiation area would constitute a violation of the RWP because a high radiation area is by definition greater than 100 mrem/hr. In the GIF SOP for in-pool source handling, there is a requirement for a self-reading dosimeter; however, RWP 2375, which was used during this work, contains no such requirement. According to the RPPM, RWPs take precedence over other TWDs, and strictly following this RWP for dosimetry requirements would result in a procedure violation. (See Findings #1 and #3.)

Radiological monitoring requirements in the RWP are not clearly defined. According to site procedures, "all appropriate requirements for monitoring radiological conditions must be specified in the RWP." RWP 2375 does not specify any requirements for the types of radiological surveys or monitoring required during the work covered by the RWP. For example, some work allowed under this RWP does not require RCT coverage or monitoring, but there is a dose rate suspension limit of 100 mrem/hr, which cannot be evaluated without dose rate measurements in the work area. Similarly, while hold points for contamination levels are specified, they are not tailored to specific operations and do not explain the action that must be taken to satisfy the hold point prior to continuing with the activity, as called for by a site procedure. This procedure states that hold points are intended to be included in the RWP when radiation protection action is needed to assess changing radiological conditions and ensure implementation of required controls, and when there is a potential for elevated or changing removable surface contamination levels on accessible surfaces. Generic hold points for dose rates and contamination are listed in RWP 2375, but the specific work conditions under which the hold points must be evaluated and health physics action is needed are not defined. For example, during remote source handling with tools, at least one dose rate measurement and hold point swipe for contamination control is needed whenever a source handling tool is raised to the surface of the pool and prior to contact with other surfaces. However, this detail is not provided in the RWP, and other survey or monitoring expectations are not defined. Such determinations are currently left to the discretion of the RCT, which is not in accordance with ES&H Manual requirements related to use and content of TWDs and skill of the worker for radiological control. Similar findings were identified in the 2003 OA inspection but have not been adequately addressed. (See Findings #1 and #3 and Appendix D, Finding #15.)

GIF does not have a requirement to perform radiation surveys periodically in the high bay when sources are raised within irradiation cells. In practice, once dose rate acceptance test criteria have been verified as less than 0.5 mrem/hr in occupied areas for a particular source/cell configuration, additional radiological surveys are not required to be taken during future cell irradiation activities. The dose rate is unlikely to change significantly, but the lack of dose rate measurements at a minimum frequency conflicts with RPPM and regulatory requirements for periodic radiological surveys to document radiological conditions, detect the potential for changes in radiological conditions, and verify the integrity of engineering controls. The RPPM also suggests radiological monitoring before, during, and after work that has a potential for changing radiological conditions. Lastly, the GIF SAR derivation of technical safety requirement (TSR) controls indicates that periodic radiation surveys are to be conducted to verify continuing shielding integrity. However, this requirement has not been adequately translated into the GIF TSRs or RWPs. (See Finding #3.)

**Summary.** Engineering controls and SOPs provide for a means to effectively mitigate most hazards during GIF operations. However, SOPs do not always specify sufficient controls for protection against ozone, and implementation of some radiological control requirements at GIF has not been fully effective.

**Core Function #4: Perform Work Within Controls**

Readiness to perform work at GIF is the responsibility of the facility manager, who authorizes all activities based on completion of required work planning. For the two evolutions witnessed by OA, this authorization was based on completed facility work requests, a revision to an SOP for acceptance testing, and availability of approved RWPs. Pre-job briefings for both evolutions were thorough and adequately covered the scope of work, anticipated hazards, controls, and operating procedures to be used. In both cases, facility work requests were prepared and served as the integrating document because several different SOPs were needed to complete all required actions.

During both work evolutions, workers performed work safely within established controls. Cell sweeps were performed appropriately before raising the source elevators, and operators displayed good conduct of operations in following GIF SOPs for cell operations and in-pool source movement. In addition, RCTs were present for both work evolutions and provided sufficient radiological coverage to ensure personnel safety. However, as noted under Core Function #3, RWPs did not always provide sufficient detail in establishing needed radiological controls for all activities that could be conducted under the RWP. In addition, as noted in Appendix E, Section E.2.5, a few conduct of operations deficiencies occurred while cell operators were performing an activity (a cell elevator operation using a bypass key) without an approved procedure.

**Summary.** Readiness to perform work is appropriately assured by the facility manager before work begins. Pre-job briefings are thorough and adequately cover the scope of work, anticipated hazards, controls, and operating procedures to be used. Workers are knowledgeable of procedures to be used and perform their tasks safely in accordance with required controls.

### C.2.4 Maintenance

Maintenance at SNL is primarily conducted by the Facilities Management and Operations Center (FMOC). FMOC is responsible for maintenance of facility infrastructure, such as electrical distribution, ventilation, water, drains, roofs, structures, roads, grounds, and steam distribution. FMOC is also responsible for operation of the SNL Steam Plant and several standby diesel generators. Maintenance, both corrective and preventive, is conducted either by SNL employees or by service contractors. Last year, FMOC completed almost 48,000 work requests, and expended over 445,000 man-hours (not including custodial services).

ISM is incorporated into the maintenance planning process through the use of maintenance service requests (MSRs), PHSs, JSHEs, and TWDs as described in the SNL ES&H Manual. MSRs are initiated by customers either by telephone through the Telecon Plus system or through a computerized work request on the Facilities E-Service page. MSRs are then processed by a planner in accordance with the FMOC "Maintenance Planning Procedure."

This assessment covered work performed by FMOC in TA-V, the microelectronics development laboratory, the robotics laboratory, maintenance shops, and several other buildings, and included preventive and corrective maintenance and modification activities. Work observed during this OA inspection included maintenance performed by different maintenance shops, inspection of shop work areas (including waste management areas), and reviews of completed work orders. Specific tasks that were evaluated included preventive maintenance on air handling units and cooling towers, confined space entries, electrical maintenance, troubleshooting, and inspection of shop lifting and rigging equipment. (See Appendix F for a discussion of hoisting and rigging activities.)

**Core Function #1: Define the Scope of Work**

Work is clearly defined with regard to the location of the work and the specific piece of equipment involved. Work requests contain fields completed by either the planner or the customer to clearly define the location and the equipment that is to be maintained. Work is scheduled on a weekly basis through time cards and release of work orders to individual craftspeople by the team leaders and supervisors.

Sandia has established DIN (Do It Now) Teams, which are teams of mechanics, electricians, structural millwrights, and painters that address any facility maintenance issues that are within their capability for specific buildings during established windows of time from a few days to two weeks. These teams visit buildings in accordance with a formal annual schedule. The Building Manager coordinates with the DIN team leader to determine what work will be performed.

The technical aspects of the work are less well defined and are normally left to the expertise of the individual performing the work at the time of the job. When job plans and work instructions are used, they often contain steps that are not applicable to the specific equipment. In many cases, establishing the scope of work is simply left to the skill of the craftsperson assigned to conduct the work. There is a set of generic operating procedures that are intended to broadly define the tasks conducted by the various maintenance crafts. Troubleshooting activities are not normally subject to any written plans and are simply conducted based on discussions between craft, customer, and system engineers.

**Summary.** Work is generally well defined with respect to location and equipment affected. Specific technical aspects of most maintenance tasks are left to the skill of the assigned workers. Overall, work definitions are adequate to support subsequent hazard identification and analysis. In some cases, more detailed definition of work steps could improve hazard identification and analysis, particularly for troubleshooting activities.

**Core Function #2: Analyze the Hazards**

The first step in hazard identification and analysis for FMOC is the PHSs that have been conducted for classes of employees. FMOC has completed twelve PHSs, one for each of the teams that comprise the maintenance division. These PHSs address the broad range of hazards to which workers might be exposed during work across SNL and identify the types of controls that should be used by the craft. These screenings have some value in analyzing hazards associated with a specific activity, but are not frequently referenced or used by workers or planners during the work planning process.

JSHEs are required when the work may involve chemical or biological agents, asbestos, environmental restoration sites, radiological operations/spaces, or other non-standard industrial hazards**.** In accordance with FMOC's "Jobsite Hazard Evaluation Administrative Procedure," the facilities service request process requires personnel requesting FMOC support to answer the question: "Are there ES&H hazards associated with customer operations or space where FMOC projects/work activities will be performed that could impact the safety of personnel performing the requested service (e.g., chemical, biological, radiological, environmental hazards)?" If the answer is "No," there is no JSHE required. If the answer is "Yes," the types of hazards present are identified by completing a jobsite hazard checklist. If the answer is "Unknown," the FMOC planner follows up as necessary to determine the hazards before releasing the work. Based on the results of the jobsite hazard checklist, the planner requests a JSHE by the customer support team.

The 2003 OA inspection found that few JSHEs were performed for routine maintenance activities and that thresholds had not been defined. JSHEs have been performed more frequently since they are required for specific cases. Approximately 250 JSHEs have been performed since September 2004, mostly for beryllium and/or radiation hazards.

However, JSHEs often do not contain detailed analyses of the hazards (e.g., sampling data results for beryllium or other hazards of concern). The JSHE lists controls, but it is difficult to determine from the analysis provided that the controls are adequate. MSDSs are not always referenced during preparation of the JSHE to identify potential hazards related to chemicals used during the work. The planning for a job to clean a solvent exhaust fan in the microelectronics development laboratory illustrates this weakness. Because of the chemical hazard, it was identified that a JSHE was required. The JSHE discussed the chemical hazard in general terms, but there was no specific evaluation by an industrial hygienist of an appropriate exposure limit based on the compounds used in the system being exhausted. The JSHE states that "many of the compounds identified are not well documented in the toxicological literature nor do occupational exposure limits exist for many of these chemicals," even though the MSDS for each of the chemicals does provide recommended exposure limits. No analysis of the work area was included to determine whether air flow would be sufficient to protect workers in the immediate vicinity, or whether the entire room should be posted as a respiratory protection area. The JSHE did not include or reference any of the chemical MSDSs and did not evaluate the materials for potential incompatibility with the cleaning methods that were to be applied. (See Finding #1.)

Other than JSHEs, SNL has no effective mechanisms for hazards analysis of specific maintenance activities, and hazards analysis is not conducted at the activity/task level when the job is considered to consist of "standard industrial hazards." Consequently, there is no effective mechanism to proactively identify unknown hazards in work spaces. (See Finding #1.)

Many hazards or potential hazards are not identified or analyzed during maintenance work planning. For example, multiple hazards in shop areas have not been identified or analyzed, resulting in inadequate specification and application of controls for those hazards. For example, locksmiths use at least two types of spray cleaning and lubricating chemicals. For both chemicals, the MSDSs recommend local exhaust ventilation, yet no such capability exists in the shops where the chemicals are used. The potential for worker exposure has not been evaluated, nor have the workers or supervisors ever requested such an evaluation. Another example was identified during air handling unit preventive maintenance activities. While changing air filters, workers wear either half-face or full-face dust respirators because they view dust as a nuisance hazard. There has been no evaluation by Industrial Hygiene to determine whether the dust is more than a nuisance hazard (e.g., possible silica content). (See Finding #1.)

Generation of polychlorinated biphenyl (PCB) waste during relamping activities has not been adequately analyzed by any of the available mechanisms (JSHE or PHS), resulting in inadequate controls for those wastes. The PHS for facility electrical work does not properly identify these wastes as Toxic Substance Control Act wastes. JSHEs are not required for work that might involve handling leaking PCB ballasts or subsequent cleanup of PCB contamination. Consequently, controls for Toxic Substance Control Act requirements from ES&H Manual Chapter 10D were not implemented in applicable maintenance procedures. (See Finding #1 and Core Function #3.)

**Summary.** Broad hazards analyses that cover the obvious hazards encountered by craftspeople have been completed. When the customer, craftsperson, or supervisor recognizes hazards, those hazards are addressed by one of the subject matter experts assigned to the customer support team. These analyses may be documented on a JSHE, but they are not always documented. In many cases, hazards analysis information is provided via verbal discussions, electronic mail, or phone calls. Hazards analysis for individual activities needs improvement to ensure that standard industrial hazards and hazards other than the well-recognized hazards (e.g., beryllium) are adequately identified and analyzed.

**Core Function #3: Identify and Implement Controls**

FMOC has a set of operating procedures that they consider as TWDs. Each operating procedure covers a broad range of tasks performed by a specific craft and identifies the required controls for most of the obvious hazards in the work spaces. For example, one of the operating procedures identifies the generic PPE required by workers who may need to verify zero energy during electrical lockout/tagout. Workers are required to review these operating procedures annually and acknowledge that review by signature. PHSs and JSHEs also contain controls that are to be applied during the course of work.

The selection and use of controls identified in operating procedures, PHSs, and JSHEs depend almost entirely on worker experience, training, and knowledge. Few, if any, procedures are used during the conduct of maintenance activities to link controls to specific job tasks. The job plans that are prepared are generally not specific, do not contain precautions or warnings, and (other than lockout/tagout) do not contain controls necessary to mitigate hazards encountered in the course of work. Instead, it is left to the workers to determine what controls must be applied at the time of work. For example, many different chemicals are used in maintenance shops. The PHS for facilities mechanical maintenance activities states: *"If FMOC staff are asked to work in an environment in which concentrations of hazardous materials may exceed occupational exposure limits [OELs], exposure to hazardous materials may cause death or serious physical harm, or OELs have not been established nor toxicological information made available, exposure control methods are identified, including engineering and administrative controls and use of personal protective equipment, and communicated to staff via Technical Work Documents."* Many of these chemicals specify the use of gloves and local exhaust ventilation, and require the presence of eyewash stations and emergency showers. However, no local exhaust ventilation is provided in the shops where these chemicals are used, and the emergency eyewash stations and emergency showers were removed from the shops approximately four years ago. Workers have not reviewed the MSDS for these products and identified the need for additional controls, and there has been no baseline exposure assessment to determine worker exposure as required by DOE Order 440.1A. (See Finding #2.)

Controls identified in JSHEs are not always adequate to control the hazard as analyzed. For the solvent exhaust fan job discussed in Core Function #2, despite the uncertainty over the appropriate limits and concentrations of hazardous materials in the fan, the PPE recommended by the industrial hygienist was an air purifying respirator. The MSDSs for the chemicals, as well as the normally accepted practice for respiratory protection, require positive-pressure, supplied-air respirators when the quantities or concentrations of the hazards are uncertain or unknown. Although there was discussion about respiratory protection boundaries during the pre-job meeting, the industrial hygienist did not define where (how far from the work) the respiratory protection boundaries should be established. (See Finding #1.)

Some controls identified in site-level documents (e.g., the ES&H Manual and the Electrical Safety Manual) are not implemented in divisional operating procedures or job plans. For example, cleaning and inspection of standby inverters are conducted in proximity to energized electrical conductors and contacts, nominally at 48 volts and potentially in excess of 50 volts. According to the Electrical Safety Manual, this work requires trained workers, proper PPE, an energized work permit, and a second trained person or safety watch. No energized work permit or safety watch were used while conducting this work. The justification was that this work is considered to be “testing,” and the electrical safety subject matter expert signed off on the procedure. Another example is that known noise areas in the maintenance shops are not posted to require hearing protection. Noise surveys conducted over ten years ago indicate noise levels as high as 110 decibels when some machines are operating, requiring hearing protection (possibly double hearing protection). The shop supervisor stated that all workers knew about the hearing protection requirement, yet workers were observed operating the machines without hearing protection. (See Finding #1.)

Controls and requirements for hoisting and rigging equipment are not implemented in accordance with site and DOE requirements (see Appendix F under “Hoisting and Rigging”).

Controls for Toxic Substance Control Act requirements from ES&H Manual Chapter 10D are not implemented in maintenance procedures, leading to incorrect controls at the point of collection of PCB items. Chapter 10D establishes requirements, including a 30-day limit for storage of PCB items and the application of a specifically defined PCB label. Several maintenance procedures incorrectly apply Chapter 10D requirements. For example, in a maintenance shop, PCB wastes are being stored in plastic containers with the words “PCB non-leaking ballasts” or “PCB leaking ballasts” on the containers. Chapter 10D requires that containers must have the PCB label, that there must be absorbent material in containers holding leaking items, and that the item must be sent for disposal within 30 days. These requirements have not been met. When informed of these requirements, action was taken to label the containers properly and arrange for timely pickup to meet the 30-day requirement. (See Findings #1 and #3.)

Some controls for SAPs for hazardous waste are not adequate to ensure effective waste management, and in some cases, workers have not been adequately informed of proper controls. For example, standard industry practice is to protect secondary containments by placing them under cover to prevent the collection of rainwater and to establish the size of the secondary containers to hold the entire contents of a leaking primary container. The outdoor SAP used by Maintenance holds a small, deteriorated cardboard container of hazardous waste located above a large secondary containment for storing liquid drums, which contains about 25 gallons of rainwater. If the cardboard container failed, the large amount of collected rainwater in the secondary containment could become hazardous waste. As another example, SNL ES&H Manual Chapter 19A, which identifies RCRA controls, requires the SAP to be under the control of the waste generator. Although the SAP is inside a locked fence, keys are readily available, and a number of workers leave hazardous and non-hazardous waste there without the involvement of the Environmental Protection Representative who manages this SAP. At least partly because of this open access, a cabinet for flammable items was found to contain a mixture of hazardous and non-hazardous material with no clear segregation, making it possible to lose track of a container of hazardous waste among the many non-hazardous items. Finally, even though SNL requires waste to be controlled in an appropriate container, at another SAP only a plastic bag was being used to hold broken glass light bulbs while awaiting pickup for disposal. (See Finding #1.)

In 2003, OA reported that FMOC had not ensured that a systematic method was implemented to document the hazards and controls for day-to-day work activities. A wide range of hazards were considered skill-of-the-craft and were not fully identified, analyzed, or documented on preventive, corrective, and troubleshooting work orders. Job-specific hazards and controls were missed because a well-defined activity/task-level work control system was not in place. Weaknesses in this area had also been identified during the 1997 OA evaluation of safety management at SNL. In February 2005, SSO conducted an assessment of maintenance work planning and control that found that "there is substantial risk that an expert's mistake can result in hazards being missed, controls not being established, and workers being placed in unsafe conditions." Although there have been improvements in the use of JSHEs and PHSs, corrective actions for these previously identified weaknesses have been insufficient, and problems with activity-level hazards analysis for day-to-day work activities persist; controls for some hazards are either inadequate or missed by the workers. (See Finding #15.)

**Summary.** PHSs, JSHEs, operating procedures, the ES&H Manual, and other site documents identify most controls that need to be implemented to protect workers and the environment. In some cases, controls are inadequate or are not identified prior to conducting work. The primary means of implementing those controls is worker training and knowledge, which is typically unreliable for ensuring that all the necessary controls are implemented prior to conducting work. Consequently, in some cases, work is conducted without proper controls, increasing the risk of worker injuries or accidents. Implementation of controls at the activity level needs improvement to appropriately supplement worker training and experience.

**Core Function #4: Perform Work Within Controls**

Workers are generally knowledgeable of and comply with the standard industrial controls of safety glasses, safety shoes, hard hats, electrical safety PPE, lockout/tagout, fall protection, and confined space entries. Most skilled craftspeople (e.g., electricians, refrigeration mechanics, structural millwrights, and plumbers) hired by SNL have at least journeyman status, having completed an apprenticeship elsewhere. Before doing work, they complete a set of required training courses tailored to their job classification. They are required to review applicable operating procedures on an annual basis. These controls are also identified in PHSs, JSHEs, the ES&H Manual, and other site documents.

The SNL Formality of Operations Manual states that "All operations and tasks requiring procedures shall be performed in compliance with those procedures" and "If personnel feel that a procedure contains errors, they should immediately notify the appropriate manager to have the situation resolved." However, other than some generic guidance in the ES&H Manual, determination of when a procedure is required is left to the workers' and planners' judgment. Workers do not rely on procedures to supplement their individual expertise; some workers believed that use of procedures would indicate that they are not experienced enough to perform the job. Consequently, some steps in procedures related to worker safety may not be completed as required. For example, during two separate confined space entries, the craftsperson acting as the attendant was required to perform a calibration check of the oxygen monitor. The monitor is supplied with a laminated operator aid that defines the procedure for performing the checks. In both cases, the attendant did not refer to the procedure while conducting the calibration check, and some steps, such as verification of alarm set points and meter response to low oxygen, were not performed before placing the meter in service to check the space.

In some cases, workers did not stop work when procedures were identified as deficient or incorrect. Instead, they continued working and did not correct the procedure problems. For example, the procedure (job plan) used for preventive maintenance on the air handling unit in Building 890 is a generic air handling unit job plan and does not accurately reflect the actual work, nor does it reflect the actual sequence of work steps. The job plan specifies performing lockout/tagout prior to removing the filters, but workers replaced the filters before tagging out the fans. In addition, even though the fan is a direct-drive fan, the job plan contains steps for inspecting the belt. Workers have not provided feedback to the planners on inaccurate or incorrect job plans and have continued working, perpetuating a culture that discounts the value of procedures and relies on individual technical knowledge for most aspects of the work, including safety.

**Finding #4. SNL procedures are not used or referenced by FMOC workers to ensure that all identified controls are followed during the course of work.**

**Summary.** Workers are generally knowledgeable of and generally comply with the standard industrial controls of safety glasses, safety shoes, hard hats, electrical safety PPE, lockout/tagout, fall protection, and confined space entries. While there is a suite of procedures to cover most maintenance-related tasks, workers rarely refer to them while conducting maintenance activities. In some cases, SNL relies too heavily on skilled workers and training to identify and implement activity/task-level controls. Procedures are not used as a means of implementing controls or supplementing worker training and knowledge at SNL, and no other mechanisms have been implemented to ensure that workers comply with established requirements. As a result, some controls are not always followed during the course of work.

### C.2.5 Subcontractor Construction

Much construction is underway at SNL. About 1,400 subcontractor construction workers are engaged in the construction of office, laboratory, and storage facilities across the site. Most of this construction is performed under fixed-price contracts managed by the FMOC or line organizations. This OA inspection reviewed construction safety at three facilities that are part of the Microsystems and Engineering Sciences Applications (MESA) project, managed by the Science and Technology Capabilities line organization, and five facilities managed by FMOC. The line-managed facilities were MESA Microfab, MESA Microlab, and the MESA Weapons Integration Facility (WIF). The facility-managed projects included construction of new Buildings 702 and 755, construction of a Thermal Test Complex (TTC), construction of the Center for Integrated Nanotechnologies (CINT), and restoration of heating, ventilation, and air conditioning in Building 6588.

The OA team reviewed the work control documents, requirements, processes, and subcontracts. The OA team also observed construction activities to assess the effectiveness of these systems.

#### Core Function #1: Define the Scope of Work

Effective application of ISM to construction work requires that the scope of work specified in construction subcontracts be translated into tasks and that these tasks be defined in sufficient detail to support the subsequent identification of task-specific hazards and controls.

SNL has included appropriate requirements in construction subcontracts for implementation of the DOE ISM policy. A requirement to have a documented system for defining work is included. The line-managed subcontractors at MESA and some facility-managed subcontractors have established such systems. The systems in place require that work be described in job hazards analyses (JHAs) and that assigned tasks be defined in writing on a daily basis in pre-task safety plans and so-called toolbox safety meeting records. When properly implemented, these systems are consistent with the DOE ISM policy.

SNL has defined higher-hazard tasks (i.e., confined space entry, critical lifts, hot work, excavation, penetration, and energized work) that must be authorized by an SNL permit. In general, these tasks are clearly specified in subcontracts. As discussed in Appendix F under the hoisting and rigging section, the requirements for lift permits for critical lifts are not clear.

MESA has developed a documented plan for implementing the construction safety protocol and requirements. The intent of the MESA Construction Safety Program Plan is to provide a summary of the day-to-day references, forms, and procedures necessary to provide a minimum set of safety and health compliance requirements that will preclude or minimize risks to the involved workers, other workers and personnel at SNL, the public, and the environment.

Although some subcontractors (e.g., for TTC, CINT, and MESA) have adequate systems in place, they do not always use these systems effectively, and planned tasks are not always clearly defined. In some cases, tasks or steps to be performed are not described in sufficient detail to ensure that task-specific hazards and controls are addressed. This situation is particularly evident when toolbox and pre-task safety meetings are conducted for large groups of workers with diverse assignments. In these cases, tasks are often not described with enough specificity to assure that each worker understands the hazards and controls associated with the tasks to be performed.

The failure to define a hazardous task in work control documents may have contributed to a recent accident. A MESA subcontractor that had an established work control process hired a sub-tier subcontractor to set up an office trailer. The setup task was not described in work control documents as required by the process, and thus hazards were not fully evaluated and appropriate controls were not in place. During setup, a worker under the trailer narrowly escaped serious injury when the trailer fell from supporting jacks.

SNL has not assured that all subcontractors for facility-managed projects have adequate systems for defining work. Some subcontractors have not established mechanisms to define or document tasks, and tasks are not always defined with sufficient specificity to support identification of task-specific hazards and controls. For example, planning documents for construction of Buildings 702 and 755 do not define the specific work steps or tasks to be performed. Hazards and controls are identified in the contract-specific safety plan and job safety evaluation, but these hazards cannot be linked to tasks because the tasks are not defined.

**Finding #5. SNL has not assured that all construction tasks are defined in sufficient detail to support the subsequent identification of task-specific hazards and controls.**

**Summary.** SNL has included appropriate ISM requirements for defining work in construction subcontracts but has not provided sufficient guidance and direction to ensure fully effective implementation of these requirements. Some subcontractors have established appropriate systems for defining work, but others have not. In addition, where appropriate systems for defining work have been established, they have not always been effectively implemented, and work has not always been defined with sufficient specificity to support identification of task-specific hazards and controls.

**Core Function #2: Analyze the Hazards**

SNL and its construction subcontractors employ a number of mechanisms for identification and analysis of hazards. SNL performs job hazard evaluations (JHEs) to identify hazards associated with the construction site before construction begins and requires construction subcontractors to establish and implement systems for identification and analysis of construction-related hazards. SNL requires subcontractors for line-managed construction projects at MESA to conduct and document a JHA, perform task-specific hazards analysis for all planned work, and present the results of this analysis to workers through daily toolbox safety meetings and pre-task plans. MESA subcontractors have established formal processes to meet these requirements. Some subcontractors for facility-managed projects have also established formal processes for systematic identification and analysis of hazards, even though subcontracts for facility-managed projects require hazards analysis only for high-hazard activities (e.g., confined space entry). Other subcontractors for facility-managed projects rely primarily on supervisory oversight and the SNL permit process to ensure safety.

Jobsite hazards were adequately identified and analyzed in JHEs for the construction projects reviewed by the OA team. Industrial hygiene, safety engineering, radiological, and environmental hazards were identified and analyzed by appropriate subject matter experts. The construction program for demolition activities uses a review committee that includes SNL's waste management expertise to ensure that waste hazards are analyzed. Waste streams are identified and disposal options are determined before the project begins. Unexpected hazards identified during demolition are also analyzed by the committee to ensure that new controls are implemented when needed.

Worker involvement in hazard identification was good on all construction projects inspected. Subcontractor superintendents or foremen met daily with workers to discuss hazards associated with planned activities. Most contractors use a checklist or worksheet as a means of systematically reviewing hazards associated with daily tasks.

The more formal work control processes used at MESA and some facility-managed projects, if properly implemented, would be consistent with DOE ISM policy and should provide adequate identification and analysis of hazards. The process applied to other facility-managed projects (e.g., Buildings 702 and 755 subcontractors) is less systematic and more dependent on the safety expertise of foremen and superintendents for hazard identification and analysis and for informing workers of identified hazards.

