Office of Enterprise Assessments
Lessons Learned From Targeted Reviews of Activity-Level Work Planning and Control

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Office of Worker Safety and Health Assessments
Office of Environment, Safety and Health Assessments
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Acronyms

CAS	Contractor Assurance System
CFR	Code of Federal Regulations
CRAD	Criteria, Review, and Approach Document
D&D	Decontamination and Decommissioning
DART	Days Away, Restricted, or Transferred
DEAR	Department of Energy Acquisition Regulation
DOE	U.S. Department of Energy
EA	Office of Enterprise Assessments
FR	Facility Representative
FY	Fiscal Year
IH	Industrial Hygiene
ISM	Integrated Safety Management
JHA	Job Hazard Analysis
LANL	Los Alamos National Laboratory
LANS	Los Alamos National Security, LLC
LO/TO	Lockout/Tagout
NNSA	National Nuclear Security Administration
NNSS	Nevada National Security Site
ORPS	Occurrence Reporting and Processing System
OSHA	Occupational Safety and Health Administration
PNOV	Preliminary Notice of Violation
PPE	Personal Protective Equipment
SME	Subject Matter Expert
SOW	Skill of the Worker
SNL	Sandia National Laboratories
TRC	Total Recordable Cases
WMS	Work Management System
WP&C	Work Planning and Control
WSHP	Worker Safety and Health Program
Y-12	Y-12 National Security Complex

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EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) Office of Worker Safety and Health Assessments within the independent Office of Enterprise Assessments (EA) conducted a series of Activity Level Work Planning and Control (WP&C) targeted reviews at six DOE sites from July 2014 to September 2015. Two of the sites reviewed are managed under DOE's Office of Environmental Management while the remaining four are managed under DOE's National Nuclear Security Administration (NNSA). Additional WP&C reviews are scheduled for 2016. For each review, EA focused on contractor performance at the activity level regarding implementation of the integrated safety management core functions (Define Scope of Work, Identify and Analyze Hazards, Identify and Implement Controls, Perform Work Safely within Controls, and Feedback and Improvement). Each review also included an evaluation of the DOE/NNSA field element oversight of the contractor's WP&C program. This report summarizes and analyzes the results of these targeted reviews.

Each DOE site that EA reviewed had established WP&C programs, including an appropriate hierarchy of documents containing appropriate management policy statements, standards and requirements, and implementing procedures. Each site relied on a graded approach to hazard analysis and used team planning that included appropriate subject matter experts in the analysis of hazards and selection of needed hazard controls. For observed work, control sets commonly followed the proper hierarchy of controls (i.e., engineered controls, administrative controls, and personal protective equipment) to mitigate hazards. Generally, trained and qualified workers performed work observed by EA within the established controls, and each site had implemented activity-level feedback and improvement processes. Recent data from the DOE Computerized Accident/Incident Reporting System and OSHA Bureau of Labor Statistics also show that most work performed within the DOE complex continues to be performed with fewer injuries and illnesses than similar work in private industry.

Additionally, EA identified good practices at a few sites that were unique and/or show promise in promoting safe work performance. These included one site using enhanced hazard analysis techniques including systematic evaluation of low probability high consequence events, another site placing specific constraints on the use of worker knowledge for hazard mitigation, and a third site providing systematic linkage of industrial hygiene exposure assessment data to its work management systems.

Despite the program strengths discussed above, EA identified several relatively common weaknesses in activity-level WP&C across the sites reviewed. The topical areas demonstrating weaknesses have similarities to those identified in previous independent oversight reviews over the last 8 years. While some improvements are evident in most areas, the results of the recent reviews indicate that corrective actions have not been fully effective in resolving previously identified weaknesses. The specific areas of weakness identified in this series of WP&C reviews are as follows:

Skill of the Worker: Skill of the worker is work that has been deemed able to be safely performed by a worker possessing the needed proficiency, skill, job position training, and experience to perform a given activity with limited work planning and hazard analysis. At most sites, EA identified programmatic weaknesses with defining limits and bounds for using skill of the worker to identify and control hazards. The misuse of this approach to conduct work beyond the boundaries of the workers qualifications based on solely training and experience has resulted in ineffective controls, injuries, unnecessary exposures, and reportable events.

Recognition and analysis of potential failure modes during planned work. While site hazard analysis processes for planned work were generally effective in identifying the likely hazards associated with actual work activities, these processes were generally ineffective in identifying and controlling hazards associated with the work during conditions other than normal (e.g., electrical sources near an emergency shower that could become a hazard when the shower is activated during an actual emergency, failure modes such as unintentional spills associated with chemical movements to laboratory fume hoods, and cryogen systems that could inadvertently lose containment and cause the potential for oxygen deficient atmospheres outside of normal work evolutions).

Industrial Hygiene Exposure Assessments: Several sites did not adequately identify the need for industrial hygiene occupational exposure assessments required by 10 CFR 851, *Worker Safety and Health Program*, as part of work planning. Exposure assessments were often incomplete or not properly based on the actual work being conducted. Furthermore, exposure assessments were often not reviewed, updated, or maintained consistently with changing workplace hazards for the planned work.

Hazardous Energy Control: Hazardous energy control implementation weaknesses were observed at several sites, resulting in events and near miss events serious enough to warrant reporting in the DOE Occurrence Reporting and Processing System. Most of these weaknesses involved electrical energy sources, but other hazardous energy concerns included use of hydraulic energy and pressurized systems. These weaknesses often result when sites rely on workers to determine hazards and controls in the field (i.e., skill of the worker) instead of using systematic WP&C processes to provide workers information related to engineering analyses and appropriate lockout points, approach boundaries, and required personal protective equipment.

Compliance with Procedures and Requirements: EA observed various examples of noncompliance with technical work documents (e.g., technical procedures, work packages, work instructions, etc.) and/or the failure to follow established controls at most sites. Deviations from site requirements were evident in the areas of procedure adherence, procedure use, and procedure suspension. In addition, established radiological control and industrial safety requirements were not always being properly implemented during observed work.

With regard to contractor assurance and DOE/NNSA line oversight, all contractors and DOE field elements had appropriate documented assurance systems to evaluate safety performance, identify and track issues, and implement corrective actions. However, there are continuing weaknesses in both contractor and DOE implementation. For example, many longstanding concerns with contractor issues management systems persist, including ineffective resolution and closure of previous EA findings, not consistently placing issues into the issues management system, and mischaracterizing significance levels. DOE field elements also continue to struggle with problems in the area of issues management and sometimes adequacy of staffing levels to support effective oversight.

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1.0 INTRODUCTION

The DOE Office of Enterprise Assessments (EA) oversight program is designed to enhance DOE safety and security programs by providing the Secretary and Deputy Secretary of Energy, Under Secretaries of Energy, other DOE managers, senior contractors, Congress, and other stakeholders with an independent evaluation of the adequacy of DOE policy and requirements and the effectiveness of DOE and contractor line management performance and risk management in safety and security and other critical functions as directed by the Secretary. The DOE independent oversight program is described in and governed by DOE Order 227.1A *Independent Oversight Program*, and EA implements the program through a comprehensive set of internal protocols, operating practices, inspector's guides, and process guides.

