Analysis of Integrated Safety Management at the Activity Level: Work Planning and Control

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Foreword

In 1996, the Department of Energy (DOE) established the Integrated Safety Management (ISM) system as its overarching framework for identifying and managing workplace hazards to ensure the protection of workers, the public, and environment. Over the last 17 years, the Department has realized its objective of integrating safety management into work planning and control in support of its missions and operations. In 2006, the Department published 10 CFR Part 851, *Worker Safety and Health Program*, establishing requirements for a worker safety and health program to reduce and prevent occupational injuries and illnesses through provision of a safe and healthy workplace. Through the implementation of ISM and 10 CFR 851, and associated Departmental Directives, DOE has demonstrated a positive and continually improving record of safety performance. Worker safety performance metrics have shown continuous improvement, with DOE generally performing as well as if not better than comparable industry averages.

The Department has a wide range of diverse missions and operations such as the cleanup and decommissioning of aging weapons production sites. Although some of our hazards are common to those of industry, many are unique to these diverse missions and pose challenges in effective hazard identification, analysis, and control. In dealing with these challenges, as a learning organization, the Department embraces opportunities to continually improve our implementation and performance of ISM, particularly at the work activity level where ISM directly impacts our workers through work procedures and controls designed to ensure the safe and successful performance of work and protection of our workers.

Accordingly, this report provides results as part of the Department's ongoing and planned actions to further improve implementation and execution of activity-level work planning and control (WP&C). The report provides an analysis of activity-level WP&C across the DOE Complex for Defense Nuclear Facility operations, identifies a set of observed deficiencies, and provides recommendations for continuous improvement. For perspective, the principal data sources applied in this analysis initiative are from assessments of activity-level WP&C and occurrence reports on adverse operating incidents that had already taken place. As such, the results of this analysis do not identify or address the preponderance of cases in which work was performed safely and without incident on a daily basis.

This report will be used to inform ongoing and planned work within the Department to continuously improve the rigor of activity-level WP&C. Departmental organizations should evaluate the results and recommendations contained in this report in light of their mission needs and activity-level WP&C strengths and weaknesses.

Office of Health, Safety and Security

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Section 1: Executive Summary

Background

On August 28, 2012, the Defense Nuclear Facilities Safety Board (DNFSB or "Board") wrote to the Department of Energy (DOE) regarding its views on DOE's need to improve activity-level work planning and control (WP&C). On November 30, 2012, DOE replied to the Board, committing to undertake three tasks, supported by six subtasks, to improve, strengthen, and influence effective implementation of activity-level WP&C. The Office of Health, Safety and Security (HSS) was assigned to be the Department's lead for coordinating the completion of these tasks.

This report documents analysis results and recommendations responsive to the following subtask: Conduct an analysis of the WP&C deficiencies identified by the DNFSB to determine common trends, causal factors, or systematic weaknesses with DOE's WP&C processes or implementation. In addition, review the Occurrence Reporting and Processing System (ORPS) for the last three years to determine if there are any common trends or areas of weaknesses with WP&C. Based on the results of these two analyses, identify specific corrective actions to address the findings.

Given the work statement for this subtask, the results of this analysis do not identify or address the preponderance of cases in which work was performed safely and without incident. Furthermore, this report is a single element that informs the work conducted under the other tasks and subtasks being completed by the Department pursuant to its commitment to the Board to: 1) enhance complex-wide awareness of the need for rigorous activity-level WP&C; 2) strengthen guidance and formality associated with contractor implementation and Federal monitoring of activity-level WP&C; and 3) enhance Federal and contractor oversight of activity-level WP&C.

Results and Conclusions

Based on the analysis of multiple data sources (including DOE sources and the findings of the DNFSB), we identified a common set of activity-level WP&C deficiencies at DOE Defense Nuclear Facility operations. These fall into five main categories: Hazard Identification and Hazard Control, Procedures and Documents, Supervision and Management, Communication, and Feedback and Lessons Learned.

The analysis identified deficiencies in WP&C hazard identification and hazard control across each of the data sources. These deficiencies were primarily associated with inadequacies in work scoping and planning, often the result of the lack of subject matter expert (SME) and worker involvement. The analysis showed examples of over-reliance on computer-based hazard analysis tools, multiple instances of failure to adequately identify activity-specific hazards, and use of controls that were not germane or appropriately tailored to specific work activities.

The analysis identified deficiencies in WP&C procedures and documents across multiple data sources. In analyzing DOE line program assessments of activity-level WP&C, deficiencies were found in procedures and documents established by contractors to plan work, and in the adequacy of work control documents (WCDs) developed as a result of the planning process. In multiple instances, hazard identification and control documentation was incomplete and WCDs were inadequate to conduct work as written. Analysis of the last three years of events recorded in ORPS identified multiple occurrences resulting from incomplete or vague work procedures and documents, often resulting in work steps being performed out of order.

Supervision and management deficiencies were identified primarily through analysis of ORPS occurrences. The most frequently identified deficiencies involved management guidance and expectations that were not well defined, understood, or enforced. Supervisors who were managing multiple or complex tasks sometimes were not able to ensure worker adherence with WCDs and hazard controls or initiate stop work orders when needed. Situations also arose in which supervisors became physically involved in the work task, thus lessening their ability to provide direction and oversight for completing work safely.

Analyses identified communication deficiencies between and within work groups and between supervisors and workers in multiple data sources. These included lack of verbal communication among workers and supervisors that contributed to work errors and work being performed outside the scope of WCDs. When faced with unclear WCDs, workers sometimes did not demonstrate a questioning attitude or stop work, or improvised procedural steps in order to complete the work. Analyses also indicated deficiencies with the communication of hazards to workers, and of new work procedures with which workers were not familiar.

Feedback and lessons learned deficiencies were prominent across all of the data sources. These deficiencies included lack of incorporating lessons learned from previous operating experience into work planning for similar types of work, less than adequate pre-job briefings, and absent or less than adequate post-job briefings to identify lessons learned from work execution for consideration in future work planning. Some lessons learned programs did not systematically or consistently evaluate feedback from activity-level work and disseminate this information through lessons learned databases. There was a lack of rigor in some DOE and contractor assessments; and less than adequate contractor effectiveness reviews to ensure that corrective actions responsive to assessments were indeed effective.

Safety culture assessments performed by HSS over the last 2 years at the Department's large nuclear projects also identified communications issues within and across organizations, ineffectiveness in learning from operating experience, and unwillingness by workers to raise concerns that align with the deficiencies identified from analysis of principal data sources.

As noted above, given the work statement for this subtask, the results of this analysis do not identify or address most cases in which work was performed safely and without incident. DOE has successfully implemented Integrated Safety Management (ISM) across the complex; however, opportunities to improve ISM implementation exist at the activity level.

Further, this analysis did not address the completeness and/or applicability of DOE's Orders and regulations with respect to activity-level WP&C. However, many of the deficiencies identified through this analysis suggest a lack of adequate implementation of DOE's requirements for WP&C rather than a lack of adequate requirements.

Recommendations

The deficiencies summarized above were found broadly across DOE Defense Nuclear Facilities and represent areas where the Department can pursue enhancements as part of its commitment to continuous improvement in safety. A series of recommendations has been developed to address the common problem areas. The recommendations should be considered by DOE and contractor organizations in light of their missions and hazards, and in the context of the strengths and weaknesses of their WP&C programs. These recommendations are presented more fully in Section 5.

To address deficiencies associated with hazard identification and hazard control, organizations should consider utilizing site-level efforts such as independent hazard review teams to review and provide mentoring on hazards identification, analysis, and control procedures and processes, and develop and implement corrective actions for their improvement. The currency and effectiveness of job hazards analysis tools, to include automated/computerized tools, for activity-level work should be evaluated as part of this review. Organizations should ensure that SMEs are involved throughout the hazards identification and analysis process and during the development of WCDs.

To address deficiencies associated with WP&C procedures and documents, organizations should consider reviewing the effectiveness of their approach to planning work and developing and approving WCDs. They should make any needed improvements through a collaborative team approach involving SMEs, workers, and supervisors. Organizations should ensure that those responsible for WCD approval have the needed competencies for evaluating the suitability of WCDs, and that they provide them mentoring and training as needed.

To address supervision and management deficiencies and lack of clear management expectations, organizations should consider incorporating and evaluating the effectiveness of performance expectations for activity-level WP&C within contracts, to include performance expectations that promote the identification and analysis of deficiencies and corrective actions to prevent their recurrence, open communication and reporting of activity-level work issues, and incorporation of feedback and lessons learned into future WP&C. Organizations should reinforce ISM expectations in their managers' performance evaluation plans and ensure that all levels of management are held accountable for their ISM performance. Organizations should reinforce expectations regarding the critical role of supervision of work versus the performance of work, emphasizing the important role that supervisors play in the safe conduct of work, and provide training to improve supervisory competencies.

To address communication and related deficiencies, all organizations should consider initiatives to establish clear and mutually understood WCDs and ensure that communication steps both between work groups and within work groups are included in WCDs and pre-job briefings. Organizations should also re-emphasize the responsibility of all managers, supervisors, and workers to initiate a work "pause," "stop work," or "timeout" whenever WCDs are not clear or contradict the observed conditions. Organizations should ensure that supervisors and workers are able to exercise their stop work authorities and express a questioning attitude without fear of retribution, and should recognize these instances as good practices. Organizations should ensure that employees understand the importance of performing work in accordance with WCDs and identified hazard controls.

To address deficiencies in incorporating feedback and lessons learned into activity-level WP&C, organizations should consider taking actions to ensure comprehensive post-job briefings are conducted consistently and that feedback from these briefings is incorporated into future WCDs. Organizations should assess the effectiveness of their Operating Experience Program as part of self-assessments conducted to evaluate organizational performance in ISM. Line programs should take actions to ensure that each of their sites/facilities is participating in their local and DOE Lessons Learned Program, including the regular sharing of lessons learned when notable positive or negative events occur. HSS should initiate efforts to improve the lessons learned and operating experience communication systems to enhance cross-site dissemination of activity-level WP&C knowledge and best practices.

