Office of Enterprise Assessments Targeted Review of Work Planning and Control at the Sandia National Laboratories

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Acronyms

AIB	Accident Investigation Board
AIS	Assurance Information System
AL-WP&C	Activity-Level Work Planning and Control
ALW	Activity-Level Work
ALWAA	Activity-Level Work Analysis and Approval
ALWCD	Activity-Level Work Control Document
CAS	Contractor Assurance System
CFR	Code of Federal Regulations
CINT	Center for Integrated Nanotechnologies
CRAD	Criteria, Review, and Approach Document
DNFSB	Defense Nuclear Facilities Safety Board
DOE	U.S. Department of Energy
DSA	Documented Safety Analysis
EA	Office of Enterprise Assessments
EA-30	Office of Environment, Safety and Health Assessments
ES&H	Environment, Safety and Health
FMA	Failure Modes Analysis
FMEA	Failure Modes and Effect Analysis
FO	Firing Officer
FON	Facility Operating Notebook
FR	Facility Representative
FY	Fiscal Year
HCM	Hazard Control Matrix
HSS	Office of Health, Safety and Security
IDT	Interdisciplinary Team
IH	Industrial Hygiene
IHEA	Industrial Hygiene Exposure Assessment
ISM	Integrated Safety Management
ISMS	Integrated Safety Management System
JAAC	Job Activity Agreement Card
JON	Judgment of Need
JSA	Job Safety Analysis
MESA	Microsystems and Engineering Sciences Application
NEPA	National Environmental Policy Act
NNSA	National Nuclear Security Administration
NOTE	Non-Occurrence Trackable Event
NP	Noteworthy Practice
OFI	Opportunity for Improvement
ORPS	Occurrence Reporting and Processing System
PHS	Primary Hazard Screening
PI	Principal Investigator
PPE	Personal Protective Equipment
QFR	Quarterly Feedback Report
QMR	Quarterly Management Review
QPA	Quarterly Performance Analysis
RF	Radiofrequency
SFO	Sandia Field Office
SIH	Standard Industrial Hazard
SME	Subject Matter Expert

SNL	Sandia National Laboratories
SOP	Standard Operating Procedure
SSO	Safety System Oversight
TCE	Trichloroethylene
TSR	Technical Safety Requirement
TWD	Technical Work Document
WAC	Work Authorization Control
WCA	Work Control Authorization
WP&C	Work Planning and Control

Executive Summary

The U.S. Department of Energy (DOE) Office of Environment, Safety and Health Assessments, within the Office of Enterprise Assessments (EA), conducted an independent review of the Sandia National Laboratories (SNL) activity-level work planning and control (WP&C) processes and activities. The review, conducted during July 2014, focused on selected SNL Divisions and Sandia Field Office (SFO) oversight. The independent review was part of a targeted assessment of WP&C across the DOE complex, including National Nuclear Security Administration (NNSA) sites that perform work at nuclear facilities and other high consequence hazards (e.g., chemical and biological). This targeted review area also partially addresses a Defense Nuclear Facilities Safety Board (DNFSB) letter and Technical Report (DNFSB/Tech-37) that included a commitment to enhance Federal oversight of WP&C.

SNL had developed and promulgated a new corporate WP&C procedure that outlines an enhanced framework for worker safety. As part of the new procedure, SNL is implementing a new process (i.e., engineered safety case reviews) that is designed to provide a structured analysis of safety of activity level work activities by an interdisciplinary team (IDT). Approximately 600 out of 1500 engineered safety cases had been completed at the time of the review. Some of the engineered safety cases reviewed by EA were effectively performed and the supporting documentation was in order. In addition, SNL workers and managers associated with the work observations indicated the importance of stopping or suspending work if a potential unsafe condition was identified. Further, SNL divisions are using internally developed formal and informal mechanisms to gather feedback and address various identified deficiencies.

However, weaknesses were evident in processes and their implementation. SNL corporate processes do not provide clear guidance in some important areas, such as failure mode analysis, and the safety case initiative requirements were intentionally written so that each Division develops its own implementation process/procedures and did not provide for sufficient corporate-level review and assessment, resulting in significant variability in approach and quality across SNL organizations. Of the work activities observed by EA, most did not meet one or more of the expectations of the corporate WP&C engineered safety requirements. For example, the output of the primary hazard screening process is not always well integrated with the research activity work document particularly with respect to hazard categorization and work scope description, some work activities did not have a compliant job safety analysis, and there were significant deficiencies in some instances where technical work documents were used to document hazard controls. In addition, a key component of the engineered safety cases is the failure mode analysis and, for some work activities, the analysis was inadequate or not conducted. In some work activities there were significant deficiencies in documenting hazard controls. Further, SNL's processes for analyzing, tracking and trending of WP&C issues have known, long standing deficiencies that SNL is working on but has not fully addressed.

SFO line management has established several appropriate risk-prioritized procedures for overseeing SNL's implementation of its WP&C processes in its non-nuclear facilities. However, SFO oversight activities for SNL non-nuclear operations are generally limited in depth and frequency (SFO cites limits on safety subject matter experts and travel resources as a cause).

Overall, SNL's improvement initiatives are appropriately targeted on establishing effective controls, and SNL is making progress implementing its new process, which is contributing to safer operations. However, weaknesses in the flowdown of process expectations to the working level are still evident, and many working level safety documents have gaps and inconsistencies that could result in safety controls not being identified, implemented, or understood, thus reducing the safety benefits of the new processes. The deficiencies warrant increased management attention including more performance assessments and training of personnel (e.g., in safety and hazards assessment processes).

Office of Enterprise Assessments Targeted Review of
Work Planning and Control at the Sandia National Laboratories

1.0 PURPOSE

The DOE Office of Environment, Safety and Health Assessments (EA-30), within the independent Office of Enterprise Assessments[1] (EA), conducted an independent assessment of the Sandia National Laboratories (SNL) Divisions 1000, 5000, and 6000 activity-level work planning and control (AL-WP&C) processes and activities. The onsite portions of the EA targeted assessment were conducted during July 7-11 and July 28 – August 1, 2014.

The purpose of this assessment was to evaluate the implementation of AL-WP&C at SNL, with a primary focus on SNL's new work control process, which requires analysis of engineered safety cases. Engineered safety cases are intended to provide a structured process for systematically and critically analyzing operational systems to identify ways in which they can fail to perform as intended and to encourage critical thinking and formal process approvals to ensure work hazards are addressed by engineered controls when feasible and by other methods if engineered controls are not feasible. EA criteria, review, and approach documents (CRADs) were adapted to establish a focused set of inspection criteria for the independent assessment.

This independent assessment was part of a larger-scale targeted assessment of AL-WP&C across the DOE complex, including National Nuclear Security Administration (NNSA) sites. EA's selection of this targeted review area considered the Deputy Secretary's response to Defense Nuclear Facilities Safety Board (DNFSB) letter and Technical Report (DNFSB/Tech-37) that included a commitment to enhance Federal oversight of AL-WP&C. This targeted review area also reflect EA's commitment to selectively review DOE non-nuclear sites that perform high consequence activities or whose performance may present significant risks, in accordance with DOE Order 227.1, *Independent Oversight Program.*

2.0 SCOPE

EA-30 conducted an independent assessment of the WP&C program at SNL, in accordance with EA's assessment plan (*Plan for the Independent Oversight Targeted Review of Work Planning and Control at the Sandia National Laboratories).* The EA team evaluated the effectiveness of the contractor's implementation of the Integrated Safety Management (ISM) core functions (i.e., Define Scope of Work, Identify and Analyze Hazards, Identify and Implement Controls, Perform Work Safely Within Controls, and Feedback and Improvement) with respect to AL-WP&C. EA reviewed the documented processes at SNL, including WP&C procedures, engineered safety cases, technical procedures, research work packages, and other WP&C documents; interviewed key SNL personnel, observed meetings; and conducted other data gathering activities. EA focused on observing activity-level work (ALW) activities in Divisions 1000, 5000, and 6000, including research work control document development (e.g., engineered safety cases, research activity walkdowns, senior management reviews, work authorization activities, pre-job or pre-evolution briefings, execution of work activities, and contractor assurance system [CAS] activities). The observed CAS activities included self-assessments, manager walkthroughs,

[1] In May 2014, EA assumed DOE's independent oversight function from the former Office of Health, Safety and Security (HSS). This report will use the current terminology for the current and former independent assessment offices, except when citing certain document titles.

independent assessments, critiques, and fact-finding meetings. Where work observations were not available or the activity did not provide the needed review samples, EA broadened its scope as necessary to ensure that the CRADs were adequately addressed. The scope of this assessment also included a focused assessment of the NNSA Sandia Field Office's (SFO's) processes for oversight of the contractor's WP&C related to SNL non-nuclear facilities.

3.0 BACKGROUND

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

EA evaluates safety and emergency management policies and programs throughout DOE with a particular emphasis on evaluating worker and public protection from high consequence hazards, which exist at many DOE sites. EA accomplishes its safety and emergency management oversight through two primary mechanisms: (1) a network of staff site leads who are assigned to monitor the activities at DOE sites with nuclear facilities or activities and coordinate office assessment activities at those sites, and (2) a program of targeted assessments that evaluate selected functional or topical areas at multiple sites across the DOE complex. Assessment activities are selected, prioritized, and planned based on such factors as risk to workers and the public, facility operational status, and performance history.

EA selected AL-WP&C as one of the targeted focus areas for 2014. In a November 6, 2012, memorandum from EA's predecessor office to DOE senior line management "Work Planning and Control" was identified as a targeted review area, with a series of reviews starting in 2013. The memorandum also stated that the areas would be further defined in associated review plans and that the performance of DOE oversight would be evaluated during the targeted assessments. EA selected several DOE sites for review to ensure that EA has sufficient information to provide insights into DOE-wide performance in the area of WP&C. When all the selected DOE sites have been reviewed, EA will prepare a report summarizing the conclusions of the assessment regarding the overall status of safety system management throughout the DOE complex, common issues, and lessons learned.

Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, manages and operates SNL as a contractor to NNSA. Established in 1949, SNL is responsible for nuclear weapon ordnance engineering and production coordination, playing a pivotal role in ensuring the safety, security, and reliability of the nation's nuclear arsenal. Sandia has evolved into a multi-program national security laboratory that provides technologies to protect the nation's infrastructure, including its transportation, energy, telecommunications, and financial networks. SNL ensures clean, abundant, and affordable energy and water; reduces the proliferation of weapons of mass destruction; helps maintain U.S. military systems superiority; and defends our nation against terrorist attacks. SNL maintains a workforce of almost 10,000 employees with main facilities in Albuquerque, New Mexico, and in Livermore, California.

The NNSA SFO consists of approximately eighty-five Federal employees with technical and administrative expertise in diverse subjects including contract management, business management, environment, safety and health (ES&H), quality, security, engineering, and nuclear safety basis. SFO is co-located with SNL at the Albuquerque, New Mexico, facilities.

4.0 METHODOLOGY

EA's *Plan for the Independent Oversight Targeted Review of Work Planning and Control at the Sandia National Laboratories,* identified the criteria to be used to evaluate AL-WP&C. The review-specific criteria are derived from:

- CRAD 64-10, Performance Based Inspection of Worker Safety and Health Utilizing the ISM Core Functions: Inspection Criteria, Approach, and Lines of Inquiry.

- CRAD 45-35, Occupational Radiation Protection Program, which was used to evaluate radiological aspects of WP&C.

- CRAD 45-21, Feedback and Continuous Improvement Inspection Criteria and Approach, which provided criteria for DOE field element line management oversight and the Facility Representative (FR) program.

Additionally, the EA team used the results of a report entitled "Analysis of Integrated Safety Management at the Activity Level: Work Planning and Control" to its review on common areas of WP&C deficiencies across DOE. The DOE Office of Analysis formerly within the within the Office of Health, Safety and Security, and now within the Office of the Associate Under Secretary for Environment, Health, Safety and Security (AU), issued a report on August 1, 2013. The report identified five common activity-level work planning and control (WP&C) deficiencies across the U.S. Department of Energy (DOE) Complex for Defense Nuclear Facilities operations, namely; 1) hazard identification and control; 2) procedures and documents; 3) supervision and management; 4) communication; and 5) feedback and lessons learned. EA designed its review of SNL and other sites in the targeted review to examine these areas of common weakness.

The members of the EA team and EA management responsible for this assessment are listed in Appendix A. A detailed list of the documents reviewed, personnel interviewed, and observations made during this assessment, relevant to the findings and conclusions of this report, is provided in Appendix B. Appendix C provided the broad and detailed criteria for WP&C that were used to evaluate SNL contractor and field office performance.

5.0 RESULTS

The results of this assessment are organized around three main areas: WP&C Program Definition, WP&C Program Implementation, and SFO oversight. The EA assessment of Program Definition and Program Implementation was organized around the five core ISM functions (1) define the scope of work, (2) analyze the hazards, (3) develop and implement controls, (4) perform work within controls, (5) feedback and improvement.

5.1 WP&C Program Definition

Criteria: EA reviewed the WP&C Program Definition to ensure that the development and approval of WP&C processes and documentation enable safe performance of work, and include hazard identification and analysis and control selection; safe and efficient execution of work activities; a management and organizational framework for (1) initiating, analyzing, planning, and approving ALW and (2) authorizing, releasing, and safely performing ALW; and a feedback and improvement process for ALW.

During the past two years SNL initiated a redesign of the institutional WP&C process as previously defined in Manual 471018, *Work Planning and Control Manual*. SNL's WP&C redesign effort was motivated, in part, by issues that were identified in investigations of accidents that occurred at SNL. For example, the DOE/NNSA Accident Investigation Board (AIB) associated with the 2008 Rocket Sled Accident identified numerous issues related to conduct of operations and work planning. In 2011, investigation of an accident at the Plasma Materials Test Facility identified two root causes: (1) an incompatible hazard analysis to identify hazards and controls to prevent lithium and water from combining and initiating the chemical explosion and (2) a design selection process that allowed the specification of incompatible materials for the lithium preheater.

More recently, on December 11, 2013, Site 9920 personnel at SNL were testing an integrated explosive device, supplied by a project team from other Sandia organizations. The test involved an integrated device containing a fireset and detonator. During the second test, the firing officer (FO) was injured when the integrated device went off unexpectedly, causing injury to the FO's left hand. The AIB cited four core causes for this accident. One core cause was the failure to effectively implement "safe by design" by intent. The accident investigation determined that SNL personnel did not adequately consider, analyze, or understand the system hazards created by combining individual components, and a "what-if" analysis (or similar failure analysis) was not conducted prior to the testing. The second core cause was insufficient WP&C of test operations. The accident investigation determined that Site 9920 team accepted and then executed work that their existing hazards analysis and operating procedures did not address, without first analyzing the hazard and then identifying and implementing controls, and also determined that SNL used an expert-based process to evaluate whether these tests fell within the approved Site 9920 operating envelope, without performing a detailed review of the existing procedures.