EA's Office of Environment, Safety and Health Assessments evaluates safety and emergency management policies and programs throughout DOE with a particular emphasis on evaluating worker and public protection from high consequence hazards, which exist at many DOE sites. This office accomplishes its mission through two primary mechanisms: (1) a network of staff site leads who are assigned to monitor DOE sites with nuclear facilities or activities and coordinate office assessment activities at those sites, and (2) a program of targeted reviews and appraisals that evaluate selected functional or topical areas at multiple sites across the DOE complex. Assessment activities are selected, prioritized, and planned based on such factors as risk to workers and the public, facility operational status, and performance history. Activity-level Work Planning and Control (WP&C) was one of several targeted focus areas associated with commitments made to the Defense Nuclear Facilities Safety Board.

These WP&C focus area reviews evaluated the effectiveness of the contractor's implementation of the integrated safety management (ISM) core functions (Define Scope of Work, Identify and Analyze Hazards, Identify and Implement Controls, Perform Work Safely within Controls, and Feedback and Improvement) with respect to WP&C. The EA performed the reviews based on lines of inquiry associated with activity-level WP&C in DOE Guide 226.1-2A, *Federal Line Management Oversight of Department of Energy Nuclear Facilities*, Appendix D, *Activity-Level Work Planning and Control Criterion Review and Approach Documents with Lines of Inquiry*. Additionally, applicable elements of DOE Criteria, Review, and Approach Document (CRAD) 45-35, Rev. 1, *Occupational Radiation Protection Program Inspection Criteria, Approach, and Lines of Inquiry*, were considered for radiological work planning.

EA's predecessor office issued an independent oversight report in June 2008 entitled, *Annual Report for Calendar Year 2007 on Status of Implementation of Integrated Safety Management at the Department of Energy*, which addressed some of the same areas as this lessons learned report. Specifically, the 2008 report stated that WP&C programs at DOE sites were generally well defined and comprehensive at the institutional level, and were generally effectively implemented for many hazards, such as nuclear material operations, explosives, and most physical safety hazards. The former report also identified some weaknesses in each of areas evaluated within the scope of the 2014-2015 WP&C reviews. EA compared the results of the current reviews with those presented in the 2008 report. The results are presented in the applicable subsections within the results section of this report.

DOE's field element oversight of the contractor's WP&C was evaluated in accordance with the inspection criteria for line management oversight and the Facility Representative (FR) program contained in DOE CRAD 45-21, Rev. 1, *Feedback and Continuous Improvement Inspection Criteria and Approach – DOE*

Field Element. The EA review team also used elements of DOE Guide 226.1-2A, section 4.1.5, *Work Planning and Control*, which specifically address expectations for field element oversight.

1.1 Report Scope

This report documents lessons learned from the independent reviews of activity-level WP&C at six DOE/NNSA sites that have hazard category 1, 2, and 3 facilities. These reviews, conducted from July 2014 to September 2015, involved seven site contractors and seven DOE/NNSA field elements (some sites have multiple contractors and field elements) and primarily focused on nuclear facilities. These reviews also included a sampling of non-nuclear facilities at several sites, such as user and research facilities that involve radiological operations. The sites and facilities reviewed, along with associated contractors and Headquarters program offices, are listed in Table 1 below.

Table 1 – Activity-Level WP&C Review Sites

Review Site	Facilities/Operations Reviewed	Operating Contractors	Headquarters Program Office	DOE Field Element
Hanford Site	Tank Farm operations, maintenance, and construction	Washington River Protection Solutions, LLC (WRPS)	Office of Environmental Management	Office of River Protection
Hanford Site	Plateau remediation decontamination and decommissioning (D&D), maintenance, and construction	CH2M HILL Plateau Remediation Company (CHPRC)	Office of Environmental Management	Richland Operations Office
Los Alamos National Laboratory (LANL)	Operations and research work	Los Alamos National Security, LLC (LANS)	National Nuclear Security Administration (NNSA)	Los Alamos Field Office
Nevada National Security Site (NNSS)	Device Assembly Facility, Radioactive Waste Management Complex, U1a Complex, Nonproliferation Test and Evaluation Complex maintenance, operations, and research	National Security Technologies LLC, Centerra –Nevada, Lawrence Livermore National Security, LLC (Nevada); LANS (Nevada)	NNSA	Nevada Field Office
Sandia National Laboratories (SNL-NM)	Operations and research	Sandia Corporation (Albuquerque, NM)	NNSA	Sandia Field Office
Y-12 National Security Complex (Y-12)	Manufacturing operations, maintenance, and construction	Consolidated Nuclear Security, LLC	NNSA	NNSA Production Office

1.2 Requirements and Guidance

DOE P 450.4A, *Integrated Safety Management Policy*, establishes the DOE expectations for ISM that enable the Department's mission and goals to be accomplished efficiently while ensuring safe operations at all Departmental facilities and activities. The ISM policy calls for a site-specific, documented description of the ISM system that is tailored to the hazards and risks associated with the facilities and work activities at each site. DOE Order 450.2, *Integrated Safety Management*, establishes requirements that DOE organizations must meet as well as associated responsibilities, including developing and implementing ISM systems for their activities, reviewing and approving contractor ISM systems, and overseeing implementation of ISM systems at their sites. The Department of Energy Acquisition Regulation (DEAR) ISM clause (48 CFR 970.5223-1, *Integration of Environment, Safety, and Health into Work Planning and Execution*) establishes requirements that contractors must meet, e.g., properly developing and implementing ISM systems for the facilities and activities at their sites, including activities that their subcontractors perform. Because DOE sites are unique and ISM systems must be tailored to the hazards and site conditions, DOE Order 450.2 requires DOE organizations to document their approach for ensuring that both their DOE offices and their contractors establish effective and efficient ISM systems that are appropriate for site hazards. The DEAR ISM clause establishes a similar requirement for contractors.

DOE Guide 450.4-1C, *Integrated Safety Management Systems Guide*, provides information related to development, implementation, approval, monitoring, evaluation, and improvement of ISM systems. The guidance is organized around the key topic areas identified in DOE Order 450.2 and/or the DEAR ISM clause, including general ISM information (e.g., discussion of the guiding principles and core functions of ISM); developing ISM system descriptions; monitoring, evaluating, and improving ISM implementation; safety culture; safety goals, objectives, and measures; safety management functions, responsibilities, and authorities; and the ISM Champions Council.

Title 10 CFR Part 851, *Worker Safety and Health Program*, establishes DOE requirements for a worker safety and health program (WSHP) that reduces or prevents occupational injuries, illnesses, and accidental losses by providing covered DOE contractors and their workers with safe and healthful workplaces at DOE sites. The DOE contractors may use their ISM system description or process as their WSHP to the extent it meets the requirements of 10 CFR 851.

