DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Washington, DC 20004-2901

August 28, 2012

The Honorable Daniel B. Poneman
Deputy Secretary of Energy
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1000

Dear Deputy Secretary Poneman:

The Defense Nuclear Facilities Safety Board (Board) has conducted a series of reviews at Department of Energy (DOE) sites since 2008 to evaluate the implementation of Integrated Safety Management (ISM) at the activity level. The Board has transmitted reports detailing deficiencies and weaknesses in the implementation of activity-level ISM in several site-specific letters to the National Nuclear Security Administration (NNSA) and to the DOE Office of Environmental Management (EM).

In your May 17, 2012, letter you reiterated DOE's commitment to complex-wide improvements in activity-level work planning and control and acknowledged the Energy Facility Contractors Group (EFCOG) effort to develop a work planning and control guideline document. The Board is encouraged by DOE's continued commitment and understands that DOE is currently evaluating the EFCOG document. The Board notes that DOE has recently solicited feedback from NNSA and EM site offices and headquarters organizations regarding this document.

The Board has developed a detailed report, DNFSB/TECH-37, *Integrated Safety Management at the Activity Level: Work Planning and Control.* This report is enclosed for DOE's use, providing additional feedback as DOE evaluates its path forward to improve activity-level work planning and control. This report summarizes the history of actions taken to improve activity-level work planning and control. The report identifies similarities between the weaknesses in activity-level work planning and control documented in recent DOE accident investigation reports and in the Board's letters to NNSA and EM. Based on this analysis it is apparent that DOE's previous improvement actions have not resulted in sustained improvement and consequently have not been effective. The Board believes that this is in large part due to a lack of formalized requirements and guidance within DOE's directives system and the resulting lack of DOE and contractor oversight in this area. The Board notes that the EFCOG document is not a recognized national standard, is not formally incorporated into the DOE directives system, and as such, is not official DOE guidance.

Therefore, pursuant to 42 U.S.C. § 2286b(d), the Board requests a report and briefing within 60 days of receipt of this letter that details the actions taken and planned by DOE to address the lack of comprehensive requirements and guidance as identified in the enclosed report. In addition, the Board requests a report and briefing within 12 months of receipt of this letter that details DOE's assessment of the effectiveness of these actions.

Sincerely,

Peter S. Winokur, Ph.D.
Chairman

Enclosure

c: The Honorable Thomas P. D'Agostino
Mr. David G. Huizenga
Mr. Glenn S. Podonsky
Mrs. Mari-Jo Campagnone

DNFSB/TECH-37

INTEGRATED SAFETY MANAGEMENT AT THE ACTIVITY LEVEL:

WORK PLANNING AND CONTROL

Defense Nuclear Facilities Safety Board

Technical Report

August 2012

INTEGRATED SAFETY MANAGEMENT AT THE ACTIVITY LEVEL:

WORK PLANNING AND CONTROL

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EXECUTIVE SUMMARY

Integrated Safety Management (ISM) is the system adopted by the Department of Energy (DOE) to ensure that work is performed safely by its workers and contractors at all DOE sites. The objective of ISM is for DOE and its contractors to integrate safety systematically into management and work practices at all levels so that as missions are accomplished, the public, workers, and the environment are protected. DOE's acquisition regulations require that contractors perform work safely in a manner that ensures adequate protection for the public, workers, and the environment. This requirement is to be accomplished through the implementation of the guiding principles and core functions of ISM.

The guiding principles and core functions of ISM provide the approach used by DOE to plan work, analyze hazards, develop and implement controls, authorize work, and assess and improve work execution. Although ISM encompasses work that is performed at all levels (site, facility, and activity), execution of DOE's national security, environmental cleanup, energy, and science missions occurs at the activity level. Throughout the DOE complex, the activity level is where planning is accomplished for safe execution of the hazardous work necessary to accomplish DOE's mission.

Line management must focus on this activity level, where work and safety must be integrated. The five core functions of ISM provide the fundamental logic for developing procedures and work controls that protect scientists, engineers, technicians, operators, maintenance personnel, and all others working within a potentially hazardous environment or with energetic processes. ISM is valuable at this level because it is applicable to all types of work. It can be used to plan and safely execute operations, maintenance, research and development, decontamination and decommissioning, construction, and any other type of work one might imagine.

DOE, with the support of the Defense Nuclear Facilities Safety Board (Board), has worked for more than 15 years to foster the implementation of ISM systems across the complex. Safety has improved, and DOE and contractor workers are now, more than ever, engaged and actively participating in many of the activities necessary to keep safety and safe operations at the center of their mission. Despite these steps forward, however, ISM must be further emphasized and implemented at the activity level.

Although the theory behind ISM and its five core functions appear to be well understood at all DOE defense nuclear facilities, the application and implementation of ISM to ensure safe work execution are not so easily accomplished. In particular, the implementation of ISM at the activity level is frequently incomplete. As a result, hazards are not properly identified and documented during work planning or controlled while work is being executed. Work packages and documents used to direct the execution of work at the activity level lack integration. A review of recent DOE accident investigations, notices of violation, and occurrence reports reveals the consequences of not fully leveraging this system of safety management. Reviews of activity-level work planning and control across the DOE complex conducted by the Board's staff have indicated a consistent set of weaknesses shared by nearly all contractors attempting to implement ISM at the activity level.

This report was produced to illustrate weaknesses in work planning and control and to summarize lessons learned through these examples. It starts with a brief history of DOE's implementation of ISM, focusing on efforts at the activity level, including ongoing efforts. Examples of the failure of work planning to ensure the control of activity-level hazards are examined to identify areas for improvement. The report also summarizes findings related to implementation weaknesses identified in DOE Accident Investigations and by observations made by the Board's staff during the past four years. These summaries highlight the need for a different approach to work planning and control to implement ISM effectively at the activity level.

Beyond the five core functions and seven guiding principles of ISM there is a lack of adequate, comprehensive requirements and guidance for work planning and control in the DOE directives system. This report concludes that if ISM is to be institutionalized at the activity-level, the issuance of adequate, comprehensive requirements and guidance in the DOE directives system is essential. Comprehensive requirements and guidance would govern the development and maintenance of effective work planning and control processes at DOE sites. Previous attempts by DOE to issue guidance to sites via memorandum, outside of the DOE directives system, have proven ineffective.

The lessons learned in Attachments A and B of this report are intended to provide a summary of potential weaknesses that requirements and guidance on this subject should address. Although these lessons learned are not all-encompassing, work planning and control requirements and guidance would be strengthened by ensuring these weaknesses are addressed to prevent their recurrence. Finally, the report concludes that sustained enhancements can be achieved through the development of review criteria and through headquarters, site office, and contractor use of these criteria to periodically evaluate the effectiveness of work planning and control processes and procedures.

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1. BACKGROUND

The U.S. Department of Energy (DOE) has embraced Integrated Safety Management (ISM) as its safety management system since 1996. In its response to the Defense Nuclear Facilities Safety Board's (Board) Recommendation 1995-2, *Integrated Safety Management*, DOE committed to institutionalizing ISM through its directives system (U.S. Department of Energy, 1996). The ISM policy was issued in October 1996, and a set of DOE guides was released soon thereafter to assist in the policy's implementation. In addition to these directives, DOE's Acquisition Regulations were changed to include a new ISM clause, 970.5223-1, *Integration of Environment, Safety, and Health into Work Planning and Execution*. As identified in the Board's technical report DNFSB/TECH-36, *Integrated Safety Management: The Foundation for a Successful Safety Culture* (Defense Nuclear Facilities Safety Board, 2005, pp. 2-3), DOE established ISM as a new approach to integrating work and safety.

In its original construct, ISM was aimed at three levels:

- **Institutional level—**DOE's regulatory and program organizations. This level has responsibility for setting standards and expectations, as well as overseeing the implementation of ISM by contractors. The institutional level also encompasses contractor management of the laboratories and production sites. The seven guiding principles of ISM are basically management requirements for the implementation of ISM at the institutional and facility levels.

- **Facility level—**the safe and compliant operation of facilities that house hazardous activities. The primary goal of implementing ISM at the facility level is to provide an approved safety basis for both production and research activities. Properly applied at this level, ISM is designed to protect workers from system-level accidents (a facility fire, for example) and the public from the release of hazardous materials and chemicals (plutonium, for example). The five core functions of ISM provide the fundamental logic for developing a compliant facility safety basis; the details are embodied in DOE directives.

- **Activity level—**the safe execution of hazardous work necessary to accomplish DOE's national security, environmental cleanup, energy, and science missions. The five core functions of ISM provide the fundamental logic for developing procedures and work controls that protect technicians, operators, scientists, and engineers working with hazardous materials and energetic processes.

The institutional level provides (1) safety requirements in the form of DOE regulations and directives, (2) mission and funding based on priorities, and (3) requirements and cultural values from local site and contractor policies and procedures. The facility level provides a safe operating platform that protects the public, workers, and the environment; it's basically a license for operation. The activity level provides procedures and work controls to protect workers while enabling safe work on hazardous systems. Individuals at each level have roles and responsibilities for integrating work and safety, but the responsibilities of line management focus

on the inner, activity level, where mission work and safety must be integrated with other priorities.

Following the issuance of its ISM policy and associated directives, DOE directed all Office of Environmental Management (EM) and NNSA sites to verify that ISM systems were completely in place by September 2000 (Richardson, 1999). While verifying that basic elements of ISM were in place, these assessments showed that full implementation of ISM at all levels had not been achieved complex-wide. Follow-on improvement efforts were identified. Of note, these assessments and improvements did not thoroughly address the implementation of ISM at the activity level, but rather focused on site-level systems.

In 2001, the Board acknowledged in a letter to the Secretary of Energy that while completion of the ISM assessments was a commendable achievement, follow-on improvement efforts had faltered. The Board questioned the effectiveness of the annual update process aimed at ensuring the continued currency of ISM programs and suggested that a method be provided for identifying deficiencies and corrective actions for those systems that were not functioning effectively (Conway, 2001). In its response, DOE agreed that competent annual reviews of ISM systems were essential for effective implementation of ISM and continuous improvement, and concluded that program offices would continue monitoring the effectiveness of site efforts to sustain and maintain their ISM systems and providing aid and direction as necessary (Abraham, 2002).

In the ensuing years, DOE explored changes to its methods for contractor management and nuclear safety oversight. The Board held a series of public meetings in 2003 and 2004 to gather information needed to understand the potential effects of these changes. The Board was concerned that proposed modifications to DOE's and NNSA's organizational structure, manpower, contract management, oversight policies and practices, and safety directives could have unintended consequences. The Board sought to ensure that any fundamental reorganization would not degrade nuclear safety, and that the likelihood of a serious accident, facility failure, construction problem, or nuclear incident would not increase as a result of well-intentioned changes.