As a result of these accidents, SNL recognized that safety needs to be considered in a "system engineering" context appropriate for a research and development laboratory. This approach resulted in a redesign of the WP&C process based on the concept of engineered safety cases. The new approach to engineered safety in WP&C is described in Manual 471021, *Work Planning and Control Criteria for Safe Design and Operations*. ALW activities that are new or revised after June 1, 2013, must be planned in accordance with Manual 471021. As of September 30, 2014, SNL plans to use the new Manual 471021 as the basis for all ALW, and retire the old Manual 471018.

SNL Corporate Process ESH100.1, *Plan Work*, describes the major activities associated with work planning functions at SNL. Corporate Process ESH100.1 is implemented through Corporate Procedure ESH100.1.WP&C.1, *Plan and Control Work*, which invokes Manual 471021. Criteria in these documents are derived from, and build upon, DOE contractual requirements for ISM and are applicable to all SNL Divisions performing ALW. Each SNL division vice president is responsible for ensuring that the criteria in Manual 471021 are implemented and used in determining the structure of the division's WP&C implementation plan. The division-level WP&C implementation plans describe methods to implementing the criteria and provide suitable justification for the graded approach to be taken. The Division's WP&C implementation plans also define the roles and responsibilities from the line manager approval and authorization level down to all team members engaged in ALW. However, EA's review determined that delegating implementation to division level and below resulted in development and use of a multitude of engineered safety case approaches at SNL, contributing to the implementation weaknesses described in Section 5.2.

The EA team evaluated the fundamental elements of the SNL redesigned WP&C process as described in Manual 471021 and related SNL institutional WP&C documents against the five core functions of ISM, as described in the following subsections. For a number of the observations in the following subsections, cross reference(s) to the applicable criteria, as identified in Appendix C, Section A, *Process and*

Documentation, are provided in parenthetical references; for example, "(A.2)" refers to criterion #2 in Part A of Appendix C. Section 5.2 provides additional details to support the finding and opportunities for improvement (OFIs) presented below.

Define the Scope of Work

Criteria: EA reviewed the work scope definitions to ensure that they were complete and comprehensive, included a comparison to established operational and administrative boundaries, required formal acceptance of work by line management, and work scheduling as appropriate and necessary.

Manual 471021, Work Planning and Control Criteria for Safe Design and Operations, as required by Corporate Procedure ESH100.1WP&C.1, Plan and Control Work, provides details on the requirements for work. In general, Manual 471021 provides WP&C concepts but few prescriptive WP&C requirements (A.2). This conceptual approach appears to be intended to accommodate the various SNL Divisions (and often each SNL group or SNL department) that, over the years, have developed WP&C processed that are adapted and suited to their type of research. As a result, there is a plethora of separate and diverse WP&C processes across SNL that are based on a common approach or framework from Manual 471021. This approach presents challenges to the work force, especially to those researchers who may have research projects across division or group boundaries. This challenge is exacerbated since few divisions, groups, or departments have documented their WP&C process (A.2), and it is difficult to discern the WP&C "rules" and "expectations" for most of these WP&C processes. (See **SNL-OFI-01**.)

The EA team generally found that the requirements and expectations for WP&C work scopes to be adequately described in Manual 471021 and related documents. For example, Manual 471021 requires line management to identify a work planner, establish a work planning team, and accept the work scope.

However, requirements and expectations for WP&C work scopes are insufficient in one area, as a result of confusion surrounding the definition and use of the terms "safety envelope" and "operating envelop." Section 4.3.1 of the SNL Integrated Safety Management System (ISMS) description states that safety envelopes are applicable to all activities at SNL and that Manual 471017, *Safety Basis Manual*, provides information relative to the safety basis. The SNL ISMS (on page 16) requires the development of an operating envelope when defining the work scope. The EA team determined that the concepts of a safety envelope and an operating envelope when applied to research activities, although defined in the SNL Corporate Dictionary, were inconsistently implemented across the divisions, and not well understood among the research staff (A.3). Although the term operating envelope is routinely used by the research staff, it is often not distinguished from the safety envelope and the interpretations of both terms are varied and inconsistent. For example, some SNL staff indicated that the terms referred to work activities described throughout the research package and others only those activities defined in the primary hazard screening (PHS). (See **SNL-OFI- 02**.)

Analyze the Hazards

Criteria: EA reviewed the implementation of these processes to ensure that all hazards that could adversely impact workers, the public, the environment, the facility, and its equipment are documented and analyzed for severity/significance.

The "analyze the hazards phase" of WP&C at SNL involves hazard identification, a failure mode analysis, and identification of mitigating controls, as specified in Manual 471021, *Work Planning and Control Criteria for Safe Design and Operations*. Hazard analysis tools include the PHS, the job safety analysis (JSA) and a variety of tools and mechanisms for performing a failure mode analysis (FMA), such

as "what-if" checklists and failure mode and effects analysis (FMEA). In general, a team consisting of subject matter experts (SMEs) including a work planner, a worker (e.g., researcher, technologist), and an industrial hygienist performed the hazards identification and analysis (A.4).

A PHS is required of all activities where workers could be exposed to hazards. The PHS process is a long-standing process consisting of a series of yes/no questions based on 25 hazard topics (e.g., chemicals, electrical, noise). Based on the responses to the PHS questions, the process results in selection of one of seven hazard categories. For this assessment, none of the work activities observed in Divisions 1000, 5000, or 6000 exceeded a moderate hazard categorization.

The four hazard categories that may apply to work activities observed during this assessment are: (1) "office hazards" or hazards that include only common office hazards, (2) "standard industrial hazards" (SIHs) or hazards that are routinely encountered in general industry, (3) "low hazards" or hazards that could cause significant injury or exposure to "local" personnel, or (4) "moderate hazards" or hazards that could cause significant injury or exposure to personnel beyond the local area, but still on site. Table 1 of Manual 471021 provides a slightly altered list of hazard categories that excludes office hazards. For each facility classification, the required level of safety basis documentation and readiness review is applied with a graded approach commensurate with the risk of the hazards. Safety basis documentation ranges from only the PHS for business occupancy and SIH through documented safety analyses and related information for nuclear facilities. Additional details are provided in Manual 471017, *Safety Basis Manual*.

Although the PHS process is documented in an appendix of the *Safety Basis Manual*, the output of the PHS is not well integrated into the ALW documents (A.6) as indicated in Section 5.2. In one case the PHS did not reflect the current ALW work scope, although the PHS may have been updated on an annual basis as required by the *Safety Basis Manual*. (See **SNL-OFI-03**.)

The JSA is the tool used during the ALW planning to identify specific and unique hazards associated with the accomplishment of any ALW and to prescribe mitigating controls for the identified hazards. According to Section 3.4.2 of the ISMS description (PG470252), a final JSA must be performed for the entire system before hazards are introduced. The SNL institutional guidance on the JSA process is minimal and consists of the JSA form with some explanatory notes (SF-2001-JSA). Although both the ISMS description and Manual 471021 address the JSA or final JSA, the discussion is limited to a brief paragraph.

The JSA process was not sufficiently defined at the policy level (SF-2001-JSA) resulting in inconsistent application of the JSA in the three SNL divisions evaluated. For example, although a final JSA must be performed before hazards are first introduced, few of the observed work activities incorporated a JSA or a Final JSA. Although Section 7.2 of Manual 471021 permits the use of a JSA "equivalent," there is no guidance concerning the criteria for a "JSA equivalent" (A.7). The only Division 1000 Center to include a JSA in their ALW document chose to use the JSA to document the results of their failure mode analysis for unexpected consequences, but chose not to use the JSA to document the routine hazards associated with the research, for which the JSA was intended. Division 5000 allowed the use of activity-level PHS and activity-level technical work documents (TWDs) to serve as a JSA equivalent. The activity-level TWDs included a discussion of hazards and controls, but did not include an analysis of the sequence of activities. (See **SNL-OFI-04**.)

One of the positive attributes of the new SNL WP&C process as defined in Manual 471021 is the emphasis on critical thinking that includes thorough understanding of the technical basis for the work and a search for failure modes that can cause accidents to occur. Section 5.3 of Manual 471012 states, "a failure mode analysis shall be performed on the new or existing system design using recognized technical

standards appropriate to the task." However, the process of performing a failure mode analysis commensurate with a research activity is not well-defined in SNL institutional processes (A.2). SNL has begun to provide Redbook Training Courses on Hazard Analyses to supplement the current descriptions, but few research staff within the three divisions surveyed have participated in the course(s) to date. As further examined in Section 5.2, there is considerable diversity in the performance and documentation of failure mode analysis performed in the three divisions surveyed. In some instances the EA team found that the failure mode analysis performed does not meet the minimum requirements and expectations of Manual 471021. (See **SNL-FINDING-01**.)

Develop and Implement Controls

Criterion: EA reviewed the implementation of processes for the identification and implementation of controls, to ensure they effectively protect against identified hazards, and that approved activity level work control documents can be performed as written.

The third safety management core function, "Develop and Implement Hazard Controls," involves establishing the safety envelope associated with facility hazard classification, identifying applicable requirements, and implementing controls to prevent/mitigate hazards. At the ALW level, "Control Hazards" involves developing job aids or TWDs as appropriate, management approval of work documents, implementing hazard controls, conducting final preparedness verification, and management authorizing work to proceed. Details are found in Manual 471021, *Work Planning and Control Criteria for Safe Design and Operations*, as required by Corporate Procedure ESH100.1.WP&C.1, *Plan and Control Work*.

A controls methodology is presented in Manual 471021, and is accomplished through a variety of mechanisms, based on applying the following hierarchy of hazard controls:

1. Elimination of or substitution for the hazard where feasible and appropriate.
2. Engineering controls where feasible and appropriate.
3. Work practices and administrative controls that limit worker exposure to the hazard.
4. Personal protective equipment (PPE).

SNL emphasizes using engineered controls by establishing a target level of engineered controls based on hazard category and unmitigated accident consequences. For example, a nuclear hazard category would result in a target level of 2 to 3 engineered controls. Additionally, SNL has established the expectation that line management is responsible for approving the safety case, one of the steps for authorizing ALW.

The administrative control most commonly used is the TWD. The TWDs identify and communicate to workers the hazards and associated controls so that potential safety and environmental impacts are mitigated or eliminated. A TWD identifies the steps necessary to perform the technical aspects of the work. The TWDs requirements are defined in ESH100.2.GEN.3, *Develop and Use Technical Work Documents*.

A variety of SNL processes identify and document controls in ALW authorization documents, PHSs, JSAs, industrial hygiene (IH) exposure assessments (IHEAs), operating procedures, and safety assessments. SNL's expectations for the need to develop and document hazard controls are generally well defined in manuals (e.g., Manual 471021, PG470252). However, there is considerable confusion across the Divisions 1000, 5000, and 6000 about using TWDs and the requirements for documenting hazard controls in TWDs (A.7). ESH100.2.GEN.3 indicates that one of the required actions for TWDs is to document and communicate hazard controls for each hazard identified. Most research activities hazard controls are documented in a variety of research work documents that are not identified as TWDs by

ESH100.2GEN.3 and PG470252; for example IHEAs, ALW authorization documents, and PHSs. (See **SNL-OFI-05**.)

Perform Work Within Controls

Criteria: EA reviewed the performance of work, to ensure that work is conducted diligently in accordance with approved work instructions and within established controls.

SNL controls include work instructions, administrative controls, PPE, and training. Requirements delineated in Manual 471021include performing final job hazard analysis and/or JSA, completing TWDs, confirming team training and qualification, and conducting readiness reviews.

Manual 471021 requires line management to formally authorize work before it begins.

Most work within Division 1000, 5000, and 6000 was performed within the hazard controls specified in ALW authorization documents, JSAs, standard operating procedures (SOPs), and other documents. EA interviewed workers and managers who indicated the importance of stopping or suspending work if a potential unsafe condition was identified. Pre-job briefings were not typically conducted because of the nature of the research work.

Feedback and Improvement

Criteria: EA reviewed the area of feedback and improvement to ensure that the WP&C processes are routinely evaluated by the Organization's CAS and to ensure feedback and improvement processes and lessons learned are adequately captured and incorporated into the planning and performance of ongoing and future work activities.

Activity and Division Level: Corporate procedures CG100.6.15, *Identify Operating Experience, and Share Lessons Learned*, and ESH100.4.FI.2 define the expectations that workers are to share information whenever opportunities arise and are expected to stay aware of, and use, the information to improve all work activities. Additionally, Manual 471021, *Work Planning and Control Criteria for Safe Design and Operations*, reinforces corporate expectations for integrating feedback and improvement into engineered safety cases and WP&C activities through the ESH100.4.FI-series procedures. These processes are broadly defined at the corporate level and delegated down to the divisions for implementation.

In general, each division has its own process for factoring feedback and lessons learned into its WP&C activities. All divisions have a process for using interdisciplinary teams (IDTs) to review WP&C engineered safety cases, including ES&H coordinators who participate on the IDTs. All divisions have an expectation, formal or informal (i.e., on a template or a checklist), for preparers of safety cases to review the ES&H lessons learned database and webpage repository for completed safety cases and best practices. In Division 1000, the Vice President routinely hosts brownbag lunches to discuss lessons learned. Corporate SMEs on WP&C provide their expertise and lessons learned to help divisions with engineered safety cases. Additionally, the divisions are implementing independent peer reviews of completed safety cases, although inconsistently at this point. For example, Division 6000 is peer reviewing all its safety cases, Division 1000 is reviewing 20 percent, and Division 5000 is still developing its expectations for peer review.

SNL makes a number of methods available to workers to provide WP&C feedback (e.g., management chain, lessons learned website, and ES&H coordinators). From discussions with division ES&H coordinators, workers routinely engage in post-job reviews with supervisors and ES&H coordinators at the center level, but most of these reviews are not formal or documented. The ES&H coordinators then

have routine meetings among themselves to share lessons learned, either through the centers or division level depending on their assignment. By participating on IDTs for review of WP&C engineered safety cases, ES&H coordinators also help facilitate process improvements based on lessons learned, although they do not prepare the safety cases. ES&H coordinators also closely follow Occurrence Reporting and Processing System (ORPS) events in their divisions (ORPS events are managed by Facility Manager/Designees, which are often ES&H Coordinators.).