In January 2006, NNSA issued a document entitled *Activity Level Work Planning and Control Processes, Attributes, Best Practices, and Guidance for Effective Incorporation of Integrated Safety Management and Quality Assurance*. This document was developed to address indications from various sources that ISM was not being effectively implemented or practiced on the floor where work is being performed. These sources included the Defense Nuclear Facilities Safety Board, EA's predecessor organization, and DOEs Occurrence Reporting and Processing System (ORPS) reports. The NNSA document provided attributes and best practice guidance for effectively incorporating ISM core functions, guiding principles, and quality assurance criteria into activity-level WP&C processes. Although developed by NNSA, the attributes are appropriate for all DOE programs, types of work and workers (e.g., scientists, operators, crafts, engineers).

In April 2014, DOE issued a DOE Handbook (DOE-HDBK-1211-2014, *Activity-Level Work Planning and Control Implementation)*, which describes non-mandatory approaches for implementing DOE requirements for activity-level WP&C at hazard category 1, 2 and 3 nuclear facilities. The DOE Handbook is intended as a resource for improving activity-level work, and also provides a common approach to developing or improving contractor WP&C processes.

The remainder of this report is organized into the following sections:

- Section 2 provides an overall assessment of the results of the targeted reviews, including common themes gleaned from the reviews. It also provides a brief analysis of operational data.

- Section 3 describes the WP&C attributes and practices that were unique and/or show promise in promoting effective WP&C at one or more DOE/NNSA sites.

- Appendix A provides recommendations for consideration as potential improvements on the part of site contractors and DOE/NNSA at all sites.

- Appendix B provides supplemental information on the organization and team members contributing to the review.

2.0 OVERALL ASSESSMENT

2.1 Institutional Work Planning and Control Programs

Results: All of the site contractors that EA reviewed had well-established WP&C programs, including a hierarchy of documents containing appropriate management policy statements, requirements documents, and implementing procedures. Due to the complexity and diversity of work performed at the various sites, the level of detail provided in the institutional documents varied depending on the types of work performed. Of the sites reviewed, most work types can generally fit into the following four basic work categories:

- Operations (including Manufacturing)
- Research and Development
- Maintenance
- Construction.

Some sites use an approach that requires all work types to follow the same basic WP&C process, while others have different WP&C systems and requirements depending on the type of work being performed. Maintenance work, such as corrective maintenance, is usually performed in discrete evolutions, which lends itself to the use of discrete work packages containing relevant hazard and control requirements. Operations work is mission-related, often repetitive in nature, and therefore performed to routine operating procedures that describe the work steps, hazards, and controls. Research and development work is often the most challenging because of relative uncertainties about the specific work scopes needed to achieve a desired outcome. Experiment safety reviews and similar documents, as well as a combination of research work documents and procedures, are often created to identify and control hazards for this type of work. Construction work is often documented similar to maintenance work except that the work scope is generally broader and less well defined to accommodate continually changing work activities, the hazards and controls are described more generically and seldom well-tailored to the work scope, and there is a significant reliance on the skill of the craft when performing work.

Contractors at each site were revising work planning and control based on lessons learned from events or feedback and improvement programs. One site had developed a new corporate WP&C procedure which was being deployed throughout all organizations to provide an analysis of safety of activity level work. At another site, the contractors were in the process of implementing organizational changes and other improvements in WP&C through a 5-year strategic improvement plan for WP&C.

In general, all sites had processes for initiating, analyzing, planning, and approving activity-level work. Work scope is identified via various mechanisms including statements of work, work orders, task authorizations, authorized program work documents, maintenance requests, etc. At most of the sites, more than one contractor and or subcontractors were involved in performing work. At one site with multiple contractor interfaces, a process was developed to ensure that work was clearly defined and authorized and that the safety coordination responsibility was assigned to a single entity. All sites had established processes for hazard identification, analysis, and selection for controls. Most of the hazard identification and analysis processes involved a job task analysis and qualitative hazards analysis. At some sites these task level hazard analyses processes were at least partially computer-based. A unique initiative at one site required the performance of a robust qualitative hazard analysis (i.e., what if analysis) or some type of failure modes analysis for each work activity in addition to the typical job hazard analysis, which EA considered a positive attribute. EA noted that all site processes included a team approach involving the appropriate subject matter experts (SMEs) to identify and analyze hazards and select controls.

Each site contractor's WP&C program was based on an appropriate application of a hierarchy of hazard controls including engineered controls, administrative controls, and personal protective equipment (PPE). Processes for work planning ranged from detailed project execution plans to the development of work packages to plan of the day meetings. Work planners were critical in developing effective work packages for maintenance work and operations procedures. The processes for authorizing and releasing work included approval of technical procedures and work packages, project kickoff meetings, the use of knowledgeable shift managers and supervisors, readiness checklists, plan of the day meetings and pre-job briefings, to confirm readiness. All sites' processes and procedures adequately addressed stop work authority.

All of the sites also had processes and procedures for feedback and improvement, including formal and informal mechanisms. Several sites reviewed applicable lessons learned in plan of the day meetings, pre-job briefings, and safety meetings. Opportunities to capture lessons learned were also solicited from workers during post-job reviews.

Based on the six sites reviewed, EA identified two common areas of concern with respect to inadequate WP&C program and procedure development, namely (1) skill of the worker, and (2) recognition and analysis of potential failure modes during planned work.

Skill of the Worker

While WP&C program requirements, policies, and procedures were generally adequate to foster effective hazard identification and control, a common challenge within DOE is the development and implementation of an effective mechanism to analyze, control, and document hazards that are associated with routine work activities that could result in injuries and illnesses. Such routine activities as minor maintenance or dispatched service work, research experiment setup and research equipment maintenance, operational rounds and surveillances, and routine construction work are often performed by skilled and trained workers. The contractors often describe these work activities as skill of the craft or skill of the researcher. In more general terms, the DOE Handbook describes these as Skill of the Worker (SOW). SOW type work is defined in the DOE Handbook as work that can be safely performed by a worker possessing the needed proficiency, skill, job position training, and experience to perform a given activity with limited work planning and hazard analysis. In general, the hazards of performing these tasks are assessed and documented as part of the individual's job description and/or general hazard analysis documents, and the training necessary to control these hazards is outlined in the individual or position training requirements document. The workers performing the work are assumed to possess the training, qualification, certification, education, and experience to safely perform the work, which is expected to

have little potential for identified hazards to change during the work activity. Furthermore, the organization performing this work has predetermined that there is little potential for identified hazards to change during the work activity.

At most sites, EA found a programmatic concern relating to proper definition of limits and bounds for SOW-type work that can be authorized and performed without a structured hazard analysis or documented work document, such as a work package, procedure, or research or experimental work plan. The EA team found that work control processes often do not adequately address a well-defined work scope, expectations, allowances, and bounds for performing SOW-type work. Furthermore, contractors and work sites are often deficient when defining "thresholds" for the type of work that constitutes SOW-type work and "low-hazard work" or when a work activity requires formal planning and structured hazard analyses. For example, although contractors typically classify custodial or janitorial work as SOW-type work, the U.S. Department of Labor has identified that custodial or janitorial work has resulted in a variety of injuries and illness caused by ergonomic stressors, chemical exposures, and biological hazards. However, EA found that contractors seldom identify and analyze the work scope, hazards, and controls of janitorial work since no work control processes address this type of activity.