Another objective of these public meetings was to benefit from the lessons learned from investigations conducted following the Columbia Space Shuttle disaster and the discovery of deep corrosion in the reactor vessel head at the Davis-Besse Nuclear Power Station in Ohio. Additionally, DOE had its own lessons to learn from an April 2003 glovebox fire that occurred at the Rocky Flats Environmental Technology Site (RFETS), where, in the interest of efficiency, contractor personnel used a generic work package for glovebox dismantlement work instead of developing a specific work package to identify and control the hazards associated with the glovebox being worked on.

As a result of these safety management issues and the evaluation of lessons learned, the Board issued Recommendation 2004-1, *Oversight of Complex, High-Hazard Nuclear Operations* (Defense Nuclear Facilities Safety Board, 2004). Recommendation 2004-1 highlighted the importance of ISM by including a sub-recommendation for DOE and NNSA to take steps to

require "that the principles of Integrated Safety Management serve as the foundation for the implementing mechanisms at the sites."

In Revision 1 of DOE's Implementation Plan for Recommendation 2004-1, the Secretary of Energy recognized and acknowledged the need to revitalize the implementation of ISM (U.S. Department of Energy, 2005). This need to revitalize ISM was due to two factors: (1) incomplete and inconsistent implementation of the guiding principles and core functions of ISM in programs, sites, offices, and facilities throughout the complex; and (2) a general waning of attention to and use of ISM as it was intended to create and sustain real continuous improvement. To reinvigorate attention to ISM, DOE issued an ISM manual to formally capture and institutionalize DOE's ISM expectations and lessons learned to date. To address inconsistencies in implementation, DOE targeted some long-recognized weaknesses for focused attention, including work planning and control, feedback and improvement processes, ISM system descriptions, and ISM implementation by DOE federal organizations. Additionally, the Implementation Plan acknowledged the need to strengthen federal oversight of ISM and numerous other core review areas.

In commitment 23 of the Implementation Plan for Recommendation 2004-1, DOE outlined an approach to improving performance in work planning and control that promoted local ownership of the problems and solutions. In November 2005, the Under Secretary for Energy, Science and Environment directed EM to require that site offices assess the effectiveness of work planning and work control processes at the activity level (Garman, 2005). A broad set of criteria review and approach documents (CRAD) was provided via memorandum to assist in these assessments (Triay, 2005). NNSA also directed its sites via memorandum to evaluate their work planning and control processes and provided them with a similarly broad set of CRADs. NNSA went one step further, however, and issued an attributes, guidance, and best practices document on how to implement ISM at the activity level (D'Agostino, 2006). Based on the results of these directed assessments, the sites were to develop action plans identifying specific areas in which improvement was needed, as well as recommended solutions. The intent of these action plans was to improve the consistency and reliability of work planning and work control at the activity level.

The site offices conducted the assessments, and used the identified gaps between the CRADs and existing programs to develop action plans to drive improvements (Brooks, 2006; Garman, 2006). Review of the assessments and action plans reveals that they varied greatly in their rigor and level of detail. Additionally, these early site office action plans appear to be the last significant steps taken by most EM and NNSA sites regarding the assessment and improvement of work planning and control. With the development of these action plans, commitment 23 was closed, as reflected in Revision 2 of the 2004 Implementation Plan, dated October 12, 2006 (U.S. Department of Energy, 2006).

Recent staff reviews have revealed that the CRADs previously developed have not been used routinely by most NNSA and EM site offices to assess contractor performance since their initial use. Based on the current status of work planning and control as identified in this report, it is clear that the expectations of DOE senior management have not been effectively institutionalized and that the attempt to reinvigorate the implementation of ISM at the activity

level following Recommendation 2004-1 was not fully successful. Additionally, one expected outcome and commitment of Recommendation 2004-1 was the issuance of an oversight guide that was to contain CRADs for many review areas, including activity-level work planning and control. DOE Guide 226.1-2, *Federal Line Management Oversight of Department of Energy Nuclear Facilities,* was issued on June 21, 2012. However, this guide simply contains a link to CRADs on the Energy Facility Contractors Group (EFCOG) website and caveats the link with a footnote, "DOE supports EFCOG activities, but EFCOG-developed guidance is not official DOE guidance." This action is little different than previously unsuccessful attempts at issuing oversight CRADs for use in this area.

2. EFFICACY OF DOE'S ACTIONS

DOE's approach to addressing weaknesses in work planning and control was ineffective and relied primarily on ownership and action on the part of the local site offices to address the problems identified without continued direction, guidance, and involvement from headquarters. This is clearly illustrated by a comparison of the findings concerning the May 2003 glovebox fire at RFETS, which occurred prior to the issuance of Recommendation 2004-1, with examples of failures in work planning and control that have occurred since the development of the site offices' action plans. Such failures can be found in DOE accident investigations and reviews by the Board as discussed in the following sections. Additionally, the Board identified common weaknesses in work planning and control at multiple NNSA sites in a May 2004 letter (Conway, 2004), yet these weaknesses remain common today. It is evident that many of the fundamental issues that existed prior to Recommendation 2004-1 persist throughout the DOE complex.

2.1 GLOVEBOX FIRE AT ROCKY FLATS

At RFETS, a large fire in a highly contaminated glovebox (Glovebox 8) in Building 371 occurred after workers cut a hole to provide a ventilation path in preparation for dismantling this atypical glovebox. The contractor had approached this effort using a standard work package intended for common-design gloveboxes that identified only generic industrial hazards (e.g., injuries from tools, heavy loads, falling from scaffolding) and failed to take into account the unique configuration of this glovebox. The other gloveboxes in Building 371 were of horizontal construction, with large viewing ports, bag ports, and a significant number of glove ports. The scope and hazard analysis in this standard work package did not address the factors that made Glovebox 8 unique: vertical construction; limited glove port access; very limited visibility for verifying conditions; and the presence of various materials in the glovebox, some of which were known to be combustible. The contractor had made no effort to tailor the scope of the standard work package to the specific configuration of the glovebox and analyze specific hazards. The work package provided no specific instructions for the tasks required to prepare for dismantling the glovebox.

The Board's letter documenting the results of its review of this fire noted in detail the deficiencies in work planning discussed above (Conway, 2003). The Board's review also revealed that DOE's site office had performed essentially no oversight of activity-level work planning for decommissioning activities at RFETS. The Board had sent correspondence to DOE in early 2002 regarding deficiencies in work planning and site office oversight at RFETS. DOE Headquarters and the DOE site office subsequently made commitments in mid-2002 and early 2003 to enhance RFETS work planning and site office oversight (Conway, 2002; Roberson, 2002).

Despite the lessons learned from this fire, numerous similar examples of the failure of work planning and control to properly identify and control hazards and of deficiencies in DOE's oversight of work planning and control have occurred since the site offices developed their action plans. The lessons learned from the fire at RFETS can be found in accident investigation reports, occurrence reports, DOE lessons learned, and the Board's letters to DOE on the subject.

The issues identified in these lessons reveal a number of recurring themes. The following sections summarize these issues in work planning and control and DOE's oversight; Appendices A and B, respectively, provide more detailed summaries of findings from DOE's accident investigations and reviews of work planning and control conducted by the Board's staff.

2.2 ACCIDENT INVESTIGATIONS

Appendix A contains a summary of the work planning and control deficiencies noted in DOE's Type B accident investigations. DOE conducted these accident investigations after declaring ISM to be implemented at the activity level and closing commitment 23 of the Implementation Plan for Recommendation 2004-1 following the site offices' development of action plans in March 2006. The following are some examples of weaknesses noted during these accident investigations:

- A weak hazard analysis process and the failure to work within specified controls resulted in a contaminated puncture wound in F-Canyon at the Savannah River Site.

- Implementation of the contractor's work control process at Hanford was inadequate to identify the work scope, hazards, and associated controls. As a result, a worker suffered significant injury after falling 50 feet to the ground from an open bridge crane hatch.

- Contamination spread at the Separations Process Research Unit in Niskayuna, New York, as a result of the failure to fully understand, characterize, and control radiological hazards and to implement a work control process that would ensure facility conditions supportive of proceeding with the work.

2.3 STAFF REVIEWS

During the past four years, the Board's staff has performed a series of reviews of work planning and control at nearly all DOE sites with defense nuclear facilities. These reviews have revealed recurring weaknesses in the implementation of ISM at the activity level. Appendix B summarizes the most salient deficiencies observed by the staff during these reviews. The following are some key weaknesses frequently identified by the staff:

General:

- Site procedures do not adequately define the processes to be used to integrate the core functions of ISM into activity-level work planning and control.

- DOE has not issued an approved requirements document on how to conduct activity-level work planning and control.

Define the Scope of Work:

- Work instructions and technical procedures have too broad a scope and do not sufficiently identify the boundaries of the work to be accomplished.

- The defined scope of work does not include adequate detail to ensure that the hazards associated with the execution of tasks and/or work steps have been individually identified and analyzed.

Analyze Hazards and Develop Controls:

- Job hazard analyses are not performed (or fail to document hazard analysis) at the appropriate task/work step level.

- In some cases, job hazard analyses are driven by a checklist. As a result, they identify generic (e.g., slips, trips, and falls), unquantified hazards (e.g., identifying the potential for chemical or radiological contamination without specifying the expected quantities or concentrations) and/or specify non-germane hazard controls (e.g., ladder safety when a ladder is not being used) while obscuring controls that are germane.

- In some cases an overreliance on automated hazard analyses results in ineffective application of the hierarchy of controls and preferential selection of administrative controls or personal protective equipment over removal of a hazard or engineered controls.

- Instead of a team approach, job hazard analyses often use a serial approach that involves routing electronic versions of hazard identifications to subject matter experts rather than assembling those personnel as a team to identify and analyze the hazards and deconflict and develop the optimal set of controls.

Work Within Controls:

- Poorly written work instructions lack sufficient specificity, in some cases cannot be performed as written, and necessitate workarounds in the field during execution.

Feedback and Improvement:

- Lessons learned from field work often are not incorporated back into work planning and control processes to improve both the processes and future planned work and thereby prevent costly and/or recurring deficiencies.

- DOE and contractor programmatic oversight usually is ineffective at identifying or correcting these recurring problems.

- DOE has not issued CRADs in its directives system for use in providing oversight of activity-level work planning and control.