The reviewed divisions are implementing corporate processes for factoring feedback and lessons learned into WP&C activities and have made many informal improvements to WP&C. However, the effectiveness of these processes is hindered by inconsistencies among the divisions and a lack of documentation.

The peer review process has been highly effective for divisions and/or centers that have employed this process. Although peer review processes have been effective, they have a limited scope. For example, they would not capture the improvements in identifying new hazards and controls as a result of performing safety cases. Other feedback and improvement mechanisms at the ALW level are inconsistent across Division 1000, 5000, and 6000. In general, at the ALW level, feedback and improvement mechanisms are localized at the group level or are based on the results shared from ES&H assessments and formal management walkarounds. (See **SNL-OFI-06**.)

Corporate Level: WP&C feedback is also obtained through other formal mechanisms at SNL. Site wide data is collected through the Assurance Information System (AIS), ORPS, and ES&H lessons learned database. A website repository for completed WP&C engineered safety cases is an easily accessible, searchable resource for best practices, frequently asked questions, and other reference materials. Other site wide databases include OOPS (an early notification process) and the Integrated Reporting Management System consisting of radiation protection improvement reports, ORPS events, and non-occurrence trackable events (NOTEs).

Lessons Learned Program: Corporate procedure ESH 100.4.FI.2, *Identify and Report Lessons Learned*, describes SNL's ES&H lessons learned program as the primary mechanism for capturing, analyzing, and disseminating lessons learned, to assist all personnel in learning from past experiences and avoiding recurrence of unplanned events. When observing ALW, EA noted that lessons learned from implementing the WP&C engineered safety process were identified but not documented in either the lessons learned database. While not formal, the WP&C Repository has an extensive list of lessons learned for all divisions that is accessible on the website. Additionally, Center 1800 acknowledged that it does not have a lessons learned process or procedure but is working to develop one. Most lessons learned are disseminated electronically by subscription, but this process depends upon the subscribers and is not designed to ensure that lessons learned are distributed to all affected workers. As a result, receipt and disposition of important lessons learned information is not formally tracked or documented. (See **SNL-OFI-12**.)

To help resolve these gaps, SNL has recently decided to align its corporate lessons learned program with the Division 4000 ES&H lessons learned program to provide a more robust process, which will be implemented for laboratory-wide use in fiscal year (FY) 2015. This collaboration will include sharing safety incidents and how they relate back to safety principles, concept videos to help understand WP&C principles, LiveSafe toolkits and safety minutes, and other collections of lessons learned best practices. Users will be required to go to the TechWeb site to review this information.

SNL also uses a less formal approach where lessons learned information and some corrective actions are managed through various safety councils such as the Executive Safety Committee, division health and safety councils, and other specialized safety councils (i.e., explosives, radiation protection, pressurized

systems, and electrical). Specific to WP&C engineered safety implementation, a line implementation working group meets monthly to discuss issues. Some of these issues are elevated to a quarterly management review (QMR) comprised of SNL senior managers who review ES&H related issues and provide direction on how to resolve them. The QMR is described as the issues management process in SNL's *Integrated Safety Management System Description*. The various other safety councils and committees are not described in the ISMS description document. SNL should supplement this document to better describe its management process(es). (See **SNL-OFI-13**.)

The implementation of WP&C engineered safety over the past year has increased the number of lessons learned and solutions shared between technicians that have similar type laboratories across the various divisions and centers. Sharing occurred infrequently under the previous WP&C process. Workers and supervisors are also more engaged in providing feedback and identifying solutions using the new engineered safety principles. For example, at the Solid Waste Collection and Recycling Center, the SNL team considered protective bollards to mitigate bales containing compressed waste from bursting (in 2010, compressed bales broke open, knocking down a worker). Less than a week after the new bollards were installed, a bale broke, but no one was injured. Across the divisions, numerous improvements and enhancements resulting from WP&C engineered safety implementation are being documented and rolled up to demonstrate how appropriate action has been taken in response to feedback and lessons learned information.

Assessments: Corporate procedures CG100.6.3, *Determine, Plan and Perform Assessments*, and ESH100.4.FI.1, *Perform ES&H Line Self-Assessment Activities*, describe SNL's process for planning, scheduling, and conducting ES&H line self-assessments. CG100.6.3 provides supplemental guidance for conducting management surveillances. Additionally, Manual 471021 reinforces corporate expectations for performing assessments and management surveillances through the ESH 100.4.FI-series procedures to integrate feedback and improvement into engineered safety cases and WP&C activities. These processes are broadly defined at the corporate level and, like the feedback and lessons learned programs and other corporate programs, are delegated down to the divisions for implementation. Therefore, SNL does have a corporate assessments process and each division prepares and conducts its assessments to the corporate and its own approved processes.

SNL divisions have conducted numerous management reviews related to WP&C. Divisions 1000 and 6000 require management reviews/peer reviews as described in their approved engineered safety implementation plans. Division 1000 conducts selected self-assessments at the center level, and cross-divisional assessments are also being conducted to identify best practices. Division 6000 plans and conducts various ES&H topical assessments and will require directors to perform walkdowns starting in FY2015 to review safety cases. Division 5000 has paused explosive operations for several months while responding to the site 9920 accident. This pause in explosive operations has disrupted and delayed the scheduling of assessment/reviews, but Division 5000 has conducted some informal management assessments on WP&C engineered safety cases.

SNL has performed some corporate-level assessments of division-level implementation of WP&C engineered safety. The SNL audit center normally performs internal independent assessments but also performs special management reviews. SNL completed one such review in February 2014, a study of engineered safety implementation, to identify what was working well, what the implementation challenges were, and what potential gaps there might be prior to the September 2014 implementation deadline. The review identified several concerns such as the lack of effective corporate guidance for the WP&C implementation process and the interrelation of the PHS, JSA, and FMA; lack of SNL SME support at the center-level and corporately; and a lack of a standardized approach to implementing WP&C (specifically related to the assignment of work planners, composition of work planning teams, hazard analysis, safety cases development, authorization processes/approaches, and tools). SNL implemented

several timely corrective actions in response to this assessment including:

- Providing more depth in WP&C300 training in the topical areas of controls, risk, and failure mode analysis.
- Corporate SME resources were doubled.
- Improving outreach and education on WP&C topics at brown bag lunch and listen sessions.
- Providing customized WP&C training for departments and managers.
- Requiring SNL division management to use IDTs and SMEs to plan work and prepare safety cases.
- Having corporate ES&H conduct 21 separate SNL Laboratory Director safety discussions with over 900 SNL managers in March 2014.
- Establishing and updating the WP&C Repository website to include additional information and resources including engineered safety videos and concept tutorials.
- Developing an external advisory board (i.e., the WP&C Advisory Board) to provide outside assessment of the new WP&C model.
- Deploying WP&C and ES&H SMEs to SNL remote sites to deliver hands-on, intensive training and assistance.
- Having SNL vice presidents lead corrective actions at the division level.

The WP&C Advisory Board conducted a review in June 2014, which assessed four safety cases. The Advisory Board observed that the reviewed safety cases did not clearly demonstrate corporate expectations in their narratives, and recommended that the WP&C training module be reviewed to see whether the old and new WP&C manuals are properly highlighted. The Advisory Board also recommended that SNL, when reviewing engineered safety cases, include a review of single point failure analysis implementation. These reviews have revealed various implementation deficiencies. SNL has initiated various corrective actions to address these deficiencies. SNL management has chosen to not make significant changes to standardize engineered safety case processes, until after the transition to the new Manual is complete (scheduled for September 30, 2014).

The audit center is scheduling a formal assessment of engineered safety implementation for FY2015. SNL has also chartered an external assessment by an independent Work Planning and Control Advisory Board which conducted a site visit in April 2014 and produced an interim report in June 2014; a subsequent visit is scheduled for September 2014.

SNL has recognized that inconsistencies in divisional implementation strategies could create vulnerabilities and/or fail to detect precursors to an accident and has some ongoing improvement initiatives. For example, the AIB report released in March 2014 for an unexpected initiation of a detonator at explosives testing site 9920 in December 2013 identified 41 conclusions and 13 judgments of need (JONs), many related to WP&C activities; based on feedback from the site 9920 accident, Divisions 1000, 2000, and 5000 are collaborating on a testbed involving three centers for explosives safety and are considering some standardization across the divisions. In July 2014, SNL also finalized a needed site-wide strategy for continued engineered safety improvement and to ensure the laboratory wide/cross

divisional safety quality by conducting numerous planned assessments. The site-wide strategy defines specific actions/assessments in the following topical areas in order to improve WP&C: effectiveness of implementation/execution, extent of condition review, independent assessment of implementation, and safety culture. Although in the initial planning stage, the site-wide strategy could drive the needed improvement in WP&C engineered safety if fully supported by SNL line management.

Issues Management: Corporate procedure CG100.6.6, *Determine and Take Action*, describes a graded approach for determining actions to take for addressing issues identified in the course of performing evaluations. Corporate procedure ESH 100.4.FI.3, *Implement and Manage Corrective Actions*, integrates the requirements for verification and validation of corrective actions resulting from events such as audits, self-assessments, and other occurrences. These procedures describe a formal, traditional approach to corrective action management. SNL uses this process to formally address deficiencies and improvement opportunities identified during assessments, where observations and findings are documented and tracked in AIS.

CG100.6.6 specifies the use of the AIS as the corporate repository for documenting take-action decisions, causal analyses, and corrective action activities and results. EA reviewed the use of AIS with corporate assurance staff and reviewed records tracked and collected in AIS. Corporate Governance provides training, hands-on and video; the requirement exists throughout corporate policy. AIS has only been functional for about two years and is still maturing. EA's interviews with SNL personnel revealed different perspectives and understanding on the threshold of issue severity that are required to enter records into AIS (e.g., some assessments are being tracked by spreadsheet and not by AIS), indicated that the use of AIS at the working level is not sufficiently communicated and understood. (See **SNL-OFI-14**.)

SNL closely tracks many assessments to ensure they are completed and entered into AIS. Many completed assessments in AIS have issues requiring corrective actions.

Although numerous records are contained in AIS that document many feedback and improvement items, it is challenging to use AIS to assess how the divisions are scheduling and performing assessments to comply with corporate expectations. Additionally, many records in AIS are locked and cannot be reviewed; some of these locked records contain safeguards information, but the reason is not provided. There is little consistency in how records are entered into AIS by title or any other tracking code (e.g., center number, type of assessment) to verify how contract requirements are being systematically implemented and evaluated across laboratories to ensure mission success. The AIS process does not include a review of new records/issues by a corporate management committee to determine whether the records/issues are being properly categorized and receiving the correct attention.

SNL also performs an annual ISMS effectiveness review, which is another opportunity for corporate-level assessment of WP&C engineered safety implementation as well as other areas such as AIS and other assurance tools related to WP&C. The most recent review, for FY2013, completed in November 2013, identified assessment quality and effectiveness as areas for improvement, which were to be a focal point in FY2014. SNL also has a Corporate Performance Scorecard where issues are rolled up for visibility for Senior Leadership and SFO. Assessment quality and effectiveness have been long-standing weaknesses at SNL (e.g., EA identified such weaknesses during a 2008 assessment). The issue remains open, directly related to the unwavering and demanding expectation from SFO management to SNL management in regard to meeting closure performance requirements. SFO continues to track this issue (#ISS-PA-4.15.2014-571365, which states that SNL's self-assessments are still non-compliant as a means for ensuring contractor management of mission and operations). SFO is waiting for SNL to demonstrate rigorous and credible validations of improvement actions for self-assessments. Additionally, SNL has not performed sufficient corporate-level assessments to verify its divisions are adequately implementing corporate policies and procedures, particularly for ES&H-related programs developed to demonstrate

corporate compliance with DOE requirements. (See **SNL-OFI-15**.)

SNL has corporate processes for analyzing, tracking, and trending many issues related to its WP&C program, but not specifically for WP&C engineered safety implementation or ISMS core safety management functions regarding analysis of hazards, development and implementation of hazard controls, and performing work within controls. SNL prepares a quarterly performance analysis (QPA) report each quarter to identify trends pertinent to injuries and events that are actionable and could result in improved controls for preventing injuries and events. The QPAs focus on ALW, an ES&H severity index, and an analysis of the Safety Incident Tracking System cause codes. The QPA report also has an appendix for a cross trending, as well as an analysis report that provides trending analysis of all ES&H-related events, incidents, and occurrences in order to identify causes and themes of injuries from previous FYs. The QPAs trend ALW versus non-ALW, incidents by month, recordable versus non-recordable incidents, and more detailed trending by division, site, building, and cause code. Additional data from ORPS, NOTEs, lessons learned, and self-assessments is also summarized in the QPAs. Through these QPA reports and QMRs, SNL senior managers are able to analyze, track, and trend many WP&C issues and concerns, even though several different databases are used to record and retain the safety information.

In addition to the several databases used for the QPA, SNL also has the AIS, ES&H lessons learned database, and various safety councils that manage WP&C information. However, these other resources lack effective means to analyze, track, and trend issues and concerns. AIS is not particularly user-friendly; safety trends are difficult to retrieve and much low-level information is not captured. AIS has an interesting feature to create risk evaluation groups and allow users to record information in these specific groups for better tracking and trending. However, performing broader analyses across all records is a challenge without other tracking codes (e.g., center number, type of assessment). SNL intends to improve the robustness of AIS to analyze, track, and trend issues, and improve the lessons learned website to be more searchable, targetable by focus area, and better able to track usage. These efforts should help improve these two systems, but SNL still faces the challenge of managing multiple systems and programs rather than having a more comprehensive issues management program. SNL's ISMS description document for issues management discusses the QMRs and the ES&H council reviews, but provides little information on implementation of issues management processes at SNL. The SNL ISMS description document does not describe management process(es) for analysis, tracking, and trending of issues and concerns to ensure it adequately satisfies DOE requirements and provides an understanding of that relationship to the current open findings related to self-assessments and corrective actions. (See **SNL-OFI-13**.)

Performance Metrics: SNL has an ES&H dashboard to track some WP&C information against performance metrics. Most of this information is the same data used in the QPA reports, and other quantifiable information is used mostly for management tracking of specific issues. For example, Division 1000 is tracking its inventory and disposal of legacy chemicals. Annual safety performance objectives, measures, and commitments are also included in the annual ISMS effectiveness reviews and tracked via corporate assurance tools. The formal assessment of engineered safety implementation by the corporate audit center scheduled for FY2015 has the potential to provide insights about the effectiveness of SNL's performance metrics, as well as the effectiveness reviews planned as part of the site-wide strategy for safety improvement in FY2015. SNL is adequately using the dashboard to compare WP&C information to established performance objectives and expectations where practical, but (like most sites across the DOE complex) has not defined a good set of leading indicators for its dashboard metrics to ensure continued improvement.