Similarly, the set-up, maintenance, and dismantlement of research equipment and experiments is often not addressed by research work documents although such activities often present a variety of electrical, chemical, and physical hazards. Many of the electrical, carpentry, and machine shops that EA observed lacked a well-defined scope of work for these shops, the hazards that workers may encounter, or the controls that should be in place to minimize risk of injury or illness. In each case, the contractor has assumed that workers have the necessary skills, training, and/or experience to perform this work safely without having adequately defined the work tasks, the potential hazards, or the necessary hazard controls. For example, in one machine shop observed by EA, there was no required training or qualifications for workers to use any of the lathes, saws, grinders, and punch or sheer presses. Furthermore, since many of the machines were old, there were no operating manuals, or posted instructions. Although workers were required to read the shop Job Hazard Analysis (JHA) prior to using any of the equipment, the JHA was generic in nature and lacked any discussion of operations, hazards or hazard controls for specific equipment items. Some workers who had used the equipment, when interviewed by EA, lacked adequate knowledge of emergency switches, machine guarding and equipment limitations. In addition, the site had experienced a number of machine shop first aid and recordable injuries during the past decade. Contractors are often prone to assume that workers inherently possess the required knowledge and skills simply by nature of the worker's education or past experience without validating that his or her training or experience is applicable to the specific work being performed. SOW was also identified as a common area of weakness in the June 2008 WP&C independent oversight report.

Recognition and Analysis of Potential Failure Modes During Planned Work.

DOE has established numerous requirements in 48 CFR 970, 10 CFR 830, 10 CFR 851, DOE P 450.4A, DOE Order 433, and DOE Order 422.1 to ensure that hazards with work and within the work environment are identified and analyzed for the protection of workers, the public, and the environment, including identifying and analyzing the potential for undesirable or unanticipated events. The safety basis requirements of 10 CFR Part 830 require the contractor responsible for a DOE nuclear facility to analyze the facility, the work to be performed, and the associated hazards. The worker safety and health requirements of 10 CFR Part 851 require contractors to establish procedures to identify existing and potential workplace hazards and assess the risk of injury and illness associated with them.

Although each of the reviewed sites and contractors had hazard analysis processes that were effective in identifying the likely hazards associated with planned activity-level work activities, few contractors had effectively designed and/or implemented a hazard analyses process that adequately addressed low

probability, high consequence events at the activity level. For example, one research laboratory routinely uses an electron microscope in a small laboratory that also contains a safety shower, for which an adequate drain was never installed. The shower is tested once a month using a bucket to contain the water. In proximity to the shower are a number of high voltage power cables and various electrical connections on the laboratory floor associated with the electron microscope. A well-defined hazard analysis was developed for the operation and maintenance of the electron microscope. However, since the use of the emergency shower was not part of the operation of the electron microscope, the hazard analysis did not identify the low probability, high consequence event of the emergency shower being used and resulting in a potentially significant electrical hazard. The site recognized that the emergency shower vulnerability was typical of a number of potential low probability, high consequence events that the existing hazard analysis process did not adequately consider and initiated positive changes to the research hazard analysis process as described in Section 3.0.

A second example involved a research laboratory that routinely used large quantities of a hazardous chemical (trichloroethylene). Although the use of this chemical during research experiments was well-controlled in chemical fume hoods and through work procedures, the potential consequences and response to a chemical spill when routinely carrying gallon glass containers of trichloroethylene across the laboratory to the chemical fume hoods had not been considered. When questioned, researchers had different answers on how they would respond to a spill, and each researcher indicated they were unsure of the response expected by the laboratory.

In a third example, research staff had identified the hazards and controls when using cryogens, but did not recognize the potential failure modes and associated hazards should the cryogen systems fail during periods when the laboratory was unoccupied, resulting in the potential for someone unknowingly entering an oxygen deficient atmosphere. In this case, the work process focused only on the hazards associated with the immediate work activity (i.e., the use of the cryogens) and missed the less probable but potentially higher consequence oxygen deficient atmosphere hazard associated with the storage of the cryogens. At the facility level, each of the sites had developed mechanisms to identify and analyze significant unanticipated and unlikely radiological and chemical accidents through formal documented safety analyses, but similar critical thinking processes had typically not been developed at the work activity level. Of the six sites reviewed, one site had recognized the value of including critical thinking processes (e.g., failure modes, “what if” analyses, and peer reviews of work packages) to better identify and analyze failure modes and related hazards and this site was in the process of improving its hazard analysis mechanisms to better identify and analyze these types of unanticipated hazards.

2.2 Implementation of Activity-Level Work Planning and Control Programs

Results: Overall, the work scopes for most of the observed activities were well-developed, easy to comprehend, and accurately described the work to be performed. All sites relied on a graded approach to hazard analysis and applied a graded approach to the implementation of hazard controls, appropriately relying on a hierarchy of controls including engineered controls, administrative controls, and finally PPE when engineered and administrative controls were not sufficient to mitigate hazards. Work that EA observed was generally performed within the established controls by trained and qualified workers. Each site had implemented one or more types of activity-level feedback and improvement processes, although some sites were more successful than others when applying feedback processes at the work activity level.

Based on the six sites reviewed, EA identified three common areas of concern with proper implementation of WP&C programs that could result in unnecessary injuries or illnesses: (1) industrial hygiene (IH) exposure assessments, (2) hazardous energy control and (3) compliance with procedures and requirements. These areas are discussed in the remainder of this section.

Industrial Hygiene Exposure Assessments

10 CFR 851 requires that the contractors assess worker exposures to chemical, physical, biological, or safety hazards through appropriate workplace monitoring and documentation using recognized exposure assessment and testing methodologies. Each site that EA reviewed had developed programs and procedures, typically through their IH organization, to implement these requirements, which was an improvement since the 2008 DOE Office of Oversight report. However, implementation of the IH exposure assessment program was generally inadequate at most sites in one or more of the following ways: (1) lack of documented exposure assessments for many established work activities, (2) the exposure assessments were incomplete or inconsistent with the work activity, (3) the exposure assessments were not routinely reviewed, updated, or maintained consistently with changing workplace hazards. As an example, at one site, the contractor acknowledged that the site's exposure assessment guide had been implemented on only 10 percent or fewer of the contractor's activities.

EA also found that the quality of exposure assessments reviewed was less than adequate at some sites. Some weaknesses included:

- The scope of the exposure assessment was inconsistent with the scope and hazards of the work activity, or the specific work activity could not be clearly identified.

- Hazard controls, such as hearing protection, local exhaust ventilation, and chemical gloves, and other recommendations in the exposure assessment had not been implemented in the associated work documents or conflicted with the prescribed controls in the work documents for the same hazards.

- Inadequate IH worker exposure sampling had been performed to validate the assumptions in the exposure assessment (i.e., no worker exposures).

- Some exposure assessments were not updated with changing workplace hazards, or in accordance with the update frequency required by the contractor's IH Exposure Assessment Program. For example, welding exposure assessments at one machine shop had not been updated during the past five years, in contrast to IH procedure requirements for updates every three years at a minimum. There were numerous changes in the shop welding procedures, materials, and welding equipment during that same period

The subject of IH exposure assessments was also identified as a common area of weakness in the June 2008 independent assessment report.