These recurring weaknesses reveal that ISM is applied inconsistently at the activity level where work is actually being conducted, and as a result, hazards are addressed inappropriately or not at all in work activities. Overall, the programmatic oversight activities of DOE and its contractors have not been fully effective at identifying and correcting the deficiencies, largely because of the lack of comprehensive requirements and guidance on how to develop adequate systems, processes, and procedures for appropriately planning activity-level work in the DOE directives system. Nor does the DOE directives system include criteria and measures for headquarters, site offices, and contractors to use in evaluating the effectiveness of work planning and control processes and procedures.

2.4 OCCURRENCE REPORTS

Although they did not rise to the level that would require a DOE accident investigation, many other events across the DOE complex that have been shared through DOE's Occurrence Reporting and Processing System and Operating Experience Program were directly attributed to failures of the work planning process to properly control hazards. These include the following:

- A release of airborne radiological contamination occurred during retrieval of legacy wooden boxes containing transuranic waste at Idaho National Laboratory's Advanced Mixed Waste Treatment Project in February 2010. Work planning efforts failed to distinguish between the two types of boxes being retrieved, which included newer boxes with a resin coating to protect against degradation and older boxes without such a protective coating. Work planning documents did not identify the hazard of a degraded box or controls to address the potential for a degraded box. An attempt to move an unprotected and substantially degraded box resulted in the release of airborne contamination and internal contamination of workers.

- An event in a glovebox at Lawrence Livermore National Laboratory resulted in a rapid pressure pulse, damaging the glovebox and ejecting depleted uranium materials into the processing room in December 2008. This occurrence was attributed to work documents that had been broadly written and failed to identify specific hazards and controls. Further, the waste processing plan was inadequate for controlling the work, and personnel failed to stop work when actions not addressed in the plan had to be performed.

- At Los Alamos National Laboratory, the use of a generic work document by a postdoctoral assistant attempting to duplicate an experiment described in a published paper resulted in an unexpected rapid energetic reaction in an oven in January 2010. The problems contributing to this event included an incomplete/informal hazard analysis and the lack of a formal work release.

- The scope of a task to transfer dry, pyrophoric uranium machining chips from one container to another in air outside of a glovebox at the Y-12 National Security Complex in March 2007 had not been formally defined during the work planning for a weapon component evaluation activity. As a result, no hazard analysis had been performed, and no procedural coverage of the chip transfer task was in place. As the transfer task was being performed, the machining chips were exposed to air and caught fire. The fire generated high levels of smoke and airborne radiological contamination. Numerous facility personnel were exposed before the building was evacuated and were later found to have received radiological uptakes.

2.5 FEEDBACK AND IMPROVEMENT

In all of the above cases, contractor and DOE oversight was inadequate to prevent the events from occurring. These cases also indicate a failure of the feedback and improvement function of ISM, as similar situations continue to occur. These examples of deficient work planning and control emphasize the need for an approach different from that taken in response to Recommendation 2004-1 to improve the implementation of ISM at the activity level. As discussed above, lessons from these events are readily available in DOE's accident investigation reports, letters from the Board to DOE, DOE's Occurrence Reporting and Processing System, and DOE's Operating Experience Program. These lessons could be used systematically to improve work planning and control processes and procedures.

3. CURRENT INITIATIVES

Many of the letters from the Board to DOE, summarized in Appendix B, have identified the lack of a work planning and control standard as a deficiency. Absent such a document, DOE's expectations for how its contractors should plan and control work at the activity level are not clearly or consistently established. Thus, DOE and its contractors lack the tools necessary to develop successful programs, oversee and measure effective implementation, and support continuous improvement in this area. All of DOE's efforts to improve work planning and control have resulted in multiple sets of guidance issued via memorandum outside of the DOE directives system. This situation is a main factor contributing to the deficiencies identified in this report.

An effort has been underway to develop guidance on how to plan work effectively at the activity level. A working group from the Integrated Safety Management and Quality Assurance Subgroup of the Energy Facility Contractors Group (EFCOG) formulated a project plan for developing a work planning and control guideline document. The project team comprised work planning professionals from contractors responsible for operating DOE sites, as well as technical experts from EM and NNSA. The guidance document is based on existing work planning and control programs and guidance documents, including:

- *Work Planning and Control Program Standard*, URS Corporation, June 2011;
- *NNSA Attributes, Best Practices, and Guidance for Effective Incorporation of Integrated Safety Management and Quality Assurance in Activity Level Work Planning and Control Practices*, January 2006;
- *EM Work Planning and Control Program Guidelines*, April 2010; and
- *Work Management Process Description, INPO AP-928, Revision 3*, June 2010.

The document is intended to provide a recommended robust approach to accomplishing activity-level work planning and control at DOE sites, facilities, and projects. It encompasses operations, maintenance, construction, decontamination and decommissioning, and laboratory research and development activities. Its purpose is to establish best practices for effective incorporation of the core functions and guiding principles of ISM and quality assurance criteria into activity-level work planning and control programs, processes, and procedures. This document was approved by the EFCOG Executive Board in May 2012, and is intended to clearly and completely describe how to develop a work planning and control program that is adequate for the highest-hazard facilities and operations. The guideline document contains a level of detail to assist work planners in conducting an appropriate hazard analysis of a properly defined scope of work, and in identifying controls from hazard analyses for incorporation into appropriate procedures/instructions for performing activity-level work.

The EFCOG effort is a move in the right direction, and represents an opportunity to take work planning and control to the next level by meeting the need for a consistent, robust, and

thorough set of directions for adequately implementing ISM at the activity level. Unless requirements and guidance are incorporated into DOE's directives system, however, this effort will likely have no lasting effect. As the recent series of reviews by the Board's staff has shown, the NNSA guidance and EM CRADs developed in response to Recommendation 2004-1, and transmitted to sites via memorandum, have suffered such a fate over time. Many sites used the CRADs when they were first issued to perform site gap analyses and to develop site office action plans, but because the CRADs were not issued through DOE's directives system, the guidance was not incorporated into site work planning and control procedures. Only a few years after these documents were issued, staff reviews identified that some site offices and contractors no longer know they had ever existed. To institutionalize a set of expectations and measures for work planning and control for the long term, they should be incorporated into DOE's directives system, not relayed via memorandum as in the past.

CRADs accompany this EFCOG guideline document, because it is also necessary to standardize the assessment of work planning and control programs and their implementation. The Board has clearly pointed to the need for such a set of tools in its letters to DOE concerning work planning and control. Additionally, in the Implementation Plan for Recommendation 2004-1, DOE committed to developing activity-level work planning and control CRADs to accompany an oversight guide (U.S. Department of Energy, 2006). The CRADs developed for the EFCOG guideline document are maintained on the EFCOG website. As previously mentioned, DOE's Office of Health, Safety and Security (HSS) included a link to the EFCOG website in the recently issued oversight guide, but caveats the reference to the EFCOG CRADs with a footnote, "DOE supports EFCOG activities, but EFCOG-developed guidance is not official DOE guidance."

The need for developing and issuing comprehensive requirements and guidance for work planning and control is evident in the effort undertaken by URS Corporation since early 2011 to develop and implement a work planning and control standard for use at sites where it is the prime contractor (URS Global Management and Operations Services, 2011). URS corporate management, work planning and control experts from each of those sites, and EM headquarters personnel worked together to develop this comprehensive standard aimed at improving the execution of work planning and control. URS corporate management has directed each of its sites to implement the standard and substantial site efforts have been devoted toward this objective. URS is in the process of conducting corporate assessments of the effectiveness of these implementation efforts.

Finally, it should be noted that in April 2010, EM's Office of Safety and Operations Assurance developed and issued via memorandum work planning and control program guidelines. These guidelines were intended for use by EM site offices and contractors in improving and assessing work planning and control programs (Krahn, 2010). The implementation of these guidelines would clearly help improve work planning and control at DOE sites. EM has directed its site offices to use these guidelines to assess work planning and control as a focus area in the annual ISM declaration process for fiscal year 2011. However, recent reviews by the Board's staff have revealed that not all site offices have provided the guidelines to their contractors or required their contractors to implement them completely.

4. KEY FACTORS FOR IMPROVEMENT

DOE's efforts to improve work planning and control following issuance of Recommendation 2004-1 have not been effective in the long term in improving the implementation of ISM at the activity level. A renewed focus and emphasis in this crucial area would be a great improvement.

Requirements and guidance in the DOE directives system developed to govern, in detail, the necessary elements of a strongly functioning work planning and control program could be a strong first step. Such requirements and guidance would benefit from incorporating the lessons learned through years of operating experience. This report summarizes some of these lessons to support these efforts.

Additionally, meaningful DOE and contractor oversight of activity-level work planning and control has not been institutionalized. Key improvements could include a formal set of CRADs, consistent with the work planning and control requirements and guidance, along with appropriate requirements for routine and thorough assessments in this area. Moreover, the most robust approach would be to leverage subject matter experts in work planning and control and supporting disciplines assigned to DOE site and field offices in addition to the work already being done in this area by DOE's facility representatives.

APPENDIX A: SUMMARIES OF DOE'S ACCIDENT INVESTIGATIONS

This appendix summarizes the work planning and control deficiencies identified by DOE's accident investigations at sites with defense nuclear facilities between October 2006 and November 2010, as listed in Table A-1. Although there were other contributing factors to many of the accidents it is clear from these summaries that inadequate work planning and control was indeed a prominent contributing factor. Not all of these accidents occurred during the execution of high hazard work. Many of them, however, were using the same processes and/or procedures used to plan high-hazard work or work in defense nuclear facilities. These vulnerabilities are clearly not acceptable for planning and controlling such work. This attachment is intended to provide a summary of weaknesses for consideration when developing work planning and control programs and directives.

Table A-1. DOE Accident Investigations, October 2006 – November 2010

Issue date	Location	Event
November 2010	Separations Process Research Unit, Niskayuna, New York	Radiological contamination event during building demolition
September 2010	F-TRU Waste Remediation Facility, Savannah River Site	Employee puncture wound
November 2009	Salt Waste Processing Facility, Savannah River Site	Employee hand injury
October 2009	D-Area Power House, Savannah River Site	Employee burn injury
July 2009	336 Building, Hanford	Employee fall injury
April 2009	Waste Isolation Pilot Plant	Abdominal injury to a passenger in an electric cart
November 2008	Technical Area III, Sandia National Laboratories	Employee injury when rocket motor unexpectedly fired
October 2006	Lawrence Livermore National Laboratory	Employee fall from ladder

A.1 SEPARATIONS PROCESS RESEARCH UNIT, SCHENECTADY, NEW YORK

A Type B accident investigation report, dated November 23, 2010, for the radiological contamination event during demolition of the Separations Process Research Unit building identified the following deficiencies in the implementation of ISM at the activity level:

Root causes:

- Washington Group International (WGI) failed to fully understand, characterize, and control the radiological hazard.