5.2 WP&C Program Implementation

EA reviewed WP&C Program Implementation to verify that the processes are implemented at the activity

level and are effective in ensuring that ALW planning, hazard identification and analysis, control selection and implementation, performance of work, and feedback and improvement result in the safe work performance.

5.2.1 Division 1000

Division 1000 conducts research in a wide range of diverse scientific fields. This division conducts its research activities in 130 occupied buildings, over 770 laboratories (general purpose laboratories, computer laboratories, high bay laboratories, and specialty laboratories), and 31 shops. The hazards that workers may encounter in these laboratories are as diverse as the division's mission and include nuclear facilities, accelerators, pulsed power, explosives, microelectronics fabrication, hazardous chemistry and large scale fire, and mechanics. Most hazardous work is performed within seven division centers, four of which were sampled for this review, namely Centers 1100, 1300, 1700, and 1800. Division 1000 has the most engineered safety cases of any SNL division, with 482 safety cases projected and 198 completed as of April 14, 2014. Additional Safety Cases have been generated and approved since 4/14/14, with a target implementation date for all Safety Cases of 9/30/14. During this targeted review, EA focused on research activities for which a safety case had been completed.

Manual 471021, *Work Planning and Control Criteria for Safe Design and Operations*, provides the framework and criteria for WP&C and execution of all ALW in Division 1000. The mechanism for tailoring and applying the requirements of Manual 471021 to Division 1000 ALWs is the *Division 1000 WP&C Implementation Plan.*

EA observed five work Division 1000 work activities as part of its assessment of WP&C program implementation: (1) the Mode Stirred Chamber research conducted by Center 1300 in Building 963, Room 120B; (2) Thermal Processing and Aging research conducted by Center 1800 in Building 701; (3) E-Beam Lithography research conducted by Center 1100 in Building 518, Room 1501, which is part of the Center for Integrated Nanotechnologies (CINT); (4) Raman Spectroscopy and Thermometry research conducted by Center 1100 in Building 897, Room 2424; and (5) Microsystems and Engineering Sciences Application (MESA) Fabs Toxic Gas Operations; Gas Cylinder Delivery and change conducted at the MESA Fabs by Center 1700. (SNL uses the term "Fabs" to refer to two fabrication facilities at MESA: the Microsystems Fabrication Facility and the Silicon Fabrication Facility.)

For a number of the observations in the following subsections, cross reference(s) to the applicable criteria, as identified primarily in Appendix C, Section B, *Program Implementation*, are provided in parenthetical references.

Define the Scope of Work

In general, work scopes for these five work activities in Division 1000 were well defined and could be understood by those performing the research and independent reviewers. For example, the work scope associated with Thermal Processing in Center 1800 is subdivided into the three major research activities performed within the laboratory, namely bench top solder hot plate reflow, oven soldering, and elevated temperature aging; and a detailed work scope description of each activity is provided.

Work scope boundaries and limits were clearly identified (B.1.1 and 3), although the specific tasks necessary to accomplish the scope of work were not systematically identified in the observed activities, with the exception of the Toxic Gas Operations at the MESA Fabs. Activities observed at the MESA Fabs are generally more operations and production driven and are well defined in operating procedures at the task level. For the other Division 1000 centers, research activities are typically not documented in

step-by-step procedures but may be captured in research journals maintained by the research staff, publications, vendor manuals, and informal operator aids (B.1.2).

Each Division 1000 center has a unique WP&C process that is considerably different in format from other Division 1000 centers. For example, the E-Beam Writer research at the CINT, Center 1100, is captured in a "Work Acceptance, Approval and Authorization" format, which is vastly different in format from the Center 1800 "Work Control Authorization." For research staff that works only within one Division 1000 center this approach may be workable. However, for researchers that have projects in multiple centers, working with vastly different research WP&C processes presents a challenge. This challenge is exacerbated since few Division 1000 centers document their unique WP&C process (Exceptions are Center 1800, which has developed an administrative operating procedure entitled "Work Planning and Control in Center 1800," and Center 1700 which has developed WP&C processes for the Fabs and Light Laboratories). None of the other Division 1000 centers observed had documented their WP&C processes (A.2). (See **SNL-OFI-01**.)

Most of the research work scopes identify structures, systems, components, and equipment involved with the research activity (B.1.5), as well as applicable TWDs and required training (B.1.6).

Hazard Identification and Analysis

The five observed research activities incorporated a variety of hazard identification and analysis techniques such as PHSs, JSAs, IHEAs, and FMA, as described in Section 5.1.

The EA team evaluated a number of IHEAs and, in general, determined that they were well written, and identified the appropriate hazards and controls for most of the work observations. Division 1000 had an IHEA for ALW observed by EA.

Although each of the observed work activities incorporated one or more PHSs, two of the five research activities reviewed in Division 1000 indicated a discrepancy in hazard category ranking between the work control authorization document for the research activity and the associated PHS (B.2.7). For example, for the thermal processing and aging research being conducted in Center 1800, the hazard categorization of the PHS is "low" whereas the Work Control Authorization (WCA), which authorizes the work, designates the activity as "standard industrial" or SIH, which is a hazard grade below the PHS hazard category of low. The PHS low category was driven by the use of asphyxiant gases for the heat treatment processes. The asphyxiant gas hazard is also identified as a potential hazard in the IHEA for this activity (SNLNM03575, SNLNM06049). In another example, Center 1100 research staff conducts advanced optical materials spectroscopy and imaging (relying on laser for most techniques). Work is performed in Building 897, Laboratory 2424, under three separate intersecting and overlapping ALW documents, but there is only one PHS for Laboratory 897/2424. In this case, the PHS concludes that the hazard classification is SIH, whereas the ALW for Class IIIB and IV laser operations indicates that the hazard category or consequences are low. (See **SNL-OFI-03**.)

The PHS for Material Science and Engineering-Center for Solder Science and Technology did not reflect the current ALW work scope (B.1.2), although the PHS had been recently updated in February 2014. For example, the PHS referred to two Thermotron cycling chambers, two Tenney thermal cycling chambers, three Sigma Systems Thermal cycling chambers, and a Sikama reflow oven that had been removed or relocated from the laboratory for over a year. (See **SNL-OFI-03**.)

The JSA is the tool used during the ALW planning to identify specific and unique hazards associated with the accomplishment of any ALW and to prescribe mitigating controls for the identified hazards. Institutional concerns with the JSA process were discussed in Section 5.1. Of the five Division 1000

work activities observed, only one ALW document incorporated the use of a JSA (i.e., the Thermal Processing, Soldering and Aging, research being performed in Building 701 by Center 1800 research staff). However, this JSA, which was incorporated into the WCA for the research activity, identified only one task (i.e., heat required to reflow solder), one hazard (i.e., a possible hot plate controller failure), and one control associated with PPE. Based on EA's review of the WCA work scope and the associated PHS, a number of potential hazards and work steps are associated with this research that are not reflected in the JSA. The SNL prescribed JSA form, however, was modified to document only the outcome of the failure mode analysis; this JSA is not intended to address all the routine research work steps, hazards, and controls that the SNL JSA form is intended to document. The SNL institutional JSA guidance is unclear whether this is an appropriate use of the JSA form (B.2.7). For the research being performed by Group 1350 associated with the Mode Stirred Chamber and the Anechoic Chamber in Building 963, the activity-level work analysis and approval (ALWAA) provides a section that identifies hazards and required training for each identified hazard, but lacks consistent discussion of hazard controls, other than training. It is unclear whether this section is intended to be an "equivalent JSA," but if so a discussion of hazard controls is not included. One exception in Division 1000 to the lack of a definition for an "equivalent JSA" is the MESA Fabs (Center 1700) WP&C procedure which defines the MESA Fab Hazard and Barrier Analysis process and resulting OPs as being equivalent to a JSA. (See **SNL-OFI-04**.)

According to Manual 471021, the failure mode analysis, required of each new or existing system design, is a key attribute of the new WP&C process because it promotes critical thinking. However, as discussed in Section 5.1, the institution guidance and training on performing and documenting a failure mode analysis is lacking for the diversity of research activities and WP&C processes being implemented at SNL. This is particularly true of Division 1000 research activities. Of the five Division 1000 research observations, two had performed and documented a robust FMA, although the documentation was considerably different. For example, at the MESA Fabs, since the facilities are moderate hazard facilities, two safety analyses have been developed: one for the MicroFab and another for the SiFab facilities. Each of these safety assessments includes an appendix that documents the "what-if" analysis that was performed to satisfy the failure mode analysis requirements of Manual 471021. In a second example, the potential hazards and consequences of operating the E-Beam Writer at CINT, Center 1100, are well documented in the Work Acceptance, Approval and Authorization for this research activity.

Unacceptable consequences are identified for eight potential failure modes. The safety documentation evaluates existing engineering and administrative controls for each potential failure mode. As a result of the performance of the failure mode analysis, several new controls were identified (e.g., the need for elevating electrical cables off the floor in the event of standing water). For the remaining three Division 1000 research observations, the failure mode analysis performed either lacked a consistent and comprehensive approach to failure analysis or the outcomes were inadequately documented (B.2.6). As indicated in Section 5.1, documented institutional hazard analysis processes and training in failure mode analysis contributed to these shortcomings. For example, Section VI of the Group 1350 ALWAA for the Mode Stirred Chamber and Anechoic Chamber indicates that the safety case is established in the hazard control matrix (HCM) or Hazard Control Outline. The HCM provides a detailed description of four anticipated hazards (e.g., non-ionizing radiation) and associated controls and how the controls are to be verified. However, a discussion of system failures is not included, nor is an evaluation of the adequacy of existing controls for these failure scenarios. For the Thermal Processing research activity in Center 1800, some potential system failures are imbedded within the description of the safety theme, but only one potential failure mechanism is identified on a modified JSA form as previously discussed. In addition, the scope of critical thinking about failure modes is not always consistent with the work scope (B.2.6). For example, two of the Division 1000 research activities involve using hazardous chemicals, usually in the preparation for dissolving samples. The use or misuse of hazardous chemicals (e.g., transporting gallon quantities or less of trichloroethylene [TCE] across the laboratory during Thermal Processing research in Building 701) is excluded from the failure mode analysis for these activities since it is

presumed that such mishaps would be considered and controlled through center-level procedures on hazardous chemicals. However, this is not typically the case, and opportunities for identifying systemic failures when using hazardous chemicals (e.g., dropping and breaking the TCE glass container) may be overlooked. (See **SNL-FINDING-01**.)

Develop and Implement Controls

Hazard controls for Division 1000 research activities are documented in a variety of mechanisms through ALW authorization documents; IHEAs; TWDs, such as operating procedures; and in some cases PHSs. In general, hazard controls are well defined for the identified hazards. For example, the Operating Envelope for Center 1100, CINT Laboratory 1501, associated with the routine operation of the E-Beam Lithograph provided a detailed listing of hazard controls, applicable TWDs, and required training for each identified hazard category such as chemical usage, pressure system operations, and nanomaterials. In some Division 1000 research activities the hazard controls are embedded in the description of the work activity and associated hazards, such as thermal processing (soldering and aging). In other ALW descriptions the hazard controls are explicitly defined in tabular format adjacent to the hazard for which the control is intended to mitigate (e.g., E-Beam Writer at CINT, or via the HCM for the Mode Stirred Chamber in Group 1350).

The ALW at the MESA Fabs is more production than research-based and like much production-based work, performed according to operating procedures. At the MESA Fabs, most hazard controls are documented in operating procedures and other TWDs.

With the exception of the MESA Fabs, Division 1000 organizations do not have a clear and consistent understanding of the use of TWDs in research activities, particularly with respect to documentation of hazard controls. Based on interviews, there are inconsistent approaches to documenting hazard controls in TWDs (B.3.4). The SNL Corporate Procedure ESH100.2.GEN.3, *Develop and Use Technical Work Documents*, defines a TWD as a "formally approved document to identify activity-level work hazards and their associated work control measures." ES&H SOPs, health and safety plans, and operating procedures are examples of TWDs. However, Division 1000 organizations used other documents that are not included in this list to identify controls, such as ALW authorization documents, IHEAs, informal operator aids or instructions, JSAs, and PHSs. These documents do not always provide the same degree of rigor and approval as a TWD. For some of these documents, such as IHEAs, IH management has indicated that the exposure assessments are not TWDs and that the hazard controls identified in exposure assessments are to be incorporated into TWDs (such as operating procedures) within the ALW research work package. However, within Section VIII of the Group 1350 ALWAA for the Mode Stirred Chamber, the IHEA is identified as a TWD. Therefore, the hazard controls identified in the IHEA have not been incorporated into a TWD. For four of the five Division 1000 research activities observed, most hazard controls are not incorporated into TWDs as defined in ESH100.2.GEN.3 and/or Section 4.3 of the SNL ISMS Description Manual PG470252. (See **SNL-OFI-5**).

Perform Work Within Controls

For the five observed research activities, work was performed within controls identified in ALW authorization documents, JSAs, IHEAs, and SOPs with few exceptions. In general the exceptions were a result of conflicting or ambiguous controls in various documents that specified hazard controls. For example, during observations of the ammonia gas cylinder changeout at MESA Fabs, the worker wore only a latex glove during the process of connecting and disconnecting the old and new ammonia cylinders; however, the IHEA for this activity (Survey SNLNM03881) for "Cylinder/Container Changeout – Ammonia" requires the use of a self-contained breathing apparatus respirator and nitrile

rubber gloves. The PPE in use was inconsistent and less conservative than that required by the IHEA, although the latex glove use was consistent with the operating procedure (B.4.7).

Feedback and Improvement

Division 1000 is implementing a peer review process, performed by qualified professionals and SMEs, as one mechanism to provide feedback and improvement at the ALW level. Peer reviews of safety cases and management decisions are implemented using a graded approach. Reviewers provide their observations, conclusions, and recommendations to the work planner and management approval authority. The use and expectations of the Division 1000 peer review process is described in the Division 1000 WP&C implementation plan. In addition to the peer review process, Center 1800 has a weekly meeting to review WCAs where feedback can be provided. Center 1700 safety cases are embedded in the PHSs; providing an annual mechanism for review and improvement (Division 1000).