However, in practice, neither process is fully effective. Some hazards were not properly identified or fully analyzed by either process. For example, several health hazards associated with both facility and line-managed construction projects were not adequately identified or analyzed. Documented exposure assessments were not performed as required by DOE Order 440.1A, Attachment 2, Section 18(d). Examples include:

- **Inhalation hazards at TTC associated with exposure of welders to welding fumes were evaluated, but the exposure assessment was not documented as required by DOE Order 440.1A.** The MSDS for the weld electrodes in use identifies hazardous ingredients in the electrodes and specifies the "Use of respirable fume respirator or air supplied respirator when welding in confined space." The inhalation hazards associated with use of these electrodes were not addressed in the JHA, the space on the toolbox safety meeting form for describing applicable MSDSs was blank, and hazards and controls identified on the MSDS for the welding electrodes were not addressed. An SNL industrial hygienist evaluated inhalation hazards associated with the job and determined that respirators were not required based upon ventilation that was to be provided. While this determination may have been appropriate, the exposure assessment was not documented as required by DOE Order 440.1A. The atmosphere inside the confined space where welding was being performed was not analyzed for the toxic ingredients listed on the MSDS to confirm the adequacy of the controls, and respirators were not worn.

- **Noise hazards have not been adequately evaluated at several construction sites.** Workers at several construction sites were not wearing hearing protection in areas where noise levels were high and potentially above exposure limits. The noise levels had not been measured, and most construction subcontractors did not have a noise monitoring instrument on site. In most cases, noise hazards were not identified in JHAs or daily briefings (e.g., pre-task safety plans or toolbox safety meetings).

- **Inhalation hazards at Building 755 associated with workers' exposure to dust from drywall joint compound were not fully evaluated.** A warning on the joint compound bag at a facility managed project site stated, "While mixing or dry sanding, wear a NIOSH/MSHA approved respirator." The MSDS for joint compounds states that workers should avoid breathing dust while handling this material and further states that "exposures to respirable crystalline silica are not expected during the normal use of this product; however, actual levels must be determined by workplace hygiene testing. The weight percentage of respirable crystalline silica has not been measured in this product." Workers using the compound said that they wore National Institute of Occupational Safety and Health (NIOSH)-approved N95 dust masks or half-face respirators when sanding. However, a company safety representative said that the respirators were worn only to control nuisance dust, and the company respiratory protection program had not been applied. Thus, required medical exams and fit tests had not been performed. The joint compound contains crystalline silica, which is a carcinogen. DOE Order 440.1A, Attachment 2, Section 18(d) requires a "Documented exposure assessment for chemical, physical, and biological agents and ergonomic stressors using recognized exposure assessment methodologies and use of accredited industrial hygiene laboratories." Worker exposures to inhalation hazards associated with mixing, sanding, routing, or otherwise causing this joint compound to become airborne have not been assessed. Similar conditions were observed at a line-managed project site, where exposures of drywall workers to joint compound dust had not been evaluated.

- **Hazards at MESA Microfab associated with the application of an epoxy coating to a wall in a line-managed construction project were not fully evaluated before the start of work.** A construction subcontractor did not identify volatile organic or particulate fumes as an inhalation hazard prior to the start of work. This hazard was not addressed in the JHA or the daily pre-task planning meeting for this task, and no exposure assessment was performed. The MSDS for the epoxy identified inhalation hazards and specified the use of respiratory protection both for volatile organic and particulate constituents of the product mixture. No respiratory protection was worn. When a subsequent JHA was developed and respiratory protection was selected, the selected respirators did not have appropriate particulate protection. Following OA's observation of this situation, filters were procured and used, and a subsequent SNL industrial hygiene review confirmed the adequacy of these filters for worker protection in the absence of a formal exposure assessment by the subcontractor.

- **Ergonomic hazards associated with use of powered soil tampers on line- and facility-managed projects were not assessed.** Workers were observed using gasoline-powered soil tampers that transmitted significant vibrations to their hands and arms. DOE Order 440.1A, Attachment 2, Section 18(d) requires a "Documented exposure assessment for chemical, physical, and biological agents and ergonomic stressors using recognized exposure assessment methodologies and use of accredited industrial hygiene laboratories." No exposure assessment had been performed to determine whether hand-arm vibrations were within the ACGIH TLV required by DOE Order 440.1A.

Theses deficiencies indicate that SNL has not ensured that construction subcontractors adequately assess exposures to chemicals, physical agents, or ergonomic stressors, as required by DOE Order 440.1A. (See Finding #2.)

Additional safety hazards were not identified or fully evaluated by work control processes at line- and facility-managed projects. For example, hazards associated with falling objects were not identified at several sites, and controls required by OSHA to protect individuals from these objects were not in place. In one case, a portable vacuum cleaner fell through a suspended ceiling and struck an individual working in the area below. Fire hazards associated with the use of propane heaters and storage of propane had not been fully evaluated. No hot work permit was obtained for the heaters, and no fire extinguishers were in the vicinity of the heaters. Lastly, an additional tank of propane was also stored inside one building; storage of propane within buildings is prohibited by OSHA regulations.

**Finding #6. SNL has not ensured that construction subcontractors establish and effectively implement systems for identification and analysis of safety hazards.**

**Summary.** SNL has established and implemented effective programs for identifying and analyzing site-related hazards and for identifying waste streams and disposal options before construction projects begin. However, processes for identification and analysis of health and safety hazards have not been fully effective. In some cases, formal and systematic processes have not been established, and in other cases established programs have not been effectively implemented. Most physical hazards have been adequately identified and analyzed, but identification and analysis of health hazards have been inadequate.

**Core Function #3: Identify and Implement Controls**

Hazard controls were specified in JHEs, contract-specific safety plans, and SNL permits for all construction projects reviewed by the OA team. In addition, for line-managed MESA projects and some facility-managed projects, controls are specified in JHAs and conveyed to workers through pre-task safety plans and toolbox safety meetings. Controls are documented on records of these meetings, which workers sign before the start of work each day. An SNL waste management program reduces the volume of construction waste through recycling.

Most of the above controls are adequate and have been effectively implemented. Aggressive recycling of materials, such as drywall, carpet, ceiling tiles, and scrap metal, has significantly reduced the volume of waste from decontamination and decommissioning and new construction projects. Controls specified in JHEs, contract-specific safety plans and SNL permits are generally adequate. Controls established in permits for access to confined spaces, performance of hot work, and excavations/penetrations are adequate in most cases. Additionally, fall protection systems for both facility- and line-managed construction projects meet OSHA requirements in most cases. Ladders were tied off when required, and scaffolds were properly designed and installed. Appropriate controls are also included in most JHAs but, as previously discussed, JHAs are not required for all projects.

The MESA project has been designated a “100 percent glove" project, over and above the traditional PPE requirements for construction (e.g., hard hats, orange reflective vests, safety glasses with fixed side shields, and safety toe footwear). Implementation of this 100 percent glove policy requires all individuals conducting hands-on work to be wearing gloves specifically suited to the task (e.g., Kevlar® glove liners under leather gloves when handling sharp materials, or appropriate snug-fitting protective gloves when conducting fine or detailed hands-on work). This additional PPE requirement has resulted in a decrease in hand injuries and reduced the severity of injuries that have occurred. It has also gained acceptance by the workforce as the construction contractors have embraced the requirement and made the appropriate glove type and fit available to workers.

Some worker safety requirements in DOE Order 440.1A have not been flowed down to construction subcontractors. SNL is required by its prime contract with DOE to ensure compliance with this order, regardless of who performs the work, and to flow the requirements down to the level necessary to ensure compliance. However, the order has not been included in construction subcontracts, and some of the requirements are not being met by construction subcontractors. As examples:

- Controls established in safety plans for facility-managed construction subcontractors limit workers' exposures to noise to 90 decibels adjusted (dBA) in an eight-hour period as required by 29 CFR 1926, instead of the more conservative ACGIH TLV of 85 dBA required by DOE Order 440.1A. The noise exposure permitted by OSHA is more than twice that permitted by the ACGIH TLV. The requirement to comply with this TLV has been flowed down to MESA subcontractors through reference to DOE Order 440.1A in their contracts but has not been flowed down to facility-managed subcontractors.

- DOE Order 440.1A, Attachment 2, Section 18(d) requires a "Documented exposure assessment for chemical, physical, and biological agents and ergonomic stressors using recognized exposure assessment methodologies and use of accredited industrial hygiene laboratories." This requirement has not been included in facility-managed subcontracts, and exposure assessments are not normally documented for construction work.

- The fire protection requirements in Section 15(c) of Attachment 2 to DOE Order 440.1A expand the fire watch requirements of National Fire Protection Association 51B, including responsibility for the safety of the welder(s) as well as the facility. Construction workers performing fire watch duties at MESA are not aware of this requirement.

**Finding #7. SNL has not ensured that ES&H requirements flow down to construction subcontractors to the extent necessary to ensure compliance as required by the prime contract.**

Preparation and review of some JHAs, pre-task safety plans, and toolbox safety meetings by construction subcontractors lack sufficient rigor to assure consistent quality of these documents, and some of these documents do not clearly identify required controls. Clear expectations for the required content of these documents have not been established. Records of many such meetings do not identify task-specific hazards or controls. JHAs and toolbox safety meetings are not formatted consistently, and some are not structured to provide clear correlation among activities, hazards, and controls. For example some pre-task safety plans include a requirement for workers' signatures indicating that they have read or been briefed on the pre-task safety plan; however, in one case at the line-managed MESA Microfab construction project, the workers had not completed this portion of the plan prior to conducting work activities. In other examples, information contained in JHAs was not included in toolbox safety meetings. In addition, some controls are not defined with enough specificity. For example, controls may be stated in vague terms, such as "use proper PPE"; such statements do not reflect thorough pre-job planning and are not adequate to ensure protection. Hazards and controls specified on MSDSs and JHEs are not normally included on JHAs. Toolbox safety meetings conducted for large groups of workers with diverse assignments and controls do not provide the degree of specificity needed to assure that each worker understands the controls associated with his/her assigned tasks.

Some controls are not addressed in daily briefings or work control documents in sufficient detail to ensure compliance**.** For example, fall protection requirements imposed for a MESA drywall subcontractor for work on staging systems were not included in the JHA or toolbox safety meeting record and were not met. Requirements in contract-specific safety plans for barricading excavations were not included in work control documents, and excavations were not properly barricaded. In addition, a lift plan for lifting a 9000-pound ventilation damper was not applicable to the lift, and the damper was dropped. (See Appendix F under "Hoisting and Rigging.")

**Finding #8. SNL has not ensured that hazard controls are adequately addressed in subcontractor work control documents and conveyed to the workforce.**

**Summary.** The waste management program for recycling construction waste is effective. Although appropriate hazard controls are in place for most construction work, a number of required controls have not been implemented for MESA-line-managed and facility-managed projects. SNL has not imposed some of the worker safety requirements from DOE Order 440.1A on its construction subcontractors, and subcontractor processes for specifying controls have not been rigorously implemented.

**Core Function #4: Perform Work Within Controls**

Construction equipment for both facility- and line-directed MESA projects is maintained in good condition. Cranes, power tools, scaffolds, fall protection equipment, and a drill rig were found to be in good condition, and the cranes and drill rig had been inspected by SNL prior to use by subcontractors.

A number of work evolutions that were observed by OA were performed safely in accordance with established controls at both line- and facility-managed job sites. Good practices included roof work at CINT, hot work at WIF, and excavation, trenching, and electrical work at several projects. Hard hats, safety glasses, safety vests, and gloves were consistently worn when required at both facility- and line-managed MESA construction project sites. With few exceptions, permits were used when required, including those for hot work, excavations/penetrations, and confined space entry. Compliance with fall protection requirements was generally good, with the exceptions noted below.

Requirements that were clearly stated in JHAs, pre-task safety plans, or permits were not always followed. For example, numerous requirements that were specified in a JHA for use of a powder actuated fastener gun at MESA Microlab were not followed. Examples included improper signage, improper barricades, failure to wear face shields, failure to wear hearing protection, and lack of an announced warning (such as "fire in the hole") at the time of tool actuation. In addition, the requirement for a dedicated spotter to restrict access was ineffective, and uninvolved workers and visitors were allowed to enter the work area unimpeded and unwarned. The toolbox safety meeting did not address the above controls. Additionally, hearing protection requirements were not followed by a MESA Microlab elevator subcontractor and other construction subcontractors at both facility- and MESA-line-managed construction sites. In each case, workers were observed to be operating high-noise generating equipment without hearing protection, even though requirements for hearing protection were called out in the JHA.

Proper use of ladders, working platforms, and scaffolding, including use of appropriate fall protection, is required by work control documents but was not met in some instances at both MESA Microlab and Microfab construction sites. A fire watch assigned on a MESA Microfab hot work permit was assisting in the hot work activity and not maintaining a vigilant watch. Additionally, the only readily accessible fire extinguisher in the work area was expended. MESA Microfab workers did not follow appropriate alarm response procedures at the Central Utilities Building. Some trenches and excavations were not properly barricaded. For example, trenches and excavations at the Building 758 construction site, which had been open for several days, were not barricaded as required by Division 1 Specification 1065. The construction sub-tier subcontractor had elected to apply administrative controls (i.e., continuous surveillance) instead of barricades. Such administrative control is not permitted by the specification, which is incorporated in the subcontractor's contract. In addition, a trench at MESA Microfab was not barricaded as required.

In a recent event, a water pipe was damaged by a MESA Microfab sub-tier subcontractor when requirements on an excavation permit were not followed. In this event, while digging a trench for construction of a security barrier wall, a construction subcontractor struck and crushed an eight-inch plastic stormwater drain line with a backhoe. SNL controls for excavation/penetration required an SNL permit (including line location) prior to excavation. The appropriate permit was in place, a line-location was conducted, and a green arrow (green typically represents a water line) was painted on the pavement immediately adjacent to where the individuals started to dig with the backhoe. The workers assumed incorrectly that since there was a partial wall and curb between the marking and where they were digging, they were clear of the utility. Additional missed information includes the fact that a water sprinkler head was clearly visible above ground where the digging was started, and it was evident that the backhoe had exposed the sprinkler line (without damage) before striking the stormwater line. A second missed data point was that the drawing that was reviewed prior to the excavation indicated the curb/wall and relative position of the pipe; this information was subsequently confirmed by the construction company's site superintendent. Thirdly, although the site excavation requirements require hand digging within five feet of a potential underground utility, no hand digging was conducted, and the center line of the buried strike was 30 to 40 inches from the marking on the pavement. Several SNL excavation events have been reported in the DOE Occurrence Reporting and Processing System. Recurring deficiencies in this area indicate a failure to effectively convey expectations for compliance with requirements, as well as deficiencies in feedback and improvement. (See Appendix D.)

As discussed under Core Functions #1, #2, and #3, a number of significant near misses have occurred during SNL construction activities/tasks that could have resulted in serious injuries. These near misses, in combination with the OA team's observations of non-compliance with procedures and safety requirements at construction sites, indicate significant performance problems in construction safety.

**Finding #9. SNL has not adequately ensured that its construction subcontractors comply with required controls.**

**Summary.** Many work requirements that are clearly defined in work control documents are not followed. Most examples of such non-compliance were observed on the job sites of line-managed projects where controls are better defined in work control documents and thus are more auditable. The number and nature of these observations indicate that expectations for compliance may not be clearly conveyed by subcontractor management and first-line supervision.

## C.3 CONCLUSIONS

SSO and SNL have established ISM systems that are conceptually sound but are implemented with varying levels of effectiveness by line management in the various line organizations. SNL personnel are typically very experienced, and many work activities are performed with a high regard for safety. In most respects, the primary facility hazards, such as hazards associated with operation of accelerators and large radiation sources, are well understood and effectively controlled. Similarly, generally adequate controls are in place for hazards that have received higher levels of visibility and management attention, such as beryllium. However, SSO and SNL have not sufficiently focused on other aspects of ISM, such as activity/task-level hazards analyses and some aspects of industrial hygiene, radiation protection, hoisting and rigging, and worker and subcontractor safety. Deficiencies in these areas were evident in a wide range of facilities and activities, including laboratory research, facility support, maintenance, construction, and waste management. SSO and SNL have made only limited progress in correcting a number of longstanding and systemic deficiencies identified by various internal and external assessments. Because of weaknesses in developing and verifying corrective actions, many findings have been closed before the effectiveness of the corrective actions was validated and verified.

Material science research and development activities within PETL are diverse and are typically conducted safely by an experienced research staff that is knowledgeable of the hazards. PETL has many design features that enhance safety and reduce exposures. However, in some cases the hazards and appropriate controls were not clearly defined in the limited work descriptions, particularly for research work conducted at the experiment or bench level. In some cases, ES&H hazards have not been adequately assessed by the appropriate ES&H subject matter experts to minimize exposures to hazardous materials and to ensure that the appropriate controls are implemented. Researchers do not always implement the appropriate controls as identified by the ES&H Manual, the manufacturer, or ES&H professionals, or document and/or justify their selection of hazard controls. Much research at the experiment or bench level is planned and performed as "skill of the researcher," without the use of activity-level TWDs. Although this approach may be acceptable for some low-risk, routine research activities, it is not adequate for research activities that may present a higher risk, or for researchers who are unfamiliar with the expected, but unwritten, hazards and controls (e.g., students).

SNL has implemented the ISM process for Z Machine work, but some longstanding and recurring implementation deficiencies have not been adequately corrected. Work is adequately defined, and most Z Machine hazards are adequately identified and analyzed. However, some activities are not adequately analyzed for chemical or noise exposure hazards, and radiological hazards analyses are not detailed or documented sufficiently to ensure appropriate controls. SNL has identified the appropriate hazard controls for most work activities, but several examples of inadequate implementation of controls indicate that increased management attention is needed to ensure appropriate worker protection. Most work is performed safely and in accordance with established controls. Increased management attention is needed to address deficiencies in implementation of readiness review requirements, and workers need to increase their diligence in meeting beryllium contamination control requirements.

The scope of work for GIF activities is generally well defined through a combination of mechanisms, including the facility PHS, GIF operating procedures, and individual experiment plans. Most hazards associated with GIF operations are also effectively identified and analyzed through these processes. Some higher-hazard activities receive additional hazards analysis through the TA-V RCSC. However, ozone hazards were not accurately identified in the PHS, and the effectiveness of engineering controls in mitigating this hazard inside irradiation cells was not fully determined before allowing personnel to re-enter cells after experiments. The design of the GIF facility incorporates numerous engineering controls that significantly enhance personnel safety and limit the nature and extent of hazards and controls needed during normal operations. The engineering controls are supplemented by administrative controls, such as operating procedures and RWPs, designed to ensure safe and consistent operation of the facility. However, SOPs do not specify sufficient controls for protection against ozone, and some radiological control requirements at GIF have not been implemented effectively. Work observed by OA at the GIF was performed safely and in accordance with established controls.

Although there have been some improvements in the use of JSHEs and PHSs for maintenance activities, deficiencies in activity-level hazards analysis and controls are a longstanding problem, identified on previous OA inspections and other reviews, that has not been adequately addressed. Implementation of the core functions of ISM has not been driven down to the activity level for maintenance activities. From a risk management standpoint, SNL has addressed some hazards (e.g., beryllium, radiation, confined spaces, elevated working surfaces), but SNL has not been as effective in addressing others (e.g., live electrical equipment, chemicals, hoisting and rigging). FMOC applies ISM principles only to very broad classes of workers and activities, attempting to create an “umbrella” under which all work can fit. This approach fosters a sense of security in workers, supervisors, and managers that all applicable hazards are being adequately identified, analyzed, and controlled. In reality, multiple hazards exist that have not been identified or analyzed and are not being fully controlled when work is performed. Although these hazards may not have immediate health effects, the potential for long-term illness exists. The heavy reliance on workers’ knowledge to control these hazards allows workers to unnecessarily expose themselves or others to increased risks. Worker training and skill-of-the-craft knowledge are not sufficient to ensure that all hazards present in shop areas are adequately identified, analyzed, and controlled while performing work. The number and nature of hazard control deficiencies identified during this OA inspection indicate that workers do not routinely review MSDSs and manufacturers’ usage recommendations and precautions, and are not sensitive to safety deficiencies and applicable requirements.

The work control system applied to SNL construction is largely expert-based. Safety relies on experienced and skilled superintendents, foremen, and safety professionals who have placed priority on safety. These individuals demonstrate good understanding of safety requirements and strong commitment to ensuring safety. Increased assurance can be gained by instituting more formal and systematic processes of work control, consistent with the DOE ISM policy. Formal, systematic work control processes have been established for MESA line-managed projects and some facility-managed projects, but expectations for documenting tasks, hazards, and controls are not clear. Hazards and controls are documented in a variety of different forms, such as JHEs, JHAs, MSDSs, contract-specific work plans, contract specifications, pre-task safety plans, and toolbox safety meeting records. This documentation is inconsistent and not always adequate. Expectations for consolidating hazards and controls into a single document for use by workers are not always met. In most cases, when requirements are documented or otherwise explicitly conveyed to workers (via postings, permits, etc.), they are followed. However, the number and nature of violations of clearly defined requirements indicates the need to clarify expectations for compliance and increased accountability. Inadequate evaluation of potential health hazards at SNL construction sites is a particular concern. Documented exposure assessments have not been performed as required by DOE Order 440.1A. Contributing causes to deficiencies in this area include inadequate consideration of hazards and controls in MSDSs, lack of industrial hygiene expertise among subcontractors, and limited participation of the SNL industrial hygienists in reviewing subcontractor work. The large number of construction activities increases the risk of a serious accident at the site. This risk and the number of deficiencies identified by this review indicate the need for more management attention to construction safety.

## C.4 RATINGS

| SNL ACTIVITY | CORE FUNCTION RATINGS | | | |
|---|---|---|---|---|
| | **Core Function #1 – Define the Scope of Work** | **Core Function #2 – Analyze the Hazards** | **Core Function #3 – Identify and Implement Controls** | **Core Function #4 – Perform Work Within Controls** |
| **PETL** | Needs Improvement | Needs Improvement | Needs Improvement | Effective Performance |
| **Z Machine** | Effective Performance | Needs Improvement | Needs Improvement | Effective Performance |
| **GIF** | Effective Performance | Effective Performance | Needs Improvement | Effective Performance |
| **Maintenance Activities** | Effective Performance | Needs Improvement | Needs Improvement | Needs Improvement |
| **Construction Activities** | Needs Improvement | Needs Improvement | Needs Improvement | Significant Weakness |

## C.5 OPPORTUNITIES FOR IMPROVEMENT

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

The following opportunities for improvement are structured to include institutional opportunities for improvement that should be considered by all of the SNL activities reviewed on this OA inspection (i.e., PETL, Z Machine, GIF, maintenance, and construction). Specific opportunities for improvement for each of these activities are also provided for consideration. In all cases, SNL should evaluate activities not reviewed during this inspection to determine the applicability of the opportunities for improvement to those activities.

**SNL (Institutional)**

1. **Develop and implement a research and development work control process that provides guidance for defining work, analyzing hazards, and defining and documenting hazard controls at the experiment or bench level.** Specific actions to consider include:

   - Establish expectations for implementing the ISM core functions at the research experiment level based on risk and a graded approach as described in the Sandia Integrated Safety Management System Description and ES&H Manual.

   - Establish risk criteria that can be used to determine when a TWD should be developed to define the work, identify the hazards, and document the controls.

- Identify typical or routine research activities on a laboratory basis, and document the typical hazards and controls expected in a TWD that would supplement the laboratory PHS.

- For higher-risk research activities, develop TWDs at the laboratory and/or experiment level.

- Establish thresholds for involving ES&H in the development, review, and/or approval of TWDs and research activities.

- Implement the aforementioned program on a prototype basis in the Center 1800 laboratories at PETL.

2. **Develop and implement an exposure assessment strategy that is based on recognized exposure assessment methodologies and meets the requirements of DOE Order 440.1A.** Specific actions to consider include:

   - Define the process by which SNL complies with the baseline hazards assessment requirements of DOE Order 440.1A, and integrate this process with the exposure assessment process.

   - Clarify the guidance and thresholds for performing and documenting an exposure assessment (e.g., health hazard rating, use of carcinogens, unexpected exposure of SNL workers to unknown levels of hazardous materials, employee complaints and follow-up).

   - Establish a mechanism whereby exposure assessments can be easily retrieved and referenced in work documents (e.g., PHSs or JSAs).

   - Ensure that sampling and monitoring data, when performed to support an exposure assessment, can be correlated to the exposure assessments and easily retrieved.

   - Develop requirements for communicating the results of an exposure assessment to line managers and a feedback mechanism to verify that recommendations from exposure assessments are adequately incorporated into work documents and appropriately dispositioned.

3. **Consider segregating regulated and non-regulated waste at the point of generation and increase management attention to compliance with SNL controls for waste management to ensure compliance with SNL and external requirements.** Specific actions to consider include:

   - Implement segregation at the point of generation by providing containers marked specifically for hazardous, non-regulated, and sanitary waste streams, and increasing the training for generators on proper waste segregation.

   - Consider revising the PHS question set for waste management to require that appropriate subject matter expertise be used to confirm a path for disposal and provide guidance for waste management before a new waste is generated.

   - Ensure that controls for meeting ES&H Manual requirements for PCBs are implemented and followed.

   - Ensure that controls for operating SAPs are implemented and followed, including requirements for direct generator control and spill prevention.

**PETL**

1. **Establish requirements for conducting work activity/task-level hazard communication training to ensure that the research personnel (including visiting researchers and students) are aware of the hazards and controls associated with a research experiment.** Specific actions to consider include:

   - Establish a mechanism for reviewing the work activity/task-level chemical training requirements when researchers change assignments or laboratories, or when new chemicals and/or equipment are introduced into the laboratory.

   - Involve the appropriate ES&H subject matter experts in the development and conduct of the training.

**Z Machine**

1. **Establish mechanisms to characterize and document key radiological hazards posed by Z Machine operations in order to establish an appropriate technical basis for radiological controls, and ensure compliance with institutional and regulatory requirements.** Specific actions to consider include:

   - Revise the PHS or establish an alternative mechanism for documenting radiological hazards associated with the various shot types at Z Machine. Information should include, at minimum, locations and the nature of potential activation products, contamination potential, x-ray energy spectrum, and related information.

   - Using the results of the hazards analysis, develop a technical basis for instrumentation and radiological monitoring equipment, including survey instruments and dosimeters. Correct any deficiencies and/or establish justification for any anomalies.

   - Using the results of the hazards analysis, develop a technical basis for radiological controls, including survey requirements, release and/or reuse of components, labeling, and air sampling.

   - Review Z Machine radiological controls against the ES&H Manual and RPPM requirements for activated materials to ensure compliance, and revise as necessary.

   - Revise the RPPM to provide additional detail on activated materials, including definition, characterization, and necessary radiological controls.

   - Consider preparing a radiological control document for Z Machine that cross-references and outlines how relevant ES&H Manual and RPPM requirements are implemented at Z Machine. Such a document could be used to identify potential gaps and areas requiring additional detail.

2. **Increase emphasis on developing RWPs that are tailored to the work being performed and are specific enough to determine the relevant radiological controls for specific work evolutions.** Specific actions to consider include:

   - Review RWPs against the requirements of RPO 06-605 and address any discrepancies with staff responsible for writing RWPs, including additional training if necessary.

- Ensure that controls contained within RWPs are clearly specified and do not rely on the subjective interpretation of the RCT.

- Ensure that the expected radiological conditions associated with work covered by each RWP include dose rates, contamination levels, and activation issues.

- Ensure that radiological monitoring and survey requirements and hold points are clearly specified in the RWP for each activity where health physics action is necessary and where records should be generated to demonstrate compliance with institutional and regulatory requirements.