- WGI failed to implement a work control process that ensured that facility conditions supported proceeding with the work.

Contributing causes:

- The work package did not integrate the hazard controls identified in the job hazards analysis (JHA).

- Execution of the work package did not ensure that all process vessels in the building had been identified and characterized.

- Radiological work permits (RWPs) were written in generic terms and were not specific to the task being performed.

- Workers had not completed steps in work packages requiring evaluation of hazards prior to performing subsequent steps.

- The responsible subject matter experts (SMEs) approved working-level documents without fully ensuring that hazard controls had been identified.

- The RWP and work plan were inadequate to support implementation of appropriate radiological controls for the work being performed.

- The work package did not specify the method being used for contamination control.

- Procedures allowed work to be performed outside of the plan of the day review and discussion process.

- Oversight did not ensure that programmatic deficiencies were identified and corrected.

A.2 F-TRU WASTE REMEDIATION FACILITY, SAVANNAH RIVER SITE

A Type B accident investigation report, dated September 2010, for a Savannah River Nuclear Solutions (SRNS) employee puncture wound at the F-TRU Waste Remediation Facility at the Savannah River Site identified the following deficiencies in the implementation of ISM at the activity level:

Root cause:

- SRNS directives specified a less than adequate graded approach for high-hazard transuranic (TRU) waste remediation work.

Contributing causes:

- Management failed to follow established protocols for ensuring that SMEs were involved in the identification and analysis of hazards.

- Management failed to ensure that a formal hazard analysis was conducted for all aspects of the task.

- The procedure did not identify a method for installation of a hole-indicating device (survey flag).

- Management failed to provide formal training on installation of a survey flag. Management demonstrated survey flag installation for 1 gallon cans but did not provide additional training on 1 quart cans.

- Waste remediation technicians (WRTs) failed to follow the demonstrated method for installing survey flags and did not notify management of their concern that the survey flags would fall out of the 1 quart cans.

- Management was unaware that WRTs were using alternative, unapproved methods of installing survey flags.

- WRTs did not understand the safety significance of modifying prescribed equipment and of failing to follow the demonstrated method for installing survey flags.

Conclusions:

- SRNS failed to fully define the scope of work for remediation and repackaging work, and the methods used to ensure the development of procedures had not matured.

- SRNS failed to adequately identify and analyze hazards associated with TRU waste remediation.

- Management failed to ensure the development of adequate controls to protect workers during the TRU waste remediation process.

A.3 SALT WASTE PROCESSING FACILITY, SAVANNAH RIVER SITE

A Type B accident investigation report, dated November 2009, for an employee hand injury at the Savannah River Site's Salt Waste Processing Facility identified the following deficiencies in the implementation of ISM at the activity level:

Root cause:

- Workers used an unsafe method to apply lubricant to the wire rope.

Contributing causes:

- Construction supervisors failed to recognize lubrication of the wire rope as a maintenance activity as described in procedure PP-SH-4382, "Mobile Cranes and Hoisting and Rigging," which requires a work order per procedure PP-CS-7201, "Construction Work Release Procedure."

- Line Management did not require a task-specific JHA be developed for the wire rope lubrication activity.

- The Safe Work Brief failed to ensure that workers understood the scope of work, associated hazards, and methods specified in the crane operating manual for performing the work activity in a safe and compliant manner.

- The project did not maintain the roles and responsibilities of the certified crane operator (journeyman) for the task of lubricating the wire rope.

- The certified crane operator (journeyman) failed to recognize the hazards associated with lubricating the wire rope while it was traveling toward the sheave and did not initiate a "time out for safety."

- The certified crane operator (journeyman) performed the work activity of lubricating the wire rope while the rope was moving toward the sheave contrary to the guidance in the crane operations manual.

- Corrective actions taken as a result of previous facility events to improve the rigor of ISM functions related to definition of the scope of work, hazard analysis, and identification of controls were insufficient to prevent this accident.

A.4 D-AREA POWER HOUSE, SAVANNAH RIVER SITE

A Type B accident investigation report, dated October 2009, for an employee burn injury at the D-Area Powerhouse at the Savannah River Site identified the following deficiencies in the implementation of ISM at the activity level:

Root cause:

- An experienced qualified electrical worker failed to comply with required and expected safe electrical work practices.

Contributing causes/conclusions:

- Past operating practices fostered an environment conducive to the use of shortcuts and workarounds without proper analysis.

- Management had not effectively enforced requirements and reinforced expectations regarding compliance with procedures to perform electrical work safely.

- Working the breakers without properly implementing the procedure was accepted practice.

- Qualified electrical workers had an incomplete understanding of procedure requirements and did not refer to the procedure for the specific work application.

- An effective work planning and control process was lacking, resulting in the use of a monthly troubleshooting procedure that did not comply with site requirements and allowed electrical work to be performed without appropriate identification of scope, hazards, and controls.

- The pre-job briefing failed to address specific scope, hazards, and controls.

- Corrective actions resulting from previously identified deficiencies did not ensure that all qualified electrical workers understood safe electrical work practices or reduce excessive reliance on qualified electrical workers as the single line of defense for identifying needed controls.

- The work in progress at the time was poorly defined and was outside the scope of site procedures and the troubleshooting work package.

- The supervisor and workers had not adequately analyzed the hazards associated with the work.

- Qualified electrical workers disregarded proper implementation of hazard controls and failed to comply with required work planning and control practices by beginning maintenance with no specific authorization or work package, and later continuing corrective maintenance with a work package that did not cover the scope of the activities being performed.

A.5 336 BUILDING, HANFORD

A Type B accident investigation report, dated July 2009, for a Washington Closure Hanford (WCH) employee falling 50 feet at 336 Building at the Hanford Site identified the following deficiencies in the implementation of ISM at the activity level:

Root causes:

- Contractor management and the 300 Area workforce accepted and normalized the recognized shortage of work supervisors and resources, the pace of work, and the inadequacies of work planning.

- Implementation of the contractor's work control process was inadequate to identify the work scope, hazards, and associated controls as necessary to perform the work safely.

- The contractor's supervisory and safety oversight methods and resources were inadequate to support safe execution of the bridge crane removal activities at 336 Building.

- The fall protection procedure and its implementation did not fully comply with Occupational Safety and Health Administration (OSHA) standards and failed to provide adequate protection for workers.

Contributing causes/conclusions:

- WCH applied the work control procedure inconsistently throughout the D4 project (D4 project is a WCH term that represents the deactivation, decommissioning, decontamination, and demolition of excess facilities).

- WCH had not adequately defined the work scope, hazards, and related controls.

- Coordination and communication of work planning and execution were inadequate.

- WCH did not manage work scope changes to assess additional hazards and controls.

- Perceived schedule pressure was a significant contributor to the failure to plan the work adequately.

- Because of multiple assignments, sufficient resources were not consistently available to provide oversight for the level of work being performed.

- Key supervisory and safety personnel failed to execute their roles and responsibilities consistent with their authority and accountability.

- The content of the fall protection procedure was inadequate to clearly convey the applicable regulatory requirements to the workforce.

- The contractor's previous self-assessments and corrective actions on the integrated work control procedure and fall protection procedure were ineffective in correcting underlying weaknesses.

A.6 WASTE ISOLATION PILOT PLANT

A Type B accident investigation report, dated April 2009, for an abdominal injury to a Washington TRU Solution's (WTS) employee in an electrical cart at the Waste Isolation Pilot Plant identified the following deficiencies in the implementation of ISM at the activity level:

Root causes:

- WTS determined that the electric cart activity was low-risk and short-term.

- WTS failed to analyze the hazards of the work and implement controls.

- Oversight was lacking.

Contributing cause/conclusions:

- Training was not formal or complete.

- Formal inspection of electric carts was not required.

- WTS failed to communicate previously identified issues with activation of the accelerator pedal.

- WTS failed to evaluate the effectiveness of past corrective actions, including those for vehicle issues.

- Neither WTS nor the Carlsbad Field Office (CBFO) performed oversight of vehicular safety.

- Family Day (term used for Wednesdays when both crews A and B are onsite) created additional tasking issues, supervisory challenges, and unrecognized safety concerns when all the workers were present.

- WTS had not performed a JHA for use of electric carts on the surface, and as a result, the appropriate controls were not implemented.

- WTS failed to analyze spotter activities for the hazards associated with the task to ensure that appropriate controls were implemented.

- WTS oversight had not been extended to the safety and health programs to establish that they included the technical requirements for the work activities being performed and to determine effective implementation of requirements at the activity level.

A.7 TECHNICAL AREA III, SANDIA NATIONAL LABORATORIES

A Type B accident investigation report, dated November 2008, for an unexpected rocket motor firing that resulted in personnel injury at Sandia National Laboratories' (SNL) Technical Area III identified the following deficiencies in the implementation of ISM at the activity level:

Root causes:

- SNL had not accurately analyzed or fully controlled hazards associated with this rocket sled test series.

- The design of this rocket sled test series did not ensure that the test package was electrically isolated from the Super Zuni rocket motor.

- The test series setup did not provide adequate grounding, shorting, and bonding.

- SNL management did not adequately educate and train employees in the hazards and precautions entailed in handling explosives and materials used in conjunction with explosives operations.

- The actions of the workers involved in this test series did not demonstrate an understanding of explosives safety requirements or principles of conduct of operations.

Contributing causes/conclusions:

- SNL did not perform the safety analyses used to support the rocket sled testing in sufficient detail to adequately address all scenarios associated with this accident.

- The hazard assessment process did not thoroughly identify the hazards associated with the test series, and as a result, workers did not clearly identify and follow required hazard controls.

- The controls were based on historical operations and not a detailed analysis of the rocket sled test series as required by ISM.

A.8 LAWRENCE LIVERMORE NATIONAL LABORATORY

A Type B accident investigation report, dated October 2006, for a ladder fall accident at Lawrence Livermore National Laboratory (LLNL) identified the following deficiencies in the implementation of ISM at the activity level:

Root causes:

- The systemic root cause of this accident was that LLNL's senior management failed to provide the leadership necessary to ensure that ISM processes were implemented rigorously.