Where appropriate, organizations should increase the rigor associated with assessments of activity-level WP&C. They should consider integrating safety culture attributes into assessments of activity-level WP&C. Organizations should ensure that properly qualified and staffed review teams perform periodic evaluations of WCDs. Organizations should ensure that corrective actions to assessment findings include effectiveness reviews involving actual observation of work in the field to verify improvement. DOE line program and contractor oversight of activity-level WP&C should be incorporated into annual ISM assessment schedules to ensure that DOE's commitment to implementing ISM at the activity level is maintained. HSS should consider conducting periodic reviews of the effectiveness of DOE line program and contractor oversight of activity-level WP&C.

The analysis of WP&C-related operational data identified a wide range of specific implementation deficiencies, related causes, and recommendations for enhancements. The results and recommendations derived through this analysis provide information that DOE and contractor organizations should use to enhance their WP&C management processes and enhance the safety of their mission activities. The results will also serve to inform ongoing efforts to develop a WP&C handbook to more clearly articulate expectations to DOE contractors and WP&C CRADS used to guide assessments of operational work activities.

Section 2: Introduction

2.1 Purpose

The purpose of this analysis is to provide information and insights for use by DOE in continuously improving, strengthening, and influencing effective implementation of ISM at the activity level, specifically in the area of WP&C. This analysis supports DOE's objective of enhancing complex-wide awareness of, and reinforcing the need for, rigorous and tailored activity-level WP&C programs that meet ISM requirements and expectations. Appendix A provides descriptions of the ISM Core Functions.

Specific objectives of this analysis were to:

- Analyze the WP&C deficiencies identified by the DNFSB in their report, *Integrated Safety Management at the Activity Level: Work Planning and Control* (DNFSB/TECH-37) to determine common trends, causal factors, or systemic weaknesses with DOE's WP&C processes or implementation;
- Review and analyze events in the Occurrence Reporting and Processing System (ORPS) for the past three years to determine if there are any common trends or areas of weakness with activity-level WP&C; and
- Provide specific recommendations to address any complex-wide activity-level WP&C deficiencies identified through each analysis component.

The analysis of DOE operating experience and lessons learned provided in this report can be applied in organizational learning for continuous improvement of activity-level WP&C to support DOE mission success. As such, DOE and its contractors can use this analytical information to support DOE's efforts to strengthen guidance and formality associated with contractor implementation and Federal monitoring of activity-level WP&C.

2.2 Background

In an August 28, 2012, letter to DOE, the DNFSB transmitted their detailed report, *Integrated Safety Management at the Activity Level: Work Planning and Control* (DNFSB/TECH-37), for DOE's consideration in its continuous efforts to improve activity-level WP&C. The report identified similarities between WP&C weaknesses documented in DOE Accident Investigation reports and weaknesses that the DNFSB identified through a series of DNFSB Staff Reviews at selected DOE sites. The DNFSB concluded that DOE's efforts to address the DNFSB's findings at these specific sites had not resulted in sustained improvement, and that this failure was due in large part to a lack of formalized requirements and guidance pertaining to WP&C implementation and oversight within DOE's directives system. The DNFSB further requested that DOE submit a report and briefing with details of actions taken and planned to address the issues in DNFSB/TECH-37.

On November 30, 2012, the DOE Deputy Secretary responded to the DNFSB's August letter with a letter and report outlining DOE's ongoing efforts and continued commitment to improve WP&C. In the report attached to that letter, DOE outlined *improvement actions taken to date* and *planned actions*. DOE's commitments focused on three principal areas: 1) enhancing complex-wide awareness of, and reinforcing the need for, rigorous and tailored activity-level WP&C; 2) strengthening guidance and formality associated with contractor implementation and Federal monitoring of activity-level WP&C; and 3) sustaining Federal and contractor oversight of the effectiveness of activity-level WP&C.

As noted in the Deputy Secretary's response, WP&C is at the core of DOE's ISM framework to safely plan, execute, and monitor work activities. The ISM framework encompasses three main levels of work activities: the institutional level, the facility level, and the activity level. The *institutional level* provides the safety requirements issued by DOE, the work priorities based on funding, and the requirements from local sites and contractor policies and procedures. The *facility level* provides for an approved safety basis so that workers at the facility can perform their work safely. The final level, the *activity level*, provides individual work procedures and controls to protect workers while they perform the work. Thus, WP&C is ISM at the activity level and is where ISM directly involves the individual worker.

The Department has requirements for WP&C that are contained within DOE directives and regulations (Appendix B). These requirements address ISM implementation, hazards identification, conduct of operations, management systems, and oversight responsibilities for various aspects of activity-level WP&C. DOE and contractors are required to comply with these requirements on a consistent basis.

Section 3: Data Sets, Analysis Methodologies, and Results

The DOE Office of Health, Safety and Security's Office of Analysis (HSS) performed an analysis of activity-level WP&C for the DOE defense nuclear facilities as agreed to in DOE's November 2012 response to the DNFSB.

HSS reviewed and analyzed the following sources of information for activity-level WP&C issues:

- WP&C deficiencies identified in DNFSB/TECH-37 and associated reports and letters;
- DOE line program and contractor assessments associated with corrective actions responsive to DNFSB Staff Reviews of activity-level WP&C;
- ORPS reports for the three-year period January 1, 2010, through December 31, 2012. Specifically, ORPS Occurrences by Cause Codes, ORPS Occurrences by Keywords, and an in-depth analysis of representative ORPS Occurrence Reports;
- Human Performance Improvement (HPI) error precursors present in ORPS occurrence reports; and
- Results from the analysis of Extent of Condition Safety Culture Assessments.

This section of the report is organized by the analyses listed above. Each subsection includes a description of the data set employed, a discussion of the methodologies used to analyze the data set, and observations drawn from the analysis. Appendix C provides a table of the observations.

The observations from this section are used in Section 4 to identify cross-cutting themes that were common among the data sets and point to key deficiencies in activity-level WP&C at DOE defense nuclear facilities. Full in-depth analyses, including charts and graphs, are presented in the Appendices.

3.1 Analysis of Information from DNFSB/TECH-37

The individual activity-level WP&C deficiencies associated with each of the DNFSB Staff Reviews and the DNFSB-identified activity-level WP&C deficiencies from their review of DOE Accident Investigations were used as discrete observations for this analysis. HSS analyzed the Accident Investigation and DNFSB Staff Reviews sections individually to identify common causal factors and key observations. Appendix D provides a detailed analysis, including ISM Core Function distributions.

The key observations are:

- Less than adequate identification and communication of hazards;

- Work Control Documents (WCDs)[1] that do not properly characterize the hazards;
- WCDs that do not effectively identify/communicate the existence of controls already in place to prevent accidents or injuries; and
- Work planning that does not integrate previous operating experience into the early work planning stages.

3.2 Analysis of DOE Documents

HSS reviewed DOE line program and contractor assessments associated with corrective actions in response to WP&C deficiencies and concerns identified by DNFSB Staff Reviews of DOE sites and projects conducted from 2008 to 2011. HSS also reviewed selected assessments of activity-level WP&C and conduct of operations for several DOE sites and projects highlighted as part of DOE improvement actions taken to date in DOE's November 30, 2012, response to DNFSB/TECH-37. Appendix E provides the full analysis of DOE Documents.

The key observations are:

- Need for improvement in incorporating hazards analysis and the resulting controls into WCDs;
- Potentially confusing WCD step sequences that do not follow the logical order of work operations;
- Over-reliance on waiver statements or "notes" to compensate for poorly planned work orders;
- Lack of worker and subject matter expert (SME) involvement in the WP&C process leading to hazard analysis gaps and incomplete WCDs;
- Lack of task and activity-specific hazards identification and analysis;
- Issues with reliance on a computerized approach, an over-reliance on generic hazard analysis, and the use of predetermined (canned) controls for identified hazards;
- Procedures that are too broad in scope create the vulnerability that work will be performed outside of the intent of the WCDs;
- Poor quality of WCD verification and validation;
- Over-reliance on skill-of-the-craft rather than specific instructions that outline the exact steps to be taken in a process;

[1] A document that records at a minimum the scope of an activity, the Responsible Manager, location, a list of activities/tasks, hazards and controls associated with the activity. This work document is used in the field to implement activity level work. This includes technical procedure, test plans, and work instruction. *Energy Facility Contractors Group Work Planning and Control Program Guideline Document,* May 18, 2012.

- Procedural non-compliance, with work performed outside of work controls;
- Supervisors not enforcing compliance with WCDs or initiating stop work when needed;
- Work being performed outside the scope of work, and workers not exercising stop work authority;
- Workers not questioning supervisors when work instructions lack clarity;
- Verbal communication issues between work groups, and between managers and workers;
- Lack of effectiveness reviews to ensure that corrective actions associated with improvements to WP&C are resulting in improvements;
- Lack of incorporation of lessons learned into future WP&C; and
- Need for enhanced oversight to improve WP&C.

3.3 Analysis of ORPS Occurrences

ORPS is the database into which DOE sites enter all reportable occurrences. Between January 1, 2010, and December 31, 2012, there were 3,703 occurrence reports entered into the ORPS database. Of these reports, 2,490 occurred at DOE defense nuclear facilities.

The 2,490 ORPS reports include all types of occurrences, both those related to activity-level WP&C and those without an activity-level WP&C component. To gain a complete picture of activity-level WP&C as reflected in ORPS, HSS looked at occurrences through two distinct analysis lenses: Cause Codes and HQ Keywords. *Cause Codes* are assigned to an ORPS report by the reporting organization after a causal analysis has been performed. *HQ Keywords* (Keywords) are assigned daily by the HSS ORPS Analysis Team. Every morning, the Analysis Team objectively reads and discusses each new occurrence and applies Keywords representing descriptive operational areas relating to the occurrence. For both analysis methods, the goal was to isolate only the occurrences with an activity-level WP&C component.

3.3.1 Analysis of ORPS Occurrence Cause Codes

HSS performed an analysis of Cause Codes and Cause Code pairings to determine the causal factors most prominently associated with activity-level WP&C occurrences. When filtered by Cause Codes, roughly one-half of all ORPS occurrences were related to WP&C. Results of this analysis are summarized below and in Figure 1. Appendix F provides a complete description of the methodology and results of this analysis, with representative ORPS summaries illustrating the role these causes played in the reported events.