3. **Increase line management attention to determining causal factors and correcting deficiencies related to industrial hygiene and safety concerns, including exposure assessments, beryllium contamination control, confined space entry, and fall protection.** Specific actions to consider include:

   - Determine root causes for failures to identify and correct previously identified issues related to confined space permit program requirements, fall protection, and exposure assessments.

   - Conduct additional training for supervisors who authorize entry regarding their responsibilities for confined space permit preparation. Include a review of identified permit deficiencies.

   - Modify the confined space permit form to include a requirement for retrieval gear unless a formal review of the operations has been conducted by Industrial Hygiene and specific justification for the lack of retrieval gear is documented as part of the form.

   - Modify work planning documentation to ensure that open penetrations over Z center section lids are either covered or guarded or that personal fall arrest systems are used when working in the vicinity of unguarded penetrations.

   - Provide specialized training to Z Machine personnel addressing fall hazard recognition and beryllium contamination control techniques, emphasizing that beryllium areas should be considered and treated as rigorously as "contamination areas" for radiological control.

4. **Increase line management attention to and involvement in identification and mitigation of activity-level hazards.** Specific actions to consider include:

   - Incorporate IHIR and other safety professional recommendations into existing tracking systems at Z Machine. Ensure that all recommendations are incorporated, renegotiated with the initiating safety professional, or adequately justified and documented when recommendations are rejected.

   - Ensure that previous IHIRs are reviewed and addressed as appropriate.

   - Review and revise the Z Machine PHS to ensure that all hazard types are identified (including skill-of-the-craft hazards) and that all potential hazards are addressed for each hazard type. Include exposure assessments where appropriate to ensure that all hazards are adequately analyzed.

**GIF**

1. **Revise work control process descriptions to better define when facility work requests may be used to supplement existing operating procedures or in place of developing new operating procedures.** Specific actions to consider include:

    - Revise the outdated 6431/6433 Work Control Instruction to reflect the current organization and practices, including the use of this process for operations-related work.

    - Revise GIF SOP 001 to reflect those conditions and criteria where facility work requests may be used and when new operating procedures must be developed, noting that operating procedures receive additional scrutiny and must be formally reviewed and approved by RCSC.

2. **Strengthen activity-level hazards analysis and controls to verify the continued effectiveness of engineering controls.** Specific actions to consider include:

    - Implement a formal mechanism to track Industrial Hygiene recommendations to ensure that they are properly implemented, and incorporate the results of sampling/monitoring into operating procedures as necessary (e.g., clearance time for ozone prior to re-entering cells).

    - Implement periodic radiation surveys on a predefined frequency to verify prior measurements and the integrity of engineering controls, and to ensure compliance with institutional radiological monitoring requirements.

    - Review the discrepancy between the GIF SAR Chapter 5 derivation of TSR controls related to periodic dose rate measurements and the current TSRs, which do not require periodic dose rate measurements. Correct as necessary, including whether such conditions require any action under nuclear safety requirements, the potentially inadequate safety analysis process, the unreviewed safety question process, etc.

3. **Increase emphasis on developing RWPs with a more manageable span of control tailored to the work being performed and with sufficient specificity to determine the appropriate radiological controls for intended work evolutions.** Specific actions to consider include:

    - Subdivide the existing GIF RWP 2375 into several RWPs, with focused work scopes and similar radiological control requirements. For example, in-pool source handling, which requires continuous RCT coverage, should not be mixed with an activity that does not require RCT coverage, such as in-cell source irradiation.

    - Ensure that RWP work descriptions adequately address only those activities to which the RWP applies and that activities covered by the RWP are grouped to reflect similar radiological hazards and controls.

    - Ensure that radiological monitoring and survey requirements and hold points are clearly specified for each activity where health physics action is necessary and where records should be generated to demonstrate compliance with institutional and regulatory requirements.

    - Review all SOPs that may be used in conjunction with RWPs to ensure consistency of controls.

- Review a sampling of RWPs against the requirements of RPO 06-605 and address any discrepancies with the staff responsible for writing RWPs, including additional training if necessary.

**Maintenance**

1. **Implement a pre-task hazards analysis checklist for use by workers at the beginning of a new task or shift, as appropriate.** Specific actions to consider include:

    - Include checks to remind workers to look for all hazards associated with the task, including standard industrial hazards.
    - Use the form to encourage workers to review the applicable PHS or TWDs before conducting the work.
    - Use the form to encourage workers to specify exactly those controls they intend to use and associate those controls with the specific hazards identified.
    - Include triggers to request Industrial Hygiene review of hazards (e.g., if workers are intending to use respiratory protection).
    - Use the form to encourage workers to ask questions about hazards, such as chemicals used during the maintenance activity.
    - Include reminders to review the MSDS or label precautions, and verify that those precautions are adhered to during the course of the work.
    - Maintain a supervisory file of the checklists for 30 days, and require supervisory review of the checklists to ensure that they do not become "boilerplate."
    - Provide incentives for workers to use the checklists to identify previously missed hazards or controls.

2. **Review job plans and work instructions before issuance to craft workers to ensure that the job plans accurately define the work to be performed.** Specific actions to consider include:

    - Encourage workers to stop, make corrections to job plans (pen and ink changes), and receive supervisory approval before continuing work (e.g., radio or telephone contact).
    - Ensure that changes made by craft workers to job plans are incorporated into the job plans stored in Maximo.
    - Include appropriate precautions and warnings in job plans at the appropriate steps. Minimize the need for workers to refer to other procedures or manuals to interpret controls.

3. **Conduct more frequent supervisory reviews of maintenance work.** Specific actions to consider include:

    - Raise the supervisory threshold for acceptance of work practices to encourage a more questioning attitude towards safety in the workplace.

- Reward workers for identifying and correcting poor safety practices in the field and shops.

**Construction**

1. **Increase efforts to ensure that workers are aware of identified hazards.** Specific actions to consider include:

   - Require use of a formal and systematic process, such as toolbox safety meetings or pre-task safety plan briefings, for all construction work to inform workers of anticipated hazards. Incorporate discussion of JHA, JHE, and MSDS hazards and controls relevant to work to be conducted.

   - Establish clear expectations regarding the content of these briefings. Consider using a checklist or similar tool to ensure that briefings meet expectations.

   - Consider describing hazards and controls in a single document to facilitate review of this information by workers and foremen.

   - Attach documentation to worker briefings for reference, such as the industrial hygiene exposure assessment, hot work or excavation/penetration permits, or other such documents.

2. **Increase the rigor of evaluation and implementation of hearing protection requirements and monitoring of noise levels to ensure that representative sampling is conducted for construction jobs that involve power tools and/or equipment that can generate noise levels above 85 dBA.** Specific actions to consider include:

   - Evaluate the noise from power tools, generators, and other heavy equipment to determine whether monitoring data is available to ensure that appropriate controls have been established and whether other hearing conservation program requirements are warranted.

   - Provide additional guidance to subcontractors concerning implementation of noise monitoring or personal dosimeter sampling in order to obtain accurate assessments of workers' exposure potential.

   - Consider use of personal noise dosimetry to supplement direct measurements of sound levels.

3. **Establish requirements for JHAs where none exist, and improve the quality of current documented JHAs.** Specific actions to consider include:

   - Incorporate JHA requirements for subcontractors in Sandia Contract Specification 01065, similar to that required by MESA contracts.

   - Encourage construction inspectors to review implementation of current JHAs to ensure that requirements and expectations outlined in the 01065-S specifications are sufficiently applied at the working level.

   - Require that prime construction subcontractors develop JHA guidance documents for their sub-tier subcontractors to address the specific format and the information to be included in JHAs, and provide additional guidance to ensure that Sandia expectations are met.

- Establish formal guidance for review and approval of JHAs by the construction prime subcontractor or SNL subject matter experts.

- Include in JHAs the hazards and controls specified in MSDSs.

4. **Convey expectations for strict compliance with ES&H requirements to construction subcontractors.** Specific actions to consider include:

- Continue efforts to implement a behavior-based safety program.

- Provide feedback to subcontractors, during periodic meetings with senior management, on the extent to which safety performance has met SNL expectations.

- Increase the focus on compliance with safety requirements by subcontractors during safety inspections.

- Consider more frequent use of the deficiency notice process.

5. **Establish requirements for prime construction subcontractors to approve and/or augment sub-tier subcontractor work planning documentation (JHAs, toolbox safety meetings, or pre-task safety plans) to ensure that sufficient hazards analysis has been conducted and that requisite controls have been applied.** Specific actions to consider include:

- Consider developing a safe work permit process (i.e., similar to hot work or excavation/penetration) for approval by the prime contractor or SNL, to augment subcontractor JHAs or other work planning documents.

- Require review and approval of sub-tier subcontractor JHAs by prime subcontractors or SNL before initiating work.

6. **Formalize requirements for subject matter expert involvement in hazards and exposure assessment for activities where subcontractors do not demonstrate sufficient knowledge of DOE standards or where DOE imposes expectations that are more stringent than general industry.** Specific actions to consider include:

- Establish a set of subcontractor activities or tasks that should be reviewed by the prime construction contractor or SNL subject matter experts (if the subcontractor has none) on a routine basis (e.g., beryllium, hoisting and rigging, radiological, and chemicals with ACGIH TLVs), and require that these activities be reviewed by an SNL subject matter expert.

- Document required follow-up actions from Sandia construction safety engineers, construction quality engineers, and Sandia designated representatives or subject matter expert reviews, and provide administrative controls, such as hold points in JHAs or pre-task safety plans, to ensure future compliance.

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# APPENDIX D

# Feedback and Continuous Improvement (Core Function 5)

## D.1 INTRODUCTION

The U.S. Department of Energy (DOE) Office of Independent Oversight and Performance Assurance (OA) evaluation of feedback and improvement processes at Sandia National Laboratories (SNL) included an examination of the DOE Sandia Site Office (SSO) and contractor environment, safety, and health (ES&H) programs and performance. The OA team examined National Nuclear Security Administration (NNSA) and SSO line management oversight of SNL integrated safety management (ISM) processes and implementation, including the interface with the DOE Office of Nuclear Energy, Science, and Technology (NE), which has programmatic responsibility for the Annular Core Research Reactor (ACRR). The OA team also reviewed SNL institutional processes, such as assessments and inspections, corrective action/issues management, injury and illness investigation and reporting, lessons learned, the employee concerns program (ECP), and activity-specific processes, such as post-job reviews.

## D.2 RESULTS

### D.2.1 DOE Line Management Oversight

**NNSA and NE Headquarters**

NNSA Headquarters has recently issued its revised Functions, Responsibilities, and Authorities Manual (FRAM), dated February 2005, to update and delineate NNSA expectations for organizational accountability for safety management. As such, the NNSA Principal Deputy Administrator (NA-2) and Deputy Administrator for Defense Programs (NA-10) have been assigned the authority for the programmatic and ES&H line oversight aspects of safety management for SNL. NA-10 has been assigned authority for all nuclear safety, nuclear explosive safety, and ES&H matters and is the lead program secretarial officer for SNL. SSO has been delegated the authority for day-to-day execution of the safety management program for SNL, including approval of safety basis documents, technical safety requirements (TSRs), and preparation of safety evaluation reports for Hazard Category 2 and below nuclear facilities and accelerators, with the exception of ACRR, the old Gamma Irradiation Facility, and the Hot Cell Facility within Technical Area (TA)-V. Authority for approval of safety basis documents for these nuclear facilities, including approval of TSRs and changes to the facility involving changes to TSRs or an unreviewed safety question, and approval of facility restarts resides with NE.

Currently, documentation for nuclear safety authorities and functions for NE-managed nuclear facilities at SNL (i.e., ACRR) is defined in a dated management agreement between NE and the Office of Defense Programs (dated June 1997), which was signed before NNSA was established. An addendum to the management agreement (dated October 2003) was signed to delineate the terms and conditions under which ACRR at SNL will be operated by NE for research activities and by DOE Office of Defense Programs (DP) for irradiation services for component testing activities. This addendum reaffirms NE nuclear safety oversight responsibilities as outlined in the 1997 management agreement. The management agreement also specifies that NE and DP will review the management agreement on a biennial basis to identify and implement any needed changes. Given the recent issuance of the NNSA Headquarters FRAM to reflect NNSA organizational changes and nuclear safety responsibilities, specifically those involving the Central Technical Authority and Chief of Defense Nuclear Safety, review of the existing management agreement between NE and NNSA/DP appears warranted. In addition, the current NE FRAM has not been maintained up-to-date and is not fully reflective of current organization.

NNSA has neither adequately assigned roles, responsibilities, and authorities nor established clear expectations for management of the DOE ECP. The NNSA FRAM and SSO FRAM include DOE 442.1A in the list of references but do not clearly delineate who (e.g., site manager or NNSA Service Center) has overall lead responsibilities for ensuring DOE Order 442.1A implementation. Furthermore, the NNSA matrix of functions and activities by location, which defines where work is to be performed and which NNSA organization (e.g., Headquarters, site office, NNSA Service Center) has the primary organizational responsibility for implementation of various functions, does not address the ECP.

SSO and the NNSA Service Center have not placed sufficient priority and attention on maintaining the ECP and providing oversight of the contractor's program, as required by DOE Order 442.1A. Similar concerns were identified at other recently inspected NNSA site offices, including Pantex, Livermore, and Kansas City Plant. Lack of clearly assigned functions for lead responsibility for ECP implementation has been identified as a contributing cause to performance deficiencies identified in SSO and in all other NNSA site office ECPs reviewed.

**Finding #10. NNSA has not clearly defined and assigned functions and activities for implementation of the employee concerns program, as required by DOE Manual 411.1.**

**Sandia Site Office**

**Roles, Responsibilities, and Authorities.** The SSO FRAM, dated January 2004, and the SSO Quality Assurance Program Manual adequately define SSO responsibilities and reflect the requirements of the DOE and NNSA FRAMs. However, the SSO FRAM does not reflect and/or incorporate the flowdown of NE roles, responsibilities, and authorities for nuclear safety oversight for NE-managed facilities (e.g., ACRR, old Gamma Irradiation Facility, and the Hot Cell Facility) at SNL TA-V.

**Finding #11. SSO has not formally defined and documented nuclear safety oversight authorities and functions for NE-managed nuclear facilities at SNL, as required by DOE Manual 411.1.**

SSO is in the process of developing a comprehensive set of site office procedures to fully implement all assigned site office functions and responsibilities. The new SSO procedures that were reviewed provide adequate guidance on assigned roles, responsibilities, and authorities. SSO personnel interviewed demonstrated an adequate understanding of their assigned roles, responsibilities, and authorities. However, significant work remains to complete the development of a comprehensive set of procedures.

**ES&H Assessments and Facility Representative Program.** SSO has made progress in formalizing its ES&H assessment program. SSO has developed a procedure, *ES&H Assessments*, which defines roles and responsibilities and management expectations for implementation. Annual schedules have been developed for and include SME functional area assessment, typically on a three-year cycle. Assessment schedules are also being tracked and maintained by SSO team leaders. Assessment schedules cover key institutional feedback programs for review, such as self-assessment, issues management, and lessons-learned programs.

Subject matter experts (SMEs) are coordinating with Facility Representatives (FRs) on the scope of reviews, and most assessments scopes include observations of work activities to evaluate performance. SMEs in coordination with FRs, help to develop guidance cards to improve the rigor and depth of operational awareness activities in various functional areas. For example, guidance cards were developed to help FRs perform more effective oversight of SNL-regulated and hazardous waste operations. SMEs are also required to develop formal assessment plans and/or guidance cards for the conduct of assessments, coordinate the assessment plan and lines of inquiry with applicable FRs, and have their assessment plans formally reviewed/approved by their respective SSO team leader. Assessment plans are also required to address planned observations of work.

SSO has conducted a variety of ES&H assessments of contractor performance. Some assessments provided an effective evaluation of programs and performance. For example, assessments of work planning and control, feedback and improvement processes, waste management activities, pollution prevention activities, industrial hygiene, and occupational safety areas were generally comprehensive and were conducted against defined criteria. Most of these assessments were conducted with sufficient rigor and identified contractor performance deficiencies that were consistent with some of the results of areas reviewed during this OA inspection.

Several mechanisms are being employed to formally communicate FR activities to SSO and SNL management. All FRs develop and issue weekly reports to the SSO manager. The reports for TA-V are also sent to NE. Weekly reports are adequately implemented and provide a summary of evaluative observations by FR staff on Occurrence Reporting and Processing System (ORPS) and corrective actions, as well as commitments/activities and the focus of FR activities. Observations reports developed by FRs at TA-V are an effective mechanism for communicating detailed FR reviews of significant SNL nuclear activities. Some FRs (i.e., FRs who cover only non-nuclear facilities) also develop quarterly reports, which are sent to both SSO and SNL management.

SSO reports of FR performance indicator information (e.g., field time) are developed consistent with the guidelines set forth in DOE-STD-1063-2000, *Facility Representative.* FR performance indicator information is tracked weekly, reported weekly, and is based on adequate records.

FRs develop annual surveillance and/or master activity plans that describe assessment areas and facilities to be assessed. In most cases, surveillance plans are being developed with input from SMEs to better coordinate SSO resources. Coordination of TA-V oversight activities (responsibility of the Assistant Manager for Nuclear Facilities and Safety Basis) with SMEs oversight activities (responsibility of the Assistant Manager for Oversight and Assessment) is a recognized area for improvement. Review of FR documentation mechanisms (Kirtland Issues Management System [KIMS] database and weekly reports) indicates most planned FR activities are being accomplished as planned.

SSO has completed an updated FR staffing analysis and developed a formal continuing training program in accordance with NNSA guidance and direction. Under the recent workforce analysis, the FR staffing level remained the same current level of eight; however, as discussed below, OA has continuing concerns related to current level of FR staffing and overall continuity and leadership of the program. SSO has also recently issued a procedure, "Facility Representative Continuing Training Program," to establish requirements for continuing training of FRs.

Assessment of the implementation of the FR program is being performed within the required triennial periodicity delineated in DOE-STD-1063-2000. The most recent program assessment was conducted in December 2002. The assessment followed the guidance and direction within the standard and used independent reviewers from the NNSA Service Center. The assessment also followed up on previous program concerns. The December 2002 assessment indicated that many of the corrective actions for the previous October 2000 program findings have not been completed or effective. The focus of the assessment was primarily on compliance with established processes rather than the effectiveness of the

FR program in accomplishing its mission of identifying concerns and driving improvements in contractor performance.

Overall, FR and SME staffing and utilization have not yet been sufficient to fully provide effective line management oversight of SNL activities. SSO has made progress in recruitment of outside technical expertise to strengthen ES&H oversight of the contractor; however, most of these gains occurred recently and the full benefits of new staff have yet to be realized. A number of individuals, particularly safety system oversight engineers and FRs, are still devoting a significant amount of their time to training and qualification commitments. Most SME new hires are in the process of "baselining" their assigned functional areas to determine overall contractor program strengths and weaknesses. Thereafter, they will focus on developing a tailored oversight plan of the contractor in areas requiring increased attention.

Although SSO has a comprehensive set of FR program documentation and procedures, the set is outdated (1997) and not fully reflective of current SSO organization and site processes. While significant efforts were initiated in 2003 to update FR program manual procedures, these efforts were not completed because of resource and priority decisions.

While FRs and SMEs continued to strengthen the coordination of ES&H assessment and operational awareness activities, the FR program has not yet reached the required level of maturity and stability. FR continuity and staffing remains a continuing concern due to turnover; recent attrition within the FR ranks included the loss of the FR team leader. As a result, most of the remaining FR team members have significant training and qualification commitments coming due this year, including four in Phase II qualification and two in re-qualification in addition to their normal day-to-day operational awareness duties. FRs assigned to non-nuclear facilities and construction activities indicated that they devote a large fraction of their oversight time reacting to events/occurrences. In addition, the scope and rigor of FR assessments is questionable based on a review of the last 12 months of FR activities. FRs identified only one level two finding (as defined in quarterly reports and the KIMS manual) in the past 12 months that required the laboratory to develop a corrective action plan. SSO management is placing high priority on filling the vacant FR positions and having FRs complete qualification commitments this year.

SSO assessments have not yet fully matured and thus need to be further enhanced to include more rigor and depth, and more focus on the effectiveness of the contractor's self-assessment processes. In some cases, SSO oversight and assessments of Z Machine operations lacked sufficient depth, rigor, and actual work observations to fully characterize SNL program implementation deficiencies in the areas of exposure assessments, beryllium controls, radiological controls, and confined space permitting that were identified during this inspection. In addition, until recently, most SSO assessment reports reviewed had minimal performance-based information and contained little information about the adequacy of SNL self-assessment program implementation for the area being assessed. In most cases, assessment scope and guidance cards did not include elements for evaluating the SNL self-assessments. Lack of an effective SNL self-assessment program has been identified as a long-standing weakness by OA during the 1997 Independent Oversight evaluation of safety management at SNL.

However, SSO has recently made progress in improving their ES&H assessment program. SSO also has a new senior management team and has hired new staff with needed expertise and experience. Recognizing that SSO oversight has significant weaknesses, the new management is taking a number of appropriate steps to develop and implement an effective oversight program, including placing emphasis in developing good site office procedures and using the performance-based information effectively. SSO has made progress in formalizing its ES&H assessment program and in scheduling and conducting assessments. SSO's recent ES&H assessments of contractor performance provided an effective evaluation of programs and performance in such areas as work planning and control, and feedback and improvement. Most of these assessments were conducted with sufficient rigor and identified contractor performance deficiencies that were consistent with some of the results of areas reviewed during this OA inspection. Although much work remains, the initial efforts show potential and are appropriate to address the longstanding weaknesses in the SSO line oversight program.

**Project Safety Management Oversight.** The SSO Assistant Manager for Facilities and Project Management has established adequate policies and a procedure (i.e., "Project Safety Procedure") to define roles, responsibilities, authorities, and interfaces within SSO for safety oversight of construction projects. The procedure requires the Federal project director to meet with SNL construction safety management to validate that the construction manager has established a baseline project-specific construction safety program and will periodically conduct field visits to verify contractor safety program effectiveness. Discussions with Federal project directors assigned to projects within the scope of the OA inspection indicate they are knowledgeable of the safety issues and overall status of their projects, and periodically conduct weekly meetings with their construction project counterparts, which typically include a walkthrough of the construction site.

However, Federal project directors expressed a need for more training in assessing construction safety program oversight, and do not have guidance cards or checklists to help them assess construction site safety conditions. In addition, not all Federal project directors are using the KIMS database for capturing walkthrough results.

**Self-Assessment.** SSO has made progress towards developing and implementing a self-assessment program that meets the DOE/NNSA assessment requirements, including DOE Order 414.1B and NNSA Policy Letter, NNSA Site Office Self-Assessment Programs. SSO has developed a procedure, "Self-Assessment for Federal Operations," which clearly defines the process, roles, and responsibilities for program implementation. A self-assessment schedule was established for fiscal year (FY) 2004, and self-assessments have been conducted.

One of the SSO self-assessments focused on its SSO ES&H assessment process. It included an evaluation of selected corrective actions from the OA 2003 inspection of SSO ES&H programs and identified two findings and two observations for corrective action. SSO also conducted a self-assessment of the safety basis review and approval processes and identified a number of observations and recommendations for improvement, many of which were subsequently confirmed by an independent review team from NNSA Headquarters.

However, the SSO performance assessment coordinator has not performed all assigned functions, such as pulling together the FY 2005 self-assessment schedule; collecting and centralized filing of all self-assessments conducted; ensuring that deficiencies are entered into the SSO issues management system; and providing quarterly reports to SSO senior management on the status of compliance with self-assessment schedules and corrective action resolution. In addition, assessments could be strengthened by ensuring that the focus of the self-assessment evaluates the overall effectiveness of the management system or process being evaluated, rather than just compliance with procedures.

**Federal Employee Occupational Safety and Health (FEOSH).** SSO recently issued a procedure, "Federal Employee Occupational Safety and Health for the Sandia Site," to establish a written worker protection program for SSO employees. Annual FEOSH assessments of Federal workplaces are identified as an ES&H functional area review requirement. However, the most recent documented FEOSH review for SSO occurred in July through September 2003.

**Technical Qualification Program (TQP).** SSO is effectively managing the TQP. SSO relies on NNSA Service Center for tracking of SSO employee TQP status. The Assistant Manager for Oversight and Assessment has been assigned lead responsibilities for TQP implementation and has been actively tracking and ensuring employee progress towards TQP milestone requirements. In addition, the status of

TQP for SSO staff is reviewed by SSO manager on a monthly basis. Most SSO employees are making good progress in maintaining TQP qualification status, and all appropriate SSO technical personnel are enrolled and participating in the TQP program.

**Issues Management and Corrective Action.** Although work remains, SSO has recently taking some steps to address weaknesses in issues management and corrective action processes from the last OA inspection. SSO has developed a site office policy for an issues management process that addresses NNSA Headquarters policy on issues management and SSO management expectations, and SSO recently issued a procedure for issues management. SSO is working with SNL to develop a shared system to capture and track issues/corrective actions. Access and use of the SNL corrective action tracking system (CATS) for SSO is tentatively scheduled for April 2005. As an interim compensatory measure, SSO has established an internal issues management database, which is in the process of being populated with the more significant actions/commitments.

While SSO oversight processes have improved in identification and communication of ES&H issues of contractor performance through more effective use of contractual mechanisms (see discussion below), deficiencies in the management of safety issues are resulting in insufficient corrective and preventive actions to address some weaknesses. Verification of closure of corrective actions to some findings from the 2003 OA inspection (e.g., self-assessment, work planning and control, worker exposure assessment, unreviewed safety question [USQ] determinations) has not been sufficiently rigorous to prevent recurrence or drive continuous improvements of the contractor.

In some instances, prior OA 2003 inspection issues, such as in the areas of self-assessment, USQ program deficiencies, and work planning and control, have been closed primarily based on completion of the specific actions rather than on an overall evaluation that the actions effectively addressed the performance issue. As a result, similar weaknesses were identified in the same areas during this OA inspection. In addition, effectiveness reviews of implementation of corrective actions are not always being required of the contractor, and/or formal root cause analyses are not always being required of the contractor when repetitive performance concerns are identified. Weaknesses with SSO's adequacy of closure and verification of effectiveness of SNL corrective actions were identified by OA during a concurrent OA inspection of emergency management at SNL (see OA report, *Inspection of Emergency Management at the Sandia Site Office and Sandia National Laboratories – New Mexico*, Volume III, May 2005).

Although some progress is being made, longstanding weaknesses in issues and corrective action management still exist. Corrective actions and commitments are still being tracked in a variety of databases among the various assistant managers, thus preventing easy trending and tracking of information. Information is not always being entered correctly and the information in the databases is not always accurate. Review of printouts of open items in the KIMS and TA-V commitment databases revealed inconsistencies in data quality and accuracy. SSO staff does not always use databases, as required by SSO procedures. For example, KIMS (a primary mechanism for documenting facility representatives and federal project manager oversight activities) is not consistently being used by FRs and project managers.

Weaknesses in the use of KIMS and in data quality have been longstanding issues identified on previous assessments, including the OA 2003 inspection. Evidence of SSO actions in verification of closure of issues, corrective actions to address occurrences, and assessments is not always readily retrievable. Most records are currently being maintained by individuals rather than being stored in a retrievable manner. Furthermore, lack of adequate mechanisms to track commitments and issues is a contributing factor to performance weaknesses in the management of safety basis activities (see Appendix C). The OA 2003 inspection finding on SSO assessments and corrective actions was still open as of this OA inspection due to limited progress being made in issues management and corrective action areas. Lack of an adequate issues management and commitment tracking system has contributed to current performance deficiencies in SSO oversight of SNL's implementation of DOE Order 420.1A, and in timely review of safety basis document submittals by the contractor (see Appendix F).