- The processes implemented by LLNL did not ensure that the roles and responsibilities for safety and health were understood at all levels of the organization, did not identify the conduct of unsafe work practices, and did not hold management accountable for accepting such practices.

Conclusions:

- The work planning and control process used for the air conditioning unit replacement project did not effectively implement any of the core functions of ISM.

- LLNL did not adequately define or scope the tasks involved in accomplishing the project to facilitate an effective safety review.

- LLNL did not properly identify or analyze the hazards associated with the work.

- LLNL did not explicitly develop or implement controls for the hazards that were identified. Thus total reliance was placed on a set of generic controls from which individual workers had to select based on their personal perspective on the hazards associated with the work.

- LLNL did not take advantage of multiple opportunities to ensure that the work was being conducted within the established controls.

- There was no indication that feedback or lessons learned from previous assessments or work experiences had been incorporated into the current project.

APPENDIX B: SUMMARIES OF STAFF REVIEWS OF WORK PLANNING AND CONTROL

This appendix contains summaries of reviews of work planning and control conducted by the Board's staff from June 2008 to the present. These summaries focus on the deficiencies identified in the processes and procedures used at the sites to conduct work planning and control. Table B-1 provides a chronological listing of the sites and projects reviewed, identifying the location of each review and the resulting correspondence from the Board to DOE. Many of the Board's letters to DOE contained examples identified by the staff in which deficiencies in processes and procedures were manifested in poorly written work instructions and poor performance in executing those instructions. These examples are not repeated here, but are available in the referenced letters.

The summaries that follow provide a snapshot of the salient findings from the staff's reviews at those moments in time. They are provided as a feedback and improvement tool to assist DOE and contractors in making enhancements to work planning and control processes and procedures. Additionally, these summaries provide lessons learned that DOE and its contractors can use when performing both routine and more formal focused assessments of the health of the work planning and control processes and procedures in effect at their sites.

It should be noted that the response by DOE and its contractors to most of these reviews was to take considerable action to improve the respective work planning and control processes and procedures in order to correct the identified deficiencies. Therefore, the summaries do not necessarily reflect the current condition of work planning and control at these sites.

Table B-1. Sites/Projects Reviewed by the Board's Staff

Week of Review	Location	Outcome
June 9, 2008	Hanford River Corridor Closure Project	October 30, 2008, letter from the Board providing observations from the staff's review
September 29, 2008	Y-12 National Security Complex	January 22, 2009, letter from the Board providing observations from the staff's review
November 17, 2008	Idaho Nuclear Technology and Engineering Center Cleanup	March 23, 2009, letter from the Board establishing a 90-day reporting requirement
April 20, 2009	Savannah River Site	Staff provided verbal comments directly to site personnel
August 10, 2009	Los Alamos National Laboratory	December 2, 2009, letter from the Board establishing a 90-day reporting requirement
November 2, 2009	Hanford Tank Farms Project	March 12, 2010, letter from the Board establishing a 90-day reporting requirement
March 1, 2010	Lawrence Livermore National Laboratory	June 14, 2010, letter from the Board establishing a 90-day reporting requirement
April 12, 2010	Pantex Plant	Staff provided verbal comments directly to site personnel
May 17, 2010	Hanford Central Plateau Remediation Project	September 23, 2010, letter from the Board establishing a 90-day reporting requirement
July 12, 2010	Waste Isolation Pilot Plant	October 22, 2010, letter from the Board establishing a 90-day reporting requirement
September 27, 2010	Hanford River Corridor Closure Project	February 25, 2011, letter from the Board providing observations from the staff's follow-up review
November 15, 2010	Nevada National Security Site	March 28, 2011, letter from the Board establishing a 90-day reporting requirement
August 15, 2011	Y-12 National Security Complex	December 29, 2011, letter from the Board establishing a 120-day reporting requirement
October 24, 2011	Sandia National Laboratories	Staff provided verbal comments directly to site personnel
November 14, 2011	Savannah River Site	April 13, 2012, letter from the Board providing observations from the staff's review

B.1 HANFORD RIVER CORRIDOR CLOSURE PROJECT

During the week of June 9, 2008, the staff reviewed the work planning and control processes and procedures used by Washington Closure Hanford (WCH) to plan operations and maintenance work. The Board issued a letter to the Assistant Secretary for Environmental Management (EM) dated October 30, 2008, for use in improving work planning and control at the River Corridor Closure Project. Identified process enhancements and areas in which implementation could be improved included the following:

- Documents used for planning and control of preventive maintenance and waste operations did not include:

  — the expected level of rigor governing the preparation of job hazards analyses (JHA);

  — a process for evaluating the degree of complexity and difficulty associated with work to be planned and the hazard categorization of the work; or

  — adequate provisions for feedback and improvement.

- WCH directives failed to clearly define or control the scope of work that was authorized to be accomplished without work instructions.

- WCH directives provided no direction on how to perform JHAs and no guidance on recognized methods for performing hazard analyses.

- Contrary to WCH's work planning directives, planning teams frequently performed JHAs as tabletop exercises instead of worksite walkdowns.

- The level of hazard review was based on a highly subjective process that would rarely result in requiring the most rigorous level of planning.

- The planning team did not always analyze radiological hazards and controls for integration into the hazard analysis process; rather, radiological control technicians separately performed the analyses and controlled the hazards through radiological work permits (RWPs).

- Contrary to planning directives, planners failed to incorporate all hazard controls identified in JHAs into task instructions as appropriate.

- WCH could have enhanced verification of required training for workers by improving the tools and data available to the work supervisors.

- WCH failed to make procedural changes in accordance with site directives.

- The process for capturing lessons learned and using them to improve work packages was ineffective and failed to permanently capture and distribute worker feedback.

- Job debriefs were optional, but WCH directives provided no criteria to help supervisors determine when debriefs would be appropriate.

- WCH was not conducting formal assessments of work planning and control using established criteria and review approaches.

B.2 Y-12 NATIONAL SECURITY COMPLEX

During the week of September 29, 2008, the staff reviewed the work planning and control processes and procedures used by Babcock & Wilcox Technical Services Y-12 (B&W) at the Y-12 National Security Complex (Y-12). The staff's review focused on B&W's maintenance and production work. The Board issued a letter to the National Nuclear Security Administration (NNSA) Administrator dated January 22, 2009, for use in improving work planning and control at Y-12. Identified deficiencies included the following:

- The maintenance, production, and health and safety procedures and processes for work management were not well coordinated and in some cases conflicted.

- The directive for developing technical procedures was complex, confusing, and difficult to use. As a result, there were numerous cases in which it was not being followed.

- Planners were using the wrong level of planning for a given scope of work.

- The term "risk analysis" was misused throughout B&W's work planning and control directives when there was no intent to analyze the probability and consequence of activity-level work causing an accident.

- B&W's health and safety organization was responsible for the hazard analysis procedure without clearly understanding work planning procedures for maintenance and production work. This resulted in the following observed deficiencies:

  — the automated job hazard analysis (AJHA) tool generating predetermined, general controls that were non-germane and/or too generic too be beneficial; and

  — the AJHA inappropriately screening out subject matter experts from hazard analyses and work planning teams.

- B&W released for work predeveloped work packages intended for multiple uses without first reevaluating them to ensure that they adequately defined the current scope of work or fully identified potential new hazards.

- As the result of a failure of the RWP revision process, procedures referenced outdated and/or inaccurate RWPs.

- The Y-12 Site Office (YSO) was not effective at identifying the deficiencies identified by the staff.

B.3 IDAHO NUCLEAR TECHNOLOGY AND ENGINEERING CENTER CLEANUP PROJECT

During the week of November 17, 2008, the staff reviewed the work planning and control processes and procedures used by CH2M-WG Idaho, LLC (CWI). The review focused on maintenance and production work conducted within the Idaho Nuclear Technology and Engineering Center Cleanup Project. The Board issued a letter to EM dated March 23, 2009, that requested a report outlining actions taken or planned by DOE's Idaho Operations Office (DOE-ID) and CWI to address the identified deficiencies, which included the following:

- CWI's processes and procedures for work planning and control were not well written, contained complex and confusing language, and relied on overly generalized instructions.

- Contrary to work planning and control procedures, planners were making non-administrative changes to work packages developed for multiple uses, thus averting the additional rigor required of the planning process and failing to analyze newly introduced hazards.

- CWI relied heavily on a talented workforce, lowering the focus on effective activity-level work planning.

- Required qualification and training for personnel involved in the work planning process did not match their roles and responsibilities.

- Recognized hazard analysis methods were not required and had not been used for planning complex and high-hazard work.

- CWI used an automated hazard analysis tool that had the following vulnerabilities:

  — Based on hazards selected by the planner, the tool generated automatic controls that were generic, thereby circumventing a team planning approach.

— For high-hazard or complex work, the tool screened out subject matter experts from the planning team if planners did not correctly identify all hazards.

— The controls generated by the tool were limited to administrative controls and personal protective equipment.

- Additional necessary hazard controls were being identified during pre-job briefs.

- Industrial hygiene experts evaluated chemical hazards outside of the hazard analysis process, and work packages did not specify their controls.

- DOE-ID had not been effective at identifying the deficiencies identified by the staff.

- DOE-ID was unable to provide any written assessments of CWI's work planning and control and had no work planning expert assigned to its staff.

B.4 SAVANNAH RIVER SITE

During the week of April 20, 2009, the staff reviewed the work planning and control processes and procedures used by Savannah River Nuclear Solutions (SRNS). The review focused on activity-level work being conducted at Savannah River National Laboratory (SRNL) and in the Tritium Facility. The staff identified a number of deficiencies and communicated them directly to the Savannah River Site Office (DOE-SR) and SRNS personnel. These deficiencies included the following:

- SRNS did not formally document and approve the types of work allowed to be accomplished at SRNL and the Tritium Facility without work instructions.

- Planners used an enhanced process for planning more complex or hazardous work at the Tritium Facility that was not formally documented or approved.

- SRNS did not consider the level of hazard when determining the complexity of work control documents. As a result, highly hazardous work could be accomplished using the lowest level of planning.

- To identify the level of rigor for hazard analyses, SRNS planners used a table of severity (high, medium, or low) and frequency (frequent, occasional, or unlikely) that had no defined criteria for determining severity level or frequency.

- SRNS allowed pre-existing safe practice procedures to be used for hazard analysis for work with potentially high-severity consequences instead of conducting new hazard analyses.

- Hazard analyses often confused controls and hazards. For example, one hazard was identified as "maintain less than 0.2 on the magnehelic."