Hazardous Energy Control

10 CFR 851 and the Occupational Safety and Health Administration (OSHA) require a hazardous energy control program if employees service and/or conduct maintenance on machines and equipment. Direction for developing and integrating required hazard controls were generally contained in procedures, work packages, job hazard analyses, and lockout/tagout (LO/TO) permits. In cases of SOW type work, site procedures typically require controls to be conveyed and discussed by the field work supervisor or person in charge during pre-job briefings. However, EA observed hazardous energy control implementation weaknesses at several sites, resulting in near miss reporting and/or the need to report the event to ORPS. The following examples occurred during EA reviews at the sites visited:

- Two workers were working within the swing radius of a large pneumatic-operated door without active control of the door (control of building or LO/TO of door).

- A worker driving a tandem dump truck with the bed extended contacted an energized 13.2 kilovolts overhead powerline.

- Two workers had initiated troubleshooting activities on a programmatic wire forming mill when a worker crossed the Limited Approach Boundary with the equipment energized and its cover removed.

While requirements and/or guidance for hazardous energy controls contained in 29 CFR 1910.147 and National Fire Protection Association (NFPA) 70E, as well as other documentation, predate 10 CFR 851 and have been implemented at sites for many years, implementation typically was relegated to training individuals (or hiring trained individuals) and designating these individuals as qualified workers. All sites reviewed possessed institutional hazardous energy control programs and procedures as required. However, the majority of the sites rely on their use of qualified workers to determine hazards and controls based on conditions in the field, instead of systematic WP&C processes to provide workers information related to engineering analyses and required LO/TO points, limited approach boundaries, PPE, etc. EA observed a number of sites where qualified electrical workers were not supplied sufficient information through the work planning process to determine potential hazards and controls. In these cases, workers commonly self-performed actions, such as tracking down the closest up stream arc flash hazard determinations and determining the appropriate PPE. Recent hazardous energy control related events across the DOE complex have resulted in ORPS entries and/or injuries. At some sites, the responses to corrective actions or lessons learned associated with these events have resulted in a more systematic and effective approach to WP&C for electrical work. However not all sites reviewed have applied a sufficiently systematic approach that ensures qualified electrical workers are provided the appropriate hazard analysis and control information in advance, to ensure safe performance of work. (e.g., Engineering analyses and required LO/TO points, limited approach boundaries, PPE)

Compliance with Procedures and Requirements:

A key tenet of DOEs integrated safety management policy is adherence to written procedures and requirements; this principle is further delineated at DOE nuclear facilities through DOE Order 422.1, *Conduct of Operations,* and subordinate DOE and facility conduct of operations guides and manuals. During the WP&C reviews, EA observed examples of noncompliance with technical work documents (e.g., technical procedures, work packages, work instructions, etc.) and/or the failure to follow established controls at most sites. Procedure implementation weaknesses were evident in the areas of procedure adherence, procedure use, and procedure suspension, as required by conduct of operations requirements. In addition, established radiological control and industrial safety requirements were not always followed. Specific examples include not stopping work to correct procedures that could not be performed as written, deviating from certain steps in procedures, walking underneath a suspended load, not keeping hands away from rotating equipment, improper work release, not implementing required electrical safety controls, lack of required hearing protection, radiological posting and boundary control violations, and improper PPE doffing practices. Some of the deficiencies are due, in part, to requirements that are not clearly communicated to workers and/or managers who do not sufficiently establish expectations for full compliance with processes and procedures.

The subject of compliance with procedures and requirements was also identified as a common area of weakness in the June 2008 independent assessment report. It should be noted that these are longstanding concerns that not only result in potential for health and safety consequence but can also adversely affect DOE mission, as evidenced by recent DOE work stoppages and stand downs related to conduct of operations weaknesses. For example, at one of the sites included in our review a major operation was shut down due in part to procedural use issues, EA identified another site as having a continuing

deficiency in this area based on work observations, and a third site outside of the review scope had initiated a stand down in response to procedural use concerns.

2.3 Injury and Illness, Occurrence Reporting and Processing System, and Enforcement Data Analysis

Injury and Illness Data

Since WP&C activities encompass the wide and varied scope of work performed at DOE sites, a measure of WP&C effectiveness is the rate at which work is performed safely. A recognized measure of safe work in both DOE and private industry is the rate of occurrence of injuries and illnesses in the workplace as well as the record of injuries that result in days away (from work), restricted, or transferred (DART). Total recordable cases (TRC) rates of injuries and illnesses indicate the magnitude of injuries and illnesses, while the DART rates are typically indicators of the severity of these injuries and illnesses. Like other government agencies and private industry, DOE uses the Department of Labor recordkeeping and reporting regulations as the core set of requirements to measure worker injuries and illnesses. Data reported for 2014 (the most recent compiled data) indicate that the number and rate of occupational illnesses for DOE workers remained steady for the third consecutive year. Forty-six percent of all DOE injury and illness cases in 2014 were serious enough for the worker to experience DART.
In comparison to DOE, the TRC and DART incidence rates for private industry for 2013 were 3.3 per 100 full-time workers and 1.7, respectively. For 2014 the TRC and DART rates for private industry were 3.2 and 1.7, respectively. These totals for private industry include industry groupings unrelated to work performed by DOE workers and are not necessarily the best gauge for DOE performance. However, when private industry groups who perform work similar to DOE workers are compared, DOE incidence rates typically compare favorably, as indicated in Table 2.

Overall, as evidenced in the six DOE sites reviewed for this report, work within the DOE complex continues to be performed with fewer injuries and illnesses than private industry. In addition, for those injuries and illnesses incurred by DOE workers, for the six DOE sites surveyed and the work types involved (e.g., construction, waste treatment and disposal), they are generally less severe and of shorter duration than those injuries and illnesses experienced in private industry for comparable work activities. One exception, however, is research work performed at the DOE defense laboratories. For research work at laboratories evaluated by the EA team, DOE injury and illness rates (TRC and DART rates) are comparable to or in a few cases higher than research work performed in private industry in CY 2013 and CY 2014. EA's observations indicate that the higher injury and illness rates at DOE defense research sites may be attributable to overreliance on skill of the researcher to analyze and control the hazards, particularly in the set-up and dismantlement of research experiments, the lack of formalized programs to identify and analyze unanticipated hazards in the research environment, and not following established procedures and work documents, as discussed in other sections of this report.