**Finding #12. SSO has made limited progress in establishing an effective issues management and commitment tracking system, and has not conducted adequate reviews of contractor corrective actions to verify closure and effectiveness in ensuring resolution of OA findings and preventing recurrence, as required by DOE Order 414.1B and DOE Order 470.2B.**

**Employee Concerns Program.** SSO currently does not have a formal documented program plan describing the methods and processes to implement ECP requirements. In addition, no formal training for SSO point of contact has been conducted. The current NNSA Service Level Agreement with SSO states that the NNSA Service Center will monitor the ECP hotline and provide support to SSO for ECP investigations; however, posters and SNL ES&H awareness training state that employees should direct concerns to the local SSO site office or use the ECP hotline or forms. In addition, SSO is maintaining records of a recent whistleblower case. Thus, SSO is providing a lead role for resolving ECP concerns.

No formal annual management assessments of the ECP or the SNL ECP are being conducted, as required annually by DOE Order 442.1A. The NNSA ECP manager stated that while informal meetings and discussions have occurred in the past, no formal documented management assessment of ECP implementation for SSO has been conducted within the last three to four years. Neither NNSA Service Center ECP manager nor the SSO ECP liaison could provide evidence of documented management assessments of the ECP. In addition, the NNSA Service Center ECP procedures are out of date, and ECP posters are not always being maintained throughout the SNL site. ECP posters are posted in many buildings, but there are varying versions of the posters.

**Finding #13. NNSA Service Center and SSO have not ensured that a formal, documented program for implementing the employee concerns program has been maintained, and have not provided effective oversight of the SNL employee concerns program, as required by DOE Order 442.1A.**

No concerns (safety or otherwise) have been submitted via the ECP within the last two years. However, a recent whistle-blower's safety concern was investigated by SSO in coordination with the NNSA Service Center ECP manager, and two other concerns identified by whistle-blowers were investigated in 2003.

**Contract Management and Assessment of Contractual Performance.** SSO has formalized a process in its "PEP/PER Procedure," which SSO uses to prepare its annual performance evaluation plan (PEP) for SNL and the resultant annual performance evaluation report (PER). Joint performance review teams, comprised of SSO and SNL SMEs, meet quarterly to discuss progress, issues, and areas of attention. Issues and areas of attention are formally captured in the SNL tracking system, and corrective actions are developed and negotiated with SSO to address weaknesses. Review of quarterly and annual PEP results indicates that SSO is effectively using this mechanism to communicate ES&H issues to the contractor. For example, due to SSO concerns that SNL did not have a clear direction for implementation of its EMS per DOE Order 450.1, the contractor's progress rating in this area was downgraded to a yellow rating by SSO during the first quarterly review of PEP in FY 2005.

SSO has taken positive steps to address SNL performance concerns and increase accountability of ES&H performance at SNL. For example, following 15 near misses at the Microsystems and Engineering Sciences Applications (MESA) MicroFab construction project in early 2004, SSO initiated a construction safety study of the prime construction contractor and identified issues in supervision, safety oversight, training, and work planning. As a result of this study, the construction contractor increased its inspection/oversight of construction activities and implemented a worksite observations trending process to detect trends in unsafe work as a proactive means to improve safety. SSO has also increased FR oversight of major construction project sites.

In other examples, SSO formally imposed continuing restrictions on radiological operations at the Z Machine until formal causal analyses of radiological and other repeat occurrences are conducted to determine why earlier corrective actions were not effective. As a result of longstanding issues with inadequate contractor submittals of safety basis documents, SSO has included more specific milestones within the PEP directed at improvement of quality and timeliness of submitted safety basis documents. In first quarter 2005 PEP feedback to SNL, SSO rated SNL “red” in this area due, in part, to rejection of a MicroFab safety assessment because of inadequate independent review by SNL as well as timeliness issues with other safety basis submittals. SSO has also incentivized laboratory performance for implementation of SNL’s self-assessment program to focus SNL senior management attention and drive improvement in this longstanding area of weakness.

### D.2.2 SNL Feedback and Improvement Systems

In February 2003, OA identified weaknesses in a variety of ES&H management systems at SNL and cited specific findings for which formal corrective action plans were required, including the areas of communication of ES&H expectations, self-assessment, corrective actions and issues management, the USQ program, design control, and work control processes. The OA team identified many examples of inadequate implementation of safety programs in a variety of functional areas that demonstrated the weaknesses in these management systems. Although causal analyses were conducted, corrective action plans were developed, most of the corrective actions were completed, and most of the findings were closed, SNL feedback and improvement processes have not been effective in addressing the management system weaknesses identified by OA in 2003. SNL management currently acknowledges that there are continuing weaknesses even though progress has been made in some areas, including a number of ongoing process improvements and initiatives. However, the root causes of these performance deficiencies have not been sufficiently established, and the corrective actions taken and planned have not been comprehensive or timely.

**Assessments.** The 2003 OA inspection identified weaknesses in SNL’s self-assessment program, including formal assessments of line ES&H performance that lacked sufficient frequency, focus, and rigor to provide assurance that safety programs were being adequately implemented. SNL’s causal analysis and corrective actions have not been effective or timely in addressing these weaknesses. SNL conducts a variety of self-assessment activities that identify deficiencies in safety processes, conditions, and performance, but the program still lacks the consistency and rigor of a mature and effective performance assurance system in evaluating ISM processes and performance.

SNL conducts assessment and inspection processes that evaluate ES&H programs and processes and the physical condition of work areas for unsafe conditions. The ES&H Manual chapter on self-assessment was revised in January 2005 to clarify and strengthen self-assessment requirements. Each division and subordinate units develop annual assessment plans/schedules. As part of the corrective actions for the OA finding from 2003, the ES&H Center annually risk-ranks functional areas and identifies the top 10 “critical” areas that are to be included in division assessment schedules and become the focus of self-assessments. The assessment of these areas by the line was directed by the Line Implementation Working Group in 2004 and is included as a requirement in the newly revised ES&H Manual chapter on self-assessment. The ES&H Center has detailed the requirements for conducting their functional area evaluations by program/area owners in a formal self-assessment plan. These top 10 critical functional areas were evaluated by the ES&H program owners in FY 2004 and are scheduled for assessment in FY

2005. Over 60 functional area assessments were performed by the ES&H Center SMEs in 2003 and 2004, and 27 functional area assessments are scheduled for FY 2005.

Some of these functional area assessments were very thorough and included evaluations of line implementation (not addressing implementation was a deficiency identified during OA's 2003 inspection). The most common line self-assessment activities are management surveillances, which is a program described in an institutional corporate policy requirement (CPR), which requires all managers, from the President to department managers, to periodically conduct surveillances of facilities within their area of responsibility. Typically, management surveillances consist of annual facility walkthrough inspections for Occupational Safety and Health Administration (OSHA) violations, and managers usually are accompanied by their ES&H customer support team and ES&H coordinators.

Some facilities and organizations conduct other self-assessments, such as the criticality safety assessments in TA-V facilities. TA-V also maintains a comprehensive database to ensure that required inspections are performed on such various equipment as ventilation hoods, signage, fall protection gear, electrical ground fault circuit interrupters, forklifts, and fire extinguishers. Construction health and safety performance is monitored and documented on daily reports by construction inspectors and by construction safety professionals. Maintenance first-line supervisors conduct documented, monthly work observations of maintenance activities.

The ES&H, Quality, and Safeguards and Security Assessments Department conducts independent assessments of safety programs. Seven independent assessments related to safety were conducted in FY 2004 and 18 are scheduled for FY 2005. These assessments are formally planned and conducted in accordance with a CPR document and, in general, are comprehensive and rigorous.

During the past two years, SNL – New Mexico (NM) has conducted several studies and has initiated various programs that are intended, in part, to improve the self-assessment program. In addition, several process improvements related to the assessment program are ongoing. Examples of these initiatives and ongoing improvements include the following:

- An independent team, made up primarily of SMEs from outside SNL, conducted an ES&H program review in late 2003 to benchmark DOE and commercial programs, recommend a model program, conduct a gap analysis, and identify suitable metrics. The review identified strengths and weaknesses and recommended a number of gap closure actions, including establishing a formal benchmarking program; requiring management at all levels to provide visible, consistent, and persistent motivation and incentive in establishing a strong ES&H culture; driving ES&H policy and program down through the organization; and improving ES&H integrated safety management system (ISMS) implementation and management across the laboratory.

- An implementation plan, issued in January 2005, describing a path forward for SNL to become "Best in Complex" in ES&H in three years, and "Best in Class" in ES&H in ten years.

- The director of the ES&H Center and the vice president of Division 6000 recently conducted one-on-one communication of ES&H performance "scorecards" to each division vice president.

- The ES&H Center developed an ES&H assurance system description document intended to describe how the ES&H organization and the line implement the corporate integrated laboratory management system and the contractor assurance system. As part of this effort, the ES&H organization is developing performance standards and associated measures for some ES&H functional areas as part of their effort to aid in grading overall performance in each program.

- SNL is drafting an institutional-level document (i.e., a CPR) for self-assessment to set minimum expectations for these processes.

- Behavior-based safety observation programs are being established in maintenance and at the SNL site in Livermore, California.

- Computer-based training on how to conduct assessments was developed by the ES&H Center and is available to SNL employees.

Despite the positive assessment activities and ongoing initiatives noted above, the OA team identified little fundamental change in the level of self-assessment of ES&H performance at SNL, especially by line organizations. Line management continues to perform few topical area assessments, and there is a continuing lack of rigor in the planning and conduct of self-assessments. SNL self-assessments continue to lack sufficient focus on observing work activities, line implementation of ES&H programs, and the attributes of ISM, and lack sufficient rigor to effectively evaluate safety processes and performance. The corrective actions for prior OA findings related to assessments have not been timely or effective. Examples of these continuing weaknesses include:

- The revision to ES&H Manual, Section 22A, strengthening expectations for conducting ES&H self-assessments, an action in the corrective action plan (CAP) for the 2003 OA finding, was not issued until January 26, 2005, almost two years after the OA inspection.

- Line assessment schedules do not include the top 10 critical functional areas that are specified to be assessed each year by all organizations, and the quarterly and annual analyses of line self-assessments by the ES&H Center mischaracterizes the findings in these functional areas as "assessments" of functional areas; that is, because line inspections identified approximately 800 deficiencies related to these 10 critical areas in FY 2004, the report concluded that approximately 800 assessments had been performed.

- Line organizations are conducting only limited assessments of performance in ES&H functional areas, work observation, and the ISM core functions. The 2004 and 2005 schedules for the line organizations evaluated by OA are limited to periodic (often annual, but sometimes monthly) management surveillance walkthroughs of facilities, mandatory inspections of equipment and waste operations, and rule-driven radiological protection program assessments. No management surveillances or formal assessments were performed in Center 1800 (the Materials and Process Sciences Center within the Processing and Environmental Technology Laboratory) in 2003 or 2004.

- There is no plan or expectation for periodic assessment of the majority of the approximately 90 ES&H functional areas. Unless they are selected as one of the top 10 critical areas each year, many functional areas will probably never be selected for the critical area listing.

- Some functional area self-assessments conducted by the ES&H Center still did not sufficiently address line implementation, did not address all aspects of the program (e.g., did not include construction in the assessment of the occupational noise program), or were not of sufficient scope or rigor to identify significant weaknesses (e.g., occupational noise, excavations, trenches, and floor or wall penetrations).

- Assessment reports often inadequately describe the scope and details of what was inspected to reach the specified conclusions. Many management surveillance reports do not include the fundamental information required by the governing requirements document.

- The requirements for the construction safety oversight program are not delineated in site procedures and this program has not been fully effective in consistently identifying unsafe behaviors and effecting appropriate preventive measures for identified safety violations. (See discussion below under corrective action and issues management.)

- Self-assessment activities have not been effective in identifying the process and performance deficiencies in ISM, electrical safety, construction safety, and other safety programs identified by SSO and by OA during this inspection (e.g., hearing protection, radiation protection at the pulsed power facility, construction safety, confined space, maintenance shop conditions, and configuration control at the Gamma Irradiation Facility).

Although various process changes and initiatives are being directed at improving what SNL management has acknowledged is an inadequate self-assessment program, there has been no rigorous analysis performed to identify the root causes of the program and implementation deficiencies to ensure that the resources and efforts include, and are focused on, the appropriate corrective actions that will effectively solve the problem. Responsibility for identifying and developing corrective actions for all ES&H performance issues identified by ES&H Center assessments is typically delegated to the ES&H organization with inadequate leadership and acceptance of responsibility by the line organizations that plan and perform potentially hazardous work. The "Assessment Processes Roadmap" of the "Best in Class" Safety Implementation Plan, issued January 28, 2005, does not provide clear and specific goals and objectives for improving the performance of self-assessment. Establishing, implementing, and ensuring the appropriate scope, rigor, and formality of line self-assessments is not addressed and the methods for validating performance are not specific or adequate.

**Finding #14. SNL has not established a program of effective assessment activities with sufficient scope and rigor to ensure that ES&H performance at all levels and in all organizations is consistently and accurately evaluated.**

**Corrective Action and Issues Management.** The 2003 OA inspection report identified weaknesses in SNL's corrective action and issues management program. Defined processes for managing corrective actions to safety deficiencies had not been established, and the management of corrective actions was inconsistent and often ineffective. The subsequent SNL causal analysis and corrective action plan were not sufficient, and corrective actions were limited in scope and have not been effective or timely in addressing these weaknesses.

SNL documents many safety deficiencies in a variety of tracking systems and takes corrective actions that are tracked to closure. Some improvements have been made in the analysis of assessment findings to identify systemic issues and in tools for tracking ES&H deficiencies identified by external sources and Center 6300 assessments. However, the program still lacks the consistency and rigor of a mature and effective continuous improvement system. Identified safety problems are not being consistently managed or adequately analyzed to identify appropriate recurrence controls.

SNL manages the correction of identified safety deficiencies using a variety of tracking systems and formal and informal processes, depending on the source of the issues being addressed. Some progress has been made in consolidating tracking systems for line self-assessment results. With the exception of the 10000 Division, line organizations are documenting the findings and observations from management surveillances into a single system called the line self-assessment database. Results of external assessments (e.g., OA, SSO, and Lockheed Martin corporate audits), internal independent assessments, functional area and other self-assessments conducted by the ES&H Center, and systemic issues identified through the ES&H issues management process are managed in accordance with a program document and the ES&H corrective action tracking system (ECATS). This tracking system was being developed during the 2003 OA inspection, and significant efforts are ongoing to replace this system with a more comprehensive tool that will schedule and track line and ES&H Center assessments, assessment results, and corrective actions. In addition, an institutional corrective action development and tracking process CPR is being drafted that is intended to apply to safety and nonsafety-related external assessment findings, violations of external statutes or the SNL/DOE prime contract, and issues identified by senior laboratory management. SNL has elected to use an existing Nuclear Weapons Division corrective action tracking system for tracking deficiencies and actions governed by this institutional process.

Recent improvements have been made in the identification and management of systemic issues resulting from routine, formal analyses of assessment findings. A CPR describes an institutional issues management process. Eight institutional issues have been identified and assigned to issue owners and management champion/decision maker. The ES&H Center has also established an issues management process to analyze ES&H assessment data for trends and systemic issues, with criteria for determining whether the issues must be managed at the institutional level or can be managed at the Center level. A chartered, Center-level ES&H Issues Management Review Board evaluates potential issues identified through assessment finding data analysis. Two ES&H issues are being addressed at the Center level, and two ES&H issues were elevated to the institutional level.

The MESA construction project requires feedback from its prime contractor for each safety deficiency notice issued in the form of an incident report that reflects analysis of the incident and action taken. The MESA project also tabulates all safety notices and documented safety observations, identifies ISM causal factors, and performs periodic trend analysis of the data. In 2004, an adverse trend was identified in excavation work by one contractor and escalated actions were initiated. MESA also established and uses a monetary penalty process in its contracts to promote safe work performance.

Notwithstanding the above improvements and initiatives, the fundamental deficiencies in corrective action management identified in previous OA inspections have not yet been addressed. SNL still has multiple tracking methods for ES&H deficiencies, many of which are informal. SNL also lacks a structured process to collect and evaluate issue and action data, hindering effective management of feedback information. Insufficient attention is directed to the identification of trends and precursors, and structured evaluations of operational and injury/exposure incidents. Procedural and performance deficiencies further limit the effectiveness of corrective action management at SNL. Deficiencies in the SNL corrective action program include:

- There is no clearly defined development or implementation plan with actions and milestones to establish an effective corrective action management system for resolving ES&H deficiencies at SNL. SNL has still not established an institutional procedure delineating common requirements or procedures for evaluating ES&H deficiencies and developing and managing corrective actions. The ES&H Center corrective action program description document is insufficient and is not delineated in formal procedures or requirements documents. The roles, responsibilities, scope, and interfaces of the various tracking systems, and policy/procedure documents already in existence and being developed by various organizations are not clearly documented. It is not clear that the resulting processes will result in consistent and effective management of safety deficiencies and corrective/preventive actions.

- Although the ES&H Manual requires causal analysis of all ES&H self-assessment findings, there is no formal causal analysis procedure, only a website with tools, training, and guidance. Tracking tools have no fields for documenting causes or analysis information and linkage of actions to identified causes has not been documented.

- SNL documents indicated that currently approximately 17 to 30 tracking systems are still in operation at SNL, and current planned actions will still result in redundant tracking systems. Not all divisions are using the line self-assessment database for documenting assessment findings, as intended by site management.

- Root causes are not consistently accurately identified; appropriate recurrence controls are not always identified; and the effectiveness of corrective actions in fully addressing the identified issues is not typically validated. Causal analysis for several of the 2003 OA inspection findings was inadequate, and not all identified causes and recommended actions specified in the analysis were captured in the corrective action plans. After completion of corrective actions for prior OA findings, SNL did not conduct any validation activities to ensure that the actions were effective in fully addressing the issues.

- All of the opportunities for improvement identified by OA in the 2003 inspection report were captured in the ES&H corrective action tracking system, but no observation disposition forms were completed as required by the ES&H corrective action program description document, and thus all are still listed as open.

- To comply with DOE Order 231.1A and DOE Manual 231.1-2 requirements to track and trend incidents that do not meet the criteria for reporting to DOE, SNL has added a section to ES&H Manual Chapter 18C for non-occurrence trackable events (NOTEs). Thirty-seven NOTEs were documented by SNL in calendar year (CY) 2004 and nine were documented through March 23, 2005. The detailed requirements for implementing this program are not identified in the applicable ES&H Manual section, but are referenced in website information and a reporting template. Further, although the SNL NOTEs process requires a statement as to immediate actions taken, it does not require any analysis or specification of causes, any subsequent or planned corrective and preventive actions, or any lessons learned because they are optional fields on the form. Only 3 of the 45 NOTEs reviewed specified any long-term corrective/preventive actions, and only 5 specified any lessons learned. NOTEs are collectively reviewed for event trends by the ES&H Center as part of its quarterly performance analysis process. However, the NOTES did not specify any causes and are not adequate to manage the issues involved with operational and safety incidents, so as to prevent recurrence and drive continuous improvement.

- The corrective actions to the ISMS issues identified by a July 2003 SNL-chartered review of SNL's ES&H program by a group of external experts were only tracked in a database until May 2004, thus many of the actions are listed as incomplete. Some of the remaining corrective actions might have been subsequently completed or other initiatives might have overtaken identified actions, but there was no formal evaluation and closure or revision to the defined action tracking document when personnel responsible for maintenance of the action plan were reassigned.

- Completed construction safety deficiency notice forms for facilities do not identify what corrective and preventive actions were taken, except in cases when immediate actions taken were recorded. There are no formal instructions on how issues documented on construction deficiency notices are to be resolved. Although there is a block on the form for indicating the date the problem is corrected, the determination of what constitutes correction is left to the quality assurance inspector or safety professional who generated the deficiency notice. For facility construction projects, in most cases, no formal response is required from the contractor. Many of the incidents identified on these deficiency notices were violations of OSHA requirements that should have been formally communicated to the contractors with responses required to identify causes and the corrective and preventive actions taken. For example, approximately 24 deficiency notices were issued on MESA and facility projects for violations of SNL and OSHA excavation/trenching requirements in CY 2004 and the first three months of CY 2005. Only three deficiencies were reported through ORPS, and three others were documented using the NOTEs process. These reportable events and precursor incidents were not managed in a consistent and rigorous manner to effectively address prevention of events that have serious potential consequences.

**Finding #15. SNL has not established an effective corrective actions program that ensures that safety deficiencies are appropriately documented, rigorously categorized, and evaluated in a timely manner, with root causes and extent of condition accurately identified, and appropriate recurrence controls identified.**

**Injury and Illness Investigation and Prevention.** Injury and illness statistics for recordable and lost workday rates at SNL are among the highest in NNSA and are higher than all-DOE trend lines. Facts related to cases of OSHA recordable injuries and first aid cases, including evaluations of the conditions and causes and specification of corrective and preventive actions, are documented on forms that are consistent with DOE requirements. In some cases, safety investigations were performed effectively and addressed the appropriate issues.

In response to the high injury and illness rates at SNL, Lockheed Martin and SNL management have set aggressive goals for reducing occupational injuries and illnesses. To achieve these goals SNL has initiated several comprehensive programs that include starting a behavior-based safety observation program, which is being piloted in Divisions 8000 and 10000, and developing a predictive model for injuries and illnesses. The predictive model has been used to identify and refine an approach to addressing repetitive motion injuries, which are the biggest contributor to recordable injuries at SNL. A comprehensive data analysis tool combined with sample field surveys and inspections were used to establish screening tools and criteria for identifying likely candidates for ergonomic injuries and for evaluating these employees and effecting preventive actions. Screening and evaluation of workers in Division 6000 are currently being conducted.

The management of injury and illness cases is a collaborative effort among individual supervisors, the medical department, and the industrial hygiene and industrial safety SMEs on customer support teams. Supervisors are required to promptly complete the manager’s statement regarding injuries and illnesses on the investigation report form and provide details of the incident, the conditions and activities that contributed to the incident, and the corrective actions taken. The customer support team personnel assigned as investigators for each case complete the form listing further recommended actions. The ES&H Center staff maintains the OSHA Form 300 logs, manages lost and restricted workday cases, and reports injury and illness data to the DOE computerized accident/incident reporting system (CAIRS). A comprehensive database facilitates collecting and processing injury and illness investigation information in CAIRS.

Notwithstanding the positive initiatives and recent management attention on injuries and illnesses, some significant weaknesses were apparent in the investigation of, and reactions to, injuries and illnesses, especially non-reportable first aid cases. Some injuries and illnesses are not being rigorously investigated and investigation reports are not being completed as required. Investigations by the industrial hygiene and industrial safety SMEs and the statements by workers’ managers did not address work control and ISM aspects of the incidents (e.g., Was work adequately planned, hazards identified, and controls specified? What personal protective equipment [PPE] was being employed? Was work adequately supervised?) Statements by managers were often either missing or did not address all questions on the form, even though managers have been allowed to write a narrative statement about the incident rather than filling in the specific block and questions on the form. The ES&H investigators did not always complete all information required on the investigation form, including actions taken and recommended actions. Examples of these deficiencies included:

- In one case a student suffering from shortness of breath and tightness in the chest after chemicals in a fume hood had splashed on her arm went home without getting medical attention or reporting the incident and symptoms to supervision, as required by the ES&H Manual. When notified two days later, the supervisor correctly sent her to the medical facility. However, this failure to report and respond to the incident in accordance with site requirements was not addressed in the report.

- In another case, the statement by the worker's manager was, "Since I was not informed about this accident, I have no knowledge of what the employee was doing, what was the cause, and what will be corrected."

- In a third case, when a newly installed cubical was found to have an incorrectly installed power strip (the hot lead was in contact with the faceplate) that resulted in a shock and burn to a worker, the only corrective action was for maintenance to repair the power strip. There was no discussion of why it was installed in an unsafe and untested condition, whether there may have been a vendor material problem, or whether any training or lessons learned were required (although a lessons-learned bulletin was subsequently issued).

- Five of 16 exposure, burn, and shock incidents occurring between June 9, 2004, and January 21, 2005, reviewed by the OA team involved undergraduate students, who were working in potentially hazardous conditions without the knowledge and experience that is strongly relied on at SNL to protect workers from those hazards. In this small sample, such a large proportion of exposure injuries involving students raises the question of the adequacy of safety training and oversight provided to student workers at SNL. (See Findings #2 and #3 in Appendix C.)

Implementation of DOE and SNL policies and expectations that all accidents and injuries are preventable and achieving DOE and SNL goals to significantly reduce occupational injuries will require a more rigorous approach to injury/exposure investigations. Prevention of similar events will result from fully understanding all aspects of past events, analyzing root and contributing causes, and developing and applying effective recurrence controls.

Although injury and illness case management is an institutional program that involves responsibilities in line organizations, contractor organizations, medical staff, ES&H subject matter experts, and ES&H administrative staff, it is only delineated as a functional area under the Industrial Safety Program and briefly referred to in ES&H Manual Chapter 16, "Benefits and Health Services." There is insufficient management, direction, and monitoring of the overall program to ensure that all aspects of case management are appropriately performed. The administration of the injury and illness investigation and reporting process and the CAIRS process is not delineated in the ES&H Manual or other formal procedure or requirements document. An unsigned, undated desk instruction describes the administrative elements of tracking the administrative aspects. The OSHA record-keeping system is an expert-based system that depends on the knowledge and experience of the safety reporting administrator. Formal communications of treatment details from the medical department to the administrator are limited, and privacy considerations could impact compliance with reporting requirements. The ES&H staff has drafted an internal administrative procedure describing their SME investigation process, but it has not been issued.

**Finding #16. SNL injury and illness investigations lack sufficient rigor to ensure that causes are identified and appropriate and that effective corrective and preventive actions are identified and implemented.**

**Lessons Learned.** SNL has established and implemented a process for identifying, evaluating, and applying lessons learned. The SNL lessons-learned program is described in ES&H Manual Chapter 22C, and the roles of the program manager and program coordinators have been identified as part of a feedback and improvement program description document. A variety of lessons learned are posted to the internal SNL database and communicated to workers through a variety of vehicles, including bulletin board postings, electronic mail to managers and technical staff, such publications as the *Porcelain Press* and Construction's *News Sense,* discussion at Line Implementation Working Group meetings, and presentations at safety meetings. The institutional procedure provides for screening of externally generated lessons learned by ES&H Center risk analysts to establish applicability and any needed actions. Internal lessons learned are being generated, external lessons learned are being disseminated to department managers/supervisors, and various documents reflect that lessons learned are being communicated to workers. Over 200 current lessons have been posted to the website, and over 550 archived lessons are available. The website also provides links to external lessons-learned sources and databases and templates for generating new lessons learned. A subscription service is available for receiving both internally and externally generated lessons learned. Subscribers may subscribe to all categories or only specific hazard categories.

Although many lessons learned are being reviewed, generated, and disseminated, SNL has not addressed the program weaknesses identified in the 2003 OA inspection report. Consistent and effective evaluation and application of externally generated lessons learned cannot be demonstrated because of weaknesses in the established process and implementation. Processes are insufficiently defined, and applicability evaluations and required actions are not documented. The SNL lessons-learned program does not include evaluation of FY 2004 and 2005 special reports published by DOE's Office of Environment Safety and Health on the DOE website related to significant events involving electrical safety, laser safety, and hoisting and rigging, or include them in published lessons learned at SNL, even though SNL has also recently experienced events in these areas. An analysis of the SNL electrical safety occurrence documented in a March 2005 report included a review of the April 2004 electrical safety report. Formal post-job/experiment briefings are not required by procedures or typically employed as a method to obtain lessons learned feedback from workers.