- A work package for the Tritium Facility did not include a list of tools or materials required to accomplish the task.

- A work package for the Tritium Facility listed controls and specified them to be used "as needed" when the needed controls could readily have been determined a priori.

- There were no instructions for how or when walkdowns should be accomplished.

- Radiological suspension limits were set unnecessarily high and were not based on expected conditions. These artificially high limits could result in unanticipated radiological conditions going unnoticed.

- SRNS had not performed an independent self-assessment of its work planning and control processes.

- Although mechanisms existed for performing post-job reviews to gather feedback and lessons learned, this action was optional and as a result was rarely performed.

- Both the Savannah River Operations Office and DOE-SR relied almost exclusively on their facility representatives to perform oversight of work planning and control. Neither organization had a subject matter expert well versed in work planning and control to provide oversight in this area.

B.5 LOS ALAMOS NATIONAL LABORATORY

During the week of August 10, 2009, the staff reviewed the work planning and control processes and procedures used by Los Alamos National Security, LLC (LANS) at Los Alamos National Laboratory. The review focused on maintenance and programmatic work in the Plutonium Facility and the Radioactive Liquid Waste Treatment Facility. The Board issued a letter to NNSA dated December 2, 2009, requesting a report outlining actions taken or planned by the Los Alamos Site Office (LASO) and LANS to address the identified deficiencies. These deficiencies included the following:

- Institutional-level directives for work planning and control did not contain sufficient detail for planning and control of activity-level work.

- LANS did not clearly define the roles and responsibilities of those involved in work planning and control.

- LANS did not have a documented and approved process for performing hazard analysis of activity-level work.

- The document control system failed to ensure that the correct revisions of work planning and control directives were used to plan work.

- LANS's work planning and control self-assessment program had not been effective in identifying and correcting problems.

- Posters and handbooks used for education and reinforcement of ISM principles listed the fifth core function of ISM as "ensure performance" instead of the correct "feedback and continuous improvement."

- Documents designed for activity-level work confused "risk analysis" with "hazard analysis."

- The automated job hazard analysis tool generated generic hazards and controls that were not specific to the task at hand, and planning teams performed no analysis to ensure that the final work packages identified germane hazards and their controls.

- Post-job reviews were optional, and supervisors did not normally conduct them unless problems were encountered during work execution.

- There was no mechanism in place to link lessons learned from post-job reviews with the work planning process.

- LASO had not institutionalized the NNSA-prescribed criteria and review approach documents so that the site office routinely assessed activity-level work.

- LASO did not have a work planning and control subject matter expert on its staff to direct its oversight efforts in this important area.

B.6 HANFORD TANK FARMS PROJECT

During the week of November 2, 2009, the staff reviewed the work planning and control processes and procedures used by Washington River Protection Solutions, LLC (WRPS), with a focus on operations and maintenance in the Hanford Tank Farms. The Board issued a letter to EM dated March 12, 2010, requesting a report outlining actions taken or planned by the Office of River Protection (ORP) and WRPS to address the identified deficiencies. These deficiencies included the following:

- WRPS's work planning and control directives were unnecessarily complex and confusing.

- WRPS's hazard analysis process was not well defined or executed.

- The contractor's ISM system description listed "identify hazards" as a core ISM function instead of the correct "analyze hazards." As a direct result, hazards were identified but not analyzed.

- WRPS did not adequately employ a team approach to walkdowns, verifications and validations, and hazard analyses. A single individual would perform these tasks, and then pass his/her work along for the remaining team members to review.

- Radiological Control and Industrial Hygiene developed hazard plans independently of the worksite hazard analysis. No formal process required that these three processes be coordinated or ensured that specified controls were evaluated, deconflicted, and adequately dispositioned.

- The workforce modified work procedures ad hoc when the procedures could not be performed as written.

- Work packages and operating procedures did not clearly delineate the steps to be followed and often could not be performed as written.

- No single document for use by workers documented all hazards and controls associated with a given work package.

- WRPS did not evaluate hazard analyses for changing conditions prior to authorizing work.

- The process used by WRPS to change technical procedures did not ensure that potential new hazards introduced by a change were adequately analyzed.

- Several external and internal reviews revealed that the feedback and improvement function required improvement.

- ORP had admittedly provided little oversight of WRPS work planning and control until shortly before the staff's review. ORP had placed a newly pronounced emphasis on work planning and control at the time of the review that had not had time to take hold.

B.7 LAWRENCE LIVERMORE NATIONAL LABORATORY

During the week of March 1, 2010, the staff reviewed the work planning and control processes and procedures used by the Nuclear Materials Technology Program (NMTP) at Lawrence Livermore National Laboratory (LLNL). The review focused on work permits and operational safety plans (OSPs) for the Superblock facilities and work permits for the Radioactive and Hazardous Waste Management (RHWM) facility. The Board issued a letter to NNSA dated June 14, 2010, requesting a report outlining actions taken or planned by NNSA, the Livermore Site Office (LSO), and NMTP to address the identified deficiencies. These deficiencies included the following:

- NMTP directives used to plan work lacked specificity, in particular in the areas of defining the scope of work and analyzing the hazards.

- Required qualification and training for personnel involved in overseeing and performing work planning and control did not match their roles and responsibilities.

- The Superblock work control manual did not specify or provide criteria with which to determine when a work package required a detailed work instruction or procedure.

- Work packages lacked detail, hazards associated with certain tasks were not clearly identified, and appropriate controls for the hazards were not clearly documented.

- Programmatic work was not controlled by procedure, but relied on workers' knowledge of the scope of the operation, the activities to be performed, and the associated hazards.

- Work permits and OSPs did not define work activities and boundaries in sufficient detail to allow work planning teams to determine the job steps necessary to complete the work.

- OSPs did not thoroughly identify the tasks necessary to complete an operation.

- Because the OSPs did not identify tasks, the hazard analysis process could not systematically and thoroughly identify, analyze, and document hazards to allow for proper identification and implementation of controls for all tasks.

- NMTP used OSPs in lieu of written instructions even when hazards were significant enough to warrant work instructions or procedures.

- NMTP revised work permits without analyzing newly introduced hazards.

- LSO had been ineffective at identifying and correcting the issues identified by the staff and had not institutionalized the work planning and control criteria prescribed by NNSA.

- LSO had not conducted focused reviews of activity-level work planning and control, but instead relied solely on routine field observations by DOE facility representatives.

B.8 PANTEX PLANT

During the week of April 12, 2010, the staff reviewed the work planning and control processes and procedures used by Babcock & Wilcox Technical Services Pantex, LLC (B&W Pantex) at the Pantex Plant. The review focused on the development of work packages used within the Special Nuclear Material and Maintenance Divisions. The staff verbally presented its findings to B&W Pantex and the Pantex Site Office (PXSO) following the review. These findings included the following:

- The Pantex work planning and control process was unnecessarily complex and required the use of multiple process documents, work instructions, and forms. No overarching document described the coordination and integration of these processes.

- The AHA program required work planners to select predetermined controls before identifying hazards.

- Hazard analyses did not employ a team-based approach. The planning team did not review the AHA together; instead, the planner developed it and routed it to representatives of the appropriate disciplines for their review.

- For operating procedures, the procedure writer developed a draft procedure with a proposed set of controls. This draft was routed to appropriate subject matter experts, who documented on a separate form any additional controls not already specified.

- Procedures did not incorporate radiological controls.

- Procedures specified controls without clearly communicating to workers the hazards those controls were intended to mitigate.

- Not all members of the work planning teams were trained or qualified to perform hazard analyses.

- Lessons learned were not always being fed back into the work planning and control process.

- PXSO had recently begun evaluating the contractor's performance with facility representatives using NNSA's guidance for work planning and control. However, the most recent assessment revealed only superficial comments and observations.

- PXSO's assessments would have benefited from the participation of subject matter experts on the assessment teams.

- PXSO's assessments would have benefited from the assessors being trained in the use of the specified criteria and review approach documents.

B.9 HANFORD CENTRAL PLATEAU REMEDIATION PROJECT

During the week of May 17, 2010, the staff reviewed the work planning and control processes and procedures used by the CH2M Hill Plateau Remediation Company (CHPRC) at the Hanford Site. The review focused on the processes used by CHPRC to develop work packages and technical procedures at the Plutonium Finishing Plant Closure Project and the Waste Fuels and Management Project. The Board issued a letter to EM dated September 23, 2010, requesting a report outlining actions taken or planned by EM, the Richland Operations Office (RL), and CHPRC to address the identified deficiencies. These deficiencies included the following:

- The hazard analysis process provided insufficient focus on task-specific hazards and their associated controls.

- CHPRC did not always integrate identified hazards and their controls into work instructions when appropriate.

- CHPRC did not have a formal process for documenting or retaining feedback obtained during work planning walkdowns.

- It was not evident how walkdown results fed into the work planning process or how walkdown comments were dispositioned or considered during the hazard analysis process.

- The AJHA tool focused primarily on general work area hazards and included overly generic or non-germane hazards and controls.

- General hazards and associated controls listed in AJHAs could not readily be linked to specific tasks or activities to be performed.

- No mechanism was in place, and no single document was developed, to ensure that the hazards identified and the controls required to complete a work activity safely were appropriately documented, deconflicted, and implemented.

- Hazards and controls identified in AJHAs and other documents included in work packages, such as radiological work permits or industrial hygiene sampling plans, were not consistently specified and in some cases were in conflict.

- CHPRC relied heavily on field work supervisors to overcome shortcomings in work planning and control processes, requiring them to both communicate hazards and their controls to workers and identify and verify workers' training and qualification requirements.

- Several internal and external reviews identified weaknesses in the feedback and improvement function of ISM.

B.10 WASTE ISOLATION PILOT PLANT

During the week of July 12, 2010, the staff reviewed the work planning and control processes and procedures used by URS Washington TRU Solutions (WTS) at the Waste Isolation Pilot Plant (WIPP). The review focused on operations and maintenance both above- and underground. The Board issued a letter to EM dated October 22, 2010, requesting a report outlining actions taken or planned by EM, the Carlsbad Field Office (CBFO), and WTS to address the identified deficiencies. These deficiencies included the following:

- WIPP procedures that directed the conduct of work planning did not contain sufficient detail or instruction for work planners to ensure that work was adequately scoped, hazards were identified, and hazard controls were implemented.

- WTS directives did not define work planning roles and responsibilities for subject matter experts, such as radiological control technicians, industrial hygienists, and industrial safety personnel.

- Work planners did not define the scope and boundaries of work activities in sufficient detail to allow work planning teams to determine the necessary job steps so that all hazards could be identified, appropriate controls established, and adequate work instructions developed.