Management policy guidance/expectations not well-defined, understood or enforced was the most frequently identified cause associated with all activity-level WP&C occurrences. This cause code is defined as: personnel exhibiting a lack of understanding of existing policy and/or expectations, or policy/expectations not well-defined or enforced. It is paired most frequently with the following five Cause Codes:

- **Verbal Communication between work groups less than adequate:** Lack of communication between work groups (production, technical, or support) contributed to an incident;
- **Written communication incomplete/situation not covered:** Details of the written communication were incomplete and/or insufficient information was presented. The written communication did not address situations likely to occur during the completion of the procedure;
- **Check of work was less than adequate:** Individual made an error that would have been detectable and correctable if a check of the completed, or partially completed, work was performed;
- **Management follow-up or monitoring of activities did not identify problems:** Management's methods for monitoring the success of initiatives were ineffective in identifying shortcomings in implementation; and
- **Job scoping did not identify special circumstances and/or conditions:** Work scoping process was not effective in detecting work process elements having a dependency upon other circumstances or conditions.

CAUSE CODE 1		CAUSE CODE 2
Management policy guidance/ expectations not well-defined, understood or enforced	+	Verbal communication between work groups less than adequate
		Written communication incomplete/situation not covered
		Check of work less than adequate
		Management follow-up or monitoring of activities did not identify problems
		Job scoping did not identify special circumstances and/or conditions

Figure 1: Cause Code Pairs

3.3.2 Keyword Analysis

The Keyword analysis method filtered the same set of 2,490 ORPS reports by the selected Keywords assigned by HSS to each ORPS report. Using this filter, approximately two-thirds of the occurrences had Keywords related to activity-level WP&C. The aim of this method was to identify activity-level WP&C issues and to determine whether those issues are systemic or isolated. See Appendix F for the complete Keyword analysis, with summaries of representative ORPS reports illustrating the role these issues played in the reported events.

First, the Keywords were grouped based on the Keywords that most closely reflect specific elements of activity-level WP&C; each group contained one or more Keywords.

The results are listed below in order of predominance.

- **Procedures and Documents:** Procedures identified as technically deficient, ambiguous, non-existent, or not reflecting as-built conditions.
- **Supervision and Management:** General management administrative issues; including inadequate supervision of subcontractors, less than adequate pre-job briefings, less than adequate job site walk-downs, management expectations that are not clearly communicated, and incorrect personnel assignments.
- **Work Planning:** Less than adequate job planning, less than adequate hazard analysis (e.g., all potential job hazards were not analyzed), effect on other systems was not addressed, required permits not obtained, less than adequate pre-job scope briefings, failure to conduct pre-job surveys, and the absence of SMEs in job planning.
- **Personnel Errors:** Systems or equipment left in an unsafe state, tasks that are performed without authorization, failures related to "skill-of-the-craft," or human performance failures.
- **Procedure Compliance:** Work performed without/before authorization, procedure steps skipped, working outside the scope of a procedure, and equipment/components (e.g., switches/valves) discovered out of position.
- **Safety Compliance:** Failure to comply with health and safety procedures, failure to use required safety equipment and PPE, and failure to obey safety signage.
- **Communication:** Inadequate verbal communications between work groups, or lack of effective work coordination or shift turnover.

HSS then performed a review and analysis of selected occurrence reports submitted to ORPS involving WP&C deficiencies. All of the WP&C-related ORPS reports were reviewed from within the Keyword-filtered data set. Of these, a representative set of reports was selected and analyzed in depth for WP&C applicability, causal factors, and potential lessons learned, and then summarized. Appendix F provides the complete summaries of these occurrences, including HSS's evaluation, as operating experience for continual learning and improvement.

Observations derived from this in-depth analysis of WP&C-related ORPS reports are presented below.

- Procedures and WCDs did not always provide the best methods for performing work.
- Routine tasks often did not have formalized job aids such as checklists to make sure steps were not skipped and critical verifications were made.
- WCDs did not always address potential impacts to other systems or components, particularly those that are safety class.
- Hazard screening sometimes was not commensurate with the level of hazards associated with the work.
- SMEs were not always included in the planning of activity-level work.
- Supervisors did not always remain in their management position (e.g., role of oversight and job direction) and became physically involved in the task, such that they lost sight of the big picture.
- Supervisors did not always ensure strict adherence to the WCDs and avoid trying to manage multiple or complex tasks from memory.
- Supervisors did not always ensure that workers had the appropriate level of experience, training, or certifications to perform tasks.
- Management did not consistently ensure that members of the work force understood that they are accountable and responsible for the work they perform.
- Job planners did not always communicate with safety engineers and facility management regarding systems operability requirements.
- Workers did not always understand the requirement to stop work and reassess hazards when unanticipated situations arise or if the job scope needs to be expanded.
- Work groups did not always communicate with each other, and plan-of-the day meetings and joint pre-job briefings were not always held when multiple work activities were occurring within the same area.
- Pre-job briefings did not routinely include lessons learned from similar work activities.

- First line supervisors did not always fully communicate the work scope to the workers and convey management's expectations for performing the work correctly and safely.
- Post-job briefings were not always held to discuss what went right or wrong.
- Job planners did not always incorporate lessons learned from similar work activities in the planning process.
- Workers were not always involved in the development of lessons learned or improvements to work practices.
- The potential impacts to systems that support the facility safety basis were not always fully understood.

3.4 Analysis of Human Performance Improvement

HSS performed a qualitative analysis of Human Performance Improvement (HPI) elements to understand the human error precursors associated with activity-level WP&C occurrences and to identify potential management system weaknesses. The identified HPI error precursors may indicate organizational weaknesses in WP&C, organizational interfaces, supervisory involvement, and communications. Appendix G provides the complete HPI analysis.

Below are the most frequently associated HPI error precursors in order of predominance.

- **Imprecise communication habits:** Communication habits or means that do not enhance accurate understanding by all members involved in an exchange of information.
- **Lack of knowledge:** Unawareness of factual information necessary for successful completion of task; lack of practical knowledge about the performance of a task.
- **Unclear goals, roles, or responsibilities:** Unclear work objectives or expectations. Uncertainty about the duties an individual is responsible for in a task that involves other individuals. Duties that are incompatible with other individuals.
- **Interpretation of requirements:** Situations requiring "in-field" diagnosis, potentially leading to misunderstanding or application of wrong rule or procedure.

3.5 Analysis of HSS Independent Safety Culture Assessments

This analysis effort included the review of extent of condition assessments of nuclear safety culture at DOE defense nuclear projects and sites. Many of these assessments focused on engineering design and construction activities, with limited sampling of operating activities.

However, HSS reviewed these assessments to determine whether they revealed useful insights about WP&C and if so, whether these insights aligned with results from the principal data sources utilized in this analysis effort. Appendix H provides the complete analysis of Safety Culture.

Key observations associated with general summary results on organizational culture, and with the work processes safety culture trait (defined in the assessments as "the process of planning and controlling work activities is implemented so that safety is maintained") applicable to activity-level WP&C include:

- An unwillingness by workers to raise concerns, and in some cases fear of reprisal if issues were raised;
- Communications issues;
- Issues with work formalization that include needed improvement in the use of post-job briefs and the association of lessons learned into daily work activities;
- Ineffective means to learn from operational experiences and lessons learned; and
- Schedule pressures and other factors such as inadequate planning, frequently shifting priorities, and inadequate work packages.

Section 4: Conclusions

Section 3 presented observations through several lenses of analysis utilizing different data sets and methodologies. This section of the report presents cross-cutting or systemic themes resulting from the analysis of activity-level WP&C deficiencies.

4.1 Hazard Identification and Hazard Control

The first theme relates to **Hazard Identification and Hazard Control** deficiencies that were identified across each of the data sources. Common observations included a lack of adequate hazard identification and control during work scoping and planning, usually associated with a lack of SME involvement.

The analysis found multiple examples of failure to adequately identify activity-specific hazards that affected subsequent hazards analysis and resulted in controls being required that were not germane or sufficient to mitigate the associated hazard. It also found examples of an over-reliance on automated, computerized approaches that do not focus on activity-specific hazards; and an over-reliance on predetermined (canned) controls for mitigating identified hazards. As a result of poor hazards identification and analysis, hazard controls were not always tailored to specific work activities, and controls were implemented ineffectively.

4.2 Procedures and Documents

The second theme relates to **Procedure and Document** deficiencies that were identified across multiple data sources. Common observations included poorly written WCDs that were inadequate to perform the work as written or that increased opportunities for, and in some cases resulted in, errors in the performance of work. Another common observation was a lack of SME involvement in the development and review of WCDs.

Analysis of DOE and contractor assessments of activity-level WP&C found deficiencies in both the procedures and documents established by contractors to plan work, and in the adequacy of the WCDs developed as a result of the planning process. Contractor processes and documents used to guide WP&C were sometimes inconsistent and lacked specific direction. The analysis found examples of recently developed or updated WP&C guidance prepared by contractors and DOE line organizations that was not fully utilized across all planning groups; a lack of clear guidance for the development of work order changes; confusion caused by work packages written in different formats; and WCDs conflicting with other documents, policies, or guidance.

Procedure and document deficiencies were also manifested in WCDs that were too broad in scope and lacked specific work instructions, increasing the risk of work being performed outside the intent of the work scope. Further examples in the analysis identified generic or confusing work step sequence logic that created conditions for workers to perform work outside of the intended work scope or that resulted in WCDs that were unable to be implemented as written. Some WCDs were too lengthy, leading to difficulty in locating key information within the WCD, such as worker protection procedures that were integrated into complex work procedures.

Multiple ORPS reports identified incomplete or vague work procedure and document deficiencies that resulted in work steps being performed out of order. Other reports identified the lack of SME and worker involvement in work planning.

Finally, this review found that SMEs often were not utilized either in the development of the initial WCDs or in the review of these WCDs before issuance to the field for performance of the work. Just as SMEs are often in the best position to identify the hazards, they are also often the best resource for technical and procedural input in the development and review of robust WCDs.

4.3 Supervision and Management

The third theme relates to **Supervision and Management** deficiencies that were identified primarily through analysis of ORPS occurrences. Common observations across the data sets centered on management guidance and expectations that were not well defined, understood, or enforced. A prevalence of occurrences involved supervisors not ensuring worker compliance with WCDs, in some cases while managing multiple or complex tasks. Other examples included supervisors not initiating stop work when needed, and supervisors' physical involvement in the work task, which lessened their ability to provide direction and oversight for completing work safely. In some instances, supervisors did not recognize when work plans did not align with the actual work to be performed, and in other instances, work tasks and individual worker accountability were not made clear to workers.

The analysis also found examples of management not consistently ensuring that workers understand their responsibility and accountability for the work, and their authority to stop work when appropriate. Management monitoring or follow-up of work activities was sometimes lacking or not sufficient to identify work execution errors.