Apart from the aforementioned processes and routine ES&H assessments and management walkarounds, there are few additional ALW-level mechanisms for feedback and improvement within Division 1000. Currently, there are no post job reviews or formal mechanisms to share successes from the critical thinking process associated with preparing a safety case (B.5.2). For example, the E-Beam Lithography research team performed their "what-if" failure mode analysis and identified new potential hazards (such as a potential floor flooding hazard caused by a lack of drain from the safety shower); however, there was no formal mechanism to share this discovery or the research team's suggested hazard controls with other groups of divisions that may experience similar unidentified hazards. (See **SNL-OFI-06**.)

Division 1000 Summary

In general, work scopes for these five work observations in Division 1000 were well defined and could be understood by those performing the research as well as independent reviewers. Most of the research work scopes identify structures, systems, components, and equipment involved with the research activity, applicable TWDs, and required training. For Division 1000 research activities, hazard controls are documented in a variety of mechanisms including ALW authorization documents, IHEAs, TWDs (such as operating procedures), and in some cases PHSs. In general, hazard controls are well defined for the identified hazards. For the five research activities observed within Division 1000, work was performed within controls identified in ALW authorization documents, JSAs, IHEAs, and SOPs with few exceptions, and the peer review process is a useful feedback and improvement mechanism although the process has not yet been fully implemented. A number of WP&C concerns were also identified by the EA review team including a wide diversity of work control processes and formats throughout Division 1000 that are not well documented. In addition, there are inconsistencies in the use and incorporation of PHSs, TWDs and JSAs into ALW documents and in the performance and documentation of failure mode analyses in accordance with the requirements of Manual 471021.

5.2.2 Division 5000

Division 5000, Defense Systems and Assessments, supports defense communities through a variety of missions, with activities ranging from light laboratories to explosive operations. The detonator accident, discussed previously, was a Division 5000 activity.

Division 5000 issued their engineered safety implementation plan on September 12, 2013, which was approved by the Division 5000 Vice President. Consistent with Manual 471021, the plan sets forth expectations for using a systems engineering approach with a focus on critical thinking; outlines a strategy for using engineered controls consistent with Manual 471021; identifies "unacceptable

consequences" for Division 5000; and requires the formal documentation by line management for three decision points: 1) accept work; 2) approve the engineered safety case; and, 3) authorize work to begin. The implementation plan appropriately includes a control selection strategy based on the hierarchy of hazards elimination/reduction, use of engineered controls, administrative controls, and PPE. Division 5000 has further delegated implementation of the engineered safety process to the centers, which have developed their own engineered safety case processes (e.g., Centers 5300 and 5500 have developed web pages for their processes).

However, the Division 5000 WP&C implementation plan lacks several key attributes that are discussed in Manual 471021. For example, the Division 5000 implementation plan does not address the identification of a "safety theme," a requirement set forth in Manual 471021. There is limited discussion on the FMA, which provides insufficient guidance to work planners on appropriate hazard analysis techniques. Although the Division 5000 implementation plan addresses the elements for defining the work scope and analyzing and controlling hazards, it does not address the actions necessary to prepare and perform work. The Division 5000 implementation plan does not specifically address TWDs, the requirement to prepare a final JSA, readiness reviews, pre-job briefings, positive verification, or feedback and improvement, all of which are required by Manual 471021. (See **SNL-OFI-07**.) (B.3, B.4, B.5)

Division 5000 also has another document, *Work Planning and Control* (*WP&C*), 5000 WP&C-01, issued April 2, 2010, which provides an overview of the Division 5000 WP&C process. The status of this document is unclear because it is not referenced in the Division 5000 implementation plan and is not consistent with the Manual 471021 expectations (e.g., this document still refers to rigor level of work). However, this document provides guidance on TWDs, JSAs, pre-job briefings, accepting work, and authorizing work to start. This document references a job activity agreement card (JAAC), which is used to document the decision to accept, reject, or continue work, as well as the authorization to begin work. The JAAC still refers to rigor level; does not address "unacceptable consequences;" does not address site, facility, and equipment condition; and does not address cost and schedule. The JSA requirement can be met by either performing a JSA, an activity specific PHS, or an activity specific TWD. (See **SNL-OFI-08**.) (B.3)

EA observed activities at two Center 5300 areas, a machine shop and a light laboratory for radiofrequency (RF) testing. Center 5300 operates a small machine shop that is used to machine small pieces and miscellaneous other items. The light laboratory, used for RF testing and calibration, included a number of hazards (e.g., electrical, chemical, non-ionizing radiation).

Define the Scope of Work

The Division 5000 implementation plan includes roles and responsibilities for the Division 5000 Vice President, the center directors, senior managers, managers, and work planners. Consistent with Manual 471021, the Division 5000 Implementation Plan requires the level 1 manager to be the work planner, or to formally delegate the responsibility. The manager is also responsible for establishing an IDT consisting of SMEs. The individuals of the division implementation team are identified, as well as mentors. Duties of the work planner are described, and the Division 5000 implementation plan recommends training for work planners. The implementation plan requires line management to develop formal documentation for accepted work.

Division 5000 uses the JAAC to define and authorize the work. The JAAC points to the facility operating notebook (FON) for the TWDs, includes a list of the hazards, requires the completion of a JSA (or other document), requires a review of the operating envelope, and requires management approval (signifying both acceptance of work scope and authorization to proceed with work). The JAACs for both the machine shop and the RF testing laboratory contained the exact wording for the work description, a

generic description of Center 5300 activities, with a reference to the FON for specific activities authorized for the laboratory (the machine shop was also referred to as a laboratory). The FONs did not identify the specific work activities that were approved for the laboratories; however, they did reference a projects list of approved work at a SNL website. For the RF testing and calibration laboratory, a weekly e-mail from the project leads determines what work is to be accomplished that week. New work would have to be approved by the manager if it did not fit within the existing operating envelope. The B44A machine shop workers were familiar with the electronic spreadsheet of approved work and knew that if new work is not listed, the level 1 manager's approval must be obtained. An electronic spreadsheet of approved work does not clearly document or communicate the work scope to the workers. (See **SNL-OFI-09**.) (B.1.1, 1.2 &1.3)

Hazard Identification and Analysis

Consistent with Manual 471021, the Division 5000 implementation plan sets forth expectations for using a systems engineering approach with a focus on critical thinking, identifies unacceptable consequences for Division 5000, and requires the formal documentation by line management approval of the engineered safety case. The Division 5000 implementation plan does not address the identification of a safety theme, a requirement of Manual 471021. The plan's limited discussion on the FMA provides insufficient guidance to work planners on appropriate hazard analysis techniques. EA observed two activities, both of which had completed an engineering safety case in accordance with the Center 5300 process. The work planners had not been trained in hazards analysis techniques. In one case, some hazards had not been considered during development of the safety case. (See **SNL-OFI-13**.)

In the Center 5300 machine shop, EA observed two machinists—one drilling small parts, the other milling material from an optical lens piece. Center 5300 utilizes the PHS, the FON, the JAAC, the safety case, and their operating procedures (i.e., TWDs) for their operations envelope. A review of the JAAC 5343/891/B44-082509-009 indicated that in lieu of a JSA, an activity-level TWD would be prepared. EA reviewed the operating procedure for the machine shop in Center 5300 (Operating Procedure 5343001 Issue: B) and found that it identified hazards and controls, but did not meet the definition of a JSA because it did not include an analysis of the sequence of activities. (See **SNL-OFI-09**.) (B.2.6)

Division 5000 used a team that included work planner, a machinist, an IH SME (as stated by the manager, but not listed on the safety case), and the level 1 manager to develop the safety case for the machine shop. The safety case included a description of the hazards as well as unacceptable consequences and mitigations/controls. The hazards analysis process was informal, did not include failure modes (an FMA or what-if checklist was not included.), and did not find new hazards or controls. None of the participants had been trained on hazard analysis techniques. The safety case included a layout of the area. The safety case was approved by the level 1 manager. (See **SNL-OFI-13**.)

The RF testing and calibration laboratory has a number of hazards such as electrical, chemical, and non-ionizing radiation. The technologist is the laboratory owner/work planner for this laboratory and the work planning team included another work planner, an IH, two technologists, and the ES&H coordinator. The hazards analysis process began with the PHS list of hazards. Neither the work planner nor the ES&H coordinator had received formal hazards analysis training. No new hazards or controls were identified during the hazard analysis process. The technologist indicated that he had been trained on the hazardous operations. Line management had previously conducted an assessment of the RF non-ionizing radiation, and conducted an IHEA. EA reviewed the PHS, the safety case, and Operating Procedure 2345-0001, *Operation of Traveling Wave Tube Amplifiers in 5345/5342 Laboratories, Aircraft and Bistatic Mode*. The procedure appropriately addressed the hazards involved with the operation. The hazards identified in the PHS and safety case matched; however, neither addressed three hazards that were identified in the operating procedure (i.e., beryllium oxide, a high speed cooling fan, and hot surfaces on the traveling

wave tube amplifiers). The procedure stated that some traveling wave tubes contain beryllium oxide ceramics. The dust from these damaged ceramics is highly toxic. These hazards were not excluded through the IHEAs, and no explanation was provided as to why they were not addressed in the PHS or engineered safety case. A review of the JAAC 5345/891/2003/03262013-001showed that the list of hazards did not include electrical, although the technologist indicated this was a major hazard for the work, nor did it include beryllium. The safety case included a schematic of the layout of the area, including identification of where the hazards existed. The safety case was approved by the level 1 manager. (See **SNL-OFI-10**.) (B.2.7)

Center 5500 demonstrated their WP&C process, which uses an electronic system to guide users through the engineered safety process. This system is based on Military Standard 882, and is the only center to employ a risk based approach including probability of the event. The process for developing the safety case for Organization 5522 forklift activities was demonstrated, and involved a strong interdisciplinary review team comprised of managers, workers, and SMEs. The hazard analysis process was thorough and identified a number of new controls, many of which were implemented (e.g., height restrictor and strobe flash). The ES&H coordinator served as the team facilitator, and conducted a review of lessons learned associated with forklifts to encourage the team to consider other potential failure modes. This Center 5500 engineered safety case was an effective application of the concept and was effective in enhancing worker safety. (B2.1, 2.3, 2.4, 2.5, 2.6 and 2.7)

Develop and Implement Controls

The Division 5000 engineered safety implementation plan appropriately includes a control strategy election based on the hierarchy of hazards elimination/reduction, use of engineered controls, administrative controls, and PPE (B.3.1). Hazard controls are identified in the engineered safety case, the IHEAs, and the TWD. Per the JAAC for the machine shop and the RF testing and calibration laboratory, the JSA function is accomplished by an activity specific TWD (i.e., operating procedure). The operating procedure for the B44A machine shop, *Operating Procedure for Machine Shop in Center 5300*, OP 5343001, identified hazards and controls consistent with machine shop activities. The TWD for the RF testing and calibration laboratory includes *Operation of Traveling Wave Tube Amplifiers in Laboratories, Aircraft, and Bistatic Mode*, OP 2345-0001, Issue F. This procedure identifies the hazards associated with this work, and includes controls, cautions, and warnings (B.3.7). The safety case and IHEA also identified hazards and controls, with the exception of the hazards noted above.

Perform Work Within the Controls

Although the Division 5000 implementation plan does not address the actions necessary to prepare and perform work, the actions to authorize and execute work are addressed in the Division 5000 WP&C document. This document calls for conducting a final preparedness verification, authorizing work, executing work, and finalizing work. The JAAC is used as the mechanism to authorize work, and provides a comparison to the operating envelope, which includes a review of work scope; technical feasibility; hazards mitigation; TWDs; and personnel knowledge, skills, abilities, and qualifications. Operations within the B44A machine shop are limited to journeyman machinists (the level 1 manager maintains the list of approved machinists). In the machine shop, EA observed two machinists—one drilling small parts, the other milling material from an optical lens piece. The machinists were knowledgeable of the operations, the hazards, and the operating procedures. Both machinists were journeyman level, wore appropriate PPE (i.e., safety glasses and hearing protection), and used machine guarding. One machinist was the laboratory owner/work planner. The machinists indicated that they were familiar with “stop work,” and would not hesitate to stop work if needed (B4.4, 4.5, 4.6)

For the RF testing and calibration laboratory, a weekly e-mail from the project leads determines what work is to be accomplished that week. New work would have to be approved by the manager if it did not fit within the existing operating envelope (B.4.1). The technologist was trained on the operating procedure, understood the identified hazards, and was familiar with stop work and would not hesitate to do so. For the activities observed within Division 5000, work was performed within controls identified in the ALW authorization documents and TWDs.

Feedback and Improvement

The Division 5000 implementation plan does not address feedback and improvement; however, the Division 5000 WP&C document addresses improving processes through post-job reviews and analyzing and processing feedback. B44A machinists indicated that lessons learned are discussed at the end of jobs, but are not formally documented. The technologist at the RF testing and calibration laboratory had not generated any lessons learned, and neither group indicated using lessons learned. Formal post-job reviews were not conducted by either group (B5.1 and 5.2). No lessons learned were generated as the result of their engineered safety case process. All departments in Center 5300 had department-wide meetings to review the results of the detonator accident, including a video of lessons learned; spent time discussing the relevance to their work, emphasizing stop work authority; and other safety topics. Division 5000 does not currently use a peer review process as part of their engineered safety process.

Division 5000 Summary

Overall, the Division 5000 implementation plan addresses most of the elements of Manual 471021; however, it did not address the actions necessary to prepare and perform work (the third critical decision point). The relationship between the implementation plan and the document *Work Planning and Control (WP&C) in Division 5000* is unclear, and the latter has not been updated. The JAAC, which is used to accept work and to authorize work, needs to be updated to be consistent with Manual 471021. Division 5000 allows the JSA process to be accomplished through various methods, which are not consistent with the expectations for conducting a JSA. Division 5000 has delegated the development of the engineered safety case to each of its centers. EA observed two activities, both of which had completed an engineering safety case in accordance with the Center 5300 process. The work planners had not been trained in hazards analysis techniques. In one case, some hazards had not been considered during the safety case development. Center 5500 demonstrated their WP&C process, which was successfully used to develop an engineered safety case for forklift activities, resulting in numerous safety improvements. Lessons learned are not being formally generated and documented.

5.2.3 Division 6000

Division 6000, Energy, Non-Proliferation, and High-Consequence Security, supports a number of missions including nuclear energy, geothermal energy, global security, critical asset protection, and other related areas. Division 6000 revised their *Engineered Safety Implementation Plan and Procedure*, R2, on June 30, 2014. The original document was approved by the Division 6000 Vice President. This implementation plan appropriately addresses the elements identified in Manual 471021, and additionally addresses stop work authority. This plan/procedure is consistent with Manual 471021, straightforward, and easy to follow. Although FMA is addressed, very little detail is provided on appropriate methodologies in the Implementation Plan. However, a FMEA template is included in the Division 6000 Engineered Safety Tool. The recent revision reflects the Division 6000 decision to emphasize the use of the peer review process, which is encouraged but not mandatory for the “define scope and plan work” and the “prepare and perform work” phases, and is mandatory for the “analyze and control hazards” phase. Division 6000 requires peer review for all safety cases, and is the first SNL division to take this proactive step. (See **SNL-NP-1**.)