Table 2
Occupational Injury and Illness Incidence Rates
Private Industry and Select DOE Organizations Reviewed by EA

Private Industry/Select DOE Organizations	North American Industry Classification System Code/DOE Code	2013 Total Recordable Cases	2013 DART Cases	2014 Total Recordable Cases	2014 DART Cases
Total Private Industry		3.3	1.7	3.2	1.7
Total DOE		1.0	0.4	1.0	0.4
Private Industry Waste Treatment and Disposal	5622	4.0	3.1	4.6	3.3
DOE Hanford Tank Farms Waste Treatment	4707104	0.5	0.2	0.6	0.2
Private Industry Scientific Research & Development	5417	1.1	0.5	1.2	0.5
DOE LANL	0544003	1.2	0.4	1.3	0.4
DOE SNL	0578003	1.0	0.4	1.0	0.5
Private Industry Heavy and Civil Engineering Construction (incl. D&D)	2379	2.5	1.3	3.1	1.6
DOE Hanford (Richland)	7505	1.0	0.7	0.8	0.2
Private industry Primary Metal Manufacturing	331	5.2	2.8	5.2	2.9
DOE Y-12	0558	0.9	0.6	0.7	0.4
DOE NNSS	NTC	2.1	1.2	2.0	1.3

Occurrence Reporting and Processing System

EA reviewed ORPS data from January 2014 to August 2015 for the six sites reviewed to identify any trends relevant to activity-level WP&C. EA was able to relate information and common themes identified in the ORPS reports to some aspects of WP&C concerns discussed in this report. The most common and readily evident theme gleaned from the ORPS reports was the large percentage of events that can be directly attributed to electrical safety deficiencies, consistent with the hazardous energy control concerns discussed in this report. Table 3 includes a breakdown of the number of ORPS reports at each of the six sites, along with the number that pertained specifically to electrical safety, and the number of reports that listed each of the core functions as partially attributable to the event. Electrical safety events comprised anywhere from 9 percent to over 30 percent of the ORPS events at each site. Each ORPS report also lists the core functions of ISM that likely contributed to the event. More than one core function can be listed in each report. Table 3 also demonstrates that most events indicate weaknesses in analysis of hazards and implementation of hazard controls and in proper execution of work performance, which is also consistent with the ORPS data analysis presented in the independent oversight report issued in June 2008.

Table 3[1]
Site Occurrence Report WP&C Summary

Site	ORPs Total	Electrical Safety Totals		ISM Core Function 1 Define Scope of Work		ISM Core Function 2 Analyze the Hazards		ISM Core Function 3 Develop and Implement Hazards Controls		ISM Core Function 4 Perform Work Within Controls		ISM Core Function 5 Feedback / Improvement	
		#	%	#	%	#	%	#	%	#	%	#	%
Hanford Site - WRPS	31	11	35%	1	3%	16	52%	18	58%	13	42%	0	0%
Hanford Site - CHPRC	61	14	23%	2	3%	28	46%	33	54%	35	57%	10	16%
LANL	240	32	13%	11	5%	47	20%	54	23%	50	21%	51	21%
NNSS	56	7	13%	5	9%	14	25%	11	20%	15	27%	12	21%
SNL-NM	61	17	28%	7	11%	34	56%	27	44%	33	54%	13	21%
Y-12	97	9	9%	3	3%	37	38%	32	33%	27	28%	25	26%
TOTAL	546	90	16%	29	5%	176	32%	175	32%	173	32%	111	20%

[1] *The percentages for the five core function categories add up to more than 100 percent because ORPS reports may identify more than one factor as a contributor to an event.*

Because each ORPS report contains a narrative summary, some event types, such as those attributable to the electrical safety/hazardous energy control aspects of WP&C, were easy to identify and quantify. In addition to these event types, the ORPS data also provided some level of indirect relationship to other main WP&C concerns identified in this report, including SOW, recognition of unanticipated hazards, IH exposure assessments, and procedure compliance. For example, the cause codes presented in ORPS contain terms (such as skill based, knowledge based, and human performance) in a number of reports, and EA's observations at the six sites indicate that many electrical safety events may be attributable to overreliance on SOW to analyze and control the hazards at the time of the work activity rather than before, i.e., during preplanning. Similarly, the number of reports that contain reference to core function 2, Analyze Hazards, is indicative of and consistent with EA's concern with recognizing potential for unanticipated hazards. For example, a number of ORPS report narratives contain descriptions of unanticipated events or chemical reactions. Finally, EA noted that some ORPS reports describe exceedance of American Conference of Governmental Industrial Hygienist Threshold Limit Values or OSHA Permissible Exposure Limits for exposure to noise and/or chemicals, which also indirectly relates to the weakness in IH exposure assessments.

DOE Office of Enforcement Data

EA reviewed enforcement investigation documentation for the period covered in this report for violations or potential violations related to WP&C implementing procedures. There were three Preliminary Notices of Violations (PNOVs) and one WSHP enforcement letter issued to three of the six contractors within the scope of this lessons learned report. In addition, there was one nuclear safety enforcement letter (related to 10 CFR Part 835, *Occupational Radiation Protection*). The PNOV's collectively noted 10 severity

level I and four severity level II violations, most of which occurred because of ineffective implementation of the WP&C programs. The primary WP&C weaknesses leading to violations or enforcement concerns included:

- Hazard assessments were either ineffective or not conducted for activity-level work.
- IH/occupation exposure assessment plans for potential exposures to hazardous chemicals were not established during work planning activities.
- Work was performed without implementing the WP&C procedure.
- Hazard controls implemented in activity-level WP&C documents were not properly identified (including not applying the appropriate hierarchy of controls), or did not meet 10 CFR Part 851 WSHP safety and health standards,

EA enforcement investigations noted these weaknesses that were initiated by events involving serious or potential for serious injuries to workers. These weaknesses are consistent with the examples of weaknesses found during the WP&C assessments described above, in sections 2.1 and 2.2.

2.4 Contractor Assurance and DOE Line Oversight

2.4.1 Contractor Assurance

Results: EA reviewed DOE contractors' oversight of WP&C as a subset of the oversight performed as part of the contractor assurance system (CAS). The effectiveness of the systems in driving improvements in WP&C was evaluated by reviewing WP&C assessment scheduling, assessment content, metrics, and issue resolution. Each of the DOE and NNSA contractors evaluated had assurance systems that were documented by procedures, integrated assessments schedules, assessments, and ISM declarations.

WP&C assessment scheduling and content: At most sites, contractors scheduled and performed WP&C assessments at an adequate frequency. Some of the assessments addressed functional areas, such as conduct of operations, maintenance, conduct of maintenance, and electrical safety. These assessments identified deficiencies and evaluated the major aspects of the WP&C programs, and were generally coordinated with DOE/NNSA field elements through integrated assessment schedules that facilitated shadowing activities by the field elements. Some contractors also performed unscheduled management assessments that were less formal and did not use CRADs, but which provided more immediate feedback on WP&C activities. However, while assessments included appropriate aspects of the WP&C programs and identified issues, most contractors relied too heavily on document reviews without sufficient performance evaluation through field observations, as needed to validate effective implementation.

Metrics: At most of the sites reviewed, either no metrics were established or there was an over reliance on the use of lagging indicators, such as occupational injury/illness reports, to evaluate WP&C effectiveness. Contractors rarely used leading indicators, such as identified deficiencies, corrective action effectiveness, work package quality, and/or personal protective equipment infractions to provide the predictive information that may help resolve potential issues before they occur or lessen their impact.

Issue resolution: All sites reviewed had weaknesses with the issues management process. Weaknesses identified in issues management for WP&C activities for the sites reviewed included previous EA findings not being effectively resolved, issues not being consistently placed into the issues management system, reoccurring issues, issues categorized at a lower significance level than warranted, and inadequate

effectiveness evaluations. The weaknesses with the issues management were systemic, have existed for many years, affect all safety management programs assessed by the contractor assurance system (CAS), and have been documented by previous EA and predecessor organization assessments.