**Employee Concerns Program.** SNL has established and implemented an ECP that provides various avenues for workers to voice and obtain objective evaluation and resolution of ES&H concerns. This program is advertised through posters and forms located on site bulletin boards, ES&H awareness training for visitors and new hires, and on an intranet website. SNL staff members are encouraged to report and seek resolution of safety concerns through their supervisors, but workers can also report ES&H concerns to their ES&H coordinator, ES&H and union safety committees, to ES&H customer support teams, division ES&H personnel, the operations center, an ombudsman office, to the ES&H concerns staff either online or by telephone, or to NNSA/SSO. The means for employees and contractors to express and get resolution of safety concerns and suggestions for improvement are delineated in Section 18A of the ES&H Manual.

Few concerns are being formally reported to the ES&H concerns staff (only two concerns were reported in CY 2003, eight in CY 2004, and one in the first three months of 2005). Most of the reported concerns related to traffic issues. With one exception, safety concerns reported to the safety concerns coordinator are being appropriately evaluated and resolved in a timely manner. There has been no documented resolution for an October 2003 concern related to the lack of exit signs and a locked exit door in a conference room. A number of weaknesses in the documentation of concerns and resolutions were identified. The concerns documentation does not identify the date a concern was received, or in one case the final resolution for closure.

## D.3 CONCLUSIONS

In a number of areas, such as the EMS and protective force training, SSO has been actively involved in monitoring program effectiveness and providing direction. SSO is also devoting significant attention and resources to effectively implementing the relatively new requirements for safety system oversight of essential systems. SSO is making progress in strengthening its site office programs and processes for oversight of contractor ES&H operations. Improvements in the ES&H assessment program, use of new SNL contractual mechanisms for evaluating SNL performance (PEP), recent new hires in key technical positions, and the new SSO senior management team are starting to positively impact SNL ES&H performance. However, many of the processes are new and have not yet fully matured, and actions are still ongoing to fully establish internal management systems and processes at the site office. SSO actions to address SNL's longstanding weaknesses in such areas as work planning and control and self-assessment through greater use of available contractual mechanisms are significant positive steps. However, weaknesses in staffing and management of corrective actions and issues continue to hinder progress. In addition, the ECP has not received sufficient management attention to ensure that it is being implemented in accordance with DOE Order 442.1A.

SNL has various processes for conducting the basic elements of feedback and continuous improvement. Some progress has been made in improving the formality and effectiveness of these processes since the 2003 OA inspection, including efforts to develop several long-term process tools and programmatic initiatives. However, most of the process and implementation deficiencies identified in prior OA inspections continue to exist. Line self-assessments of safety programs and performance are not rigorously planned or performed, with little observation of work or evaluation of the implementation of integrated safety management. Corrective action processes are still insufficiently defined and fragmented, operational and injury and illness incidents are not rigorously evaluated, and causes and preventive actions are not being adequately identified. The root causes of feedback and improvement program weaknesses have not been identified and thus timely, effective corrective and preventive actions have not been developed and implemented. Organizational barriers and an inadequate requirements management flowdown structure continue to impede effective and timely resolution of longstanding deficiencies, and there is insufficient accountability for ISM implementation and performance improvement.

Both SSO and SNL have made a number of changes in personnel and have hired some new managers and staff. SSO and SNL senior management indicated that they recognize that some corrective actions have not been timely or effective and recognize a need for improvement in this area. While much work remains, some of the recent initiatives are appropriate steps toward addressing longstanding deficiencies.

## D.4 RATING

Core Function #5 – Feedback and Continuous Improvement…………..............NEEDS IMPROVEMENT

## D.5 OPPORTUNITIES FOR IMPROVEMENT

This OA inspection identified the following opportunities for improvement. These potential enhancements are not intended to be prescriptive. Rather, they are intended to be reviewed and evaluated by the responsible DOE and contractor line management and prioritized and modified as appropriate, in accordance with site-specific programmatic objectives.

**NNSA and NE Headquarters**

1. **NNSA Headquarters should clearly define and assign primary and support functions and activities for implementation of the ECP within NNSA.** Specific actions to consider include:

    - Revise the NNSA Headquarters FRAM and the NNSA matrix of functions and activities by location documents to specifically address which NNSA organization (e.g., Headquarters, site office, NNSA Service Center) has overall primary organizational responsibility for implementation of the ECP and which organization has support functions.

    - Ensure that all NNSA Service Level Agreements with site offices have been revised to be consistent with the NNSA Headquarters FRAM and the NNSA matrix of functions and activities by location documents.

    - Ensure that NNSA organizations that are assigned lead primary responsibility for ECP implementation and organizations performing support functions have established the necessary ECP procedures and guidance, and have sufficient resources to effectively implement the requirements of DOE Order 442.1A.

2. **In accordance with the 1997 management agreement between the NE and NA-10, NE and NA-10 should review the provisions of the existing management agreement to identify and implement any needed changes as a result of the recent NNSA issuance of the NNSA Headquarters FRAM, which delineates new NNSA expectations on nuclear safety oversight.** NE and NNSA should consider improved mechanisms other than management agreements, such as incorporation of key shared nuclear safety oversight responsibilities within existing NNSA/NE Headquarters FRAMs, to ensure that roles, responsibilities, and functions for nuclear safety oversight are periodically reviewed and clarified, as necessary, in accordance with DOE Manual 411.1.

**SSO**

1. **Enhance FR assessment processes and implementation.** Specific actions to consider include:

    - As part of the triennial FR self-assessment for 2005, consider including independent reviewers from other NNSA/DOE site offices with mature FR programs to provide a broad perspective on program implementation. Ensure that FR self-assessments focus on overall FR program performance in driving improvements in laboratory ES&H performance, increasing their technical rigor and oversight of laboratory work activities, rather than merely assessing compliance with FR procedures and FR DOE Standard 1063-2000.

    - Update FR procedures and instructions to reflect the current organization and management expectations.

    - Re-evaluate the overall use of the KIMS database as a management tool for documentation of FR and project manager operational awareness activities. Address the root causes for non-compliance with database usage by SSO staff, and develop a path forward with SSO staff involvement. Hold SSO staff accountable to the new process and/or solution to documentation of SSO oversight activities.

- Re-evaluate the current method for categorizing the results of FR operational awareness and assessment activities. Consider standardizing definitions and categorizing assessment findings for all SSO assessment processes, including FR operational awareness activities.

- Re-evaluate all formal reporting mechanisms to SSO and SNL senior managers, with a goal of streamlining and ensuring that performance information is appropriately captured and effectively communicated to both SSO and, in particular, SNL senior management. Consider standardizing expectations for documentation and reporting of FR activities. Use such documentation for verification and closure of effectiveness of contractor actions to address ORPS and FR findings, and ensure that the documentation is readily identifiable and retrievable.

2. **Enhance the performance of line management oversight activities.** Specific actions to consider include:

   - Ensure the rigor and effectiveness of SSO FR and SME assessment and operational awareness activities by establishing expectations for evaluation of the laboratory's self-assessment program as an integral part of all SSO assessment activities.

   - Consider formally scheduling SSO direct observation of selected laboratory assessments, with formal SSO reports developed and issued to the laboratory that critique the rigor, depth, and breadth of the laboratory's assessment (similar to overseeing a contractor's assessment of readiness to restart facilities).

   - Train and/or establish mentoring of SSO FRs and SMEs in the techniques used in performance-based observation of work activities.

   - Consider having SMEs conduct informal routine seminars (e.g., brown bag lunches) on selected functional areas to increase the SSO staff's knowledge and awareness of requirements and of weaknesses and vulnerabilities most commonly found in program implementation.

   - Expand the practice of SMEs developing guidance cards to improve SSO staff (e.g., FRs and project managers) knowledge and awareness of ES&H requirements in their conduct of day-to-day operational and field walkthrough activities.

3. **Increase SSO senior management involvement in the management of SNL safety issues.** Specific actions to consider include:

   - Increase SSO involvement and oversight of SNL effectiveness reviews in CAP verification and closure actions. Clearly set expectations that effectiveness of corrective actions is just as important as meeting schedule commitments.

   - Ensure that CAPs for safety issues submitted by the laboratory contain appropriate effectiveness elements and mechanisms throughout the implementation of the CAP to provide midcourse changes/direction as well as final verification of overall effectiveness of actions at closure of the overall CAP.

   - Ensure that appropriate root cause analyses are required of the laboratory as part of the CAP development process, particularly for cases where previous actions were determined to be ineffective and/or where repetitive performance concerns were identified.

- Ensure that laboratory corrective action assignments for issues within CAPs are assigned to laboratory line organizations, as appropriate.

- Consider developing a checklist for SSO staff to use when reviewing CAP submittals by SNL to ensure the consistency, quality, and completeness of SSO staff reviews.

4. **In coordination with the NNSA Service Center, increase management attention to ensure that the ECP is being maintained and implemented in accordance with DOE Order 442.1A.** Specific actions to consider include:

   - Consistent with direction from NNSA Headquarters, ensure that roles, responsibilities, and authorities for ECP implementation are clearly defined in SSO and NNSA Service Center FRAMs and Service Level Agreements.

   - Ensure that ECP plans and procedures have been appropriately established within SSO and are being maintained at the NNSA Service Center.

   - Review ECP poster information, ECP forms, applicable ECP-related websites, and SNL ES&H awareness training modules to ensure consistency in the direction and guidance being provided to personnel at the SNL site on mechanisms for reporting ECP concerns to NNSA/DOE.

   - Ensure that lead responsibility for oversight of the SNL ECP (e.g., ombudsman program) has been established. Ensure that annual assessments of the laboratory's ECP are included in the SSO ES&H baseline schedule of assessments, in accordance with DOE Order 442.1A.

   - Ensure that annual management self-assessments of the ECP are identified and scheduled in the SSO self-assessment program implementing procedure.

**SNL**

1. **Formally define and implement clear institutional expectations and processes that comprise the self-assessment, corrective actions management, lessons learned, and other feedback and improvement programs to ensure that requirements for implementation are clearly communicated.** Specific actions to consider include:

   - Clarify and establish at an institutional level the ownership of these feedback and improvement programs and the responsibility and accountability mechanisms for ensuring that these programs are effectively implemented by line and support organizations. Mechanisms to consider include review and approval of assessment schedules, review of assessment reports and corrective actions, regular reports to management on the status of corrective action management, and implementation assessments for such programs as lessons learned, injury and illness investigations, ORPS, and NOTEs. Include specific oversight mechanisms and controls that ensure that independent assessments and management/self-assessments of ES&H routinely and specifically address all elements of ISM, including such crosscutting topics as assessments, corrective actions, lessons learned, training, and work control processes, and that ES&H assessments have a routine focus on observation of work activities.

   - Consolidate, integrate, and provide clear linkage between the institutional requirements for these programs, which are contained in various requirements and guidance documents. Clarify the distinction between requirements and guidance, and detail the required processes in step-by-step work instructions/procedure formats.

- Clarify in all documents when communications and processes apply to ES&H Center activities and when they apply to the broader ES&H aspects of the Laboratory.

2. **Provide training and mentoring for team leaders, supervisors, and workers on assessment and job observation techniques to improve the effectiveness of self-assessments and surveillance activities.** Specific actions to consider include:

   - Provide mandatory training and mentoring to the divisions/centers/departments in the planning, conduct, and documentation of assessments. Consider developing workshops in which required processes and practical techniques are taught to organizational assessment teams through the conduct of actual self-assessments.

   - Have knowledgeable managers and ES&H personnel accompany team leaders and supervisors during job observations to increase the experience base related to observing work and identifying deficiencies.

3. **Ensure that the essential elements of an effective corrective action/issues management program are formally established, implemented, and documented.** Specific actions to consider include:

   - Ensure that the following items are addressed: reporting vehicles and tracking tools (including a general deficiency or problem report); a process for determination of risk/significance/priority (application of a graded approach) and extent of condition; causal analysis (applied to all items, but with rigor based on a graded approach, to include root and contributing causes); consideration of reporting in accordance with the Price-Anderson Amendments Act (PAAA), ORPS, and NOTEs; assignment/reassignment of ownership; expectations for developing corrective actions that prevent recurrence; CAP and closure approval requirements (supervisory review); timeframes for executing process steps and the process for extending due dates; closure and verification of CAPs (on a graded approach and/or sampling basis); and including effectiveness reviews in CAPs for significant issues, and trending and analysis of issues.

   - Establish a single process and tracking system for ES&H deficiencies and corrective actions regardless of the source of the issues to ensure consistent evaluation and disposition of safety deficiencies based on the substance of the issue rather than its source. Possible exceptions might include actions that are tracked externally, such as ORPS or PAAA items.

   - Develop mechanisms for routinely communicating the status of corrective actions to senior management and for holding management accountable for performance.

   - Conduct a senior management review of the performance, composition, charter, and oversight of the Line Implementation Working Group and make necessary changes to ensure that it becomes an effective, proactive agent of change for improving the implementation of ISM core functions at SNL.

4. **Strengthen the processes for industrial hygiene and industrial safety investigation reports, evaluating injury and illness reporting, construction safety, and screening of events for reporting to PAAA, ORPS, and NOTEs.** Specific actions to consider include:

   - Establish clear requirements for the documentation, tracking, and assurance of implementation of recommended actions on industrial hygiene and safety investigation reports, or an agreed-upon justification when recommendations are not implemented.

   - Issue a comprehensive procedure detailing the requirements for injury and illness investigations and the CAIRS reporting program.

   - Integrate and apply the issues management/corrective action elements cited above to the evaluation and resolution of injury incidents.

   - Identify and evaluate options for facilitating injury and illness reporting evaluations and addressing concerns about privacy information (e.g., according the safety reporting administrator full access to medical information in a trusted agent status).

   - Conduct an investigation to determine whether exposure incidents (i.e., chemicals, burns, shock) involve a disproportionate number of students working at SNL. Ensure that training and supervision of students are sufficient to protect student workers.

   - Document the construction safety program and issue procedures for implementation, including a process for managing construction safety deficiencies.

   - Extend MESA project deficiency notice response and trend analysis processes to other SNL construction activities.

   - When developing the improved corrective action/issues management program, the injury/illness reporting evaluation process, and construction safety program, ensure that they include steps for evaluating and reporting issues through PAAA and ORPS/NOTEs as required.

5. **Establish and implement clear institutional expectations and processes that provide assurance that lessons learned are reviewed and applied and that feedback is formally solicited from workers.** Specific actions to consider include:

   - Consolidate and issue in the form of a step-by-step work instruction/procedure the information contained in various lessons-learned websites and documents that clearly delineate the roles, responsibilities, and authorities of the program owner, evaluators, and potential users, and define the requirements and process for reviewing and implementing lessons learned and for generating lessons learned for dissemination to other SNL-NM organizations and the DOE complex.

   - Incorporate more rigor into the lessons-learned processes. Include documentation that ensures that any necessary actions are identified (beyond information dissemination), tailored to the conditions and processes at SNL, and implemented as required.

   - Incorporate explicit expectations into institutional documents and procedures for training plan development and work planning that lessons learned are to be reviewed and applied to these activities. Include controls to document the lessons learned that were identified and reviewed during development of training and work documents.

- Establish processes for formal documentation and resolution of post-job reviews for maintenance work packages and construction project and experimental activities to promote direct worker feedback and procedure improvement.

6. **Review, revise, and strengthen the infrastructure and processes for communicating ES&H requirements at all organizational levels at SNL.** Specific actions to consider include:

    - Consider establishing a standard format for procedures and developing a writer's guide to promote consistent and complete procedures.

    - Establish an unambiguous and effective hierarchical framework of documents that communicate management expectations and the requirements and procedures for implementing SNL policies and ES&H programs, from broad corporate policies down to implementation instructions for use at the task level.

    - Conduct a comprehensive review of all published ES&H-related documents, including requirements documents, manuals, templates, guides, program/system/process descriptions, and implementation plans, as well as other communication mediums, such as websites, to ensure that requirements for conducting safety-related activities are communicated in designated, configuration-managed documents (i.e., with defined processes for review, approval, and management of changes).

    - Eliminate redundant documents and consolidate information sources for requirements and guidance to simplify and facilitate personnel understanding of what is required and who must do it.

    - Ensure that requirements documents sufficiently detail the roles and responsibilities as well as the procedural steps required to implement the requirements, processes, and programs, including mechanisms that ensure accountability for compliance and effective performance.

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# APPENDIX E

# Essential System Functionality

## E.1 INTRODUCTION

The U.S. Department of Energy (DOE) Office of Independent Oversight and Performance Assurance (OA) evaluated essential system functionality (ESF) at Sandia National Laboratories (SNL). The ESF evaluation focused on two facilities at SNL's Technical Area (TA)-V: the Annular Core Research Reactor (ACRR) and the Gamma Irradiation Facility (GIF). The review of ACRR focused on the documented safety analysis (DSA) aspects of their engineering design. The review of GIF examined selected safety systems, including the pool, the irradiation cells, the elevator power interrupt subsystem, and the radiation monitoring system, and their engineering design, configuration management, surveillance testing, maintenance, and operations.

The purpose of an ESF assessment is to evaluate the functionality and operability of selected structures, systems, and components (SSCs) in a facility that are essential to safe operation. The review criteria are similar to the criteria for the Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 2000-2 implementation plan reviews; however, the OA reviews also include technical evaluations of the selected SSCs' design, operation, maintenance, testing, and other technical disciplines. These reviews also address a facility's authorization bases, its configuration management program, and other related programs, such as the unreviewed safety question (USQ) program. The reviews included analysis of system calculations, drawings and specifications, vendor documents, facility-specific technical procedures, facility walkdowns, and interviews with system engineers, design engineers, maintenance and testing engineers, operators, technical managers, and other technical support personnel.

Both SNL and the Sandia Site Office (SSO) presently are initiating major corrective action programs in response to the "fundamental weaknesses in the implementation of nuclear safety requirements" identified by the DNFSB in its letter of September 27, 2004, and which subsequently were validated by reviews by external experts sponsored by SSO and SNL. On January 25, 2005, the SNL Price-Anderson Amendments Act (PAAA) program manager filed a noncompliance report on the DOE Noncompliance Tracking System to document SNL's nuclear safety basis process weaknesses. OA also examined the SSO and SNL safety basis process improvement efforts applicable to all TA-V nuclear facilities.

## E.2 RESULTS

### E.2.1 Engineering Design and Safety Basis Process

**SSO Safety Basis Processes.** SSO appropriately responded to DNFSB concerns by obtaining a review by a National Nuclear Security Administration (NNSA) Independent Evaluation Team to identify and understand the causes and extent of problems. SSO directed SNL to take near-term actions; perform an independent root cause analysis of the issues identified by the Independent Evaluation Team, SNL's own independent review, and the DNFSB; and develop a draft corrective action plan. Subsequently, on March 14, 2005, SSO directed SNL to develop a detailed resource-loaded corrective action plan and an integrated schedule for developing revised DSAs for TA-V nuclear facilities. SSO also conducted a self-assessment and developed a broad-scope corrective action plan to improve its own safety basis processes.

SSO does not have adequate mechanisms to track safety-basis-related activities, commitments, and issues, which may contribute to the problems discussed in Sections E.2.2 and F.2.3 with regard to the review and approval of a USQ procedure, implementation of the systems engineer program in accordance with DOE Order 420.1A guidance, and the delay and lack of formality in executing safety-basis-related commitments and communications. The SSO corrective action plan for improving its safety basis processes, which was submitted in response to the DNFSB letter, does not include development and implementation of the necessary actions and commitment tracking mechanisms for planning and executing safety-basis-related activities (see Appendix D and Finding #12).

**SNL Safety Basis Processes.** SNL has taken urgent and important steps to identify its weaknesses and to make improvements in its safety authorization basis processes for TA-V nuclear facilities. In response to concerns expressed by the DNFSB, SNL obtained independent reviews of the safety basis of its nuclear facilities and conducted a self-assessment and root cause analysis of the problems identified. Previously, SNL enhanced the corporate role in the safety basis process by establishing a safety basis department within the ES&H and Emergency Management Center, which is independent of nuclear facility operations. This department presently is developing a detailed corrective action plan that is intended to address all gaps and weaknesses identified by the root cause analysis and various independent reviews.

SNL understands the causes of its weaknesses and is committed to succeeding in its proposed efforts. SNL submitted a corrective action plan to the Noncompliance Tracking System on March 30, 2005, in accordance with the milestone targeted in SNL's response to the DNFSB letter. SNL plans to structure and manage its corrective action plan, called the Safety Basis Improvement Project, as a formal project, with a work breakdown structure, schedules, target milestones, and resource commitments. However, at the time of this onsite inspection, SNL had not reached a stage where a draft version of such a detailed plan could be reviewed by the OA team.

SNL's report in response to the DNFSB letter discussed key elements of the Safety Basis Improvement Project and provided a task summary of short-term, mid-term, and long-term actions to be taken to improve the development of adequate safety bases for nuclear facilities. However, it does not provide adequate details on the actions, and the task summary lacks traceability to the causal factors and recommended corrective actions derived from root cause analysis. For example, it is not clear how the task summary addresses the need for in-depth regulatory review, systemic weaknesses in the TA-V safety basis training program, or the various types of concerns related to communications on nuclear safety basis issues with internal and external groups.

Although SNL is developing and implementing corrective actions, the lack of adequate nuclear facility safety basis processes, procedures, and expertise continues to adversely impact nuclear safety management. For example, SNL did not follow its USQ process for nuclear facilities by declaring a potentially inadequate safety analysis (PISA) and initiating an occurrence report when facility-specific inadequacies in safety bases were identified by the DNFSB. Other deficiencies applicable to ACRR and GIF are discussed below. SNL did not self-identify such deficiencies in preparing and reviewing the revised DSA for the facility.

**Annular Core Research Reactor Facility.** The limited-scope review of the ACRR DSA identified a list of discrepancies in the DSA that warrant further follow-up with TA-V management. During the onsite data collection period, these discrepancies were presented to ACRR management and staff. The ACRR staff is investigating these items as resources permit and has invoked the PISA process, which requires placing the facility in a safe condition. SNL personnel indicated that no final conclusions have been reached regarding any potential safety impacts of the discrepancies, and that the analysis will take some time.

The discrepancies address weaknesses with the assumptions in the accident analysis associated with the loss-of-coolant accident initiated by a design basis accident (DBA) seismic event. The discrepancies below warrant further evaluation and analysis and resulted in requests for additional information that OA will evaluate:

1. The ACRR's defense-in-depth strategy appears to conflict with specific guidance provided in DOE-STD-3009, *Preparation Guide for U.S. DOE Nonreactor Nuclear Facility Safety Analysis Reports*. The standard provides a method of compliance by means of multiple barriers and protection of "the barriers to avert damage to the plant and to the barriers themselves." Specific concerns include:

   - ACRR DSA Table 15.3-6, "ACRRF Defense-in-Depth and Worker Protection Controls Derived from the Hazard Analysis," identifies two barriers related to loss of coolant: (1) core design, and (2) reactor pool/tank design. Both of these controls rely on the ability of these systems to maintain the water in the pool; however, the water retaining boundaries for these systems are not classified as safety-significant or safety-class.

   - The table also identifies the Reactivity Control and Plant Protection System that is required to perform an active safety function (i.e., shut down the reactor); however, this system, the facility structure, and the rod control structure are not designed or evaluated to survive/function following a DBA seismic event.

2. The rate of dissipation of pool water to the soil from a breach of the pool liner or reactor piping has not been sufficiently analyzed, which is a concern because the pool liner and reactor piping are not classified as safety-significant/safety-class.

3. The analysis is not sufficient to demonstrate that a seismic event would not result in multiple breaks in the reactor piping and the pit.

4. There is no analysis to demonstrate that a "slow" leak will not result in chugging in the core and subsequent failure of the cladding. A conservative estimate indicates that the reactor pool temperature could increase from 60 to 70 degrees Celsius (critical temperature for channel voiding and chugging) at maximum power of 4.4 megawatts in less than nine minutes, not accounting for the effect of the level drop. Thus, the premise stated in Section 15.4.3.3 that "This type of leak, however, is incredible because there are no volumes below the tank that could accept 10,500 gallons in a short time period" is potentially not conservative.

5. There is no analysis to demonstrate that critical heat flux will not take place shortly before the level drops to the core level, thus negating the temporal effect of water scrubbing.

6. The DBA for partial loss of pool water assumed that the water level will be 2.4 meters above the top of the core. This assumption was based on the large break, which short circuits the circulating pump and sump pump. A smaller (about 40 gallons per minute) un-isolable leak between the return flange and isolation valve could result in the draining of the pool to the level 1.5 meters above the core and is not addressed in the DSA. There is no analysis to indicate that such a smaller leak is not significant.

**Finding #17. At SNL, the ACRR DSA accident analysis for the seismic event with a loss-of-coolant accident is not supported by rigorous analysis that ensures acceptable safety performance for the design basis accident conditions.**

SSO's latest safety evaluation report for ACRR erroneously required that conditions for approval be incorporated into the reactor's technical safety requirement (TSR) prior to reactor restart. However, SSO's readiness review and approval of ACRR did not intend to nor did it verify that the TSR was revised to incorporate conditions of approval.

**Gamma Irradiation Facility**. The review of the engineering design portion of the GIF focused on the actual design of the targeted safety SSCs, the associated documentation, including supporting analyses and calculations, the DSA, the translations of the designs into facility procedures and programs, the engineering design processes, and the observed technical knowledge and qualifications of the facility staff.

The design of the GIF and its safety SSCs generally appeared to be adequate to perform their safety functions. Further, the GIF staff was knowledgeable of the facility, broadly technically capable, and conscientious, with a strong sense of ownership of the facility. In spite of the design and accident analysis deficiencies identified during this OA inspection, most operational, maintenance, and testing measures currently being applied to these SSCs are providing reasonable assurance of their ability to perform their safety function and permit the facility to operate safely. Exceptions are addressed in the Opportunities for Improvement section.

The engineering deficiencies at GIF were grouped into the following major categories: inadequate design of the elevator power interrupt system, inadequate DSA safety classification of SSCs, inadequate identification of ozone worker safety controls, missing or inadequate DSA analyses and supporting calculations, and miscellaneous other DSA discrepancies. It is noted that GIF management has appropriately invoked the PISA process to review many of the identified deficiencies. The following paragraphs provide a detailed discussion of the engineering design deficiencies that were identified.

<u>Inadequate design of the elevator power interrupt system</u>. Although the design of most safety-related SSCs is robust, a deficiency was discovered in the design of the safety-significant cell source elevator power interrupt circuit. This subsystem is intended to protect workers by lowering the source elevator(s) from the raised position when a cell door is opened. Based on an estimate provided by the facility staff, a lethal dose would be received in approximately seven seconds if a worker was exposed to the design basis source, 500 kCi. The DSA states that the elevator power interrupt circuit is designed to protect the workers entering the cell from acute fatality or serious injuries from exposure to radiation from sources on the cell elevator. The descent speed of the source elevator is a critical safety parameter in providing this protection, but it was not adequately considered in the design of this subsystem. The current descent speed is not fast enough to prevent a worker entering the cell from receiving a lethal radiation exposure if the source were raised. In practice, however, a number of barriers, interlocks, and administrative controls prevent personnel from entering the cell when the source is raised; however, these other measures are not safety-class or safety-significant and thus cannot be considered in the formal accident analysis and DSA.

**Finding #18. At SNL, the design of the safety-significant cell source elevator power interrupt system is deficient in meeting the required DSA objective of preventing worker fatalities or serious injuries due to radiation exposure.**

<u>Inadequate DSA safety classification of SSCs</u>. A concern was identified with the classification of SSCs in the safety analysis. Consistent with DOE-STD-3009-94, SSCs intended to prevent acute worker fatality or mitigate serious injuries must be classified as safety-significant. Contrary to this requirement, the following SSCs that perform such functions were not so classified in the DSA.