Division 6000 has developed an electronic engineered safety tool that provides work planners with templates and guidance for completing the nine steps for WP&C. Division 6000 does not further delegate the implementation process to the centers, so there is only one WP&C process for Division 6000.

Define the Scope of Work

EA observed activities in three Division 6000 centers: Centers 6500, 6600, and 6900. The Center 6500 activity was the systems advanced concepts research and evaluation laboratory, which involved imaging and camera research. A formal work scope and acceptance document identified the work planning team (including an electrical engineer, the ESH coordinator, and an IH), provided a clear description of the work scope, identified the hazards category, the PHS number, a comparison to the approved operating envelope, applicable permits, and management acceptance of the work. (B1.1, 1.3, and 1.6)

The next work observation, Center 6900, annex dynamometer, involved a project that is part of the geothermal research group. This project involves testing motors for downhole drilling application. This activity was the pilot case for the Division 6000 engineered safety case process. A formal work scope and acceptance form was completed (including the scope of work paragraph), a work planning walkdown checklist, the hazard category review, review of the operating envelope, an evaluation of key factors including current status of training and qualifications, cost and schedule, and other work prerequisites. The level 2 manager accepted the work scope. However, because of the moderate hazard category, the director should have accepted the work. An *Accept Work Checklist*, which aligned the proposed work with the operating envelope, was also completed.

The third work observation was in Center 6600, chemistry laboratories/decontamination. A work scope and acceptance form had been completed for the decontamination laboratory. The manager stated that any new work would be compared to the operating envelope to ensure that it was within that scope, and that he was responsible for approving any new work.

Hazard Identification and Analysis

The Center 6500 safety case involved the development of a safety theme, unacceptable consequences, failure mode analysis, hazard controls, and was approved by the level 1 manager. The work is straightforward and the laboratory is categorized as SIH. The most hazardous activity in the laboratory is the use of a Class 3R laser. The IH assessment, SNLNM06338, assessed the laser and determined that no IH hazard existed and no PPE was required. A JSA was not prepared for this activity, but rather depended upon the skill of the worker.

The engineered safety case for the dynamometer center (Center 6900) was high quality, very thorough, and well documented, resulting in safety improvements. Since this was the pilot case for Division 6000, the engineered safety case was not in the current Division 6000 format; however, it did address the three decision points (i.e., work acceptance, safety case, and work authorization). The principal investigator (PI) was the work planner for this engineered safety case. He initiated the safety case which was subsequently reviewed by the IDT. The WP&C documents included a FMEA, the PHS, the safety case, a JSA, and a design basis review and supporting documentation (B2.1). The PI had not received training on hazards analysis or WP&C300. The safety case included a description of the hazards, failure modes, and unacceptable consequences; actions to eliminate or mitigate the hazards; passive engineered controls; administrative controls; and PPE. A detailed design basis provided an overview of the test station; requirements including the safety theme; operational system design including tools and equipment; personnel and procedures; positive verification; hazards identification and analysis; hazard mitigation; risk assessment including failure analysis; and engineered safety compliance. The hazard identification

and analysis process for this laboratory were very thorough and complete (B2.6, 2.7). EA noted a discrepancy between the PHS and other safety documents on the hazard classification. The PHS showed this to be a low hazard, but the *Work Scope and Acceptance* document said it was a moderate hazard. The PI stated that the manager wanted to conservatively elevate the hazard classification; however, such a decision would call for director, not the level 2 manager, to approve the *Work Scope and Acceptance* document and this did not occur. There is an inconsistency between the hazard categorization of the PHS and the *Work Scope and Acceptance* document for the Division 6000 dynamometer test station. (See **SNL-OFI-03**.)

For Center 6600, chemistry laboratories/decontamination, the work planner had not been involved in the development of the safety case for this laboratory, and was not familiar with the safety case for *Chemical & Biological Systems Laboratories*, which had been provided to EA. The PI, who had authored the safety case, stated that it was specific for his laboratory directed research and development project and was not applicable to this laboratory work. No one was able to produce an engineered safety case for the chemistry laboratories/decontamination activity, so it is unclear if those activities have been analyzed. (Note: It was later determined that the Safety Case for these two laboratories had been consolidated into one document.)

EA reviewed the hazards identification and analysis documentation provided, including the safety case, the PHS, and the IHEA report. Regarding the safety case that was provided for the laboratory directed research and development project, no new hazards or controls were identified during the engineered safety case process. The PI indicated that he had performed the FMA and had consulted with SMEs as appropriate. The PI and the work planner did not appear on the list of attendees for the WP&C300 course, and they had not been trained in hazard analysis techniques. The failure mode analysis was limited to one scenario (i.e., chemical spill), although numerous hazards are known to exist within the laboratories. (See **SNL-FINDING-01**.)

Develop and Implement Controls

For the Center 6500 imaging activity, work authorization documentation included a listing of the TWDs (i.e., IHEA, work planning walkdown, and owner/operator instructions). The work authorization also required confirmation of team training and qualifications, and the completion of readiness reviews or assessments. The line manager approved the work authorization (B.4.1).

The design basis for the Center 6900 dynamometer test station identified both engineered and administrative controls. The engineered controls include pressure relief valves, a slip clutch mechanism to decouple the flywheel, and guards on rotating equipment. Additionally, the PI obtained an independent assessment of the engineered safety case, which identified additional considerations with kinetic energy (flywheel), resulting in the addition of shear bolts as engineered controls (B3.1). The TWD management review checklist was completed and addressed roles and responsibilities, training, logical sequence of tasking, etc. (B.3.7, 3.8). Additionally, an approved *Technical Work Documents Checklist* was completed and indicated that all controls were identified and implemented, JSA's completed, etc. (B3.4). Controls were adequately developed and implemented for the dynamometer test station activity.

Center 6600 uses a TWD, Div-6000 ESH Form TWD, which addresses hazards, controls, hazard specific training, the procedure, contingency planning, and feedback and improvement. This document included a JSA-like table, which included the basic activity/step, hazard, and hazard control/PPE, but did not address the biological hazards. The SOP for autoclave (steam sterilizer) operation and safety appropriately addressed training qualifications, hazards, and operating procedures, including the use of PPE. The Operating Envelope 06632 was for the bio-safety laboratories. The format of the operating envelope included information on the laboratory capabilities; the various PHS and National Environmental Policy

Act (NEPA) reviews; safety assessments; a list of hazards, limitations, and special requirements; applicable TWDs; and work packages. Although there was confusion about whether these documents applied to this particular laboratory, the format used to compile information from this suite of documents was a useful way to present the controls that need to be implemented.

EA reviewed the IHEA Survey Report for the Center 6600, Chemistry Labs/Decontamination Laboratory, SNLNM05789, dated June 6, 2013. The IHEA report stated that the controls for the chemical fume hood were ineffective. The flow indicator and low flow alarm were disabled at the time of testing, and line management was required to obtain an air flow indicator as required per Corporate Procedure ESH100.2.IH.15, *Control Hazards Using Local Exhaust Ventilation and High Efficiency Particulate Air Filters*. At the time of the assessment, no evidence was provided that indicated any action was taken to correct the identified non-conformance. Pursuant to the EA inquiry, SNL stated that the PI obtained a hand-held air flow indicator on August 27, 2014, over a year after the IHEA was issued. Although SNL is in the process of eliminating the hand-held devices in lieu of installed indicators, SNL considers the use of the hand-held devices to be acceptable as an interim measure. (See **SNL-OFI-11)**

Perform Work Within the Controls

The documentation to authorize work at the dynamometer test station included a workability walkdown checklist, which in turn included a clearly defined scope of work, work control documents (JSA, PHS, NEPA, TWD, and failure modes), workspace considerations, and training. Also, an *Authorize Work to Start Checklist* was completed, and the work authorization document was signed by the level 2 manager.

The PI for the dynamometer test station provided an excellent overview of the project and the engineered safety process utilized for this project. The PI and technologist demonstrated the operation of the dynamometer test station. Prior to demonstration, the PI went through a thorough pre-job briefing. The PI referred to an operating procedure during startup of the activity. Appropriate PPE (safety glasses and ear plugs) was worn. The demonstration was shutdown in an orderly fashion. Both the PI and the technologist were comfortable with stop work. The ability to perform work within controls was effectively demonstrated for the dynamometer test station (B4.1, 4.2, 4.3, 4.4, 4.5, 4.6, and 4.7).

Regarding work conducted in the Center 6600, Chemistry Labs/Decontamination, both the work planner and the PI indicated that they had been trained on the hazards within the laboratories. They both were familiar with the concept of stop work, and would have no reservation about using it. According to the level 1 manager, pre-job briefings are not held for on-going work. For larger projects, a project kickoff and more formal work authorization would be used.

Feedback and Improvement

For the three activities observed in Division 6000, no formal documentation of lessons learned was observed. The PI for the dynamometer test station maintained a log notebook and entered notes for process improvement in the log notebook. The dynamometer test station compliance documentation included a *WP&C Manager Walkthrough Checklist* as part of the self-assessment activities. The work planner and PI in Division 6600 decontamination laboratory did not generate lessons learned. The Center 6500 imaging team leader said that a peer review was conducted prior to every experiment, but this was not formally documented. Division 6000 was conducting all-hands meetings to share lessons learned from the recent accidents at SNL. Additionally, Division 6000 is strengthening the use of the peer review process, and is the first division to require 100% peer review of safety cases. Overall, no evidence was presented that lessons learned are being formally generated or effectively used in Division 6000 (B.5).

Division 6000 Summary

Overall, the Division 6000 engineered safety implementation plan and procedure and engineered safety processes are consistent with Manual 471021, straightforward, and easy to follow. However, training on hazards analysis techniques has not been provided to personnel with key roles in work planning and safety cases. Division 6000 has implemented a 100 percent peer review process during the safety case development to drive improved hazards identification and controls. In response to the accident in Site 9920, Division 6000 has held all-hands meetings with the Vice President and directors to discuss the accident and its applicability to work in this division. The implementation of the Division 6000 engineered safety case process is ongoing, and EA noted one example of a high quality, thorough and well documented engineering safety case, resulting in safety improvements, and one example of where the process had not been appropriately followed. Lessons learned are not being formally generated and documented.

5.3 Sandia Field Office Oversight

Criteria: EA reviewed the SFO to ensure that effective oversight processes have been established and implemented with respect to AL-WP&C.

SNL oversight of the CAS as well as other SNL management oversight processes was reviewed. Since EA completed a review of SFO oversight processes in January 2014, the EA team focused on selected elements related to oversight of AL-WP&C for non-nuclear facilities. Unlike nuclear facility oversight that includes FRs and safety system oversight (SSO) personnel, SFO oversight of non-nuclear facilities is conducted by ES&H SMEs.

SFO's business management system (SBMS) policy SBMS 0804, *Sandia Site Office Oversight*, and process SBMS 0804.01, *Plan, Manage, and Improve SSO Oversight*, define how SFO plans and executes oversight activities. These oversight processes result in an annual oversight plan and schedule that details additional focus and guidance. In the SFO *FY2014 Oversight Plan & Schedule*, SFO developed risk scores for 21 selected non-nuclear hazardous facilities/activities and then scheduled oversight resources proportionate to the relative risks for the selected facilities/activities. SFO SMEs are tasked with oversight at the non-nuclear facilities. Planned oversight activities include SME operational awareness activities to determine functional area program health and to conduct SME limited scope reviews.

SFO has a staff of seven ES&H SMEs to perform oversight of ES&H at non-nuclear facilities. SFO assigns SMEs either by functional area or geography (e.g., Technical Area IV). SFO personnel indicated that prioritizing oversight activities and providing sufficient coverage is a significant challenge given the large number of SNL facilities, which include remote facilities. SFO personnel also indicated that oversight of offsite locations was limited by constraints on travel; SFO SMEs indicated that they are able to travel off site about once every three years to conduct oversight activities. EA confirmed that many SNL facilities are rarely reviewed by the SFO SMEs. One of the JONs from the March 11, 2014, Site 9920 accident investigation report identified that SFO needs to develop and implement a plan with a graded approach for oversight of all operations. This JON was accepted by SFO for action. At the time of this review, SFO had not finalized changes to its future oversight processes (FY 2015) to address the JON. SFO indicated their intent to focus future oversight on the major SNL line organizations, higher consequence operations, and programmatic activities.
(See **SFO-OFI-01**.)

SFO has been proactive in providing direct oversight to the development of the SNL corrective action plan in response to the Site 9920 accident, which involved numerous WP&C issues. SFO has also been proactive in providing additional oversight training to SFO staff this calendar year.

EA reviewed the implementation of the approved SFO oversight plan and schedule for FY 2014 by reviewing records and interviewing SFO staff. SFO SMEs are generally following the schedule and using a 2012 assessment guide for AL-WP&C. The assessment guide is essentially a checklist approach for evaluating AL-WP&C activities on an ongoing basis. While the approach is appropriate, the assessment guides have not been updated to reflect changes made in the recent revision of DOE Guide 226.1-2A and other lessons learned since 2012. (See **SFO-OFI-02**.)

SFO SMEs are adequately documenting their ongoing evaluations in weekly ES&H issues reports and monthly functional area program health reports, using the ePegasus database. SFO limited scope reviews and other scheduled assessments are also adequately documented in ePegasus.

According to SBMS 0804, SNL's CAS results for low and moderate risk activities are reviewed and evaluated by SFO to monitor and provide follow up on identified safety vulnerabilities. In some cases, SFO may conduct oversight of low and moderate risk activities. SFO communicates its oversight results in this area by posting to SNL's Integrated Laboratory Management System, a database for tracking identified issues. For high-risk activities, SFO plans and performs compliance-based oversight on a sample of Sandia activities. For most SFO oversight on AL-WP&C activities at the non-nuclear facilities, SMEs roll up their ongoing observations and issues into a monthly report as previously discussed. These functional area program health reports (e.g., pressure safety, hearing protection, confined space permits, fire protection) document the SME's operational awareness activities and oversight results, assessment of the contractor's performance assurance system, and an overall assessment of the functional area performance. SFO line management reviews these monthly assessments and further discusses them during regular quarterly joint analysis meetings attended by the SMEs and SFO managers. The meeting results are further expressed in a quarterly feedback report (QFR), which evaluates SNL's current performance against performance objectives established in the annual performance evaluation plan.