4.4 Communication

The fourth theme relates to **Communication** deficiencies that were identified throughout the analyses. Common observations across the data sources included communication deficiencies between and within work groups, and between supervisors and workers.

The analysis found examples of poor or lack of verbal communication among workers and supervisors that contributed to work errors and/or work being performed outside the scope of WCDs. In many examples, workers faced with poorly written WCDs did not demonstrate a questioning attitude or stop work, and workers improvised to complete the work rather than stopping to ask for clarification. Communication deficiencies often compounded other deficiencies and turned them into larger issues.

4.5 Feedback and Lessons Learned

The fifth theme relates to **Feedback and Lessons Learned** deficiencies that were prominent across all of the data sources. Common observations included lack of incorporation of lessons learned from previous operating experience into future WCDs, and ineffective pre- and post-job briefings.

The analyses identified examples in which similar problems occurred multiple times despite the prior identification of corrective actions. This indicates that either corrective actions were not reviewed for effectiveness, or that feedback mechanisms were not used in the development of WCDs. There were examples of some lessons learned programs not systematically or consistently evaluating feedback from activity-level work to improve WCDs. The analysis found examples of the need for improved rigor in some DOE and contractor assessments of activity-level WP&C; and examples of less than adequate contractor effectiveness reviews that were intended to ensure that corrective actions responsive to assessments were being successfully implemented to improve activity-level WP&C performance.

4.6 Summary

Based on the analysis of multiple data sources utilizing different lenses of analysis, we identified a common set of activity-level WP&C deficiencies across the DOE Complex for Defense Nuclear Facility operations that fall into five main categories: 1) Hazard Identification and Hazard Control; 2) Procedures and Documents; 3) Supervision and Management; 4) Communication; and 5) Feedback and Lessons Learned. These five categories of deficiencies are symptomatic of programmatic weaknesses in WP&C.

Although not serving as a primary data source, safety culture assessments tended to align with the deficiencies identified from analysis of the principal data sources in this report. Specifically, they identified communications issues within and across organizations, ineffectiveness in learning from operating experience and lessons learned, and an unwillingness by workers to raise concerns.

Appendix C provides a complete listing of analysis observations corresponding to each of the five main deficiency categories and their relationship to ISM Core Functions and their analysis methods and data sources. Section 5 of this report presents recommendations corresponding to these five deficiency categories for continuous improvement in activity-level WP&C.

Finally, this analysis did not address the adequacy or applicability of DOE's Orders and regulations with respect to activity-level WP&C. However, many of the deficiencies identified through this analysis suggest a lack of adequate implementation of DOE's requirements for WP&C rather than a lack of adequate requirements.

Section 5: Recommendations

This analysis focused on identifying systemic trends in activity-level WP&C deficiencies at DOE defense nuclear facilities holistically, rather than from each individual reporting organization.

Provided below is a set of recommendations corresponding to the five main deficiency categories in activity-level WP&C identified in Section 4. The five categories of deficiencies summarized in Section 4 are symptomatic of programmatic weaknesses in WP&C. Integration of the Department's ongoing efforts to strengthen safety culture with those to improve WP&C performance would be beneficial in addressing these weaknesses. This is reflected in several of the recommendations.

These recommendations span multiple interfaces within DOE's organizational structure (e.g., Program Office to Site Office; Site Office to Contractor; HSS) as well as interfaces at the activity level (e.g., supervisor to worker, worker to worker, and the various feedback loops in all of these interactions) and should be implemented as needed by the appropriate organizations.

DOE organizations should use the analysis results in this report to review the extent of these deficiencies within their programs and sites. Based on that review, when developing corrective actions for continuous improvement in activity-level WP&C, DOE organizations should consider the set of recommendations provided below for their applicability to the specific deficiencies identified within their programs and sites.

DOE should also apply the results contained in this report in related actions to improve activity-level WP&C as communicated in DOE's November 30, 2012, letter to DNFSB. Examples of such actions include development of a Criteria Review and Approach Document (CRAD) to assess the effectiveness of WP&C, and development of a handbook to provide performance expectations for effective WP&C.

5.1 Hazard Identification and Hazard Control

Contractor Management:

1. Establish and maintain site-level efforts such as independent hazard review teams to conduct technical reviews of existing processes and procedures for identifying and analyzing activity-level work hazards, and for identifying appropriate controls. The team should assist in identifying corrective actions, implementing improvements, and verifying that improvements are effective. Thereafter, the hazard review teams should be maintained in a mentoring role to foster continuous improvement.
2. Evaluate job hazard analysis tools for their effectiveness in addressing the specific hazards associated with activity-level work and ensure these tools are maintained current. Ensure automated/computerized job hazards analysis tools are not relied upon as the sole means of

job hazards analysis. Automated/computerized job hazards analysis tools should be applied as a starting point and supplemented by evaluation of specific hazards associated with the individual work activity.

3. Ensure appropriate SMEs and workers are involved throughout the hazards identification and analysis process during the development of WCDs.

5.2 Procedures and Documents

Contractor Management:

1. Review the effectiveness of and improve the approach to planning work and developing and approving WCDs through a collaborative team approach involving SMEs, workers, and supervisors. Areas to be addressed include team planning; hazard identification and analysis; identification of hazard controls associated with the work activity; and WCD technical accuracy, workability, approval, and revision. Ensure that improvements are incorporated into organizational WP&C programs and processes. Provide training on improved work planning and WCD development processes.

2. Ensure that individuals responsible for WCD approval have the competencies for evaluating the workability of WCDs, and provide mentoring and training as needed to strengthen these competencies.

Line Programs:

3. Establish measures to evaluate and trend WCD quality and WCD implementation to identify best practices as well as areas for continuous improvement.

5.3 Supervision and Management

Contractor Management:

1. Reinforce expectations regarding the critical role of supervision of work versus the performance of work, emphasizing the important role that supervisors play in the safe conduct of work. Reinforce supervisor responsibility for ensuring that workers perform activity-level WP&C in accordance with WCDs through training, observation, and oversight.

Line Programs:

2. Incorporate and evaluate the effectiveness of performance expectations for activity-level WP&C within contracts. Include performance expectations that promote the identification and analysis of deficiencies and corrective actions to prevent their recurrence, open communication and reporting of activity-level work issues, and incorporation of feedback and lessons learned into future WP&C.

Contractor Management and Line Programs:

3. Reinforce ISM expectations in their manager's performance evaluation plans and ensure that all levels of management are held accountable for their ISM performance.

5.4 Communication

Contractor Management:

1. Ensure that clearly articulated communication steps both between and within work groups are included in WCDs and pre-job briefings.
2. Re-emphasize the responsibility of all managers, supervisors, and workers to stop work whenever WCDs are unclear or in contradiction to the observed conditions. Ensure that supervisors and workers are able to exercise their stop work authorities and express a questioning attitude without retribution, and recognize these instances as good practices.
3. Ensure that employees understand the need for strict adherence to WCDs and identified hazard controls.

5.5 Feedback and Lessons Learned

Contractor Management:

1. Ensure that comprehensive post-job briefings (e.g., as a forum for identifying and discussing lessons learned from successful and unsuccessful elements of work execution; human error precursors; external and self-imposed schedule pressures) are conducted consistently and that feedback from these briefings is transmitted to the appropriate groups for incorporation into future work planning and WCDs.
2. Assess the effectiveness of their Operating Experience Program as part of self-assessments conducted to evaluate organizational performance in ISM.
3. Ensure that each of their sites/facilities is participating in their local and DOE Corporate Lessons Learned Program, including the regular sharing of lessons learned when notable positive or negative events occur.
4. Ensure that properly qualified and staffed review teams perform periodic evaluations of WCDs.

5. Ensure that corrective actions responsive to activity-level WP&C deficiencies identified through DOE and contractor assessments include effectiveness reviews involving actual observations of work in the field to verify that improvements are being implemented.

Contractor Management and Line Programs:

6. Incorporate DOE line program and contractor oversight of activity-level WP&C (e.g., planning, WCD quality, performance of work, feedback and improvement) into annual integrated assessment schedules. Disposition identified deficiencies and strengths using organizational issues management programs.

Contractor Management, Line Programs, and HSS:

7. Integrate safety culture attributes into assessments of activity-level WP&C to identify organizational weaknesses in WP&C.
8. Apply a holistic approach in the analysis and trending of activity-level WP&C performance that includes consideration of results and lessons learned from Accident Investigations, DOE and contractor performance assessments, occurrence reporting, and organizational culture assessments. Share results of site-specific and complex-wide analyses of WP&C performance to foster continuous improvement.

HSS:

9. Initiate efforts to improve the lessons learned and operating experience communication systems to enhance cross-site dissemination of activity-level WP&C knowledge and best practices.
10. HSS, working collaboratively with DOE line programs and the Energy Facilities Contractors Group (EFCOG), should establish an Operating Experience Recognition Program to recognize best practices and performance improvement efforts in WP&C.
11. HSS should consider conducting periodic reviews of DOE line program and contractor oversight of activity-level WP&C.