Concerns with the effectiveness of contractor assurance systems discussed in this report, particularly in the areas of assessments and issues management, were also noted as an area of weakness in the June 2008 independent assessment report. Concerns in these areas continue to persist, indicating a need for continuing emphasis on improvement.

2.4.2 DOE/NNSA Line Oversight

Results: For the most part, Federal oversight of activity-level WP&C for the reviewed sites is adequate. Overall, the DOE/NNSA field element roles and responsibilities for WP&C oversight are defined and documented. All reviewed field elements had assigned WP&C oversight roles, and some had designated a programmatic lead for WP&C oversight. Most field elements have documented WP&C roles and responsibilities in their Functions, Responsibility and Authorities Manual, and/or field element specific procedures. All field elements have documented oversight processes, including assessment planning and conduct, and issues management. The oversight processes include the development of an annual assessment plan, and most assessments were completed as scheduled. All field elements were performing some oversight of WP&C. Although the oversight processes were generally effective, some of the issues that were identified in the in the June 2008 independent assessment report were still evident. This included less than adequate issues management programs. Some of the field elements were working on improvements, including an update to their existing issues management systems. One field element realized that improvements were needed in Federal oversight of WP&C and established a special focus area, including increased oversight.

All reviewed field elements had conducted formal oversight assessments of at least some aspects of the contractors' WP&C programs. Formal assessments included field-led assessments as well as shadow assessments of contractor-led reviews. In general, the assessments reviewed were appropriately conducted and documented; included CRADs; and identified issues and areas for improvement. One field element had identified concerns with skill-based work, which prompted the contractor to develop corrective actions. The shadow assessments included an appropriate level of Federal involvement, review criteria and evaluation, and documentation. Although most field elements appropriately planned, scheduled and conducted assessments, it was noted that one field element had not scheduled a 2015 assessment of WP&C even though it's performance had been assigned a risk ranking of yellow, warranting greater oversight, and another field element had not completed two in-depth team assessments on WP&C, which had been scheduled as part of their efforts to increase oversight of WP&C.

All reviewed field elements provide routine operational awareness oversight of WP&C activities at nuclear facilities. For those facilities with assigned FRs, the FRs perform the majority of operational awareness activities. For facilities without assigned FRs, typically non-nuclear facilities, most operational awareness of WP&C activities is performed by SMEs and less frequently. Operational awareness oversight is also provided by SMEs (e.g., maintenance; environment, safety, and health; radiological control; fire protection) and safety system oversight engineers. Overall, the operational awareness activities were effective at identifying issues. Evidence supporting operational awareness activities included quick check forms, operational awareness reports, daily reports, etc. During FY 2014, quick check forms at one field element identified approximately 90 issues, resulting in the identification of a negative trend in the contractor's operational discipline. As a result, the field element directed the contractor to provide a path forward to address the systematic problems.

EA also reviewed the technical qualification and competence of the Federal staff primarily responsible for oversight of WP&C, focusing on the FR program. The FRs perform most of the activity-level WP&C oversight. Overall, the FR programs complied with DOE-STD-1063-2006, *Facility Representative*. The triennial self-assessments and staffing analyses were completed as required. The FRs were experienced and well-qualified, all having completed or in the process of completing the FR technical qualification program. Two field elements had a personnel shortage in the FR program; one of the sites had developed a compensatory plan until a permanent replacement was selected. The other site was significantly understaffed. In addition to FRs, other Federal staff members (including SMEs and safety system oversight engineers) provide oversight of WP&C. The SMEs and safety system oversight engineers were generally well-qualified and experienced, and had completed the technical qualification program for their area(s) of expertise.

Some field elements do not assign a programmatic lead or identify WP&C as a separate functional area, instead addressing portions of WP&C through review of other functional areas. DOE Guide 226.1-2A states that assigning a lead can enhance programmatic oversight and improve coordination. To a limited extent, the results of activity-level WP&C oversight are analyzed, tracked and trended. However, the tracking, trending, and analysis of WP&C conducted by the field elements did not meet the expectations outlined in DOE Guide 226.1-2A.

The June 2008 independent assessment report identified deficiencies with issues management programs, and EA noted continued concerns with issues management during this series of focused WP&C reviews. At one site, EA identified problems with the issues management instruction including lack of a process for categorizing findings based on risk (DOE Order 226.1B), reference to a team review which was no longer performed, and the omission of a separate process that the FR team used to transmit issues to the contractor. Also, several draft issues had not been finalized, even though they were initially identified more than 6 months earlier. At another site, a corrective action plan for a work control finding contained corrective actions which were beyond their expected due date. At another site the Federal staff was not always represented on the joint issues screening team. Additionally, two field elements were in the process of updating their issues management system to address known deficiencies.

3.0 GOOD PRACTICES

WP&C attributes and practices that were unique and/or show promise in promoting safe work performance at one or more DOE sites are described below. This information may be useful to sites that are working to improve the effectiveness of their programs. EA recognizes that the information below is derived from a sample of DOE sites and that other sites may also have effective, innovative approaches.

Use of Failure Mode Type Analyses in WP&C

At SNL, the laboratory and research staff recognized that a number of laboratory and research hazards were being missed by the traditional approach to workplace hazard analysis, such as the job hazard analysis. As a result, SNL embarked on a new approach which, in addition to the typical workplace hazard analyses, began employing the use of multidiscipline teams, including the research staff and Group Leaders, to collectively brainstorm for the identification of additional but unexpected or unlikely hazards in the work activity and work environment. SNL uses a variety of hazard analyses techniques, such as "what-if" analyses and failure mode analyses, to identify non-routine hazards that could adversely affect the work activity. Typically, these hazards were low probability, high consequence events. For example, when these techniques were applied to one SNL research experiment involving electron microscopy, (as previously described in Section 2.0) the hazard analysis team identified a new potential electrical hazard. The potential electrical hazard associated with electrical cables and connectors being submersed in water from the actuation of the emergency shower had never been considered until the laboratory expanded its

hazard analysis process and laboratory researchers began employing critical thinking skills, including a "what-if" thought process in their hazard analysis process. Once this low probability, high consequence event had been identified and analyzed, a facility modification was initiated to fix the shower drain and elevate the electrical cables. At the time of the EA review, the SNL expanded hazard analysis process was in the development stages, but had been implemented as a pilot project on a number of research projects resulting in the identification of additional workplace hazards that had not been recognized previously as in this example.

Definitive Guidelines for Managing Skill of the Worker Type Work

At Y-12, maintenance work involves a wide spectrum of tasks, including predictive and proactive maintenance, post-work tests, and emergency maintenance work. Three basic work planning methods (i.e., dispatched work, minor work, and complex work) are used to address the variety or work activities. Dispatched work is predetermined low hazard work that falls within the skill of the craft/worker and requires no formal work instructions. Dispatched work is well-defined in the Y-12 Integrated Work Control Manual. Y-12 has also developed a procedure that defines over 200 typical types of dispatched work activities. Each dispatched work activity in the procedure was selected and reviewed by a multi-disciplined review committee to ensure that the work scope, hazards, and controls for each activity were within the established Y-12 guidelines for skill of the worker type work. For a dispatched work activity to be performed as skill of the worker, the activity had to fall within the bounds of one of the 200 pre-designated work activities. In addition, prior to performing the work the workers were required to answer a set of five questions (e.g., Does the job require PPE for which I am not trained to wear?). If any response was no, then the work could not be performed as skill of the worker.