For the second quarter QFR for FY2014, SFO rated SNL below expectations against its operations and infrastructure performance objective, based in part on continued concerns in WP&C. For the second quarter report, SNL had only completed 40 percent of the safety cases through March 2014 and had not yet established defensible measurement of performance improvements in WP&C. This is a good example of SFO formally communicating oversight results in a timely manner to allow SNL senior management to make informed decisions to correct weaknesses and to meet their performance objectives by the end of the FY. At the time of this assessment, SFO was reassessing SNL for the third quarter QFR as meeting expectations in its operations and infrastructure performance objective. SFO feedback from the second quarter QFR has resulted in improved performance and SFO is appropriately setting expectations that SNL effectively implement the engineered safety case approach across the WP&C laboratories before the end of FY 2014.

SFO has sufficient processes (both formal and informal) in place to communicate oversight results to SNL management and senior managers. According to SFO oversight procedures, for significant performance assurance issues identified during oversight activities, SFO formally transmits a contracting officer's representative memorandum to SNL. SFO actively tracks to closure SNL's progress in resolving these issues by a tracking number. SFO also uses various informal communication processes to share less significant issues, such as periodic peer-to-peer meetings between SNL and SFO at the SME level and line management level. In these meetings participants are able to raise issues and concerns and provide SNL an opportunity to discuss the issue and potential solutions. Additionally, SFO has a weekly operations open meeting where FRs and SMEs update SFO line managers on issues and concerns. SNL representatives also attend this meeting on behalf of their line management.

6.0 CONCLUSIONS

Sandia National Laboratories

Since April 2013, SNL has been implementing a new WP&C process across the entire laboratory for activity-level work. The new process requires completion of WP&C engineered safety cases, which is a significant improvement that has the potential to effectively identify hazards and controls for laboratory wide activity level work. Approximately 600 out of 1500 WP&C engineered safety cases had been completed as of the date of this review.

To support the new WP&C process, SNL had developed and promulgated a new corporate WP&C procedure that outlines an enhanced framework for worker safety. The new engineered safety case process is designed to provide a structured and detailed analysis of safety of activity level work activities by an interdisciplinary team. Some of the engineered safety cases reviewed by EA were effectively performed and the supporting documentation was in order. In addition, SNL workers and managers associated with the work observations were knowledgeable of the hazards and controls, and indicated the importance of stopping or suspending work if a potential unsafe condition was identified.

However, weaknesses were evident in processes and their implementation. SNL corporate processes do not provide clear guidance in some important areas, such as failure mode analysis, and the engineered safety case initiative requirements were intentionally written so that each Division develops its own implementation process/procedures and did not provide for sufficient corporate-level review and assessments, resulting in significant variability in approach and quality across SNL organizations. Of the work activities observed by EA, some did not meet expectation of the corporate WP&C engineered safety requirements. For example, the output of the primary hazard screening process is not always well integrated with the research activity work document particularly with respect to hazard categorization and work scope description, some work activities did not have a compliant job safety analysis, and there were significant deficiencies in some instances where technical work documents were not used to document hazard controls. In addition, a key component of the engineered safety cases is the failure mode analysis and, for some work activities, the analysis was inadequate or not conducted. Further, SNL's processes for analyzing, tracking and trending of WP&C issues have known, long standing deficiencies that SNL is working on but has not fully addressed.

SNL is obtaining various feedback on ALW and its implementation of engineered safety through many formal and informal mechanisms, and is also taking some actions through many formal and informal processes to make improvements (WP&C engineered safety cases webpage repository, ESH coordinators meetings, and division/center/group safety meetings). SNL has initiated a task to improve its institutional lessons learned process. SNL's CAS has produced some effective evaluations of WP&C at the corporate and division level that have driven improvements. However, these reviews are inconsistently scheduled and recorded in the AIS, a recently instituted database repository. In addition, some feedback and improvement processes are not effectively implemented at the working level. Further, SNL's processes for analyzing, tracking, and trending of WP&C issues have known, long standing deficiencies (identified from previous external reviews), which SNL is continuing to address. In general, SNL has struggled with the task to improve its feedback and improvement processes.

Overall, SNL's improvement initiatives are appropriately targeted on establishing effective controls, and SNL is making progress implementing its new process, which is contributing to safer operations. However, weaknesses in the flowdown of processes expectations to the working level are still evident, and many working level safety documents have gaps and inconsistencies that could result in safety controls not being identified, implemented, or understood, thus reducing the safety benefits of the new processes. The deficiencies warrant increased management attention including more performance

assessments and training of personnel (e.g., in safety and hazards assessment processes).

Sandia Field Office

SFO line management has generally established appropriate procedures to evaluate SNL's implementation of its WP&C procedures in its non-nuclear facilities. Through a QFR and other mechanisms (such as issue tracking systems) SFO is effectively communicating oversight issues to SNL senior managers. SFO continues to monitor SNL's corrective actions, especially in regard to the actions being taken to address the WP&C issues from the accident investigation at Site 9920 and the long-standing issue with SNL issue management processes. SFO SMEs assigned to SNL non-nuclear facilities are performing some ongoing oversight activities. However, SFO oversight activities for SNL non-nuclear operations are generally limited in depth and frequency (SFO cites limits on safety subject matter experts and travel resources as a cause).

7.0 FINDINGS

As defined in DOE Order 227.1, *Independent Oversight Program*, findings indicate significant deficiencies or safety issues that warrant a high level of attention from management. If left uncorrected, findings could adversely affect the DOE mission, the environment, the safety or health of workers and the public, or national security. Findings may identify aspects of a program that do not meet the intent of DOE policy or Federal regulation. Corrective action plans must be developed and implemented for EA appraisal findings. Cognizant DOE managers must use site- and program-specific issues management processes and systems developed in accordance with DOE Order 227.1 to manage these corrective action plans and track them to completion.

Sandia National Laboratories

SNL-FINDING-01: The engineered safety cases for some research activities do not meet the minimum requirements of Manual 471021 with respect to performing a failure mode analysis.

8.0 OPPORTUNITIES FOR IMPROVEMENT

These potential enhancements are not intended to be prescriptive or mandatory. Rather, they are suggestions offered by the EA team that may assist site management in implementing best practices, or provide potential solutions to minor issues identified during the conduct of the assessment. In some cases, OFIs address areas where program or process improvements can be achieved through minimal effort. It is anticipated that these OFIs will be evaluated by the responsible line management organizations and either accepted, rejected, or modified as appropriate, in accordance with site-specific program objectives and priorities.

Sandia National Laboratory OFIs

SNL-OFI-01: Document each unique WP&C process across the SNL divisions. In some cases, WP&C processes may be best categorized and documented at the division level, the center level (Division 1000), or at the group level (Group 1100).

SNL-OFI-02: Enhance and clarify the current definitions for an "operating envelope" and "safety envelope" to ensure that both can be applied consistently to all SNL research activities.

SNL-OFI-03: Reassess the current PHS process to ensure that hazard category declarations and work scopes for PHSs are consistent with hazard category declarations for ALWs.

SNL-OFI-04: Develop an SNL procedure for JSAs to expand the existing limited JSA instruction provided only on the JSA form. Provide a clear definition of the term "JSA equivalent" with examples from the research ALWs.

SNL-OFI-05: Clearly define "TWD" as it applies to research activities and supporting documents (e.g., PHS, JSA, IHEAs, and ALW authorization documents). Clarify the mechanisms for documenting hazard controls in ALW documents and whether all hazard controls must be in a TWD.

SNL-OFI-06: Provide a feedback and improvement mechanism to capture the outcomes from the failure mode analyses obtained when performing a safety case to ensure that the identification of previously unforeseen hazards and controls can be shared across all SNL divisions.

SNL-OFI-07: Expand the Division 5000 implementation plan to include mechanisms for implementing all key attributes of Manual 471021 such as failure mode analysis, preparing and performing work, and readiness reviews.

SNL-OFI-08: Revise document 5000 WP&C-01 to be consistent with Manual 471021, and include an update of the JAAC process and the process for performing JSAs.

SNL-OFI-09: Incorporate the work scope, boundaries, and limits for Division 5000 work directly in the JAAC. Revise the Division 5000 JSA process to require an analysis of the sequence of activities.

SNL-OFI-10: Revise the hazards analysis process for the RF testing and calibration laboratory in Division 5000 to include the possible beryllium and electrical hazards and any other possible hazards.

SNL-OFI-11: Ensure that recommendations identified within SNL IHEAs are resolved in a timely manner and hazard controls identified within the SNL IHEAs are incorporated in a TWD.

SNL-OFI-12: Consider developing a process that requires organizations to acknowledge receipt, review, and disposition of selected important lessons learned information, and to track corrective measures to completion.

SNL-OFI-13: Supplement the ISMS description document to better describe its management process(es) for analysis, tracking, and trending of issues and concerns to ensure it adequately satisfies DOE requirements.

SNL-OFI-14: Ensure consistent use of AIS at the working level, emphasizing the expectation of AIS as the corporate repository for assurance records.

SNL-OFI-15: Perform more corporate-level assessments to verify SNL divisions are adequately implementing corporate policies and procedures.

Sandia Field Office OFIs

SFO-OFI-01: Enhance SFO oversight of non-nuclear facilities including a near term focus on SNL implementation of the engineered safety case process. Specific actions to consider include:

- As a near term measure, evaluate the benefits of requesting support from ES&H personnel at other field offices, and/or Headquarters to review SNL's extensive effort to implement WP&C engineered

safety cases for all hazardous operations, including those at remote locations.

- For the longer term, ensure that the breadth and depth of SFO oversight of non-nuclear facilities is commensurate with the risks and consequences. As part of this effort, reevaluate approaches to risk ranking of facilities and activities and reevaluate travel resources to ensure that SNL hazardous operations at remote locations in California, Nevada, Alaska, and elsewhere are periodically reviewed.
- Selectively perform performance based reviews of non-nuclear AL-WPC, including work observations and implementation of processes at the shop floor.

SFO-OFI-02: Update SFO assessment guides to reflect changes made in the recent revision of DOE Guide 226.1-2A and other lessons learned since 2012.

9.0 NOTEWORTHY PRACTICE

Sandia National Laboratory Noteworthy Practices (NPs)

SNL-NP-01: Division 6000 requires peer review of all safety cases.

Appendix A
Supplemental Information

Dates of Review

Onsite Review: July – August 2014

Office of Enterprise Assessments

Glenn S. Podonsky, Director, Office of Enterprise Assessments
William A. Eckroade, Deputy Director, Office of Enterprise Assessments
Thomas R. Staker, Director, Office of Environment, Safety and Health Assessments
William E. Miller, Director, Office of Nuclear Safety and Environmental Assessments

Quality Review Board

William A. Eckroade
Thomas R. Staker
William E. Miller
Michael A. Kilpatrick

Office of Enterprise Assessments Site Lead

William A. Macon

Office of Enterprise Assessments Reviewers

William E. Miller, Team Leader
James R. Lockridge, Professional Engineer, Certified Industrial Hygienist, Certified Safety Professional, Certified Hazardous Material Manager
Terry B. Olberding, Professional Engineer
Kevin E. Horace

Appendix B
Key Documents Reviewed, Interviews, and Observations

Documents Reviewed (relative to the findings, opportunities for improvement, and report conclusions)

- PG470252; Integrated Safety Management System Description; Rev. 4, 11/6/2013
- MN471021; Work Planning and Control Criteria for Safe Design and Operations; Rev. 0, 4/1/2013;
- Center 1800 Work Control Authorization; Thermal Processing (Soldering and Aging)
- *Corrective Action Plan (CAP) for Unexpected Initiation of Detonator at Explosives Testing Site 9920 for Occurrence Report SNL-5000-2013-0005*, Version 2, 7/11/2014
- CG100.6.3, *Determine, Plan and Perform Assessments*, 1/17/2014
- CG100.6.6, *Determine and Take Action*, 5/29/2014
- CG100.6.15, *Identify Operating Experience, and Share Lessons Learned*, 5/23/2013
- Division 1000 Implementation of MN471021, Rev. 3, 9/8/2013
- Division 5000 Engineered Safety Implementation Plan, 9/13/2013
- Division 6000 Engineered Safety Implementation Plan and Procedure, R2, 6/ 30/ 2014
- ESH100.1.WPC.1, Plan and Control Work, 4/25/2014
- ESH100.2.IH.1 Maintain a Workplace Free from Chemical, Physical, Biological, and Safety Workplace Hazards, 4/10/ 2013
- ESH100.4.FI.1, *Perform ES&H Line Self-Assessment Activities*, 5/7/2014
- ESH 100.4.FI.2, *Identify and Report Lessons Learned*, 5/20/2014
- ESH 100.4.FI.3, *Implement and Manage Corrective Actions*, 6/3/2014
- *Fiscal Year 2014 DOE/NNSA Strategic Performance Plan (PEP) for Sandia Corporation*, Revision 2, 4/30/2014
- IH Exposure Assessment Survey Report for the Center 6500 Imaging and Camera Testing Laboratory, SNLNM06338,
- IH Exposure Assessment Survey Report for the Center 6600 Chemistry Labs/Decontamination laboratory, SNLNM05789, 6/6/2013
- IH Exposure Assessment Survey Report SNLNM03881 for Mesa Fab Cylinder/Container Changeout, 11/8/2011.
- IH Exposure Assessment Survey Report; TA1 701 General Lab, 10/12/2011
- *MESA Fabs Safety Program Management Plan*, Rev. 0
- *MESA Fabs Operating Procedure, Air Products Gas Cabinet Operating Procedure, 5/20/2014*
- *Primary Hazard Screening, Spectral and Thermal Imaging Laboratory, 897/2424, 6/26/2014*
- *Primary Hazard Screening, Building 518, Room 1501 CINT Electron Beam Lithography Room, 7/30/2014*
- *Primary Hazard Screening, MSE-Center for Solder Science and Technology, 6/25/2014*
- *Report of the Work Planning and Control Advisory Board (WPCAB)*, 6/25/2014
- *Sandia National Laboratories FY13 ISMS Effectiveness Review*, 11/14/2013
- SBMS 0804, *Sandia Site Office Oversight*, Rev. 0, 8/18/ 2010
- SBMS 0804.01, *Plan, Manage, and Improve SSO Oversight*, Rev. 0, 8/18/2010
- *SFO FY2014 Oversight Plan and Schedule*, 9/18/2013
- *Sandia National Lab FY2014 Q2 Quarterly Feedback Report (QFR)*, 5/14/2014