- Work that was allowed to be performed without written instructions was too broad and included such tasks as troubleshooting, reworking, and rebuilding equipment.

- Hazard analyses identified hazards incompletely; identified hazards without specifying controls; specified generic or ill-defined controls; and included irrelevant, extraneous information.

- Hazard analyses were a nearly automatic process, reflected an overreliance on generic pre-analyzed hazards, and did not leverage a team planning approach.

- WTS's training in hazard analysis processes was limited in scope and did not compensate for the lack of direction in planning directives.

- Work instructions did not contain all necessary controls to ensure worker safety and in many cases could not be performed as written. Numerous instances of procedural noncompliance compounded this deficiency.

- WTS had identified the need for work planning improvements, but corrective actions had not been effective.

- CBFO had not been successful in identifying and correcting work planning issues identified by the staff.

- CBFO had not performed focused reviews of work planning and control using the work planning and control program guidelines issued by EM in April 2010, but instead relied on reviews of other WTS processes to reveal deficiencies in this area.

B.11 HANFORD RIVER CORRIDOR CLOSURE PROJECT

During the week of September 27, 2010, the staff conducted a follow-up review of WCH's work planning and control processes and procedures. The staff's report on this review noted that improvements had been made, but that additional improvements were necessary. Some identified deficiencies were outstanding from the staff's previous review. The Board issued a letter to EM, dated February 25, 2011, noting these deficiencies, which included the following:

- WCH directives provided examples of work that could be accomplished without work instructions but did not limit the scope of work that could be thus performed. The decision regarding what work could be performed without instructions was left to the responsible manager, but the training for these personnel did not elaborate on the subject. This was a recurring deficiency.

- Hazard controls were not integrated into work packages, and JHAs often referenced other documents to identify hazards and controls. This was a recurring deficiency.

- Planning teams did not always analyze hazards at the task level, and as a result, JHAs did not always identify task-specific hazards when appropriate.

- JHA meetings could have benefited from formal documentation of their proceedings.

- Mandating the use of "what if" scenarios in the JHA process was an improvement over previous requirements, but the scenarios reviewed by the staff appeared perfunctory.

- WCH could have enhanced verification of required training for workers by improving the tools and data available to the work supervisors. This was a recurring deficiency.

- A broad scope of work and an informal work release process resulted in workers using the wrong procedure to perform structural weakening of a building's stack.

- Feedback and improvement was focused on the immediate problem instead of the root cause.

- Training and qualification requirements for personnel with significant work planning and control responsibilities did not support or clarify these responsibilities.

B.12 NEVADA NATIONAL SECURITY SITE

During the week of November 15, 2010, the staff reviewed the work planning and control processes and procedures used by National Security Technologies, LLC (NSTec) at the Nevada National Security Site (NNSS). The review focused on operations and maintenance in the Device Assembly Facility and U1-A. The Board issued a letter to NNSA dated March 28, 2011, requesting a report outlining actions taken or planned by the Nevada Site Office (NSO) and NSTec to address the identified weaknesses. The weaknesses included the following:

- Instructions for planning work were incomplete and failed to provide adequate direction for incorporating the core functions of ISM into the work planning and control process.

- NSTec used multiple forms to aid the work planning process; in numerous cases, work planners failed to use these forms as specified and/or filled them out improperly.

- Work packages did not adequately bound the scope of work or appropriately identify the task-level instructions required to complete the work.

- The scope and applicability of work instructions were so broad that workers and supervisors were making decisions on appropriate hazard controls and acceptance criteria in the field.

- Workers did not stop when they could not follow procedures as written, but instead used their skills to complete the tasks.

- Hazards were not analyzed collectively, and tabletops were not performed as a team activity.

- Work planners identified generic hazards by using an automated checklist that provided generic controls not tied or tailored to the specific steps of the work being planned.

- Training of work planners could have been improved, particularly in the area of leading hazard analysis teams.

- Planning teams had overlooked plausible activity-level hazards, and work procedures omitted some applicable hazard controls.

- The process used to release work did not ensure that the facility manager knew in any detail all the work being performed in the facility.

- Pre-job briefs could have been improved through worker interaction.

- NSTec had not been effective at feeding back lessons learned into the work planning and control process.

- NSO provided oversight of work planning and control primarily by using DOE facility representatives to shadow the contractor performing its own assessment. This method was not effective at identifying and correcting the weaknesses noted by the staff.

B.13 Y-12 NATIONAL SECURITY COMPLEX

During the week of August 15, 2011, the staff conducted a follow-on review of the work planning and control processes and procedures used by Y-12. This review focused on maintenance and production operations in Buildings 9212 and 9204-2E. The staff's report on the review identified deficient areas, many of which remained from the September 2008 review. The Board issued a letter to NNSA, dated December 29, 2011, noting these deficiencies, which included the following:

- B&W failed to define the scope of work in work packages in sufficient detail to facilitate identification and analysis of hazards. As a result, work packages did not integrate the hazards and associated controls into work instructions.

- The lack of specificity in the scope of work extended to many of the work instructions, technical procedures, RWPs, and AJHAs.

- AJHAs were unnecessarily long (one was 25 pages), included a work scope that was too broad, lacked specificity, and obscured the necessary hazard controls with a prevalence of generic and non-germane controls. This was a recurring deficiency.

- Work steps in procedures/work instructions were not broken down into task-specific steps, resulting in AJHAs that failed to identify task-specific hazards/controls.

- AJHAs, work instructions, and RWPs provided workers and their supervisors with a menu of hazards and controls from which to select instead of prescribing appropriate controls for the hazards specific to the job being performed.

- The AJHA tool did not allow for revisions, so work planners made changes by entering comments in the remarks section rather than in the body of the AJHA.

- Work planners routed AJHAs, with hazards already identified, to subject matter experts for insertion of controls instead of gathering the experts as a team to collectively analyze the hazards and assign controls.

- AJHAs did not quantify hazards or provide any specific detail regarding their source or location.

- During the execution of work, workers skipped steps in technical procedures, performed steps out of order, or did not perform them as written; workers performed other actions outside the procedures and contrary to expectations covered during pre-job briefings.

- Recent assessments by contractor management were not devoted to assessing work planning and control, and those that were somewhat related contained no substantive critical comments.

- YSO had not identified deficiencies in B&W's work planning and control observed by the staff. This was a recurring deficiency.

- YSO assessments reviewed by the staff did not provide substantive observations regarding B&W's work planning and control.

- YSO lacked an effective oversight and assessment program for monitoring and improving the contractor's activity-level work planning and control processes.

B.14 SANDIA NATIONAL LABORATORIES

During the week of October 24, 2011, the staff reviewed the work planning and control processes and procedures used by Sandia National Laboratories (SNL) focused on operations and maintenance in Technical Area V (TA-V). The staff identified a number of deficiencies and communicated them directly to Sandia Site Office (SSO) and SNL personnel. These deficiencies included the following:

- The process used for scheduling maintenance and operations in all of TA-V lacked the fidelity necessary to identify what work was intended to be performed at any given time.

- There was no qualification standard for work planners, and subject matter experts were not trained in work planning and control processes.

- Work planning and control procedures were very broad and did not provide the level of detail necessary to direct work planners. As a result, work instructions relied heavily on the skill of the worker/researcher.

- The Facility Work Request computer program did not specify all subject matter experts required to participate on planning and hazard analysis teams.

- The job safety analysis process was not clearly integrated into the planning process.

- SNL directives did not define expectations for how and when to conduct team walkdowns.

- Weaknesses in the maintenance subcontractor's processes resulted in work instructions and procedures that failed to identify all relevant hazards and their controls.

- Tools used by facility personnel to communicate hazards to the subcontractor did not identify all hazards and their controls.

- Suspension limits for radiological work were artificially high and not based on expected radiological conditions. Radiological control personnel set the suspension limits high to provide latitude for performance of the work instead of being responsive to unanticipated hazard conditions.

- SNL had not evaluated TA-V procedures for compliance with NNSA-specified attributes or routinely performed focused assessments of work planning and control.

- SSO's oversight of work planning and control was performed primarily by the facility representatives on a day-to-day basis instead of subject matter experts being used to conduct focused work planning and control assessments.

- SSO had performed only one assessment of work planning and control using the NNSA guidance—when the guidance was issued in 2006.

B.15 SAVANNAH RIVER SITE

During the week of November 14, 2011, the staff reviewed the work planning and control processes and procedures used by SRNS. The review focused on maintenance and operations work in E and L areas. The staff identified a number of deficiencies and communicated them directly to DOE-SR and SRNS personnel. These deficiencies included the following:

- Planning directives did not prescribe the necessary level of detail for work instructions.

- The automated hazard analysis (AHA) process did not readily accommodate breaking the work down into subtasks for subsequent task-level identification of hazards and development of controls.

- The AHA process did not consistently identify or specify controls for task-specific hazards.

- Hazards and controls were not always analyzed in aggregate as evidenced in the following observed weaknesses:

  — An AHA did not specify controls associated with each identified hazard. Many of the controls were marked "N/A—will be determined during mockup training."

  — An AHA specified the control "containment and/or contamination controls are included in the technical work document."

- Hazard quantification was not required to ensure that appropriate controls would be selected.

- Walkdown training for procedure writers was inadequate.

- RWPs specified artificially high suspension limits that were not based on expected radiological conditions. Rather, the suspension limits were set high to provide latitude for performing the work instead of being responsive to unanticipated hazard conditions.

- In one instance, a radiological parameter used as a suspension limit could not be measured until after the work had been completed.

- SRNS had not performed a thorough assessment using the EM guidance issued in April 2010.

- An RWP specified different suspension limits depending on the selected personal protective equipment.

- An AHA identified hazards without specifying their controls. In some instances, the controls were not in the procedure.

- DOE-SR had only recently identified the need to increase oversight of work planning and control, and is in the process of assigning a new work planning subject matter expert.

- DOE-SR had not performed a dedicated work planning and control assessment in accordance with the EM work planning and control guidance issued in April 2010.

- DOE-SR assessments provided to the staff that referenced work planning and control as a subject matter lacked any evidence of investigation in this area.

REFERENCES

REFERENCES CITED

Abraham, S., Secretary, U.S. Department of Energy, 2002, Letter to J. T. Conway, Chairman, Defense Nuclear Facilities Safety Board, forwarding a report regarding annual reviews and updates to Integrated Safety Management systems at defense nuclear facilities, Washington, D.C., January 25.