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Acronyms

AIT	Accident Investigation Team
AJHA	Activity job hazard analysis
AMWTF	Advanced Mixed Waste Treatment Facility, Idaho
AMWTP	Advanced Mixed Waste Treatment Project, Idaho
ARRA	American Recovery and Reinvestment Act
BIO	Basis for Interim Operation
BM	Building Manager
BOA	Basic Order Agreement
CAM	Continuous Air Monitor
CF	Integrated Safety Management Core Function
CHPRC	CH2M Hill Plateau Remediation Company
CMRR	Chemistry and Metallurgy Research Replacement (facility)
CRAD	Criteria Review and Approach Document
CSB	Canister Storage Building
CSLA	Criticality Safety Limit Approval
CWI	CH2M WG Idaho, LLC
D&D	Also called D4: decommission, deactivate, decontaminate, demolish
DNFSB	Defense Nuclear Facilities Safety Board
DNFSB/TECH-37	Integrated Safety Management at the Activity Level: Work Planning and Control
DOE	U.S. Department of Energy
DOE-CBFO	DOE’s Carlsbad Field Office
DPO	Differing Professional Opinion
DSA	Documented Safety Analysis
EDF	Engineering design files
EFCOG	Energy Facilities Contractors Group

EM	Office of Environmental Management
FCA	Facility Centered Assessment
FLM	First line manager
FP	Fire Protection
FSS	Fire Support System
FXR	Flash X-Ray Accelerator
HA	Hazard analysis
HAP	Hazard Assessment Package
HPFL	High pressure fire loop
HPI	Human Performance Improvement
HQ	Headquarters
HRT	Hazard Review Teams, WIPP
HSS	DOE Office of Health, Safety and Security
IH	Industrial Hygiene (or Hygienist)
ISM	Integrated Safety Management
IWD	Integrated Work Document
IWM	Integrated Work Management
IWTU	Integrated Waste Treatment Unit, Idaho (also called SBWTP)
JCO	Justification for Continued Operation
JHA	Job hazard analysis
JPP	Job Planning Package
JSA	Job safety analysis
LANL	Los Alamos National Laboratory
LANMAS	Local Area Network Materials Accounting System
LCO	Limiting Condition of Operation
LIMITS	Liquid Metal Integrated Test System

LLNL	Lawrence Livermore National Laboratory
LOTO	Lockout/tagout
LPS	Lightning Protection System
LSO	DOE's Livermore Site Office
LTA	Less than adequate
MAR	Material At Risk
MC	Maintenance Coordinator
MCO	Multi-Canister Overpack
MFC	Materials and Fuels Complex
MSA	Management self-assessment
NMTP	Nuclear Materials Technology Program
NNSA	National Nuclear Security Administration
NNSS	Nevada National Security Site
NSTec	National Securities Technologies
NEW	Nuclear Weapons Engineering
OE	Operational Emergency
ORNL	Oak Ridge National Laboratory
ORPS	Occurrence Reporting and Processing System
OSHA	Occupational Safety and Health Administration
PG	Polypropylene glycol
PHS	Primary Hazard Screening
PIC	Person-in-charge
PIER	Project Issue Evaluation Report
PISA	Potentially Inadequate Safety Analysis
PJB	Pre-job brief
PNNL	Pacific Northwest National Laboratory

POD	Plan of the Day
PPE	Personal protective equipment
PTX	Pantex Plant
QCI	Quality Control Inspector
R	Recurring
RWP	Radiological Work Permit
SBWTP	Sodium Bearing Waste Treatment Project, Idaho (also called IWTU)
SC	Significance Category
SCI	Suspect Counterfeit and Defective items
SE	System Engineer
SME	Subject Matter Expert
SNL	Sandia National Laboratories (Albuquerque, NM and/or Livermore, CA)
SRS	Savannah River Site
SSO	DOE's Sandia Site Office
STD	DOE Standard
STO	Science and Technology Operations, LANL
SWPF	Salt Waste Processing Facility, SRS
TSR	Technical Safety Requirement
UPF	Uranium Processing Facility, Y-12
USQ	Unreviewed Safety Question
WCD	Work Control Documents
WETF	Weapons Engineering Tritium Facility, LANL
WHA	Work hazard analysis
WIPP	Waste Isolation Pilot Plant
WO	Work order
WP&C	Work Planning and Control

WTP	Waste Treatment Plant, Hanford
WTS	Washington TRU Solutions, LLC
Y-12	Y-12 National Security Site

Appendix A: ISM Core Function Definitions

The five ISM Core Functions provide the necessary structure for work activity that poses a hazard to the workers, the public, and the environment. The Core Functions are applied as a continual cycle with the degree of rigor appropriate to control the work hazards. The Core Functions are:

1. **Define the Scope of Work:** Missions are translated into work, expectations are set, tasks are identified and prioritized, and resources are allocated.
2. **Analyze the Hazards:** Hazards associated with the work are identified, analyzed and categorized.
3. **Develop and Implement Hazard Controls:** Applicable standards and requirements are identified and agreed upon, controls to prevent/mitigate hazards are identified, the safety envelope is established, and controls are implemented.
4. **Perform Work within Controls:** Readiness is confirmed and work is performed safely.
5. **Provide Feedback and Continuous Improvement:** Feedback information on the adequacy of controls is gathered, and opportunities for improving the definition and planning of work are identified and implemented.

For each Occurrence Reporting and Processing System (ORPS) report recorded, ISM Core Functions can be assigned to the report. Multiple ISM Core Functions can be assigned to a single report if multiple failures across ISM Core Functions are observed.

Appendix B: DOE Requirements for WP&C

DOE has detailed requirements related to WP&C as contained in regulations and DOE directives:

- 48 CFR 970.5223-1, *Integration of Environment, Safety and Health into Work Planning and Execution*, which specifies the requirements for contractors to implement the seven ISM Guiding Principles and five ISM Core Functions;
- 10 CFR 830 Subpart A, *Quality Assurance Requirements* and DOE O 414.D, *Quality Assurance*, which specify the requirements for contractors to establish organizational structure, functional responsibilities, levels of authority, and interfaces for those managing, performing, and assessing work. These documents also require work to be performed consistent with technical standards, administrative controls, and other hazard controls using approved instructions, procedures, or other appropriate means;
- 10 CFR 830 Subpart B, *Safety Basis Requirements*, which specifies requirements for contractors to perform work with the safety basis for hazard category 1, 2, or 3 DOE nuclear facilities, particularly with the hazard controls that ensure adequate protection of the workers, public, and the environment;
- 10 CFR 835, *Occupational Radiation Protection*, which specifies that written procedures must be developed and implemented as necessary to ensure compliance with a documented radiation protection program as approved by the DOE;
- 10 CFR 851, *Worker Safety and Health Program*, which specifies the requirements for contractors to establish procedures to identify existing and potential workplace hazards and assess the risk to associated worker's safety and health;
- DOE O 422.1, *Conduct of Operations*, which specifies that DOE line management must provide appropriate oversight of conduct of operations. DOE 422.1 also requires contractors to establish methods for analysis and implementation of hazard controls in the work planning and execution process and to establish technical procedures that ensure safe and effective facility and equipment operation;
- DOE O 450.2, *Integrated Safety Management*, which requires DOE line management organizations to document the approaches to ensure both DOE offices and their contractors establish ISM systems and perform monitoring of their contractors' ISM systems to provide feedback for continuous improvement;
- DOE O 226.1B, *Implementation of Department of Energy Oversight Policy*, which specifies that all applicable DOE organizations must establish and implement oversight programs to make informed decisions about hazards, risks and resource allocation. DOE O 226.1B also requires contractors to establish contractor assurance systems that, at a

minimum, must result in improvements in the work planning and hazard identification activities and lessons learn programs; and

- DOE O 210.2A, *DOE Corporate Operating Experience Program*, which specifies that all applicable DOE organizations must develop and implement an Operating Experience Program to identify and share lessons learned from their operations, and to ensure that operating experience is incorporated into applicable activities and processes.

These requirements documents address ISM implementation, hazards identification, conduct of operations, management systems, and oversight responsibilities for various aspects of activity-level WP&C. DOE and contractors are required to comply with these requirements on a consistent basis. In addition to these requirements documents, contractors also put in place implementing processes and procedures to conduct activity-level WP&C.

Appendix C: Analysis Observations of WP&C Issues

Table C-1: Observations of WP&C Issues

Observations of WP&C Issues by Key Deficiency Category and ISM Core Function						
Observation	**ISM Core Functions**					**Analysis**
	CF1	**CF2**	**CF3**	**CF4**	**CF5**	
Hazard Identification and Hazard Control						
Less than adequate identification and communication of hazards		•				DNFSB/TECH-37
WCDs that do not properly characterize the hazards		•				DNFSB/TECH-37
Issues with reliance on a computerized approach, an over-reliance on generic hazard analysis, and the use of predetermined (canned) controls for identified hazards		•	•			DOE Docs
Lack of detail in WP&C process documents and inclusion of task-specific hazard controls	•		•			DOE Docs
Lack of task and activity-specific hazards identification and analysis		•	•			DOE Docs
Lack of worker and SME involvement in the WP&C process		•	•		•	DOE Docs
Need for improvement in flowing hazards analysis and controls into WCDs		•	•			DOE Docs
Job scoping did not identify special circumstances and/or conditions.	•	•				ORPS Cause Codes
Hazard screening sometimes was not commensurate with the level of hazards associated with the work.		•				ORPS Reports
SMEs were not always included in the planning of activity level work.	•	•	•			ORPS Reports

Observations of WP&C Issues by Key Deficiency Category and ISM Core Function						
Observation	**ISM Core Functions**					**Analysis**
	CF1	**CF2**	**CF3**	**CF4**	**CF5**	
The potential impacts to systems that support the facility safety basis are not always fully understood.		•				ORPS Reports
WCDs did not always address potential impact to other systems or components, particularly those that are safety class.	•	•	•			ORPS Reports
Procedures and Documents						
WCDs that do not communicate the controls in place to prevent accidents or injuries			•			DNFSB/TECH-37
Elimination of potentially confusing step sequence logic, without reliance on a waiver statement or “notes” to compensate for poorly planned work orders			•	•		DOE Docs
Lack of WCD verification and validation			•		•	DOE Docs
Over-reliance on skill-of-the-craft			•	•		DOE Docs
Procedural non-compliance, with work being performed outside of work controls				•		DOE Docs
Procedures that are too broad in scope create the vulnerability that work will be performed outside of the intent of the WCDs, leaving workers to navigate the WCDs with little guidance from generic work instructions.	•		•			DOE Docs
Ambiguous (written) instructions/requirements			•			ORPS Cause Codes
Check of work less than adequate				•		ORPS Cause Codes

Observations of WP&C Issues by Key Deficiency Category and ISM Core Function						
Observation	**ISM Core Functions**					**Analysis**
	CF1	**CF2**	**CF3**	**CF4**	**CF5**	
Previous success in use of rule reinforces continued use of rule			•	•		ORPS Cause Codes
Personnel Errors				•		ORPS Keywords
Procedure and Document Deficiencies	•	•	•			ORPS Keywords
Work Planning Issues	•	•	•		•	ORPS Keywords
Procedures and WCDs did not always provide the best methods for performing work.			•			ORPS Reports
Routine tasks often did not have formalized job aids such as checklists to make sure steps were not skipped and critical verifications were made.			•			ORPS Reports
Supervision and Management						
Supervisors not enforcing compliance with WCDs or initiating stop work when needed				•		DOE Docs
Work being performed outside the scope of work, and workers not exercising stop work authority				•		DOE Docs
Interpretation of requirements	•		•			HPI
Lack of knowledge				•		HPI
Unclear goals, roles, or responsibilities	•		•	•		HPI
Management follow-up or monitoring of activities did not identify problems.				•	•	ORPS Cause Codes
Management policy guidance/expectations not well-defined, understood or enforced	•				•	ORPS Cause Codes