- Cell source elevator drive subsystem. Lowering the radiation source into the pool if a cell door is inadvertently opened is a safety-significant function needed to protect workers from potentially lethal radiation exposure. Although the elevator power interrupt subsystem is appropriately classified as safety-significant, the remainder of components (mechanical and electrical) in the elevator drive subsystem are not classified as safety-significant, although they must function to accomplish the safety function.

- Cell doors. The irradiation cell doors and appurtenances, along with their administrative controls, prevent worker entry into the cells when the sources are raised; they also permit rapid exit using the panic bar, should a worker be inadvertently locked inside a cell when a source is raised. Thus, they prevent accidental exposure to potentially lethal radiation. The DSA does not classify the doors as safety-significant. The doors also perform the important-to-safety function of reducing radiation outside the doors to within the DSA limits of less than 0.5 millirem/hr.

- GIF overhead crane and supporting structure. The crane's safety-significant functions are to prevent load drops that could defeat safety-significant functions of other SSCs, such as the cells, the pool, and the source transfer casks, and to remain structurally intact and in place in a seismic event. The crane is not classified as safety-significant. The building supporting structures for the crane also have the safety-significant functions of providing adequate crane support for normal operations and seismic events but are not classified as safety-significant.

- Pool stainless steel liner. DSA Section 3.3.2.3.3 states that the pool liner is not safety-significant, which is not consistent with its safety function of maintaining pool inventory and with descriptions in other areas of the DSA (Table 3A-5).

**Finding #19. At SNL, several GIF structures, systems, and components required to prevent worker fatalities or mitigate serious injuries are not classified as safety-significant, as required by the GIF DSA.**

Although these SSCs are not classified as safety-significant, most operational, maintenance, and testing measures that were being applied appeared to provide reasonable assurance that they could perform their safety functions.

<u>Inadequate identification of ozone worker safety controls</u>. Ozone is generated in a cell when a source is present. The cell ventilation system is used to maintain the cell at a negative pressure with respect to the high bay to remove ozone. The OA team identified four separate concerns with this system:

- Section 2.7.1.1 in the DSA is inconsistent with the operational requirements for the cell ventilation system during irradiation. It states that the cell control system prevents the start of irradiation if cell ventilation flow rates are not adequate. It also permits cell irradiation without cell ventilation after the source has been raised, and it is silent on what precautions/controls should be utilized to prevent worker exposure to ozone when irradiating without cell ventilation.

- Recent modifications were made to the cell control system logic to defeat the interlock that would lower the source if the cell ventilation is lost during irradiation. These modifications were made in an uncontrolled manner, without any safety analysis or USQ considerations, and they did not consider required worker controls for the ozone hazard. As a result of these modifications, there have been occasions where irradiations have been conducted without continuous cell ventilation.

- Another element of protecting workers from ozone exposure is sampling for its presence. Although such Industrial Hygiene acceptance tests for ozone production have been performed with the ventilation system in operation and have validated the effectiveness of the system in reducing ozone levels following the completion of irradiation activities (source lowered into pool), this sampling has addressed only one set of relatively mild source strength conditions. Additionally, Industrial Hygiene has not conducted any acceptance tests to ensure that ozone is not a worker hazard while conducting irradiation with the ventilation secured.

- The cell ventilation system contained a design deficiency, in that it could fault to a condition where one supply fan is running with no exhaust fans. This would pressurize the cells and drive ozone into the high bay area occupied by workers.

The resultant conclusion from reviewing both actual and permitted cell irradiation operations is that the design, analysis, acceptance testing, and administrative controls to provide protection of workers from ozone have not been adequately identified and instituted.

**Finding #20. At SNL, the controls established at GIF to protect workers from ozone exposure are not adequate, including inadequate DSA analyses, uncontrolled non-conservative cell ventilation system modifications, inadequate ozone monitoring during past irradiations, and an inadequate cell ventilation system design.**

<u>Missing or inadequate DSA analyses and supporting calculations</u>. All DSA statements or implications regarding the performance capabilities of safety SSCs must be verifiable by supporting analyses/calculations and/or testing. The following such analyses/calculations were either not available or were inadequate to demonstrate the DSA-stated or implied capabilities. As a result, complete verification of the adequacy of the designs in these areas could not be accomplished.

- Load drop on pool. Although load drop from the crane on the pool was addressed by a qualitative analysis in the DSA, this analysis only accounted for static load (a 14-ton load evenly distributed over a one-square-meter area of the pool floor). The analysis did not account for the dynamic forces of a falling load. The resultant event frequency described in the DSA was unrealistically low. Such an event has the potential for high worker exposure from rapid pool draining. Current formal control measures in the facility do not adequately address this and the following item (see Opportunities for Improvement at the end of this section).

- Load drop on cells. The DSA did not address load drop on the safety-significant cells, and no supporting calculations were available. Potential high worker exposure due to cell structure failure could result from this event.

- Pool temperature. Although the DSA addresses pool temperature with respect to the temperature limits on the pool water demineralizer resins, which is a non-safety parameter, it did not address the structural limits of the pool itself with respect to temperature, which is a safety-significant parameter, and no supporting calculations were available.

- Pool water evaporation. Although the DSA described an evaporation calculation, the description was inadequate to allow verification of critical assumptions, inputs, and methodology. No supporting calculations were available.

- Pool water makeup capability. Although the DSA described the capability of the pool makeup water system, no supporting calculations were available.

- Source elevator stop structural analysis. The source elevator stops at the top and bottom ends of their travel are welded to the pool liner. The lower stops must be capable of absorbing the energy of stopping the elevator without causing rupture of the safety-significant pool liner. The upper stops were modified when they were found to be structurally inadequate, but no modifications were performed on the lower stops, and no analyses had been performed to show the structural adequacy of their attachment to the pool liner.

- Cell shield windows' seismic qualification. The cell shield windows do not appear to be designed to withstand a seismic event, as required by the DSA. Per the design drawings, the internal shield panes do not appear to be retained by any mechanical feature other than friction. A seismic analysis was not available. Failure of these windows in a seismic event could expose workers to unacceptable radiation levels.

- Source elevator descent speed. As discussed previously, the descent speed of the source elevator is a critical safety parameter in the function of this system. Although descent speed was addressed in the DSA with respect to impact of the elevator at the end of its travel, it was not addressed with respect to its safety function at the beginning of downward travel.

- Auxiliary cell shield wall analysis. The initial designs of cells #1 and #2 did not provide adequate shielding to reduce radiation outside the cell doors to less than 0.5 mrem/hour for the design basis sources, as required by the DSA. Auxiliary shield walls were added inside the cells to reduce the radiation outside the cell doors to acceptable levels. The seismic analysis for these walls did not adequately consider the seismically induced bending loads on the shell-plate-to-frame welds, which could be the limiting structural element in the wall system, and the analyses did not consider the vertical seismic load component on the supporting structures.

**Finding #21. At SNL, numerous DSA analyses and/or supporting calculations required to demonstrate the capabilities of the GIF safety systems to perform their safety functions are either inadequate or not available.**

Miscellaneous other DSA discrepancies. The OA team also discovered the following DSA technical discrepancies for which no actual or direct safety impact was identified but that reflect on the insufficient rigor and accuracy of the DSA:

- The DSA incorrectly describes the source elevators as cantilevered from the hoisting cables.

- The DSA describes the overhead crane rating at 20 tons; it had been de-rated to 15 tons.

- The DSA incorrectly states that the stainless steel cobalt-60 capsules are the only safety-significant SSC.

- The DSA states that the pool liner is 1.0 centimeters (0.394 inch) thick on the bottom and 0.5 centimeters (0.197 inch) thick on the sides. According to design drawings, however, the actual thickness of the liner is less, 0.375 inch on the bottom and 0.1875 inch on the sides.

- The GIF pool water is credited in the DSA as a safety feature to shield personnel from the sources. A TSR requires the pool level, a safety-significant parameter, to be monitored on a daily basis. The GIF daily rounds procedure accomplishes this using an installed ultrasonic level instrument, which the DSA did not classify as safety-significant. As a result of this observation, the facility staff instituted a new policy to verify the pool level by observing the actual pool level rather than using this instrument. The staff committed to reflect this change in practice with a change to the rounds procedure, which will render this observation moot.

- One of the cell modes described by the TSR is Cell Irradiation Operations. The mode condition states “Normal cell irradiation activities are being performed.” In practice this mode is in place when cell irradiation activities are permitted. The phrase “are being performed” should be changed to “are permitted.”

- The limiting condition of operation for the elevator interrupt circuit does not include the movable wall emergency stop switch as required. This was an administrative oversight. A TSR surveillance for this component was defined as part of the limiting condition of operation and is being performed.

In addition, there is a discrepancy in the design document. Specifically, the cell shield window design drawings indicated inconsistent shielding pane densities on two of the drawings.

At the conclusion of the assessment the above described discrepancies were being evaluated by the GIF staff to determine whether they constituted a PISA as required by 10 CFR 830 and the site USQ procedure.

**Summary.** SNL and SSO continue to exhibit weaknesses in their safety basis processes. Although both organizations are implementing corrective actions to address gaps and deficiencies, the actions are in the initial stage of development and implementation and have not yet had a positive impact on performance.

The review of the current ACRR DSA review identified several items for further evaluation by ACRR. One key area for review is the lack of an appropriate safety designation for the pool liner, reactor piping, and control rod systems. The ACRR staff has acknowledged the team’s request for further information/analysis and has invoked the PISA process to formally evaluate these areas.

The designs of the GIF and its safety SSCs are generally adequate to perform their safety functions, and the GIF staff was very knowledgeable of the facility and technically capable. However, with one system (i.e., the source elevators), a safety-significant design deficiency was identified with respect to the elevator’s lowering speed of the sources and the resulting potential worker exposure. Although the DSA provided adequate general descriptions of most of the safety SSCs, it had numerous significant deficiencies, including inadequate classification of several SSCs that performed safety-significant functions, missing or inadequate analyses and supporting calculations, and miscellaneous other technical discrepancies. Despite the design and analysis deficiencies, the GIF is generally operated in a safe manner because of the skills of the current staff and the controls in place that are not credited in the safety analysis but that are implemented adequately in practice.

### E.2.2 Configuration Management

Configuration management is composed of many facets: design control, maintenance control, operations control, procurement control, and all other technical disciplines with the potential to impact the facility configuration or quality. Each facet contains numerous elements (e.g., design control normally includes procedures and processes for generation of modifications, calculations, specifications, and drawings). For effective configuration management, these facets and elements must be properly defined and connected by procedures to ensure that the effects of activities in each area are properly accounted for in the other areas. Additionally, sites must have sufficient rigor, discipline, and understanding of the importance of configuration management, must strictly comply with procedures, and must ensure that safety and configuration management are not overridden by production demands or an expert-based approach (as opposed to clear standards and defensible analysis and documentation).

Some elements of effective configuration management exist at GIF. In some cases, configuration management is being effectively executed or initiated. For example, GIF operating procedures are properly controlled to ensure that the latest versions are used. In addition, efforts are underway to create a set of GIF system design description documents, the cell control system draft system design documents were completed March 1, 2005, and a procedure on how to develop a systems design document has been issued. Further, a configuration management walkdown procedure, “Configuration Management System Walkdown Guidelines, TA-V Admin Instruction,” has been issued. The assigned GIF cognizant system engineer had not conducted any walkdowns at the time of this OA inspection.

However, many elements of configuration management are not in place or are not effectively implemented, and the overall configuration management program was weak. Programmatic deficiencies were identified in many areas, and there were instances where configuration control was not adequately maintained, apparently as a result of these programmatic deficiencies. In addition, SNL did not demonstrate a full understanding of the DOE expectations for effective configuration management at a DOE nuclear facility, such as the importance of rigor, discipline, and control with respect to facility configuration, and the importance of procedures and procedure compliance. The following paragraphs briefly outline examples of the programmatic deficiencies and instances where configuration control was not adequately maintained.

Programmatic deficiencies include:

- The lowest-level implementing procedures (i.e., describing how to perform the expected processes) for configuration management have not been developed. The configuration management document hierarchy starts from the Quality Assurance Program Plan and is supported by the Research Reactor and Experimental Program plans. The Research Reactor and Experimental Program plans/procedures define requirements but do not provide clear implementing information. This information should be included in performance-level procedures (i.e., procedures that direct the user on how to implement and execute the programmatic-level requirements). These performance-level procedures had not been developed. For example, procedures were not in place to describe the method for annotating and integrating design requirements and safety requirements throughout engineering documents; for controlling documents, including document identification standards and conventions and establishment and maintenance of document indices, databases, and libraries; for determining the scope of technical baseline documentation; and for managing controlled engineering documents (e.g., vendor manuals, quality assurance documents).

- The Project/Experiment Quality Plan for the GIF, completed in 2000, does not adequately define necessary quality requirements (these plans determine the quality requirements, including configuration management, for a facility). For example, under “Control and Verification of Analysis and Calculations,” the plan is marked as “no analysis and/or calculations associated with this task.” In fact, many calculations are associated with facility designs and are required to be performed from time to time in support of facility modifications or to address technical concerns or questions. Also, the quality assurance records retention requirement is not well defined, and the requirement that records be filed so that they are readily retrievable is not marked. However, the more recent Project/Experiment Quality Plans were more rigorous (e.g., spent fuel ratio experiment conduction).

- The site had no replacement item equivalency evaluation procedure for determining the acceptability of replacing components with non-like-for-like components. As a result, such facility changes were not necessarily appropriately evaluated for safety or for the potential for a USQ.

- Calculations and other design documents were generally not easily retrievable.

- Modifications were inappropriately performed as maintenance. Many facility modifications were not recognized by the staff as modifications and were performed as facility work requests, which do not have sufficient documentation for design modifications, such as references to affected documents and unreviewed safety question determinations (USQDs.)

- Even when properly categorized, modifications typically lacked complete documentation. Missing documentation typically included: design verifications, supporting calculations, designation of required quality control measures, procurement requirements, and required changes to affected operating, maintenance, and testing procedures; DSAs, TSRs, and other change request documentation required by the authorization basis; and post-modification testing requirements. Design control procedures and/or a procedure applicable to the GIF describing all of the requirements for a complete modification package did not exist.

Examples of inadequate configuration control include:

- Inappropriate cell exhaust fan control modification. The cell ventilation subsystem provides dilution air, exhausts the cell atmospheres, and maintains the cells at a negative pressure during and immediately after irradiations to protect the workers from the ozone generated inside the cells when the sources are in the up position. The original computer control logic for the cell exhaust fans was designed to lower the source into the pool if the ventilation fans (supply and/or exhaust) were lost. An inappropriate modification was performed on the computer control software logic for cell ventilation that permitted the source to remain in the cell with cell ventilation not operating. This modification could allow the cell to become pressurized and the ozone concentration in the cell to be significantly increased, thereby releasing ozone into the high bay from the cell penetrations and exposing the workers to ozone from a higher than normal concentration source. No USQ evaluation was performed for this change to the facility.

- Undocumented change to auxiliary cell shield walls. Steel channels and weld cover plates were added to the auxiliary shield wall structure without changing the design documents and without performing a USQ review.

- No overall test procedure for ozone testing. A March 2001 test to determine cell ozone levels with a raised radiation source was performed with no procedure and no USQ evaluation. Although the industrial hygiene personnel who performed the ozone measurements worked to a measurement procedure, no procedure had been produced that controlled and documented all of the other aspects of the test, such as the explicit purposes of the test, the operating conditions under which it was to be performed, precautions, prerequisites, test steps (other than performing the ozone measurements), expected results, actual results, acceptance criteria, and evaluation of results. In addition to not having a procedure, no USQ evaluation of the activity was performed.

- Undocumented change to cell door lock logic. The failure to remove a temporary jumper resulted in an undocumented change to the door lock logic controls for a cell. As a result, the door logic controls would not preclude allowed cell entry after irradiations and before the ozone protection timer was timed out.

- Calculations not performed according to procedure. Most of the calculations that were reviewed did not conform to the procedure, “Control and Verification of Analyses and Calculations,” in that they were not “…sufficiently detailed as to purpose, method, assumptions, design input, references, and units such that a person technically qualified in the subject can [could] review and understand the analyses and verify the adequacy of the results without recourse to the originator.” They were also generally not "…identifiable by subject (including structure, system, or component), originator, reviewer, and date; or by other such data such that the calculations are [easily] retrievable."

**Finding #22. At SNL, many of the fundamental processes and procedures for effective configuration management have not been established and implemented at the Gamma Irradiation Facility and, as a result, instances of inadequate configuration control have occurred.**

**Unreviewed Safety Questions.** The USQ program is another component of nuclear facilities configuration management that is explicitly required by the 10 CFR 830 rule. The site USQ procedure contained numerous discrepancies. The OA team identified 19 areas that were non-conservative, inconsistent, or ambiguous with respect to the rule and/or the DOE USQ Guide, and 15 other areas in which the procedure was unclear, incomplete, or needed improvement. The OA team determined that the sheer number and significance of these deficiencies would render compliance with the rule problematic using this procedure. Examples of discrepancies with respect to the rule and the DOE USQ Guide include:

- In Section 4.1.2, USQ Process Requirement, Item (2), Physical Change, the SNL procedure added a non-conservative qualifier (the phrase in the note, "...relied on as the safety basis") to the rule's requirement that a temporary or permanent change to the facility as described in the existing DSA is required to undergo the USQ process.

- Section 4.1.3, USQ Process Pre-screening Potential Outcomes, the third bullet listed "Use-As-Is" and "Repair" as non-compliance report corrective action dispositions that could be screened out as not requiring USQDs. These provisions are incorrect as these dispositions could be changes to the facility and, therefore, are required by the rule to undergo USQDs.

- Section 4.1.3, the fourth bullet, stated that if, for the proposed activity, the facility or operation remained within the previously established and approved safety envelope, the proposed activity could be screened out of the USQ process. This statement was incorrect because the determination of whether a proposed activity is within the safety envelope is precisely the purpose of answering the seven questions of the USQD; the determination is not to be performed informally at the screening stage, without the appropriate documentation of answering the seven USQD questions.

- Section 4.1.3, Item (4), first bullet, the phrase "...which includes a TSR discrepancy…" added a non-conservative qualifier to the as-found discrepancy criterion from the rule for a PISA.

- Section 4.1.3, Item (4), second bullet, the phrase "…in the analysis that is described…" is non-conservative. Any discrepancy in the DSA, not just in the safety analysis section, as this phrase implies, is a PISA.

- Section 4.2.2, the second bullet concerning categorical exclusions lists maintenance or repeatable activities as examples. This provision is not correct. Although maintenance activities or other repeatable activities do not necessarily require USQDs, changes to the procedures for these activities generally do. Additionally, although some types of maintenance activities or other repeatable activities could be classified as categorical exclusions, most such technical activities in a nuclear facility cannot.

- Section 4.2.3, Item (2), the second bullet, cites safety-related procedures and programs as examples of the procedure or program changes for which the USQ screening process is applicable, implying that the process is not applicable to changes to nonsafety-related procedures and programs. This statement is not correct because the process is applicable to changes to all procedures as described in the approved DSA, regardless of their safety classification or lack thereof.

- Section 4.4.2, Step 3(C), the third bullet, says "Use the graded approach," which is explicitly prohibited by 10 CFR 830.7 in implementing the USQ process.

Several of the deficiencies identified may have resulted from weaknesses in the currently approved USQ Guide.

The OA team also reviewed ten USQDs for the GIF. The following discrepancies were identified in two of these documents:

- USQD Number GIF-33 addressed either a new TSR surveillance procedure or changing an old one for testing the elevator power interrupt system. The description in the USQD was not clear and did not provide any detail about the changes being made beyond inadequate general statements that the procedure was being improved.

- USQD Number GIF-33 also answered the USQD questions for the unmitigated conditions described in the DSA rather than for the mitigated conditions. For example, the question about probability of malfunction of equipment important to safety was answered by describing the DSA discussion of the consequences if the system failed, and it concluded that the change could not further increase this probability of failure. Thus, the evaluation failed to evaluate the changes against the preventive and mitigative features that the DSA described.

**Finding #23. The SNL site USQ procedure contains numerous areas where its directions are non-conservative, inconsistent, or ambiguous with respect to 10 CFR 830 and/or the DOE USQ Guide; as a result, compliance with these requirements would be problematic using this procedure.**

SSO closed out a 2003 OA inspection finding on the USQ procedure without ensuring that the corrective action included SSO review and approval of an appropriately revised procedure. A revised procedure still has not been approved because SSO initiated a complete revision of the procedure and had concerns with the new revision. SNL subsequently rescinded the revised procedure and submitted a second proposed revision in July 2004. SSO did not provide feedback until March 4, 2005, when it directed SNL to further re-evaluate the procedure for providing additional guidance. As a result, the October 2002 version of the USQ procedure is still the only approved version and remains in effect. Several additional deficiencies remain in this procedure as discussed above.

**Summary.** Although some elements of configuration management were beginning to be established, the overall configuration management program is weak at the GIF. Programmatic deficiencies were identified in many areas. Performance-level procedures were not in place for such fundamental activities as generating design modification packages and performing replacement item equivalency evaluations. Document control processes were not established that would allow reliable and efficient identification, retrieval, and control of facility historical documentation. The USQ procedure contained numerous discrepancies that rendered its use problematic. Personnel did not demonstrate a full understanding of DOE expectations for an effective configuration management program at a DOE nuclear facility. Several examples were found where configuration control had not been adequately maintained.

### E.2.3 Surveillance and Testing

10 CFR 830 requires that surveillances and tests be defined in the TSRs. The TSRs must ensure that safety SSCs and their support systems required for safe operation are maintained, that the facility is operated within safety limits, and that limiting control settings and limiting conditions for operations are met.

The GIF TSR surveillance requirements are appropriately derived from the safety analysis and conducted as required by the DSA. The detailed instructions for performing TSR surveillances are contained in designated GIF operating procedures. The TSR operating procedures were adequate. All the TSR requirements associated with the reviewed systems were appropriately tested, and the results were documented in accordance with the instructions in the TSR procedures. For the radiation area monitors (RAMs), the TSR surveillances were adequately performed by the radiation control technician group contracted to perform these tests. The technicians performed the RAM surveillances to their own procedures, which satisfied the DSA surveillance requirements for the RAMs. The required TSR surveillance due dates are appropriately tracked, and historical records indicated that surveillances are being performed on time; no surveillances were identified to be overdue.

**Summary.** The surveillance requirements in the TSRs have been appropriately translated into detailed GIF procedures. The surveillance procedures are being correctly scheduled, rigorously performed, documented, and completed on time, and this process is being closely maintained by the facility supervisor. Overall the program is well defined and appropriately implemented.

### E.2.4 Maintenance Program

The OA team reviewed several aspects of the GIF programs for maintaining safety systems, including preventive, corrective, predictive, and life-cycle maintenance, as well as work control processes and material conditions. The maintenance responsibility for GIF is assigned to the Facilities Management and Operations Center (FMOC) organization. TA-V and FMOC have an Internal Lease Agreement that defines the specific work boundaries between FMOC maintenance staff and the GIF operators. This agreement has been effective in coordinating the maintenance efforts at GIF. Building maintenance, including corrective and preventive maintenance, is routinely performed by FMOC and is controlled by requirements detailed in the Maximo system, a work control program and database. Operational facility work requests and operational preventive maintenance are routinely performed by GIF operators. GIF operators perform work from GIF procedures for complex tasks and, when appropriate, complete simple tasks/maintenance based on their GIF operator qualification.

The maintenance program is appropriately defined in the TA-V maintenance implementation plan, and FMOC performs work as described in the maintenance work control program. The preventive maintenance work orders are adequately written to provide assurance that the GIF components are operable and reliable. FMOC ensures that the mechanics are properly trained to access the TA-V area and to perform preventive maintenance for GIF.

Preventive maintenance is appropriately performed, and any equipment deficiencies identified during preventive maintenance were noted and corrected in a timely manner. Corrective maintenance for the systems is also being identified and completed in a timely manner, and as a result, there is no maintenance backlog for the GIF.

Work order packages are developed and listed in the Maximo work control system. FMOC owns and operates the Maximo and provides the GIF supervisor a weekly work planning document that lists all FMOC work planned for the upcoming week. In addition, the completed work from the previous week is listed on each weekly work planner. The GIF facility supervisor is responsible for ensuring that required surveillances and preventive maintenances are performed. However, there is no formal, day-to-day process for FMOC to notify the GIF supervisor that work has been completed.

The GIF has been operational for four years and has not yet developed a documented life-cycle maintenance program. SNL has decided not to implement a predictive maintenance program at this time because of the simplicity of many of the systems and the fact that the systems are relatively new and thus are not at the stage where predictive maintenance would provide substantial benefits. The SNL decision is technically defensible at this time.

The OA team conducted system walkdowns to ascertain the physical condition of the facility and identify any material degradation. No material degradation was identified, and housekeeping was excellent. The master equipment list is comprehensive and up-to-date.

Maintenance tracking and trending is controlled through the use of the Maximo system. While tracking and trending can be performed in Maximo, there are currently no standardized reports developed for Maximo that allow for immediate retrieval of component trends. The current method for documenting completed maintenance work is sufficient to support performance trending but could be improved. For operational facility work requests, all documentation is maintained in the GIF control room and is readily available for review for trending. In addition, the GIF operators and supervisor maintain a comprehensive narrative log of activities affecting GIF operations.

Although most aspects of maintenance and work planning were effective, some isolated weaknesses were observed, particularly in work package documentation. Specifically:

- Facility work request 2002-001 involved drilling a screw hole into the exterior wall of cell #3. A wall penetration permit was not prepared as required by the SNL ES&H Manual.

- One facility work request that involved a modification to the software logic controlling the cell ventilation subsystem resulted in a change to the facility operations as described in the safety analysis report. This facility modification was improperly listed as a maintenance task (see Section E.2.2).

- Three elements of the GIF annual preventive maintenance surveillance were overdue. These elements included the makeup water and recirculation system, the cell elevator cable, and the shield window steel shutter hydraulic pump enclosure preventive maintenance tasks. The GIF facility supervisor was aware of these deficiencies and plans to include a notification in the narrative log in accordance with the requirements of the maintenance implementation plan. It was subsequently determined that the recirculation system preventive maintenance was completed but not documented on the preventive maintenance sheet. The remaining outstanding preventive maintenances were completed by March 30, 2005.

**GIF Crane.** The current crane preventive maintenance procedure used for the GIF crane does not include the crane manufacturer's recommendation to exercise the crane's load brake under load on a monthly basis. In June 2003, the crane experienced noise and chatter while lowering a load during a pre-use load test. The SNL investigation determined that the source of the noise was the load brake engaging while not properly lubricated. A step was added to the annual preventive maintenance to exercise the load brake under load. DOE Standard 1090 requires that any overhead crane that is not utilized for a period of time greater than six months be re-inspected under the annual inspection criteria. Review of the GIF 15-ton crane surveillance log indicated two instances where GIF did not comply with this requirement.

Discussions with the crane vendor's technical personnel raised concerns that the current "nuisance noise" encountered with the GIF 20-ton anchor crane (recently down-rated to a 15-ton crane for seismic concerns) could result in excessive wear to crane components and present concerns for safe operation of the crane if not adequately addressed. In addition, the new annual crane preventive maintenance with the 10000-pound load test may exacerbate the load brake wear rather than correct it. According to the manufacturer, if the load brake plates are "dry" and operation introduces a significant load prior to proper lubrication, it could cause significant friction material loss from the load brake plates, which could result in improper operation of the load brake and failure of the component. In addition, several other components (motor bearings, lubrication points, etc.) could experience excessive wear if infrequent use of the crane is not properly addressed in appropriate frequency and procedure inspections.