Use of Work Management Systems to Link Exposure Assessments

At LANL significant efforts have been made over the past few years to develop an inventory of all of the LANL work activities which are entered into a computer-based work management system (WMS). For each work activity entered into the WMS, the applicable work documents and work packages, hazard analyses and Process Hazard Screen have been entered, as well as any IH exposure assessments. The WMS database can be searched several ways, including via work activity title, building location, and person in charge of the activity. By linking the IH exposure assessments to the work activity within WMS, exposure assessments are readily available to line managers and the LANS Office of Environment, Safety, and Health staff. For example, of the nine research experiments at LANL randomly selected for review by EA, all nine exposure assessments were readily accessible.

APPENDIX A
Recommended Actions

The recommended actions discussed below are based on lessons learned during the Office of Enterprise Assessments reviews. While the underlying deficiencies and weaknesses did not necessarily apply to all the sites, and many sites have developed and implemented actions for the issues identified at their sites, the recommended actions provide additional insights into potential improvements at all sites. Consequently, U.S. Department of Energy (DOE) organizations and site contractors should evaluate the applicability of the following recommended actions to their operations and consider their use as appropriate in accordance with site-specific program objectives.

DOE Field Elements

Improve Federal line oversight of contractor activity-level work planning and control (WP&C). The following actions should be considered:

- Ensure site procedures are consistent with DOE Guide 226.1-2A. Consider the designation of WP&C as a functional area and assign a lead.

- Ensure adequate staffing for Federal oversight, especially FRs.

- Conduct self-assessments of DOE field element office's issues management programs and establish plans to correct ongoing weaknesses.

Site Contractors

Improve contractor assurance mechanisms in the areas of issues management, assessments, and use of metrics in evaluating performance. The following actions should be considered:

- Schedule routine WP&C assessments that emphasize observation of actual work activities and effectiveness in implementing WP&C and safety requirements.

- Increase the use of leading indicators as part of the CAS safety metrics to proactively track effectiveness of activity-level WP&C effectiveness. The DOE Handbook (DOE HDBK-211-2014), *Activity-Level Work Planning and Control Implementation*, Appendix B, *Work Planning and Control Metrics, Analysis, and Trending*, provides 90 possible WP&C metrics that are suggested by the Energy Facility Contractors Group.

- Provide more rigorous reviews when categorizing issue significance levels and conduct thorough issue closure effectiveness reviews that include performance evaluation to fully demonstrate the effectiveness of completed corrective actions.

Develop more effective work control processes for low hazard activities typically considered as SOW activities. The following areas should be of particular focus when revising or updating and existing work control process:

- Provide detailed requirements and expectations for a graded approach to low-hazard activities such that defining the work, analyzing the hazards, and developing and implementing hazard controls are consistent with the level of risk, complexity, and environmental hazards present, while factoring in the skill, experience, and training of the workers performing the work. Consider incorporating SOW

guidance contained in the DOE Handbook (DOE-HDBK-1211-2014) on *Activity-Level Work Planning and Control Implementation* and/or the National Nuclear Security Administration guidance document entitled *Activity Level Work Planning and Control Processes, Attributes, Best Practices, and Guidance for Effective Incorporation of Integrated Safety Management and Quality Assurance*.

- Provide mechanisms to verify that the work to be performed is within the boundaries and anticipated hazards and that the workers assigned to perform the work have the necessary skills, training, and qualifications.

Develop work control processes for identifying and analyzing unanticipated or unexpected hazards in the workplace, including unanticipated hazards from the work area or surrounding work areas that may adversely impact the work activity. The following actions should be of particular focus when revising or updating an existing work control process:

- Use a collaborative team approach for identifying and analyzing unanticipated or unexpected hazards in the work place on a graded approach. In addition to the typical hazard analysis team consisting of workers, job planners and subject matter experts, consider adding additional resources such as management representatives, workers/researchers who may have performed similar work in the past, and facility owners and operators.

- Incorporate peer reviews of work documents to assist in identifying potential hazards and mishaps that could adversely impact the work activity.

- Incorporate various risk analysis approaches and processes, such as "what-if" scenarios, brainstorming sessions, and failure modes and effects analyses consistent with the potential risks. Consider incorporating multidisciplinary hazard analysis methods discussed in Appendix C Collaborative Team Approaches in the DOE Handbook (DOE-HDBK-1211-2014) on Activity-Level Work Planning and Control Implementation.

- Provide approaches for identifying low probability, high hazard risks for routine work activities that could significantly impact the work activity in a comparable but measured manner.

- If new hazards and controls are identified when applying this approach, ensure that the successes are shared throughout the organization.

Follow the guidance in the American Industrial Hygiene Association's *A Strategy for Assessing and Managing Occupational Exposures* to develop and implement industrial hygiene exposure assessment programs and perform exposure assessments for all work activities involving one or more chemical, biological, physical, and ergonomic stressors. The following actions should be of particular focus:

- Ensure that work management systems catalog all work activities and link documented exposure assessments to work activities.

- Develop mechanisms so that exposure assessment can be readily accessed by industrial hygienists, safety professionals, and line managers.

- Ensure that exposure assessments are sufficiently detailed to identify the scope of the work for which the assessment applies, the identified exposure hazards, and the hazard controls recommended as a result of the exposure assessment.

- Provide a documented basis for industrial hygiene monitoring and/or sampling of the work activity or the justification for lack of monitoring and/or sampling. Sampling results (when performed) as well as the specific work activity assessed should be referenced in the exposure assessment.

- Establish a self-assessment process for routinely reviewing the quality and consistency of completed exposure assessments when compared to site exposure assessment procedures.

Increase focus on use of work planning processes in the development of hazardous energy controls. The following actions should be considered:

- Ensure electrical safety SME's are included and accountable for development of all hazardous energy controls prior to dispatch of workers into the field.

- Ensure maintenance work instruction/work packages predefine and contain documentation of the following hazardous energy controls:
  - hold points for LO/TO placement and removal verification,
  - warnings within procedures for electrical shock and arc flash hazards and required PPE,
  - Sequenced LO/TO orders (sign off documentation) where applicable,
  - Facility Electrical Hazard Analysis Record (which provides shock and arc flash hazard determinations, designates boundaries, and stipulates personal protective equipment required to safely perform described work steps).

- Ensure two qualified electrical workers independently implement and verify LO/TO and/or establish requirements for supervisory or subject matter expert verifications.

Increase emphasis on compliance with procedures, postings, and radiological control practices. The following actions should be considered:

- Conduct additional targeted conduct of operations assessments.

- Reinforce expectations for conduct of operations and compliance with postings and controls, through additional training, safety briefings, and behavior-based type safety feedback.

Appendix B
Supplemental Information

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