Observations of WP&C Issues by Key Deficiency Category and ISM Core Function						
Observation	**ISM Core Functions**					**Analysis**
	CF1	**CF2**	**CF3**	**CF4**	**CF5**	
Risks/consequences associated with change not adequately reviewed/assessed	•				•	ORPS Cause Codes
Procedure Compliance Issues			•	•		ORPS Keywords
Safety Compliance			•	•		ORPS Keywords
Supervision/Management Issues	•			•		ORPS Keywords
First line supervisors did not always ensure strict adherence to the WCDs and avoid trying to manage multiple or complex tasks from memory.				•		ORPS Reports
First line supervisors did not always remain in their management position (e.g., role of oversight and job direction) and became physically involved in the task, such that they lost sight of the big picture.				•		ORPS Reports
Management did not consistently ensure that members of the work force understood that they are accountable and responsible for the work they perform.	•				•	ORPS Reports
Supervisors did not always ensure that workers had the appropriate level of experience, training, or certifications to perform tasks.	•					ORPS Reports
Communication						
Communication issues between work groups, and between managers and workers				•	•	DOE Docs
Workers do not question supervisors when work instructions lack clarity			•	•		DOE Docs

Observations of WP&C Issues by Key Deficiency Category and ISM Core Function						
Observation	ISM Core Functions					Analysis
	CF1	CF2	CF3	CF4	CF5	
Imprecise communication habits			•	•	•	HPI
Verbal communication between work groups less than adequate				•	•	ORPS Cause Codes
Written communication incomplete/situation not covered			•		•	ORPS Cause Codes
Communication Deficiencies			•	•	•	ORPS Keywords
First line supervisors do not always fully communicate the work scope to the workers and convey management's expectations for performing the work correctly and safely.	•			•		ORPS Reports
Job planners do not always communicate with safety engineers and facility management regarding systems operability requirements.	•				•	ORPS Reports
Work groups do not always communicate with each other, and plan-of-the day meetings and joint pre-job briefings are not always held when multiple work activities are occurring within the same area.				•	•	ORPS Reports
Workers do not always understand the requirement to stop work and reassess hazards when unanticipated situations arise or if the job scope needs to be expanded		•		•		ORPS Reports
Feedback and Lessons Learned						
Work planning that does not integrate previous operational experience into the early work planning stages	•				•	DNFSB/TECH-37

Observations of WP&C Issues by Key Deficiency Category and ISM Core Function						
Observation	**ISM Core Functions**					**Analysis**
	CF1	**CF2**	**CF3**	**CF4**	**CF5**	
Lack of effectiveness reviews to ensure corrective actions associated with improvements to WP&C are resulting in improvements					•	DOE Docs
Lack of incorporation of lessons learned into future WP&C	•				•	DOE Docs
Need for enhanced oversight					•	DOE Docs
Job planners do not always incorporate lessons learned from similar work activities in the planning process.	•				•	ORPS Reports
Members of the work force are not always involved in the development of lessons learned or improvements to work practices.	•				•	ORPS Reports
Post-job briefings are not always held to discuss what went right or what went wrong.					•	ORPS Reports
Pre-job briefings do not routinely include lessons learned (if available) from similar work activities.			•		•	ORPS Reports

Appendix D: Analysis of Information from DNFSB/TECH-37

Data Set

The data set comprises information presented in DNFSB/TECH-37, including DNFSB Staff Reviews and DOE Accident Investigations.

Methodology

The individual activity-level WP&C deficiencies associated with each of the DNFSB Staff Reviews and the DNFSB-identified activity-level WP&C deficiencies from their review of DOE Accident Investigations were used as discrete observations for this analysis. Each observation from both the DNFSB Staff Reviews section and the Accident Investigation section of DNFSB/TECH-37 was classified by the most relevant ISM Core Function as determined by HSS (See Appendix A for a listing of the ISM Core Functions). HSS analyzed the results to understand the correlation between the ISM Core Functions and the complete set of activity-level WP&C deficiencies from DNFSB/TECH-37. HSS also analyzed the Accident Investigation and DNFSB Staff Reviews sections individually to identify common causal factors.

Results

Results of HSS's analysis of activity-level WP&C deficiencies identified in DNFSB/TECH-37 correlated to ISM Core Function are presented in Figure D-1. HSS analysis of the DNFSB observations identified ISM Core Function 1 - *Define the Scope of Work* as the function most frequently related to WP&C issues at DOE defense nuclear facilities. Although deficiencies were found in all areas of ISM, the HSS analysis of the DNFSB observations indicate that WP&C issues are not significantly identified with ISM Core Function 4 - *Perform Work within Controls*.

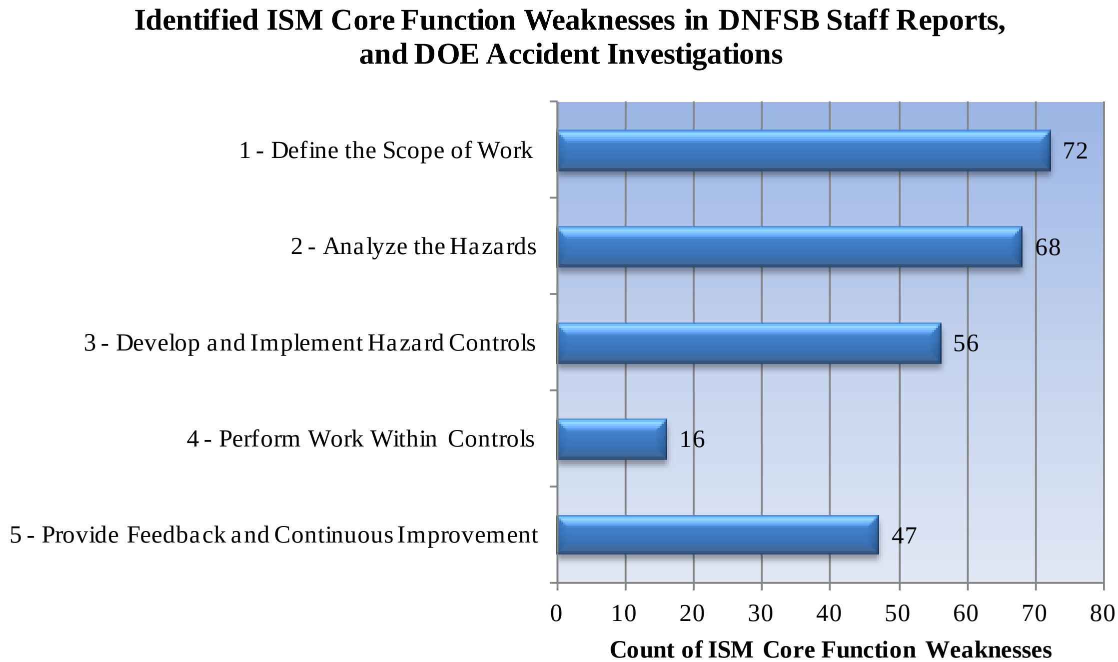


Figure D-1: HSS Analysis of ISM Core Function Weaknesses Correlating to Activity-Level WP&C deficiencies in DNFSB Staff Reports and DOE Accident Investigations Cited in DNFSB/TECH-37

HSS identified several cross-cutting causal factors associated with the Accident Investigation Reviews and the DNFSB Staff Reviews that contributed to weaknesses in activity-level WP&C. The identified causes stem from communication issues and the management of work planning and performance. The principal causes center around the following:

- Less than adequate identification and communication of hazards;
- Work Control Documents (WCDs) that do not properly characterize the hazards;
- WCDs that do not effectively identify/communicate the existence of controls already in place to prevent accidents or injuries; and
- Work planning that does not integrate previous operating experience into the early work planning stages.

Both the DNFSB Staff Reviews and the DOE Accident Investigations identify previous lessons learned that could have prevented, or at least mitigated, some hazardous situations had they been incorporated into work plans prior to conducting work. These causes are found throughout both the DNFSB Staff Reviews and the DOE Accident Investigations.

Appendix E: HSS Analysis of DOE Documents

HSS performed a review of DOE and contractor assessments associated with corrective actions in response to WP&C deficiencies and concerns identified by DNFSB in their reviews of specific DOE sites and projects conducted from 2008–2011. HSS also reviewed selected assessments of activity-level WP&C and conduct of operations for several DOE sites and projects highlighted as part of DOE improvement actions taken to date in DOE's November 30, 2012, response to DNFSB/TECH-37. Table E-1 presents results from this review.

Table E-1: Observations from DOE and Contractor Assessments

Observations from DOE and Contractor Assessments Highlighting Deficiencies in WP&C by Key Deficiency Category and ISM Core Function						
Observations from DOE and Contractor Assessments	**ISM Core Functions**					**Site**
	CF1	**CF2**	**CF3**	**CF4**	**CF5**	
Hazard Identification and Hazard Control						
A procedure that requires contamination and radiation surveys to be performed was not clear as to what must be surveyed.	•					Hanford
The discipline of CHPRC's work planning and execution process is not sufficient to maintain hazard controls for work under all conditions.	•					Hanford
Tank Farm operations procedures did not have completed JHAs. As an interim corrective action, all procedures had been walked down to identify hazards; however, deficiencies noted indicated that these walkdowns had not been entirely effective.		•				Hanford
The implementation of AJHA and WHA hazard identification and control processes do not always tailor controls to specific work activities.			•			Hanford
There is inconsistency in describing specific hazards and work controls in the AJHA process.			•			Hanford
Workers were in close proximity of an alarm being tested and none were wearing hearing protection when the alarm sounded.				•		Hanford