**Finding #24. SNL has not fully evaluated the GIF crane load brake issues that result from infrequent crane operation and has not developed an adequate testing and maintenance program that considers all the relevant factors needed to ensure safe and reliable crane operations.**

**Summary.** The programs for maintaining safety systems at the GIF have several positive attributes. GIF equipment preventive maintenance tasks are defined and performed when required and deficiencies are noted and corrected in a timely manner. The maintenance staff is adequately trained to perform their assigned preventive maintenance tasks. For the systems reviewed, corrective maintenance is current and the material condition of the systems is excellent. In a few areas, further enhancements to the maintenance program are warranted. A few facility work requests were incomplete with regard to properly documenting the work performed. Also, concerns with the GIF crane load brake have not been fully resolved.

### E.2.5 Operations

The OA team evaluated operating procedures and GIF operator training for the safety-significant components as well as the knowledge and capability of the operators and facility supervisor to operate the irradiation cells under normal conditions and to take appropriate actions in the case of abnormal and accident conditions.

**Operating Procedures.** GIF has established operating procedures to define how cell operations and the facility support equipment will be operated (e.g., cell ventilation subsystem, movable wall operation and in-pool source handling, and cell elevator carts). In addition, GIF has a set of acceptance test procedures to verify the design of the facility, such as the acceptance test procedure for cell shielding, which was performed during the OA inspection. These procedures have been reviewed by the Radiological and Criticality Safety Committee and approved by the GIF manager. With some exceptions discussed below, these procedures are adequately written, technically accurate, can be followed verbatim, and are properly controlled.

The institution guidance for operating procedures is provided by the TA-V Conduct of Operations Manual, Chapter 16. In general, the TA-V guidance on procedures properly addresses many important topics associated with procedures, including defining the type of procedures, defining procedure development and approval, document control, requirements for periodic review, and procedure use. It also provides an adequate writer's guide for technical procedures.

However, some areas of the TA-V procedure manual were not clear or lacked detailed guidance:

- The guidance provided in the TA-V Conduct of Operations Manual, Chapter 16, on procedure usage is confusing. It states that procedures/checklists are performed in a step-by-step fashion, with the procedure "immediately available." Step-by-step procedures typically require reading each step as it is performed.

- No formal verification and validation processes have been defined for new/revised procedures. For GIF, procedures are being verified/validated by the Radiological and Criticality Safety Committee. The committee did not document its review of a recent GIF procedure for which the committee provided significant comments. Formal documentation would ensure that the comments were properly addressed and would provide a supporting document to ensure that future changes do not reverse comments from the committee.

- The guidance provided in the TA-V Conduct of Operations Manual, Chapter 16, on procedure writing does not include the integrated safety management system (ISMS) expectation that for new/revised procedures, a formal/documented process will be utilized to identify the hazards and controls to be included in the operating procedure. However, GIF has properly identified hazards and controls for its recently revised/new operating procedures without the formal ISMS process.

In addition, the current set of GIF operating procedures does not envelop a few important operations.

- The cell operations procedure does not include important steps that should be followed after completion of cell irradiation (lowering the source into the pool) to guide entry into a cell. The entry procedure does not define the status of the cell ventilation system, the time required before cell entry, which is dependant on the status of cell ventilation and the source intensity, or the requirements for ozone testing. The cell re-entry process is currently performed based on operator training.

- No procedure has been developed to support bypass key operations. The bypass key is used to bypass interlocks to allow the elevator(s) to be raised in a cell with the cell door open when no source is on the elevator.

- The GIF event response procedure is not written in a user-friendly fashion such that consistent subsections are used (e.g., initiating conditions, immediate actions, and follow-up actions), so that GIF operators are able to find the required information more efficiently when responding to an abnormal condition.

- Many of the GIF operating procedures have not been updated to the revised format shown in the TA-V Conduct of Operations Manual, Chapter 16. The revised format includes adding sections addressing precautions, limitations, and prerequisites. The facility supervisor's strategy for updating these procedures was to start when the new DSA was approved; however, the approval of the new DSA has not been timely. The new format has been utilized for the few procedures that were recently revised.

**Finding #25. SNL has not established formal GIF operating procedures to control some potentially hazardous processes, including re-entering a cell following irradiation, and using the bypass key to permit a raised elevator in a cell with the cell door open.**

**Operator Performance.** During the review, the team observed GIF operators performing work. In general, when the process was clearly defined in an approved operating procedure the task was adequately performed.

For example, in-pool source handling was conducted to remove a single-pin source and replace it with the twenty-pin source on the cart for cell #3. The operators and radiological control technicians (RCTs) properly conducted this operation in accordance with GIF operating procedures. The pre-job briefing was carefully conducted, and the hazards and controls were thoroughly discussed. The task team used only the authorized handling tools, as defined in the procedure. The source movement was conducted over two days. At the end of the first day, difficulty was encountered with moving the twenty-pin source. Work was appropriately stopped to regroup and ensure that the operators did not become fatigued and potentially make mistakes. When the work was recommenced the next day, the method for moving the twenty-pin source was improved, and the visibility in the pool was greatly enhanced by using the camera light and camera display. The operations proceeded without any significant problems. The operators and RCTs work well together as a team.

As a second positive example, irradiation was conducted in cell #3 in order to perform the "Acceptance Test Procedure for the GIF Cell Shielding." The test procedure was performed because the cell #3 raised source strength was higher than previously accepted. The cell operations procedure was correctly followed and the test steps were completed as required. The pre-job briefing was thorough and included emphasis on how visitor access would be controlled until the shielding results could be verified. The GIF operator meticulously followed and signed off steps in the cell operations procedure checklist. Overall, the operation was appropriately performed. Ozone measurements in the cell were taken 30 minutes after the elevator was lowered, and no trace of ozone was found. This measurement was performed to ensure that ozone would not be encountered during cell reentry.

In contrast, the operations associated with the use of the cell bypass key were not rigorously performed to a procedure. During the operation, the participants (three facility operators and the facility supervisor) experienced some confusion about how to conduct the operation. As a result, the setup using the bypass key had to be repeated. In this activity, maintenance was performed on the cart in cell #3 by using the bypass key. This work required the elevator to be lifted into the cell without a source to allow work to be performed on the cart that rides on top of the elevator. No operating procedure had been developed for this particular operation. It involves having the facility supervisor verify that no source is on the elevator to be raised. He completed this requirement by visually looking at the cart, which was on the bottom of the pool, through binoculars. This step was informally validated by a facility operator. The bypass key is obtained from the facility manager, and then the bypass key is used on the cell control system to allow entry into the cell while the elevator is up. The bypass key bypasses the elevator interlocks with the cell door, which normally causes the elevator to lower when the cell door is opened. The operator and facility supervisor attempted to use the cell operating procedure to conduct the operation, but the procedure had not been modified to include steps to use the bypass key. The bypass key was used but it was not effective in keeping the elevator in the up position with the cell door open. The process was restarted after the elevator went to the bottom of the pool when the cell door was opened. The bypass key was then used with the cell door open based on operator knowledge.

The GIF facility supervisor and operators recognized, at the time the elevator was first raised, that the cell operating procedure could not be followed when using the bypass key. The field supervisor and operators paused work to discuss the path forward. A verbal decision was made to continue the operation using the bypass key with the cell door open. However, contrary to requirements in the Conduct of Operations Manual, Chapter 16, written changes were not made to the cell operating procedure before proceeding with the task.

**Operator Training and Qualification.** A formal qualification process for the GIF operators has been established and adequately implemented. There are currently five operators who have completed the formal qualification process. The required GIF operator's qualification card has been defined and contains the necessary detail to ensure that operators are fully qualified. A few completed operator qualification cards were reviewed, and the cards properly documented completion of the required training and tasks.

TA-V has assigned a training coordinator to assist/manage the qualification and requalification processes. The qualification process was supported by a formal training program that includes well-defined lesson plans, lectures, and tests. Continuing/requalification training has commenced and is being adequately performed.

Interviews were conducted with a couple of operators to determine their knowledge of key safety systems and cell operations. The interviewed operators had a solid understanding of the elevator power interrupt circuit and the operation of the cell elevators. The interviewed operators were also knowledgeable of the appropriate response to abnormal events/conditions. There was some confusion with one operator on the current list of cell modes. In this case, the operator answered the question in regard to the currently pending DSA revision cell mode definitions, which are different from the currently approved DSA definitions.

**Summary.** Many operations at GIF are adequately defined in well-written operating procedures. In general, operations are performed in a rigorous manner to these operating procedures. The operators are fully qualified and knowledgeable of the different systems in the GIF. One weakness with operations is that formal procedures have not been promulgated for some potentially hazardous activities, such as reentry into a cell following irradiation and bypass key operations. In addition, SNL personnel did not recognize the need to stop procedure evolutions when a procedure was found to be deficient.

## E.3 CONCLUSIONS

The ACRR DSA has a number of potential deficiencies that warrant further investigation. The main area of concern is with the assumptions used in the seismic event accident analysis and with the lack of appropriate designation of the pool liner, reactor piping, and rod control system as safety-significant/safety-class.

The ESF review at GIF focused primarily on the pool, the irradiation cells, the elevator power interrupt subsystem, and the radiation monitoring system. These SSCs were generally robust, simple, and appropriately designed to perform their safety function. Most aspects of the maintenance and testing programs were adequate, and operator training and operating procedures were generally adequate.

However, weaknesses were identified at GIF, primarily in design and configuration management. The design of the source elevator power interrupt system was inadequate with respect to the source elevator descent speed. Several SSCs were not properly classified as safety-significant in the DSA. Numerous DSA supporting analyses were inadequate or missing. Weaknesses were identified with the configuration management program and its implementation. Weaknesses were also identified with the SNL USQ program, which is used at GIF.

## E.4 RATINGS

Engineering Design........................................................................................NEEDS IMPROVEMENT
Configuration Management ........................................................................... SIGNIFICANT WEAKNESS
Surveillance and Testing ............................................................................EFFECTIVE PERFORMANCE
Maintenance ...............................................................................................EFFECTIVE PERFORMANCE
Operations .....................................................................................................NEEDS IMPROVEMENT

## E.5 OPPORTUNITIES FOR IMPROVEMENT

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

1. **Improve engineering design and configuration management.** Specific actions to consider include:

- Perform a thorough review of the existing GIF DSA and the 2004 revision of the DSA, which is not yet approved, to detect and address the following specific areas of concern:

  - Safety classification of SSCs. Starting with the SSCs discussed in this report, identify *all* of the SSCs in the facility that perform any safety function, as defined by the DSA, and change the DSA to completely describe those functions and to apply the appropriate safety designation to those SSCs.

  - Missing or inadequate DSA analyses and supporting calculations. Starting with the missing/inadequate analyses addressed in this report, identify all statements or implications in the DSA of specific functional capabilities, both active and passive, of SSCs that are or should be identified as safety-significant. For each of these capabilities, locate the analyses and/or test documents that demonstrate these capabilities for the design basis cases, review these documents to verify that they are complete and correct, and properly catalogue and store them so that they are readily retrievable for future reference. If the appropriate documents cannot be located, then regenerate them. Make the appropriate DSA changes to reflect the new information obtained by this evolution.

  - Miscellaneous other DSA discrepancies. Starting with the miscellaneous discrepancies identified in this report, review the DSA for any additional discrepancies, and make corrections as appropriate.

- Perform a complete load drop analysis for the GIF crane, to include analyses of the potential safety targets, such as the irradiation cells and the pool, to determine their structural vulnerabilities. Where such vulnerabilities are identified, formulate and place into effect compensatory measures to reduce the associated unmitigated risks to acceptable levels, such as formal, proceduralized load path and height restrictions, and pre-staged, quickly available backup water sources of sufficient capacity for emergency pool replenishment. Document all of these actions as appropriate in DSA revisions.

- Determine the pool design temperature limit for the pool water to ensure that the pool's structural integrity (for both the reinforced concrete and the stainless steel liner components of the pool) is maintained. Verify that for the worst design basis case (maximum heat load, worst design basis heat transfer conditions, i.e., no forced ventilation, pool covers in place, etc.) the pool temperature will not exceed the pool design temperature limit. Revise the DSA to reflect these activities.

- Begin to formulate the basics of configuration management by formally defining the fundamental elements that should be applicable to a Category 3 nuclear facility, such as the GIF (e.g., document control, design control, and procurement control). For each of these elements, define the components that make up that element (e.g., for design control, the components typically include procedures for generating design modifications, calculations (procedure presently exists but needs refinement), specifications, design verification, replacement item equivalency evaluation, etc).

  - A design modification procedure, for example, would describe the methods and responsibilities for performing the design activities for modifications, such as a description of the difference between a design modification and other similar activities, such as maintenance; the required contents of a design modification package, such as definitive descriptions, drawings, specifications, supporting calculations, installation instructions, required associated document changes, such as for operating procedures, maintenance procedures, the DSA, and the TSRs, required post-modification testing and acceptance criteria; and required review, verification, and approval processes and responsibilities.

  - As these procedures are developed, rigorously use them in the execution of facility activities.

- Revise the site USQ procedure to correct the discrepancies identified by this assessment. Revise the USQ training accordingly, and conduct updated training for all personnel presently qualified to perform USQ activities.

- Review the GIF USQDs identified in this report as having errors, correct the errors, and take appropriate actions as required by the site USQ procedure.

- Evaluate other nuclear facilities to determine the need for similar actions/improvements.

2. **Improve maintenance and surveillance.** Specific actions to consider include:

- Perform a maintenance review with appropriate SNL subject matter experts, vendor technical staff, and SNL crane inspection staff to determine appropriate frequency and procedures for exercising and maintaining the GIF crane to ensure proper operation.

- Restructure the GIF annual preventive maintenance surveillance so that related components are scheduled for work within the same time periods.

- Formalize a system for notifying GIF supervisors of completed FMOC work, on a day-to-day basis.

3. **Enhance the GIF operating procedures.** Specific actions to consider include:

- Develop and approve an operating procedure for re-entering a cell after the completion of irradiation. The procedure should address the required wait time for entry, dependent on cell ventilation configuration (mode), as well as the appropriate sampling requirements for ozone.

- Develop and approve an operating procedure for the use of the bypass key that is required to raise an elevator(s) in a cell with the cell door open. The procedure should document the independent verification that a source is not in the elevator(s). The procedure also should include steps that raise the elevator with the cell door shut to allow further validation visually through the cell window that the elevator does not contain a source before using the bypass key to raise the elevator with the cell door open.

- Develop a history file for the operating procedures to retain documents that support procedure development and revision. Emphasis should be placed on retaining information that supports set points or technically based action steps so that these steps will not be inappropriately revised during future reviews.

- Establish a formal procedure verification and validation process to ensure that new/revised procedures are thoroughly reviewed and that comments are addressed. Results from completed verification and validation reviews should be shared with other review teams during future reviews.

- Revise the GIF event response procedure to a format that is user friendly.

- Revise, as required, the GIF operating procedures, to the format defined in the TA-V Conduct of Operations Manual.

4. **Institute training on a safety-conscious work environment.** Institute training for all facility staff on the fundamentals of a safety conscious work environment in nuclear facilities, including the applicable rules, regulations, codes, and standards; the significance and use of procedures; the required rigor, discipline, attention to detail; and other related topics.

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# APPENDIX F

# Management of Selected Focus Areas

## F.1 INTRODUCTION

The U.S. Department of Energy (DOE) Office of Independent Oversight and Performance Assurance (OA) inspection of environment, safety, and health (ES&H) at Sandia National Laboratories (SNL) included an evaluation of the effectiveness of the Sandia Site Office (SSO) and the contractor in managing selected focus areas. Based on previous DOE-wide assessment results, OA identified a number of focus areas that warrant increased management attention because of performance problems at several sites. During the planning phase of each inspection, OA selects applicable focus areas for review based on the site mission, activities, and past ES&H performance. In addition to providing feedback to National Nuclear Security Administration (NNSA), SSO, and SNL, OA uses the results of the review of the focus areas to gain DOE-wide perspectives on the effectiveness of DOE policy and programs. Such information is periodically analyzed and disseminated to appropriate DOE program offices, sites, and policy organizations.

Focus areas selected for review at SNL were:

- Implementation of DOE Order 450.1, *Environmental Protection Program* (see Section F.2.1)
- Hoisting and rigging (see Section F.2.2)
- Safety systems oversight (see Section F.2.3)
- Chronic Beryllium Disease Prevention Program, or CBDPP (see Section F.2.4)
- Safety in protective force training (see Section F.2.5).

OA has also identified corrective action management as a focus area. Corrective action management systems, as implemented by SSO and SNL, are discussed in Appendix D as part of the overall feedback and improvement process.

The scope of the review activities for each of these areas is further discussed in the respective subsections in Section F.2. Where applicable, the results of the review of these focus areas are considered in the evaluation of the core functions and feedback and improvement systems.

## F.2 RESULTS

### F.2.1 Environmental Management System and Pollution Prevention Program

OA identified the environmental management system (EMS) as a focus area across the complex in response to DOE Order 450.1, which requires implementation of EMS at DOE facilities by December 31, 2005. At SNL, the EMS is being prepared and will be implemented as part of the SNL integrated safety management system (ISMS), and the EMS will integrate P2 activities. OA reviewed SSO and SNL EMS and pollution prevention (P2) implementation activities, focusing on the requirements of DOE Order 450.1. The OA team reviewed environmental policies, environmental requirements, site procedures, guidance, implementation plans, and site publications. In addition, the OA team observed work associated with environmental programs, and interviewed SSO and SNL personnel who were involved with the establishment and implementation of the EMS at SNL.

**SSO.** SSO has set expectations for and closely monitored SNL EMS implementation and the P2 Program. For example, SSO actively participates in SNL meetings that address the EMS, including the biweekly EMS corporate team meeting. Also, SSO has used NNSA Service Center technical support personnel to conduct rigorous reviews of the SNL P2 program every other year.

SSO plans to lead the independent verification of SNL's self-declaration of EMS implementation and plans to use SSO personnel that were directly involved in EMS development to lead the verification process. However, SSO has not evaluated its approach to determine whether personnel on its verification team meet the requirements and intent of DOE Order 450.1 guidance for independence of the verification team.

One of the performance objectives in SSO's Performance Evaluation Plan (PEP) for SNL (i.e., Performance Objective #8, "Business and Operational Support") addresses the ES&H program as well as eight other business and operational programs. The EMS is identified as one element of the ES&H program under this performance objective. However, there is no specific information or target milestone for measuring EMS performance and progress.

**SNL.** SNL has a goal of becoming the ES&H "Best in Complex" among nuclear weapons laboratories in three years, and "Best in Class" within a decade, and the EMS is part of a systematic approach to managing continuous environmental improvement in support of this goal. The SNL concept for an EMS has been evolving since 2000 based on ISO 14001, the Code of Environmental Management Principles for Federal Agencies, and the New Mexico Environment Department Green Zia Environmental Excellence Program. Based on evaluation and benchmarking, SNL has adopted the DOE Order 450.1 EMS model (as described in DOE Guide 450.1-1) and plans to implement it by the December 31, 2005, deadline.

SNL has made considerable progress in the preparation of EMS documentation, identified approximately 20 sitewide environmental aspects and goals, and instituted several actions to implement EMS. For example, an EMS corporate team consisting of environmental staff and managers has been established to manage the sitewide EMS program and facilitate the establishment of EMS requirements within the various SNL divisions. The EMS corporate team uses biweekly meetings to provide a good mechanism for exchanging ideas, discussing the concerns from various divisions, and resolving problems. An SSO representative and a representative from the line divisions' ES&H coordinators attend these meetings regularly. Environmental protection representatives and line ES&H coordinators have also been identified to assist with establishing the EMS requirements in the divisions and to assist the divisions' implementation of the requirements. In 2004, SNL initiated a pilot program in three divisions to evaluate environmental aspects and impacts and develop division-level goals. Currently, SNL divisions are being evaluated by the EMS corporate team using the sitewide aspects and impacts, and efforts are ongoing to obtain senior management commitment for the EMS goals.

SNL has adequate ongoing efforts to provide for communications and training. An EMS communication plan has been drafted, and an EMS website is being established. SNL conducted EMS sitewide awareness training and community outreach programs. Chapter 10, "Environmental Protection," and Chapter 19, "Waste Management," of the SNL ES&H Manual are scheduled to be revised in the June/July 2005 timeframe to incorporate the specific EMS requirements. The ISMS description document is scheduled to be updated to specifically include EMS corporate and division environmental aspects and targets once they are finalized and approved by senior SNL management.

A draft SNL EMS implementation project plan was submitted to SSO for review on March 15, 2005. The purpose of this implementation project plan, when accepted by SSO, is to provide a roadmap for integrating EMS with ISMS, communicate implementation progress, define the process for self-declaration of EMS implementation, and establish management commitments.

As part of the EMS implementation project plan, SNL plans to use the corporate independent assessment mechanism, Department 12870 (ES&H, Quality, Safeguards and Security Assessments), to evaluate SNL EMS status in May 2005 and to determine whether EMS preparation is complete and meeting DOE Order 450.1 requirements before their self-declaration. Based on the SSO/SNL-approved EMS implementation schedule, the site is expected to self-declare the EMS in place in December 2005. SSO will review the Department 12870 assessment results and identify any additional required actions at that time.

The SNL P2 program includes several noteworthy practices that are implemented or in the process of being implemented. These practices include: having line organizations directly fund P2 staff to facilitate division efforts to meet waste reduction goals; developing a construction specification to mandate the recycling of construction wastes/materials; using a systematic process to reduce the total number of chemicals used for custodial work (from 125 to 9); and using a Construction/Demolition Recycling Center for small construction projects' waste recycling. The SNL P2 program has received several P2 awards in 2004 and 2005, including NNSA P2 awards, the White House Closing the Circle award for environmentally preferable purchasing, NNSA P2 "Best in Class" awards for Sandia's First Green Building and for decontamination and decommissioning waste recycling and management, NNSA P2 environmental excellence awards, the New Mexico Recycling Association Federal Recycler of the Year award, and the City of Albuquerque Industrial Pretreatment Excellence award.

To integrate the P2 program in the EMS, SNL has dedicated personnel that interface with the divisions and uses environmental protection representatives and ES&H coordinators to identify P2 opportunities in divisions and seek line funds for P2 projects. Although SNL continues to have an effective P2 program, the shift in waste management funding from the Office of Environmental Management to the NNSA places more responsibility on the SNL divisions to fund P2 projects. (The centrally managed P2 program for sites to solicit funds to implement P2 projects ended with the transfer of the funding.)

**Summary.** SSO and SNL actions to implement an EMS are appropriate. SNL is using central environmental staff and managers, line representatives, and ES&H coordinators to develop, integrate, and implement the EMS as part of the broader ISMS program. SNL implementation plans and ongoing efforts in such areas as communication and training are adequate and on schedule, and SNL has appropriate plans for performing a corporate assessment prior to self-declaration. As part of EMS, SNL continues to have a proactive P2 program that has achieved reductions in waste volumes and received several awards. Sustained management attention is needed to ensure that the P2 efforts continue to be effective with the new funding model.

SSO has closely monitored SNL EMS efforts and actively participated in the development efforts. However, SSO does not have a specific process for measuring and evaluating SNL performance in implementing EMS and has not identified a strategy for verifying SNL's self-declaration that ensures sufficient independence of the verification team leadership.

### F.2.2 Hoisting and Rigging

OA identified hoisting and rigging as a focus area because OA inspection results and site occurrence reports indicate a number of sites have experienced events, near misses, and injuries during hoisting and rigging activities. OA reviewed hoisting and rigging activities performed by SNL during programmatic and maintenance work and by subcontractors during construction activities. The review of the SNL hoisting and rigging program included observation of lifting activities and crane maintenance, review of hoisting and rigging procedures, and inspection of hoists, slings, lifting fixtures, and cranes in shop areas, work sites, and construction sites.

SNL currently uses the 1999 version of the DOE hoisting and rigging standard. Neither the 2001 nor the 2004 version has been adopted by SNL or added to the SNL contract by SSO. Consequently, some requirements that were added in the 2001 standard are not being met. For example, the 2001 standard added an entirely new chapter that covered operation, inspection, testing, and maintenance for miscellaneous lifting devices, including truck-mounted cranes with a capacity of 1 ton or less, portable automotive lifting devices (PALDs), and self-contained shop cranes. Many of these devices are in use across SNL by line programs. Most of these devices are not marked in accordance with the 2004 standard and are not being tested or inspected in accordance with the 2004 standard. One PALD observed in the basement of a building appeared to have been modified from the manufacturer's configuration and had no record of being weight tested or inspected. Another change made in 2001 was the inclusion of the American Society of Mechanical Engineers (ASME) B30.9 requirements for marking and inspection of wire rope slings; this change has not been implemented at SNL. Finally, the 2004 standard extended several chapters (1, 2, 4, and 7 – 14) on construction activities. These chapters contain many inspection and test requirements for hoists, slings, critical lifts, overhead and gantry cranes, wire rope and slings, and rigging accessories that are not being applied in construction activities at SNL.

A portable lifting frame was located outside the Building 887 shop and apparently had been there for several years. The frame had no indication of its load rating or whether it had been inspected. The shop supervisors did not know who the frame belonged to, what it was used for, or why it was there.

**Finding #26. At SNL, requirements for inspection, testing, and maintenance of miscellaneous lifting devices have not been implemented in accordance with Chapter 16 of the current DOE hoisting and rigging standard.**

**Z Machine.** Department 1636 has established a detailed procedure and a daily inspection checklist for operation of the three bridge cranes owned by the department. The daily inspection verifies proper operation of the crane, including stops, and includes a visual inspection of the lifting hook and wire rope. The inspection sheet is laminated and kept with the crane, so that another operator can verify that a daily inspection has been performed prior to use. Department 1636 has also implemented a crane qualification card for crane operators, which requires retraining every three years. A possible discrepancy is that the annual inspection for the main bridge crane was overdue, possibly because of beryllium concerns in the building. The facility and the cognizant system engineer (CSE) have granted due-date extensions for the last two months based on an evaluation of the cranes normal use and detailed daily inspections. These extensions are allowed by the SNL ES&H Manual; however, the DOE standard and Occupational Safety and Health Administration (OSHA) requirements make no provisions for extending annual inspections. Normal practices for preventive maintenance would allow extension of preventive maintenance, not to exceed 25 percent of the normal periodicity. Consequently, the annual inspection should not be extended beyond April 24, 2005 (three months). The current extension expires March 28, 2005. Facility and Facilities Management and Operations Center (FMOC) personnel were working during the inspection to accomplish the annual inspection before the current extension expired. Observation of hoisting activities in Z Machine indicated no discrepancies with operation of the crane or lifting activities.

**GIF Facility.** Annual and monthly crane inspections were current for the 15-ton GIF crane. A potential problem was identified with the load brake on this crane (see Appendix E). This crane is used only occasionally and is typically not used for periods of over six months. In accordance with the DOE hoisting and rigging standard, cranes that are not used for more than six months should be inspected in accordance with the annual inspection requirements; however, this requirement has not been clearly established for the GIF crane.

**FMOC.** Two overhead rail hoists are installed in the Building 887 shops. One hoist has been tagged out because it is no longer needed. The second hoist was current on its annual inspection and had a recorded weight test date of January 21, 1999. There was no indication that other monthly or quarterly inspections in accordance with the hoisting and rigging standard were being accomplished.