Brooks, L. F., Administrator, National Nuclear Security Administration, U.S. Department of Energy, 2006, Letter to A. J. Eggenberger, Chairman, Defense Nuclear Facilities Safety Board, forwarding approved NNSA site office action plans to improve work planning and control, Washington, D.C., February 28.

Conway, J. T., Chairman, Defense Nuclear Facilities Safety Board, 2001, Letter to S. Abraham, Secretary, U.S. Department of Energy, concerning assessments of implementation of Integrated Safety Management, Washington, D.C., November 8.

Conway, J. T., Chairman, Defense Nuclear Facilities Safety Board, 2002, Letter to J. H. Roberson, Assistant Secretary for Environmental Management, U.S. Department of Energy, concerning necessary ISM and work planning improvements at the Rocky Flats Environmental Technology Site, Washington, D.C., March 19.

Conway, J. T., Chairman, Defense Nuclear Facilities Safety Board, 2003, Letter to S. Abraham, Secretary, U.S. Department of Energy, concerning a review of the causes of a glovebox fire that occurred at Rocky Flats Environmental Technology Site, Washington, D.C., December 2.

Conway, J. T., Chairman, Defense Nuclear Facilities Safety Board, 2004, Letter to L. Brooks, Administrator, National Nuclear Security Administration, U.S. Department of Energy, concerning staff reviews of the incorporation of safety into work planning at multiple NNSA sites, Washington, D.C., May 21.

D'Agostino, T. P., Assistant Deputy Administrator for Program Integration, 2006, Memorandum, *Revitalizing Integrated Safety Management: Site Office Action Plans for Improving Activity Level Work Planning and Control Processes*, Washington, D.C., January 23.

Defense Nuclear Facilities Safety Board, 1995, *Integrated Safety Management*, Recommendation 95-2, Washington, D.C., October 11.

Defense Nuclear Facilities Safety Board, 2004, *Oversight of Complex, High-Hazard Nuclear Operations,* Recommendation 2004-1, Washington, D.C., May 21.

Defense Nuclear Facilities Safety Board, 2005, *Integrated Safety Management: The Foundation for a Successful Safety Culture,* DNFSB/TECH-36, Washington, D.C., December.

Garman, D., Under Secretary for Energy, Science and Environment, 2005, Memorandum, *Work Planning and Work Control Assessments and Site Action Plans for Defense Nuclear Facilities Safety Board Recommendation 2004-1, Commitment 23*, Washington, D.C., November 9.

Garman, D. K., Under Secretary for Energy, Science and Environment, 2006, Letter to A. J. Eggenberger, Chairman, Defense Nuclear Facilities Safety Board, forwarding approved Energy, Science, and Environment site office action plans to improve work planning and control, Washington, D.C., March 3.

Krahn, S. L., Deputy Assistant Secretary for Safety and Security Program Environmental Management, 2010, Memorandum to Environmental Management Site Office Managers, *Work Planning and Control Program Guidelines*, Washington, D.C., April 7.

Roberson, J. H., Assistant Secretary for Environmental Management, 2002, Letter to J. T. Conway, Chairman, Defense Nuclear Facilities Safety Board, concerning actions taken and planned to improve work planning and ISM at the Rocky Flats Environmental Technology Site, Washington, D.C., June 25.

Richardson, B., Secretary, U.S. Department of Energy, 1999, Memorandum to all department and contractor employees, *Safety Accountability and Performance*, Washington D.C., March 3.

Triay, I. R., Chief Operating Officer for Environmental Management, 2005, Memorandum, *Work Planning and Work Control Assessments and Site Action Plans for Defense Nuclear Facilities Safety Board Recommendation 2004-1, Commitment 23,* Washington, D.C., November 18.

URS Global Management and Operations Services, 2011, *Work Planning and Control Program Standard,* July 12.

U.S. Department of Energy, 1996, *Integrated Safety Management*, Implementation Plan for Recommendation 95-2, Washington, D.C., April 18.

U.S. Department of Energy, 2005, *Oversight of Complex, High-Hazard Nuclear Operations*, Implementation Plan for Recommendation 2004-1, Revision 1, Washington, D.C., June 10.

U.S. Department of Energy, 2006, *Oversight of Complex, High-Hazard Nuclear Operations*, Implementation Plan for Recommendation 2004-1, Revision 2, Washington, D.C., October 12.

OTHER REFERENCES

Abraham, S., Secretary, U.S. Department of Energy, 2004, Letter to J. T. Conway, Chairman, Defense Nuclear Facilities Safety Board, accepting Board Recommendation 2004-1, Washington, D.C., July 21.

Conway, J. T. Chairman, Defense Nuclear Facilities Safety Board, 2002, Letter to S. Abraham, Secretary, U.S. Department of Energy, concerning effectiveness of the annual Integrated Safety Management review process, Washington, D.C., August 8.

Eggenberger, A. J., Chairman, Defense Nuclear Facilities Safety Board, 2008, Letter to J. A. Rispoli, Assistant Secretary for Environmental Management, U.S. Department of Energy, forwarding a staff issue report, *Activity-Level Work Planning for the River Corridor Closure Project, Hanford Site*, Washington, D.C., October 30.

Eggenberger, A. J., Chairman, Defense Nuclear Facilities Safety Board, 2009, Letter to T. P. D'Agostino, Administrator, National Nuclear Security Administration, U.S. Department of Energy, forwarding a staff issue report, *Activity-Level Work Planning, Y-12 National Security Complex,* Washington, D.C., January 22.

Eggenberger, A. J., Chairman, Defense Nuclear Facilities Safety Board, 2009, Letter to I. R. Triay, Acting Assistant Secretary for Environmental Management, U.S. Department of Energy, forwarding a staff issue report, *Activity-Level Work Planning, Idaho Cleanup Project,* Washington, D.C., March 23.

Glauthier, T. J., Deputy Secretary, U.S. Department of Energy, 2000, Memorandum, *Realizing the Benefits of Integrated Safety Management*, Washington, D.C., September 28.

Mansfield, J. E., Vice Chairman, Defense Nuclear Facilities Safety Board, 2009, Letter to T. P. D'Agostino, Administrator, National Nuclear Security Administration, U.S. Department of Energy, forwarding a staff issue report, *Activity-Level Work Planning at Los Alamos National Laboratory,* Washington, D.C., December 2.

Mansfield, J. E., Vice Chairman, Defense Nuclear Facilities Safety Board, 2010, Letter to I. R. Triay, Assistant Secretary for Environmental Management, U.S. Department of Energy, forwarding a staff issue report, *Activity-Level Work Planning, Hanford Tank Farms,* Washington, D.C., March 12.

Winokur, P. S., Chairman, Defense Nuclear Facilities Safety Board, 2010, Letter to T. P. D'Agostino, Administrator, National Nuclear Security Administration, U.S. Department of Energy, forwarding a staff issue report, *Activity-Level Work Planning, Lawrence Livermore National Laboratory,* Washington, D.C., June 14.

Winokur, P. S., Chairman, Defense Nuclear Facilities Safety Board, 2010, Letter to I. R. Triay, Assistant Secretary for Environmental Management, U.S. Department of Energy, forwarding a staff issue report, *Activity-Level Work Planning, Hanford Plateau Remediation Contractor,* Washington, D.C., September 23.

Winokur, P. S., Chairman, Defense Nuclear Facilities Safety Board, 2010, Letter to I. R. Triay, Assistant Secretary for Environmental Management, U.S. Department of Energy, forwarding a staff issue report, *Activity-Level Work Planning and Execution, Waste Isolation Pilot Plant,* Washington, D.C., October 22.

Winokur, P. S., Chairman, Defense Nuclear Facilities Safety Board, 2011, Letter to I. R. Triay, Assistant Secretary for Environmental Management, U.S. Department of Energy, forwarding a staff issue report, *Activity-Level Work Planning, Washington Closure Hanford, Hanford Site*, Washington, D.C., February 25.

Winokur, P. S., Chairman, Defense Nuclear Facilities Safety Board, 2011, Letter to T. P. D'Agostino, Administrator, National Nuclear Security Administration, U.S. Department of Energy, forwarding a staff issue report, *Activity-Level Work Planning, Nevada National Security Site,* Washington, D.C., March 28.

Winokur, P. S., Chairman, Defense Nuclear Facilities Safety Board, 2011, Letter to T. P. D'Agostino, Administrator, National Nuclear Security Administration, U.S. Department of Energy, forwarding a staff issue report, *Activity-Level Work Planning and Control, Y-12 National Security Complex*, Washington, D.C., December 29.

U.S. Department of Energy Acquisition Regulation, 2000, *Integration of Environment, Safety, and Health into Work Planning and Execution,* 48 CFR 970.5223-1, Washington, D.C., December.

U.S. Department of Energy, National Nuclear Security Administration, 2006, Type B Accident Investigation, *July 31, 2006 Fall From Ladder at the Lawrence Livermore National Laboratory,* Livermore, California, October.

U.S. Department of Energy, National Nuclear Security Administration, Sandia Site Office, 2008, Type B Accident Investigation, *Employee Injured When Rocket Motor Unexpectedly Fired on October 9, 2008, at the Sandia National Laboratories Technical Area III Sled Track,* Albuquerque, New Mexico, November.

U.S. Department of Energy, Carlsbad Field Office, 2009, Type B Accident Investigation Board Report, *February 25, 2009, Abdominal Injury to a Passenger in an Electric Cart, Waste Isolation Pilot Plant,* Carlsbad, New Mexico, April.

U.S. Department of Energy, Richland Operations Office, 2009, Type B Accident Investigation Report, *Washington Closure Hanford, LLC, Employee Fall Injury on July 1, 2009, at the 336 Building,* Hanford Site, July.

U.S. Department of Energy, Savannah River Operations Office, 2009, Type B Accident Investigation Board Report, *Employee Burn Injury at the D Area Powerhouse, September 23, 2009,* Savannah River Site, October.

U.S. Department of Energy, Savannah River Operations Office, 2009, Type B Accident Investigation Board Report, *Hand Injury at the Salt Waste Processing Facility, October 6, 2009,* Savannah River Site, November.

U.S. Department of Energy, Savannah River Operations Office, 2010, Type B Accident Investigation Board Report, *Employee Puncture Wound at the F-TRU Waste Remediation Facility, June 14, 2010,* Savannah River Site, September.

U.S. Department of Energy, Office of Environmental Management, 2010, Type B Accident Investigation Report, *Radiological Contamination Event During Separations Process Research Unit Building H2 Demolition September 29, 2010,* Washington, D.C. November 23.