Observations from DOE and Contractor Assessments Highlighting Deficiencies in WP&C by Key Deficiency Category and ISM Core Function						
Observations from DOE and Contractor Assessments	**ISM Core Functions**					**Site**
	CF1	**CF2**	**CF3**	**CF4**	**CF5**	
The CWI hazard identification and analysis processes are overly reliant on automated processes and post-approval in the field by IH/IS evaluation and direction. This approach has resulted in the inadequate incorporation of hazard controls into work documents.		•				Idaho
One significant concern identified is in the area of hazard identification and control development. A review of five D&D and two maintenance work orders revealed several instances where planned work orders did not identify any specific hazards, some specific hazards were identified as general hazards, and several controls were listed that were not germane to their associated hazard or provided little/no value to mitigate or eliminate the hazard.		•				Idaho
Of the several methods CWI utilizes to identity/analyze hazards and develop controls, only the JSA process requires identification of hazards at the task/job step level providing for adequate incorporation of hazard controls into work orders. The failure to identify hazards at the task level dilutes the effectiveness of subsequent hazard analysis/quantification and results in the failure to adequately incorporate hazard controls into WCDs.			•			Idaho
Electrical work is not performed in accordance with procedures designed to control electrical hazards. LLNL has had recurring events related to the control of hazardous energy due to execution errors.				•		LLNL
Some planners are far-removed from the physical location of the job site. As a result, walkdowns are not performed for some jobs during the planning process.	•					NNSS

Observations from DOE and Contractor Assessments Highlighting Deficiencies in WP&C by Key Deficiency Category and ISM Core Function						
Observations from DOE and Contractor Assessments	**ISM Core Functions**					**Site**
	CF1	**CF2**	**CF3**	**CF4**	**CF5**	
Hazard analysis process needs to rely less on a computerized approach and be focused more on the task and activity level. There is an over-reliance on generic hazard analysis and the use of predetermined (canned) controls for identified hazards rather than performing task/activity specific hazard analysis and control identification. A major concern with a hazard analysis automated process is that there is an absence of evaluation or analysis to determine if there are negative synergistic effects among the numerous controls for various hazards identified.		•				WIPP
Improvements needed in maintenance work-related hazard analysis.		•				WIPP
JHAs for work with contact-handled waste operations contained vague hand protection requirements.		•				WIPP
Procedures and Documents						
Work scope has shifted or incorporated processes beyond the original intent such that procedures no longer support current waste retrieval operations and hazards.	•					Hanford
There was ambiguous wording in a procedure regarding the order in which to perform hazardous energy control.			•			Hanford
Work package documents were of insufficient rigor to warrant approval.			•			Hanford
Radiation Control Technicians typically make mental notes of their survey results and then transcribe them after exiting the area.				•		Hanford

Observations from DOE and Contractor Assessments Highlighting Deficiencies in WP&C by Key Deficiency Category and ISM Core Function						
Observations from DOE and Contractor Assessments	**ISM Core Functions**					**Site**
	CF1	**CF2**	**CF3**	**CF4**	**CF5**	
Work was conducted on several dates during 2009 with an expired AJAH in the work package.				•		Hanford
Although improved, CH2M WG Idaho, LLC's (CWI) STD-101, *Integrated Work Control Processes* guidance document continues to lack specific direction in several key areas that contribute to the types of execution deficiencies identified during this review. The lack of programmatic requirements and guidance in STD-101 placed heavy reliance on an expert based planning approach rather than one that is process driven. Leaving so many decisions to the planners, planning team members, and approval authorities has resulted in deficient and inconsistent WCDs.	•					Idaho
Direction provided in STD-101 lacks the detail necessary to ensure consistent implementation in: developing work instruction; direction to workers regarding execution of work order steps; incorporation of task-specific hazard controls into detailed work instructions; and guidance in development of work order changes. The failure to consistently and compliantly prepare high quality work documents and execute them in the field as written is of concern to DOE-ID and warrants prompt and effective corrective action to include an extent of condition review across other CWI activities.	•					Idaho
The team found multiple instances where IWTU work instruction notes inappropriately allowed deviation from step-by-step sequencing in the execution of work steps.			•			Idaho
Hazards identified in some work orders are not always at the appropriate activity/task level and some delineated controls are not germane to their associated hazard.			•			Idaho

Observations from DOE and Contractor Assessments Highlighting Deficiencies in WP&C by Key Deficiency Category and ISM Core Function						
Observations from DOE and Contractor Assessments	**ISM Core Functions**					**Site**
	CF1	**CF2**	**CF3**	**CF4**	**CF5**	
A review of numerous work orders revealed that D&D work orders are generally well written, worker-friendly and identify critical work steps and controls with some exceptions. As one example, there is an overuse of Notes that allow the job supervisor to perform steps concurrently or out-of-sequence.			•			Idaho
STD-101 does not drive worker participation in the development of work order changes. The team noticed the absence of such participation during development of a work order change.				•		Idaho
Regarding the degree of appropriate personnel involved in the work planning and development process: the actual workers were not present for the walkdown. The revised Work Order was unable to be executed as written by personnel in the field.				•		Idaho
Facility Safety Plans were recognized to be out-of-date and lacked the implementing processes and programs for the identified Administrative Controls.	•					LANL
Work planning process/requirements documents do not provide enough detail to adequately plan work. Livermore Site Office (LSO) directed LLNL to modify Nuclear Materials Technology Program (NMTP) Work Control Manual.	•					LANL
The activity approval process for new or changed activities, which is key to formal change control for radiological or moderate hazards programmatic and facility work activities, is not consistently used throughout facilities.			•			LANL

Observations from DOE and Contractor Assessments Highlighting Deficiencies in WP&C by Key Deficiency Category and ISM Core Function						
Observations from DOE and Contractor Assessments	**ISM Core Functions**					**Site**
	CF1	**CF2**	**CF3**	**CF4**	**CF5**	
Operations were conducted with non-compliances with requirements in the following programmatic areas: criticality safety; fire protection; lightning protection; engineering; packaging and transportation; quality assurance; training and qualification.				•		LANL
WCDs conflicted with other documents, policies or guidance.			•			LLNL
Controls were not sufficient to manage subcontract work.			•			LLNL
Hazards were known and analyzed but controls were ineffectively implemented, and a time-consuming change process led workers to perform work in an uncontrolled manner.			•			LLNL
Local worker protection procedures were embedded in longer procedure and not accessed by workers.				•		LLNL
The development of work packages requires the use of multiple procedures, which can be cumbersome. As a result, planners use an "uncontrolled" instruction that works well, to develop work packages.	•					NNSS
Use of different work package formats for preventative maintenance causes confusion.				•		NNSS
The largest single area for improvement relates to personnel not following procedures and work package instructions.				•		NNSS
Maintenance work instructions were too broad in scope or lacked specific scope statement, and lacked specific work instructions.	•					WIPP

Observations from DOE and Contractor Assessments Highlighting Deficiencies in WP&C by Key Deficiency Category and ISM Core Function						
Observations from DOE and Contractor Assessments	**ISM Core Functions**					**Site**
	CF1	**CF2**	**CF3**	**CF4**	**CF5**	
Maintenance WCDs need to improve in quality. Work orders sometimes revealed a systematic approach to work but contained numerous errors and inaccuracies, resulting in concerns with the technical steps of the work. Improvement needed in flowing Job Hazards Analysis hazards/controls into the procedures and eliminating potentially confusing step sequence logic.			•			WIPP
Maintenance engineers need to develop work instructions that direct the logical, systematic sequence of steps to perform an activity safely and efficiently. They should not rely on a waiver statement to compensate for poorly planned or developed work orders.			•			WIPP
A maintenance work instruction was too broad in scope, lacked specific work instructions, and a less-than-detailed pre-job brief was performed. This created a vulnerability of performing work outside the intent of the work order. The performance of the job proceeded without incident, as was a reflection of the experience of the crew to be able to navigate the work order with little guidance from the generic Maintenance Work Instructions and weak pre-job brief.				•		WIPP
Work orders stated that the "order of completion of this work may be modified or sections may be performed in parallel…" This approach establishes a mindset with the workers that, aside from stated limits, they do not need to perform work sequentially as written.				•		WIPP
Us of "recommended" and "not recommended" in work orders for hazardous energy control is confusing to workers. While management stated that this is the lowest level of control, in at least one case, workers felt it was an optional control.				•		WIPP

Observations from DOE and Contractor Assessments Highlighting Deficiencies in WP&C by Key Deficiency Category and ISM Core Function						
Observations from DOE and Contractor Assessments	**ISM Core Functions**					**Site**
	CF1	**CF2**	**CF3**	**CF4**	**CF5**	
There is a lack of clarity in expectations for step-by-step execution of work packages. In the Conduct of Operations training it is clearly stated that procedures with step-by-step instructions will be conducted in the manner written.	•					Y-12
Lack of operator engagement in assuring the quality and accuracy of the procedures. Ensuring that procedures are accurate and complete on the floor requires engaging operators in their development and operator ownership, commitment, and attention to detail.	•					Y-12
Operators were observed conducting additional actions outside the scope of the written procedures that were obviously germane to the operations being performed. When questioned about this, many operators replied that these additional actions involved “skill of the craft” or were otherwise needed to complete the process.				•		Y-12
Supervision and Management						
The field work supervisor did not know who to contact if he had questions regarding compliance with the work order and associated special lift plan.				•		Hanford
Special lift plan instructions were not followed.				•		Hanford
A warning statement preceding a procedure step was neither read nor complied with before the step was completed.				•		Hanford
Safe condition checks were performed before the LOTO being finalized; verification had not been completed.				•		Hanford

Observations from DOE and Contractor Assessments Highlighting Deficiencies in WP&C by Key Deficiency Category and ISM Core Function						
Observations from DOE and Contractor Assessments	**ISM Core Functions**					**Site**
	CF1	**CF2**	**CF3**	**CF4**	**CF5**	
Workers performing monthly preventative maintenance on a crane did not comply with all WO hazard controls. This was especially concerning as two levels of supervision (first line supervisor and deputy nuclear facility manager) normally not present for such work observed the entire activity. There were many examples of hazard control non-compliance. Also, IWTU personnel were observed to perform work outside the scope of approved work controls.				•		Idaho
Workers performing maintenance at IWTU did not comply with approved work instructions and hazard controls.				•		Idaho
Hazards were left uncontrolled by one worker and later discovered by another worker.			•			LLNL
Workers allowed task interruptions and environmental stressors to prevent them from following controls.				•		LLNL
Communication						
During the pre-job brief, neither the supervisor nor workers noted that their planned approach for the work did not align with the special lift plan, which by reference from the work order, contained required work instructions for the activity.				•		Hanford
There was no coordination with site HAZMAT teams in response to a leaking drum.				•		Hanford
Two work release meetings were observed; one for Advanced Test Reactor activities and the other for the Materials and Fuels Complex (MFC) activities. The only improvement suggested for both PJBs is that the briefings could be more interactive between the job supervisors and the workers.				•		Idaho