Because controls for hand-chain-operated and lever-operated hoists have not been effectively established and workers were not aware of the controls, several hoists were procured or otherwise available for use by individual shops/teams without being placed into the SNL system. Three uncontrolled chain hoists and an uncontrolled boom hoist installed on an outside utility maintenance truck were identified during shop walkdowns. FMOC subsequently identified 12 additional chain hoists and a second outside utility maintenance truck boom hoist that had not been inspected. Those hoists were subsequently inspected or weight tested as necessary and were assigned a local tracking number to ensure that required inspections will be performed in the future. Three of the hoists were removed from service after failing the inspections. FMOC is planning to develop a procedure for the use and control of hoisting, rigging, and fall protection equipment that will establish processes for the purchase, issuance, control, and inspection of that equipment within FMOC. The new procedure is expected to take approximately three months to implement.

**Finding #27. At SNL, controls for the procurement, testing, inspection, and use of hand-chain-operated or manual-lever-operated hoists are inadequate to ensure that hoists are tested and inspected as required by Chapter 8 of the DOE hoisting and rigging standard.**

The warehouse had several lifting slings that were available for issue. A colored tag is attached to those slings, which indicates that the inspection is current for the calendar year. Inspection records were available for the slings; however, specific procedures that define inspection and marking requirements for slings and other lifting equipment have not been developed.

**Construction.** The 1999 version of the DOE hoisting and rigging standard, although not referenced in the Microsystems and Engineering Sciences Applications (MESA) 01065-S specification, has been included in the MESA construction contracts through incorporation into design drawings and specifications; however, those requirements have not been included in other construction contracts.

SNL requires that all cranes brought on site by subcontractors be inspected by FMOC prior to use. These inspections were being performed. In one case, the crane inspection process was proactively applied to the hoisting components of a drill rig to be used for pier drilling at the Weapons Integration Facility (WIF) construction project. Although a drill rig is technically not considered a crane, the inspection revealed some wire rope and lifting hardware deficiencies. As a result, the WIF construction subcontractor required the drilling subcontractor to repair or reconfigure the hoisting components before using the drill rig.

Construction at the MESA WIF included erection of a 185-foot tower crane. Inspection records for the tower crane and for two subcontractors' below-the-hook hoisting and rigging equipment at the MESA WIF construction site were maintained and current. The initial tower crane inspection was conducted by the supplier following erection, since SNL does not maintain certification in tower crane inspection; however, the SNL crane inspector participated in the process. The inspection was conducted by Maxim Crane Works, and a certificate of test/examination was issued on November 15, 2004. Monthly crane inspections conducted by the operator were current and included: limit switches, lines, hooks, frame members, fasteners, brakes, controllers, fire extinguishers, and other such equipment. Additionally, a daily crane log is maintained that includes the status of lighting, fire extinguishers, limit switches, line leaks, operability, hooks, chains, wire rope, slings, condition, warning devices, posting of hand signals, and load rating charts. A review of the tower crane erection/inspection included the Federal Aviation Administration permit as well as the actual assembly steps and procedure. Crane operator certification was verified, and both operators were current with their 16-hour "Crane & Rigging Certification" training.

During this OA inspection, there was a near-miss event involving hoisting and rigging by a construction subcontractor. A 9000-pound damper was being lifted into position when one of the attachment points failed and the damper dropped, damaging an oxyacetylene welding rig, which subsequently ignited. Although SNL had not completed its analysis of the event, their preliminary results indicated some significant problems with the contractor's preparation for the lift. The lift plan used by the contractor was not applicable to the lift. The plan was developed for use of lifting points provided by the manufacturer for an installation above the duct. The actual lift was made using different lift points, designed and installed by a subcontractor, to install the damper below the duct.

New lifting attachments installed by the contractor were not adequately evaluated. The manufacturer was not consulted regarding the location of the new lift points. In addition, evaluation of the lift points by the contractor was not sufficiently thorough to identify the lack of fusion in a supporting weld. The area below the lift was not adequately barricaded by the contractor. After the fall, a portion of the damper came to rest outside the area that had been barricaded to restrict personnel access. The contractor had assumed the load would fall straight down if the rigging failed. The load actually swung to one side after the first lift point failed, causing it to land in an area that was not anticipated and that was not barricaded to prevent personnel access.

SNL did not independently review the subcontractor's lift plan. SNL subject matter experts (SMEs) independently review plans for lifts that have been classified as "critical lifts" by construction subcontractors. The construction subcontractor did not classify the damper lift as a critical lift and thus did not obtain SNL approval of the lift plan. SNL agrees with the subcontractor's classification but believes that had the lift been classified as a critical lift, the subsequent independent review of the lift plan would have likely prevented the event.

SNL has not clearly conveyed its expectations for lift plans in construction contracts. SNL expects construction subcontractors to prepare and obtain lift plans for lifts of 10,000 pounds or more, but this expectation is not stated in construction contracts. The 1065 specification included in construction subcontracts requires contractors to prepare a critical lift plan for lifts that present "unacceptable risk of personnel injury" and for lifts that require "exceptional care in handling because of size, weight, close-tolerance installation, high susceptibility to damage, or other unusual factors." These criteria require judgment and may not be applied consistent with SNL expectations. There are no contractual requirements specifying the content of a lift plan or for obtaining SNL approval (see Appendix C under "Construction").

**Summary.** Hoisting and rigging activities at SNL are not meeting the current DOE standards. Inspections for hand-operated hoists and miscellaneous lifting equipment are not being conducted to ensure that rigging equipment used by workers is safe. Although SNL has adopted the DOE hoisting and rigging standard, they have not issued adequate local procedures to implement the standards and ensured that the standards are implemented by all construction subcontractors. Overall, hoisting and rigging by SNL personnel and subcontractors needs improvement.

### F.2.3 Safety System Oversight

OA selected safety system oversight as a focus area because DOE requirements in this area are relatively new, and previous OA inspection results indicate that a number of deficiencies in engineered safety systems could be corrected and prevented by effective safety system oversight. To assess this area, OA interviewed SNL and SSO personnel, reviewed various documents and procedures, and examined training and qualifications. OA focused on oversight of the safety and defense-in-depth systems of Technical Area (TA)-V nuclear facilities.

**SNL System Engineer Program.** SNL recently took some positive steps to implement the requirements of DOE Order 420.1A, *Facility Safety,* for a CSE and configuration management program for TA-V nuclear facility safety systems. SNL issued a few key administrative instructions to describe program responsibilities, training and qualification requirements, system walkdowns, and requirements for developing system design description (SDD) documents. SNL has identified 25 safety and defense-in-depth systems to be covered by the program, and has assigned those systems to individuals designated to become CSEs.

However, the effort to implement a system engineer program was significantly delayed, and SNL management generally has not given sufficient priority and attention to its implementation. SNL was late in complying with the April 1, 2004, target milestone for defining the system engineer program as required by SNL's implementation plan for DOE Order 420.1A. SNL did not issue a TA-V administrative instruction that describes program responsibilities and requirements until October 1, 2004, six months after the DOE target milestone.

SNL's implementation plan for meeting the system engineer program requirements of DOE Order 420.1A does not adequately delineate important steps needed to meet major milestones and to track progress. For example, it does not identify the date by which CSEs would be appropriately qualified to execute their duties and responsibilities. Also, the specified completion date for establishing configuration management and developing SDDs is 2011. This timeframe does not demonstrate a proactive approach, and it is not clear how these program elements will support the planned configuration management and system assessment efforts. In June 2004, SNL developed and proposed a revised schedule for completing SDDs in the 2007-2008 timeframe.

SNL's procedure on the CSE training and qualification program adequately describes competency requirements. SNL is developing a detailed plan for training and qualifying the CSEs; however, this plan has not yet been finalized and approved. Training courses and qualification schedules have not yet been developed, and there are no qualified CSEs to date.

SNL has developed a schedule for conducting assessments to cover the set of safety and defense-in-depth systems using a prioritization approach and has begun to perform these assessments. However, this schedule is not integrated with plans for preparing SDDs, configuration management, developing the necessary system review procedures, and training and qualifying the designated CSEs. Furthermore, it is not clear how those assessments would be used in tracking and trending the operability and performance of safety systems.

**Finding #28. The SNL implementation plan for the system engineer program requirements of DOE Order 420.1A is inadequate and has not been implemented as scheduled.**

**SSO Safety System Oversight.** The SSO Functions, Responsibilities, and Authorities Manual (FRAM) appropriately assigns to the Director of Nuclear Facilities and Safety Basis the dual responsibilities to (a) oversee and assess SNL implementation of the system engineer program, and (b) oversee and assess the nuclear facility vital systems.

SSO is in the initial stages of implementing a safety system oversight program. Two system engineers with backgrounds in mechanical engineering and instrumentation and control, respectively, have been assigned to cover the safety systems. Presently, these engineers are in the process of qualifying to the required standards and are making good progress. The two system engineers have the right technical background and are very motivated to perform their duties. These engineers also are working to develop the necessary procedures for the safety system oversight program. SSO is considering the possibility of using engineers with specialized expertise (e.g., fire protection) to complement the designated system engineers to provide better coverage of the systems.

SSO also recently (March 17, 2005) issued an operating procedure describing safety system oversight program responsibilities and expectations. This procedure is consistent with the safety system oversight guidance in DOE Manual 426.1-1A, *Federal Technical Capability Manual*. However, it does not provide adequate site- or facility-specific guidance to safety system engineers. For example, it does not clearly delineate the two office-level responsibilities assigned in the FRAM, and it does not describe which SNL programs, processes, or mechanisms (such as, configuration management, SDDs, maintenance management, and change control) would be reviewed for the selected systems. It does not identify which methodologies, tools, and products, (e.g., SNL and SSO documents and system databases) would be used to monitor, track, and trend SNL's program and safety system performance.

SSO is now planning to perform assessments of the complete set of systems to establish a baseline. SSO prepared a draft guide on developing and maintaining a master oversight plan for performing periodic surveillances and other activities linked to system engineer responsibilities described in the operating procedure. However, there is no formal assessment plan or schedule, and the system engineers have not yet conducted formal safety system oversight assessments, surveillances, or other specific activities as part of the proposed program.

Furthermore, SSO has not provided adequate oversight of SNL's development and implementation of the CSE and configuration management program for TA-V nuclear facilities. SSO did not act to prevent SNL's significant delay in developing a CSE program in accordance with the schedule in the DOE Order 420.1A implementation plan. SSO provided comments to SNL regarding its implementation plan for DOE Order 420.1A and received the SNL response, but SSO did not follow up to obtain an adequate formal plan. The lack of an adequate commitment tracking system may have also contributed to this problem.

SSO has not yet completed a review of the list of safety and defense-in-depth systems included in SNL's CSE and configuration management program. It also has not completed a review of the schedule proposed by SNL in October 2004 for developing SDDs. Additionally, the designated safety system engineers, who are presently in training, have not participated sufficiently in assessments of safety systems. SSO has not taken adequate compensatory measures, such as requesting the assistance of the NNSA Service Center or outside experts, to assess the SNL CSE effort, the configuration management program, SDD development, or system assessments.

**Finding #29. SSO has not provided adequate oversight of SNL's implementation of DOE Order 420.1A system engineer program requirements.**

**Summary.** SNL has not been timely or proactive in implementing DOE Order 420.1A requirements for a system engineer program, which includes CSE support and configuration management for TA-V nuclear facility safety systems. SNL did not comply with the schedule in its implementation plan for defining the program. SNL has recently initiated concerted efforts to implement the system engineer program, to include developing certain pertinent procedures. However, the implementation plan is inadequate with respect to specifying the schedules for completing training and qualification of CSEs, developing SDDs, and establishing configuration management. SSO has also recently begun its effort on a safety system oversight program, but so far has not provided adequate oversight of SNL's implementation of the system engineer program.

### F.2.4 Chronic Beryllium Disease Prevention Program

DOE has established regulatory requirements for the CBDPP in Title 10 of the Code of Federal Regulation (CFR), Part 850 (10 CFR 850). The rule is intended to protect workers and prevent exposure to beryllium, establishes voluntary medical surveillance requirements to ensure early detection of chronic beryllium disease, and requires a reduction in the number of workers currently exposed to beryllium in the workplace. DOE also developed guidance (DOE Order 440.1-7A) to assist line management in meeting their responsibilities for implementing the beryllium prevention program. This OA review focused on SSO and SNL implementation of the CBDPP rule and the effectiveness of the SNL implementation of the CBDPP.

SNL safety and health personnel, in conjunction with the responsible DOE Headquarters and site organizations, began to establish elements of a beryllium prevention program as early as 1997. In 2001, the SNL CBDPP was submitted and approved. DOE personnel in SSO and the NNSA Service Center were actively involved in the development and review of the 2002 version of the SNL CBDPP and subsequent revisions. Documentation indicates that the original efforts by SNL personnel to identify and characterize beryllium materials, activities, and potential locations of contamination were consistent with the suggestions in the beryllium program guidance documents (e.g., current and former employees were interviewed, notices asking for information were placed in the plant newspapers, breathing zone and surface samples were taken, records were searched for legacy sample data and procurement data, and focus groups were held at the division level to identify potential activities that would identify beryllium sources).

In late 2003, there was an occurrence at SNL in which a previously beryllium-contaminated overhead crane that had been properly decontaminated was being released to the public without the markings required by 10 CFR 850. This event prompted discussions, investigations, and analysis by SNL and SSO that determined that other beryllium-contaminated items may have been released to the public and that additional SNL facilities and materials had not been accurately characterized for beryllium. The investigations also identified numerous weaknesses in the original CBDPP program analysis, documentation, sampling, and characterization processes. A comprehensive corrective action plan was developed, and a Corporate Issue Management Team was established to manage corrective actions, implement a communication plan, and determine (to the extent possible) all current and legacy sources of beryllium. Since then, SNL has taken an additional 18,500 beryllium-related samples, performed exhaustive site characterization studies of nearly 100 SNL facilities, completed a self-assessment of the New Mexico CBDPP, and revised beryllium awareness training and the applicable section of the site ES&H Manual.

Continued attention is needed to ensure that several ongoing program-related corrective actions are completed and verified to be effective, that corrective actions for the beryllium program self-assessment findings are completed and verified to be effective, and that contamination control at the site activity level is enhanced (see Appendix C under "Z Machine"). In addition, many significant lessons learned were derived from the 2003 occurrence and resulting corrective actions, but these lessons learned have not been adequately captured and disseminated for the benefit of the DOE complex.

The incidence of beryllium sensitization and disease at SNL sites has been very low. Elevated breathing zone samples have not been routinely identified, and effective controls are in place when airborne beryllium is a concern. Continuing efforts to control both surface and breathing zone beryllium contamination will help to maintain current injury and illness statistics.

The voluntary medical surveillance program is an integral component of the CBDPP. An SNL occupational health physician has been assigned the responsibility to manage and develop the medical components of the CBDPP. The medical staff has participated in campaigns to identify, educate, and counsel individuals with beryllium concerns or potential exposures and has referred individuals to specialists as necessary. Following the 2003 beryllium event, SNL medical staff participated in both site and public forums to help answer questions and concerns with the occurrence and the CBDPP. The medical program will also accommodate all subcontractors or private citizens that may have had contact with beryllium through contracts or procured services from SNL. The current medical program documents are comprehensive and properly reference 10 CFR 850 requirements.

**Summary.** With the recent enhancements, the current SNL CBDPP and medical surveillance program are generally adequate. However, a number of ongoing corrective actions need to be monitored by SNL and SSO ES&H personnel to ensure their effectiveness and to ensure that surface-contaminated areas are properly controlled and adequately decontaminated to prevent any additional occurrences. In addition, the program deficiencies revealed by the 2003 event indicate that the original development of the CBDPP did not receive sufficient SNL management attention and review. SSO will need to follow up on the implementation of the specific CBDPP for the Z Machine, which was developed as one of the corrective actions for the 2003 event, especially at the activity level to assure that requirements and controls have adequately flowed to the line managers responsible for implementing the site-specific beryllium controls.

### F.2.5 Safety Management for Protective Force Training

A recent Inspector General report identified weaknesses in some aspects of site Basic Security Police Officer Training programs and identified a need for increased safety management for protective force training. The DOE corrective action plan for the weaknesses identified in the Inspector General report committed OA to examine selected aspects of protective force training from a safety management perspective on OA ES&H inspections.

At SNL, OA reviewed Appendix G of the site contract for applicable directives pertaining to DOE firearms training and qualification requirements, and interviewed SSO and SNL personnel, including protective force personnel, safety coordinators, Safety and Industrial Hygiene staff, and assessment/oversight personnel. OA also observed a Security Police Officer (SPO) II and SPO III "refresher" training course that covered a variety of classroom and live-fire exercises. In addition, OA reviewed live-fire course documentation, including live-fire range operating procedures, course-specific lesson plans (SNL and National Training Center), hazard/risk assessment documents, safety checklists, and Industrial Hygiene monitoring data for lead and noise (collected during live-fire range activities). SSO and SNL firearms safety assessments and recently updated firearms-related safety manuals were reviewed. OA also evaluated selected aspects of SNL feedback and improvement activities and SSO line management oversight as it applied to protective force training activities.

**Firearms Range Safety and Hazards Analysis During Protective Force Training.** The observed classroom and live-fire training was well controlled and consistent with the associated course-specific documentation. Protective equipment was extensively discussed and verified by range instructors.

Student/instructor ratios were adequately maintained. Adverse weather conditions were monitored by the lead range instructor, and the instruction times were adjusted to avoid potential hazards associated with cold and snow.

SNL Safety and Industrial Hygiene SMEs are assigned to protective force training/firearms activities. The SMEs participate in hazard/risk assessment development, provide hazard characterization data, assist with functional area assessments, and participate in joint firearms safety committee assignments. SMEs were actively engaged in all aspects of protective force training and have responsibilities for assuring compliance with DOE Standard 1091-96, *Firearms Safety*, as well as site-specific ES&H support for protective force training.

Until 2001, SNL Industrial Hygiene performed extensive monitoring for lead at the live-fire range. The firearms safety standard (1091-96) requires semi-annual lead monitoring of all ranges; however, previous monitoring has consistently indicated no significant lead exposure hazard. SNL indicated that, in accordance with the OSHA 29 CFR 1910.125 lead standard provision, lead monitoring only needs to be performed for new weapon systems. SNL indicated that the previous SSO Industrial Hygiene official officer had been informed of and agreed with SNL's position on this exemption. Although an exemption could be justified, neither SSO nor SNL had documentation indicating the exemption was approved by SSO, and the current SSO safety officer was not aware of the SNL practice.

SNL Industrial Hygiene performs extensive monitoring for noise at the live-fire range, and the results have been analyzed for all existing and new weapon systems used by the SNL protective force. The SNL protective force recently transitioned to new weapon systems that have higher decibel levels. Correspondingly, SNL increased their attention on noise sampling and incorporated some noise monitoring techniques that are more appropriate for live-fire ranges (e.g., focusing on measuring impulse levels rather than sustained sound levels). SNL also recently (February 2005) approved a new guideline for protective force hearing conservation that clearly outlines the hazards and controls associated with impact and impulse noise resulting from firearms and pyrotechnic devices used during training exercises and qualification examinations.

**Protective Force Training Feedback and Improvement.** An SNL firearms self-assessment was completed for 2004 as required. The SNL safety SME has substantial firearms safety experience and has been involved in numerous functional and self-assessment activities of firearms and protective force training. SNL Safety and Industrial Hygiene personnel were actively involved in providing feedback on firearms and protective force training hazards and concerns to line management. SNL established a Sandia Joint Firearms Safety Committee to discuss issues, manage the assessments required by DOE Standard 1091-96, and ensure compliance with SNL corporate policies and procedures. The committee has an appropriate charter and includes line management, SMEs, and protective force representatives.

**SSO Line Management Oversight.** The SSO firearms safety audit was completed for 2004 as required and indicated a good understanding of the current issues associated with the SNL protective force. A firearms safety SME from the NNSA Service Center normally assists SSO personnel in completing their assessments and has mentored the SSO safety staff on general firearms safety.

SSO Safety and Industrial Hygiene personnel adequately work with SSO Safeguards and Security personnel to identify and schedule required oversight activities to monitor SNL firearms safety and protective force training requirements and issues. The SSO protective force manager regularly interfaces with SNL training personnel and SSO ES&H personnel. As a result of these communications, appropriate SSO personnel are aware of most protective force training and safety-related issues.

Although firearms safety and protective force training safety issues are informally communicated and discussed between SSO and SNL personnel, SSO personnel do not regularly receive or maintain information about protective force safety and firearms safety that is relevant to implementing their oversight responsibilities. For example, SSO typically does not maintain copies of contractor self-assessments, Sandia Joint Firearms Safety Committee meeting minutes, revised guideline documents, Industrial Hygiene monitoring data, or hazard/risk assumptions.

**Summary.** Protective force training observed by OA was well controlled and consistent with the associated safety and health documentation. Firearms range safety and protective force training activities are effectively supported by SNL ES&H personnel. SSO and SNL audits and assessments are performed as required, and the various SSO and SNL protective force and Safety/Industrial Hygiene organizations communicate regularly.

## F.3 CONCLUSIONS

The SSO and SNL efforts to implement the EMS are comprehensive and effective, and several aspects of P2 are noteworthy. SSO and SNL are also effectively incorporating ES&H into security protective force training. The CBDPP is supported by SSO and SNL senior management and meets the intent of 10 CFR 850; however, this program initially had weaknesses that were not identified and corrected until SNL experienced an undesired event. Although additional actions and improvements are needed in each of these focus areas, SSO and SNL have devoted appropriate resources and management attention to these areas and have an adequate understanding of the residual deficiencies and needed actions.

Increased management attention is needed, however, in the areas of hoisting and rigging and safety system oversight. SNL was not timely in developing its systems engineer program, and there are deficiencies in SNL's safety basis processes. SNL is now making a concerted effort to address these weaknesses. SSO is making progress in implementing its safety system oversight program but did not take adequate actions to identify and address SNL's deficient progress on the system engineer and configuration management program. SNL's hoisting and rigging program does not meet some applicable requirements, and SSO has not ensured that SNL adopted and implemented updated hoisting and rigging requirements.

## F.4 OPPORTUNITIES FOR IMPROVEMENT

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

**SSO**

1. **Consider expanding or revising Performance Objective #8, "Business and Operational Support," to provide specific performance measures and target milestones for the SNL EMS program.**

2. **Consider using a verification team leader who has not been actively involved in developing the EMS to assess SNL's self-declaration.**

3. **Enhance the review and evaluation of SNL protective force and firearms safety documentation by establishing a formal process and documentation file to capture and archive useful**

**information from contractors that could be used in planning and completing scheduled assessments of protective force training and safety.**

4. **Modify the SNL contract to include the 2004 version of the hoisting and rigging standard in the List A requirements.** Ensure that future changes to the standard are incorporated into the contract within a reasonable time period.

5. **Make the review and assessment of SNL's implementation of the system engineer program a priority.** Specific actions to consider include:

   - Assess and formally comment on the list of safety and defense-in-depth systems included in the SNL CSE and configuration management program.

   - Review the content and schedule of SNL's efforts to implement the program, such as for training and qualification of CSEs and development of SDDs, and determine whether those efforts are properly focused and directed.

   - Consider using external expertise to support contractor oversight efforts while SSO system engineers are in training.

6. **Improve safety system oversight by conducting selected surveillances or partial assessments in parallel with system engineer training and qualification.** Ensure that SSO system engineers either participate to a greater extent in observing contractor's safety system assessments or conduct selected or limited system reviews of their own to improve system oversight, as well as provide more rounded training.

7. **Ensure timely review and feedback to the contractor for safety basis submittals.** Specific actions to consider include:

   - Ensure that long-term actions to implement a shared issues management and commitment tracking system with SNL specifically address tracking of all SSO and contractor safety basis activities and DOE order target implementation milestones.

   - Ensure that SSO development of an interim computer-based commitment tracking system or another suitable mechanism addresses the need for nuclear facility and safety basis staff to specify and track schedules for reviewing, concurring, or approving nuclear safety deliverables.

**SNL**

1. **Complete EMS planning efforts and finalize the draft EMS implementation project plan and the draft EMS communication plan as soon as possible to ensure that senior management's support is formalized and that implementation of the EMS will be sustained.**

2. **Finalize and implement Construction Specification 1505, "Construction Waste Management Plan," to mandate construction waste recycling for small construction projects and further enhance construction/demolition waste recycling**.

3. **Maintain awareness of DOE Headquarters and/or NNSA P2 funding actions taken in response to the Inspector General report, and seek innovative funding mechanisms for executing cost-effective P2 projects**.

4. **Implement the most recent version of the DOE hoisting and rigging standard**. Specific actions to consider include:

    - Perform a gap analysis between the 1999 standard and the 2004 standard to determine which requirements have not been implemented at SNL.

    - Develop training materials and briefings for the other line programs.

    - Inspect all shops and buildings at the Laboratory to identify hand-operated hoists, chainfalls, PALDs, slings, and other lifting equipment purchased or acquired outside the Laboratory purchasing process. Ensure that equipment is labeled, inspected, and tracked for required tests and inspections.

    - Establish a Laboratory procedure that implements the requirements of the DOE Hoisting and rigging standard. Include identification of training and qualification requirements for use and inspection of hoisting and rigging equipment.

    - Ensure that hoisting and rigging equipment removed from service is rendered unusable as soon as possible to prevent unauthorized "reacquisition" of equipment from disposal.

5. **Continue to identify and address potential pathways and activities for inadvertently spreading beryllium contamination within the facility or off site**. Specific actions to consider include:

    - Review experiments or test plans to ensure that lessons learned from the recent Building 888 lightning simulator test contamination incident are considered and that engineering design controls are sufficient.

    - Establish a more detailed re-allocation policy and guidance to identify potential beryllium contamination, especially in machine shop tools and equipment, to include evaluations for internal contamination and methods for ensuring that items with potential internal contamination are controlled and not released.

    - Publish more detailed lessons learned derived from beryllium sample and characterization data, including such details as beryllium found in crane brakes, copper door jams, and non-sparking tools.

6. **Develop a process to more accurately identify and track the number of beryllium-associated workers and the goals for reducing the number of potentially exposed employees.** Consider developing training rosters or other division/facility-specific listings that would more accurately reflect the current beryllium-associated worker population.

7. **Develop a more detailed lessons-learned document to better characterize the SNL investigation of Building 983 beryllium contamination at SNL.** Include insights about the metal alloys used for parts and fixtures, the lack of information available from weapons components that are re-furbished or sanitized, and numerous common products discovered by SNL that have beryllium components, such as door jams, packing materials, and sand-blasting products. Share the lessons learned with the DOE complex.

8. **Update, as necessary, the list of safety and defense-in-depth systems under the system engineer program based on a proper review of the safety bases of TA-V nuclear facilities.** Specific actions to consider include:

   - Review and update the present list of systems using the documented safety analyses that are being or have been revised.

   - Incorporate guidance and lessons learned from the implementation of Defense Nuclear Facilities Safety Board Recommendation 2000-2.

9. **Develop a sufficiently detailed implementation plan for the system engineer program requirements of DOE Order 420.1A.** Specific actions to consider include:

   - Develop a formal integrated schedule for training and qualifying CSEs.

   - Develop a suitable configuration management plan.

   - Develop SDDs, protocols, and procedures for conducting and utilizing safety system assessments, and perform the periodic assessments.

   - Use a graded approach in the implementation effort, as provided in the DOE order.

   - Issue a revised DOE Order 420.1A implementation plan that reflects the detailed integrated schedule.

10. **Consider taking appropriate additional compensatory measures for inadequate safety basis staffing and expertise while corrective actions are being implemented to achieve adequate capabilities.** Recognizing that SNL's plans to add staff, train new and existing staff, and develop processes and procedures may take years, SNL should consider augmenting its capabilities in the interim by obtaining appropriate additional technical expertise to assist in developing adequate procedures, preparing adequate safety bases, and managing the established safety envelopes of nuclear facilities. Prioritize activities based on risk, to include revising the USQ procedure on a priority basis and providing training on the procedure.

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