- *Site 9920 Accident Investigation Board Report*, 3/11/2014
- *Site-Wide Strategy for Safety Improvement*, 7/11/2014
- *SSO Activity Level (AL) Work Planning and Control (WP&C) Assessment Guide*, 3/2012
- *Study of Engineered Safety Implementation*, 2/13/2014
- JAAC # 5343/891/B44-082509-009, Room B44A, Machine Shop
- JAAC #: 5345/891/2003/03262013-001, RF Testing and Calibration Laboratory
- Facility Operations Notebook, RF Testing and Calibration Laboratory, Issue D, 5/8/ 2014
- Facility Operations Notebook, B44A Machine Shop, Issue F, 1/21/ 2014
- Operating Procedure for Machine Shop in Center 5300 OP Number: OP5343001
- Operating procedure OP 2345-0001, Operation of Traveling Wave Tube Amplifiers in 5345/5342 Laboratories, Aircraft and Bistatic Mode.
- Work Acceptance, Approval and Authorization, CINT E-Beam Writer Program, 5/15/2014
- Work Planning and Control in Division 5000, 5000 WP&C-01, 4/2/2010

Interviews

- Division 1000 ESH Coordinator
- Division 5000 ESH Coordinator
- Center 5300 ESH Coordinator
- Center 5500 ESH Coordinator
- Division 6000 ESH Coordinator
- WP&C Program lead for corporate
- Principal member of technical team (PHS process)
- safety basis engineer
- Human Factors expert (SCWE)
- Work Planners (5)
- SNL Senior Managers, Divisions 1000/5000/6000
- SNL Director, ES&H
- SNL Senior Manager, ES&H
- SNL Manager, Engineering Systems Integration/Implementation
- SNL Manager, Technical Operations
- SNL Manager, Industrial Hygiene Program
- SNL Manager, Corporate Governance
- SNL Senior Engineer, Audit Center
- Corporate Internal Audit Center
- SFO Director, Contractor Assurance
- SFO Assistant Manager, Operations
- SFO SMEs, Occupational Safety and Industrial Hygiene

Observations

- Walkdowns of research laboratories/activities in Division 1000, 5000, and 6000.
- Weekly SFO operations meeting/call
- SNL Division 4000 Quarterly Management Assurance Review
- Center 5300 Machine Shop

- Center 5300 RF Testing and Calibration Lab,
- Center 6500 Imaging and Camera Research Laboratory;
- Center 6600 Chemistry Labs/Decontamination;
- Center 6900 Dynamometer Test Stand Laboratory
- Observed demonstration of Center 5500 Engineered Safety Case and web-based application for the forklift activity
- Mode Stirred Chamber research conducted in Building 963 Room 120B by Center 1300;
- Thermal Processing and Aging research conducted in Building 701 by Center 1800;
- E-Beam Lithography research conducted in Building 518 (CINT) Room 1501 by Center 1100;
- Raman Spectroscopy & Thermometry research conducted in Building 897 Room 2424 by Center 1100
- MESA-FAB Toxic Gas Operations; Gas Cylinder Delivery & change conducted at the MESA Fabrication Facilities (Fab) by Center 1700.

Appendix C
WP&C Inspection Criteria

A. PROCESS AND DOCUMENTATION

EA reviewed the WP&C program definition to ensure that the development and approval of WP&C processes and documentation enable safe performance of work, and include hazard identification and analysis and control selection; safe and efficient execution of work activities; a management and organizational framework for (1) initiating, analyzing, planning, and approving activity level work and (2) authorizing, releasing, and safely performing activity level work; and a feedback and improvement process for activity level work.

1. The WP&C processes include feedback and improvement. They include provisions for active worker involvement in identification, planning, and improvement of work and work practices and incorporation of lessons learned into active and in-development activity level work control documents and/or the WP&C procedure.

2. The WP&C processes include a clearly defined, logical, and approved process for (1) initiating, analyzing, planning, developing, and approving activity-level work and, (2) authorizing, releasing, performing, and completing activity level work. The processes include clearly defined roles, responsibilities, and authorities. These processes cover all work activities. The processes are documented.

3. The WP&C processes define the work scope elements and associated boundaries for development of activity level work control documents and ensure coordination among different organizations.

4. The WP&C processes ensure appropriate personnel, including workers and ES&H SMEs, are involved in the hazard identification and analysis.

5. The WP&C processes define requirements for walkdowns and team approaches utilizing appropriate personnel (e.g., work planners, work supervisors, workers, and SMEs) in the planning process.

6. The Organization has developed and approved WP&C processes that adequately establish and integrate hazard identification and analysis and control selection. The WP&C processes ensure hazards and controls from other safety program analyses have been considered and integrated into the hazard analysis.

7. The hazard identification and analysis process ensures controls applicable to each hazard are specifically identified and justified by the analysis. The WP&C processes describe the method to incorporate hazard controls, technical and administrative requirements identified in the job hazard analysis/ job safety analysis, and other permits/analysis into activity-level work control documents (ALWCDs).

8. The WP&C processes communicate the need to produce clear, concise, and worker friendly activity level work control documents with properly sequenced work instructions.

9. The WP&C processes ensure first line supervisors and workers follow work controls as written in activity level work control documents. The WP&C processes establish line management responsibility for planning and safe performance of activity level work with clear, unambiguous lines and levels of authority; clear roles, responsibilities, authorities, and accountabilities; and integration and coordination of organizational interfaces. The process includes criteria for senior management review (i.e., independent hazard review teams) of select activities.

10. The WP&C processes establish WP&C responsibilities for all personnel performing, planning, and authorizing work at their site. The WP&C processes establish the level of review and approval for different types of work activities. The planning detail and resultant documentation chosen is based upon the hazards of the work, complexity of the work activity, frequency the work is performed, and complexity of the applicable controls.

11. The WP&C processes provide for assuring readiness for and performing work.

12. The WP&C processes provide for activity level work review and closeout.

13. The WP&C processes identify training and qualification requirements for all personnel involved in WP&C.

B. PROGRAM IMPLEMENTATION

1. Define the Scope of Work

EA reviewed the scope of work to ensure that the work planning process is sufficient to identify hazards associated with the work and to develop necessary schedules, priorities, and work instructions.

1. The work to be accomplished, condition to be achieved, problem being corrected, and/or expected outcome is clearly documented and/or communicated to the worker.

2. The specific tasks necessary to accomplish the scope of work are identified and discernible.

3. Work scope boundaries/limits are clearly identified.

4. Conditions under which the work must be performed are clearly identified.

5. Structures, systems, and components; equipment; and documents impacted/affected by the work are identified.

6. Applicable standards and requirements, documented safety analysis (DSA) information (including technical safety requirements [TSRs]), and design basis information (including manufacturer's recommendations) are identified and used during work planning.

7. Applicable prior work history information, including feedback and lessons learned information from previous or similar work is used during work planning.

8. Acceptance criteria are established for conclusively determining whether the work is accomplished successfully and has not caused other problems or deficiencies.

9. Personnel involved in work planning understand and appreciate the need to define the work scope completely and accurately so that subsequent planning activities ensure safety.

2. Analyze the Hazards

The next major area of review was hazard identification and analysis. EA reviewed the implementation of these processes to ensure that all hazards that could adversely impact workers, the public, the environment, the facility, and its equipment are documented and analyzed for severity/significance.

1. Personnel involved in work planning activities have the appropriate technical and operational backgrounds and expertise given the work to be performed and the hazards associated with the work. The SMEs and system engineers are used where appropriate.

2. Personnel involved in work planning activities have been trained in integrated safety management and the WP&C processes, including the systematic identification and analysis of hazards, and understand how their roles and responsibilities contribute to ensuring the safe and reliable accomplishment of work.

3. The synergy/interaction of a team approach is used where appropriate to systematically identify and analyze work hazards and their significance.

4. Workers are involved in hazard identification.

5. Walkdowns are used where appropriate to identify hazards associated with both the work tasks and the work environment.

6. The hazard identification and analysis process provides for the identification and analysis of job/task specific hazards and selection of their associated controls. Hazard analysis considers appropriate analysis tools (e.g., "what if' scenarios, error-likely situations, fault trees, exposure assessments, arc-flash analysis).

7. The hazards, and their potential consequences to workers, the public, and the environment—for the scope of work being assessed—have been adequately identified, quantified, analyzed, and documented. If utilized, automated/computerized job hazards analysis tools are applied only as a starting point and supplemented by evaluation of specific hazards associated with the individual work activity.

8. Work planning and scheduling coordinates work activities with those who may impact or be impacted by the work so that the combined effect of ongoing work activities is understood, and adverse or undesirable impacts from work activities are avoided.

3. Develop and Implement Controls

EA reviewed the implementation of processes for the identification and implementation of controls, to ensure they effectively protect against identified hazards, and that approved activity level work control documents can be performed as written.

1. The WP&C processes ensure a hierarchy of controls methodology is employed that first seeks to eliminate the hazards, then to reduce the level of hazards, and finally to control the hazards—first

through the use of engineered controls, then through administrative controls, and lastly through personal protective equipment (PPE).

2. Appropriate controls are identified for all hazards associated with the work activity. Unnecessary controls are avoided.

3. The WP&C processes ensure evaluation of the possibility of creating additional hazards due to selected controls (i.e., excessive PPE causing heat exhaustion), and the potential for negative synergistic effects of selected controls. Hazard controls are reconciled to ensure selection of an optimum set that do not conflict with each other or create uncontrolled hazards.

4. The WP&C processes ensure the chosen method of implementing the hazard control into the ALWCDs is appropriate. The hazard controls are integrated into activity level work control documents.

5. Potential unwanted/undesirable impacts from the conduct of work activities (e.g., alarms, entry into TSR Required Actions, degraded or diminished safety or mission capability) are identified and addressed in the ALWCD.

6. The WP&C processes ensure the control or level of control established for a hazard is maintained throughout the activity or until the hazard has been eliminated or reduced (controls can be graded to level of hazard reduction). Hazard controls are adequately designed, implemented, and remain in effect as long as the hazards pose a health or safety threat.

7. Activity level work control documents include prerequisites, precautions, limitations, warnings, cautions, notes, hold points, independent verifications, notifications, or announcements where needed to ensure worker safety, protection of critical equipment, and continuity of operations.

8. Activity level work control documents clearly define the work scope and boundaries; are written in a clear, concise, and worker friendly manner with properly sequenced work steps where needed; clearly identify hazard controls; and can be performed as written.

9. ALWCDs and subsequent change/revisions are reviewed by applicable workers, supervision, and SMEs and Senior Management Review (i.e., independent hazard review team) prior to approval by designated management personnel consistent with established requirements.

4. Perform Work Within the Controls

EA reviewed the performance of work, to ensure that work is conducted diligently in accordance with approved work instructions and within established controls.

1. The WP&C processes designate work control authority for review authorization and release of all approved work prior to commencement of work. The responsibilities and work release criteria are defined. The WP&C processes provide for the request of work and prioritization of work planning, planning of work approval of any resultant ALWCDs, and scheduling. Provisions require screening of the requested work against the existing safety envelope and/or permits. Work is systematically scheduled and integrated (e.g., Plan of the day (POD) / Plan of the Week (POW) meetings) with ongoing work activities, and is formally authorized to proceed by the responsible line manager.

2. Requirements for the use of pre-job briefings, post-job briefings, and the Stop Work Readiness to conduct work is confirmed, including verification that work site conditions are as expected (i.e., have not changed since planning and hazards analysis activities, de-conflicting other work activities), and that tools, materials, parts, and support is ready and available prior to work release by responsible line management.

3. Pre-job briefings are conducted to ensure that workers and first line supervisors adequately understand responsibilities, work procedures and instructions, hazards, controls, and stop work/pause work authority, and have an opportunity for questions and feedback.

4. Workers exposed or potentially exposed to hazards are provided with the training and information on that hazard and are trained and qualified to perform their duties in a safe and compliant manner.

5. Personnel understand their responsibilities for ensuring that work is performed safely and as written. Workers understand what to do if unexpected, unusual/abnormal or threatening conditions are encountered, and how to stop or pause work if necessary.

6. Workers take appropriate actions in response to unexpected circumstances or conditions (e.g. Stop/Pause Work), and where necessary adequately document and record observations and actions, including as-found and as-left conditions, unexpected circumstances or conditions encountered (e.g., unplanned alarms, abnormal or unplanned equipment behavior or response, unexpected data or indications/display values, or other discrepancies) and actions taken, opportunities for improvement, and other feedback and lessons-learned information.

7. The acceptability of work products and outcomes is adequately documented and verified (e.g., post-work tests and inspections), and the work is formally accepted by the requestor/owner/user.

8. Activity level work control documents are closed out in a timely manner, including updates of affected documents (e.g., Master Equipment Lists, training materials, procedures, drawings, load lists, DSA and design basis documents).

5. Feedback and Improvement

EA reviewed the area of feedback and improvement to ensure that the WP&C processes are routinely evaluated by the Organization's Contractor Assurance System and feedback and improvement processes and lessons learned are adequately captured and incorporated into the planning and performance of ongoing and future work activities.

1. Post-job reviews and other mechanisms are conducted to obtain feedback, both good and bad, in order to make process improvements.

2. Feedback and lessons learned information is captured, documented (post-job reviews, log/status sheet entries, databases, etc.), and forwarded to the Organization designated individuals and/or organizations for analysis and disposition.

3. Appropriate action is taken in response to feedback and lessons learned information, the rationale for the action taken is documented, and the action is discussed with the individuals that provided the information for closure.

4. The contractor has developed processes so that external and internal feedback and lessons learned are factored into ongoing and future WP&C activities.

5. The Contractor Assurance System produced periodic scheduled and non-scheduled evaluations (e.g., self-assessment, independent assessment, management walkthroughs, etc.) of WP&C activities which identified issues, concerns and opportunities for improvement in the WP&C program.

6. The contractor has developed processes that result in analyzing, tracking, trending internally and externally identified issues/concerns; evaluates this information against established performance objectives and expectations (i.e., measures or metrics); develops and implements corrective actions; and conducts effectiveness reviews to ensure continued improvement of the WP&C program.

C. SANDIA FIELD OFFICE OVERSIGHT

EA reviewed the SFO to ensure that effective oversight processes have been established and implemented with respect to AL-WP&C.

HSS CRAD 45-21

1. DOE Field Element Line Management Oversight

DOE Field Element line management has established and implemented effective oversight processes that evaluate the adequacy and effectiveness of contractor assurance systems and DOE oversight processes.

2. DOE Field Element Facility Representative (FR) Program

DOE Field Element has implemented an effective FR program.