Observations from DOE and Contractor Assessments Highlighting Deficiencies in WP&C by Key Deficiency Category and ISM Core Function						
Observations from DOE and Contractor Assessments	**ISM Core Functions**					**Site**
	CF1	**CF2**	**CF3**	**CF4**	**CF5**	
Communicating the limits in work scope and work directions can be difficult when WCDs are lengthy. Many WCDs were 16-252 pages long.			•			LLNL
Issues with communication between work groups, between managers and workers, or workers not questioning the experts.				•		LLNL
Work task and individual accountability were not made clear to the worker.				•		LLNL
Feedback and Lessons Learned						
The CHPRC internal lessons learned program does not systematically evaluate activity-level feedback.					•	Hanford
The team found inadequate and errant implementation of the existing STD-101 requirements at IWTU.				•		Idaho
Oversight needs to be more rigorous. DOE-CBFO oversight was briefly examined. To date, DOE-CBFO WP&C oversight activities have not utilized the EM WP&C guidelines. Additionally, only the Facility Representatives (FacReps) evaluate work document compliance and adequacy during observation of Washington TRU Solutions, LLC (WTS) operations. Given the previously identified issues, DOE-CBFO would benefit by having management, SSO and safety personnel periodically perform activity level oversight. Oversight activities should be performed with the associated work document in hand versus a general walkthrough of the area.					•	Idaho

Observations from DOE and Contractor Assessments Highlighting Deficiencies in WP&C by Key Deficiency Category and ISM Core Function						
Observations from DOE and Contractor Assessments	**ISM Core Functions**					**Site**
	CF1	**CF2**	**CF3**	**CF4**	**CF5**	
Contractor WP&C procedures contain mechanisms for providing WO lessons learned and feedback. There is guidance on solicitation of feedback into the work control process. Mechanisms focus on using a Task Evolution Feedback Form for documenting feedback and lessons learned. However, a review of this database (Just in Time Lessons Learned System) indicates 4 items since May 2010. Items included appear to be determined arbitrarily. Several other lessons learned have been released over the course of the last year that were not included in this database.					•	Idaho
Process improvements include involving the workers with peers and SME engagement to their work pre-planning, periodic work reviews, and development of feedback mechanisms to enable alignment and value for their work processes.					•	LANL
Work execution in the field and compliance with written procedures, including the feedback and improvement process were identified with weaknesses.					•	NNSS
Hazard Review Teams (HRTs) established to provide independent technical review of work packages to improve their quality, ensure safety and quality are integrated into work packages, and provide mentoring and feedback need to be more rigorous in order to carry out senior management expectations. The HRTs need to be a more demanding customer.					•	WIPP

Observations from DOE and Contractor Assessments Highlighting Deficiencies in WP&C by Key Deficiency Category and ISM Core Function						
Observations from DOE and Contractor Assessments	**ISM Core Functions**					**Site**
	CF1	**CF2**	**CF3**	**CF4**	**CF5**	
Regarding the review of Contractor Assurance System: Surveillance reports contained within evidence files documented the “effectiveness reviews” that have been performed to date, but that title appears to be a misnomer. The surveillance review was more accurately titled “independent verification of closure.” These surveillances verified that the agreed upon procedure changes had occurred, the agreed upon training had been developed and provided, however, they did not provide objective evidence of effectiveness. “Effectiveness reviews” have been completed on several of the corrective actions but the actual observation of work in the field to verify improved procedural compliance has not been completed. This is the critical activity needed to verify effectiveness.					•	WIPP
Deployment of procedure development guidance and goals for the procedure writers is needed.	•					Y-12

Appendix F: Analysis of ORPS Occurrences

Data Confidence and Defining the Data Set

Searching the ORPS database for WP&C occurrences presents several challenges because no specific reporting criterion exists for searching for WP&C at the activity level. In addition, a keyword search using the ORPS narrative search feature might not capture every WP&C report because of the natural variability in data reporting and differences in terminology and spelling. To address these search issues and to improve confidence in the data, HSS chose two distinct methods or filters for identifying WP&C reports in the database.

In the first method, HSS used a defined set of Cause Codes that best represent WP&C issues to identify a set of data using the Cause Code search feature. This method ensures a high level of confidence that the majority of the reports in this data set include the reporting organizations' causal analysis.

In the second method, HSS used a defined set of HQ Keywords that best represent WP&C issues to identify a set of data using the Keyword search feature. This method also ensures a high level of confidence because the HSS ORPS Analysis Team reviews Notification and Final ORPS Reports on a daily basis for trending, analysis, and identification of lessons learned. The team members use their collective experience coupled with a thorough review and understanding of each occurrence to assign Keywords to each ORPS report to enhance the search capability of the database.

Data Set

HSS conducted the ORPS data analysis using the date range January 1, 2010, through December 31, 2012. During this period, 3,703 occurrence reports were entered into the ORPS database; of these reports, 2,490 occurred at DOE defense nuclear facilities. Table F-1 displays the ORPS occurrences at each DOE defense nuclear facility.

For the purposes of this report, the Hanford, Idaho, ORNL and SNL sites are defined as follows:

- Hanford refers to Hanford River Protection, Hanford Richland, and the PNNL Radiochemical Processing Laboratory (Building 325).
- Idaho refers to the Office of Environmental Management (EM) operations at the Idaho National Laboratory. This scope of work is commonly referred to as the Idaho Cleanup Project.
- ORNL refers to the EM operations at Oak Ridge National Laboratory.
- SNL refers to operations at both Sandia National Laboratory, Albuquerque and Sandia National Laboratory, Livermore.

Table F-1: ORPS Occurrences by DOE Defense Nuclear Facility

DOE Defense Nuclear Facility	Number of ORPS Occurrences
Hanford	543
Idaho	151
Los Alamos National Laboratory (LANL)	502
Lawrence Livermore National Laboratory (LLNL)	190
Nevada National Security Site (NNSS)	73
Oak Ridge National Laboratory (ORNL)	28
Pantex Plant (PTX)	253
Sandia National Laboratories (SNL)	134
Savannah River Site (SRS)	355
Waste Isolation Pilot Plant (WIPP)	30
Y-12 National Security Site (Y-12)	231
Total	**2,490**

Methodology

These 2,490 ORPS reports included all types of occurrences, both activity-level WP&C-related occurrences and those without an activity-level WP&C component. To identify the occurrences with an activity-level WP&C component, the data set was filtered utilizing two separate methodologies that rely on standardized ORPS fields.

The first method filtered the ORPS Cause Codes assigned by the reporting organization when ORPS reports are finalized in the database. The second method filtered the 2,490 ORPS reports by selected HQ Keywords assigned by HSS to each ORPS report. The aim of both methodologies was to isolate activity-level WP&C issues and determine whether those issues are systemic or isolated.

Work Planning and Control Occurrences filtered by Cause Codes

This section discusses the analysis of ORPS reports that were filtered by the HSS-selected Cause Codes. The Cause Codes are entered by the reporting organization when ORPS reports are finalized, and when combined with the in-depth causal analysis performed in the ORPS *Description of Cause* field, provide a data-rich segment of the ORPS database.

To further understand the impact of activity-level WP&C issues identified in ORPS occurrences, HSS selected specific Cause Codes that best relate to deficiencies that might have been prevented by proper activity-level WP&C. Table F-2 provides an example of the Cause Codes, and Appendix I presents the complete list of Cause Codes identified as relating to activity-level WP&C.

Table F-2: Example of Activity-Level Work Planning and Control-Related ORPS Cause Codes

Node A*	Node B	Node C
A4 - Management Problem	B3 - Work Organization & Planning Less Than Adequate	A4B3C01 - Insufficient time for worker to prepare task
		A4B3C02 - Insufficient time allotted for task
		A4B3C03 - Duties not well-distributed among personnel
		A4B3C04 - Too few workers assigned to task
		A4B3C05 - Insufficient number of trained or experienced workers assigned to task
		A4B3C06 - Planning not coordinated with inputs from walk downs/task analysis
		A4B3C07 - Job scoping did not identify potential task interruptions and/or environmental stress
		A4B3C08 - Job scoping did not identify special circumstances and/or conditions
		A4B3C09 - Work planning not coordinated with all departments involved in task
		A4B3C10 - Problem performing repetitive tasks and/or subtasks
		A4B3C11 - Inadequate work package preparation

* Nodes A, B and C represent the three levels of the ORPS Cause Code hierarchy.

The following sections of this document display data and analysis that have been filtered by the HSS-defined Cause Codes relating to activity-level WP&C.

Cause Codes

The ORPS database provides functionality to complete a basic causal analysis of each occurrence reported into the system. HSS performed the causal analysis by utilizing the Causal Analysis Tree included in Attachment 1 of DOE-STD-1197-2011, *Occurrence Reporting Causal Analysis.* The Causal Analysis Tree is broken down into a hierarchy of nodes that filter to precise causal statements. These statements are assigned to ORPS reports and are commonly referred to as the Cause Codes. The Cause Codes usually are assigned after an event has been thoroughly analyzed by the reporting organization. Multiple Cause Codes can be assigned to provide a detailed picture of the causes leading to an ORPS occurrence. A complete causal analysis is required to be provided in the *Description of Cause* field, which is a free-form text field that is expected to include detailed analysis of the causes of occurrences, an analysis of ISM deficiencies associated with the event, and any extent of condition reviews that have taken place.

Results

The causes of activity-level WP&C deficiencies range across the breadth of the ORPS causal analysis framework. To understand which causes are most prominently associated with activity-level WP&C occurrences, HSS filtered the universe of ORPS reports at DOE defense nuclear facilities to just those reports containing at least one activity-level WP&C Cause Code as referenced in Appendix I. From this subset of ORPS reports, HSS grouped all of the associated causes and plotted them at the highest causal factor level (Node A) (Figure F-1). The counts used in the chart represent unique ORPS reports for each Node A cause group. Many of the ORPS reports had multiple Cause Codes defined, both within a node as well as between nodes. For each node, the ORPS report was counted only once.

Figure F-1 shows that the activity-level WP&C ORPS reports cite *Human Performance Less Than Adequate*, *Management Problems*, and *Communications Less Than Adequate* most frequently. Of particular interest, even though training is often prescribed as a corrective action in response to an ORPS event, it is not often chosen as a cause of the occurrence.

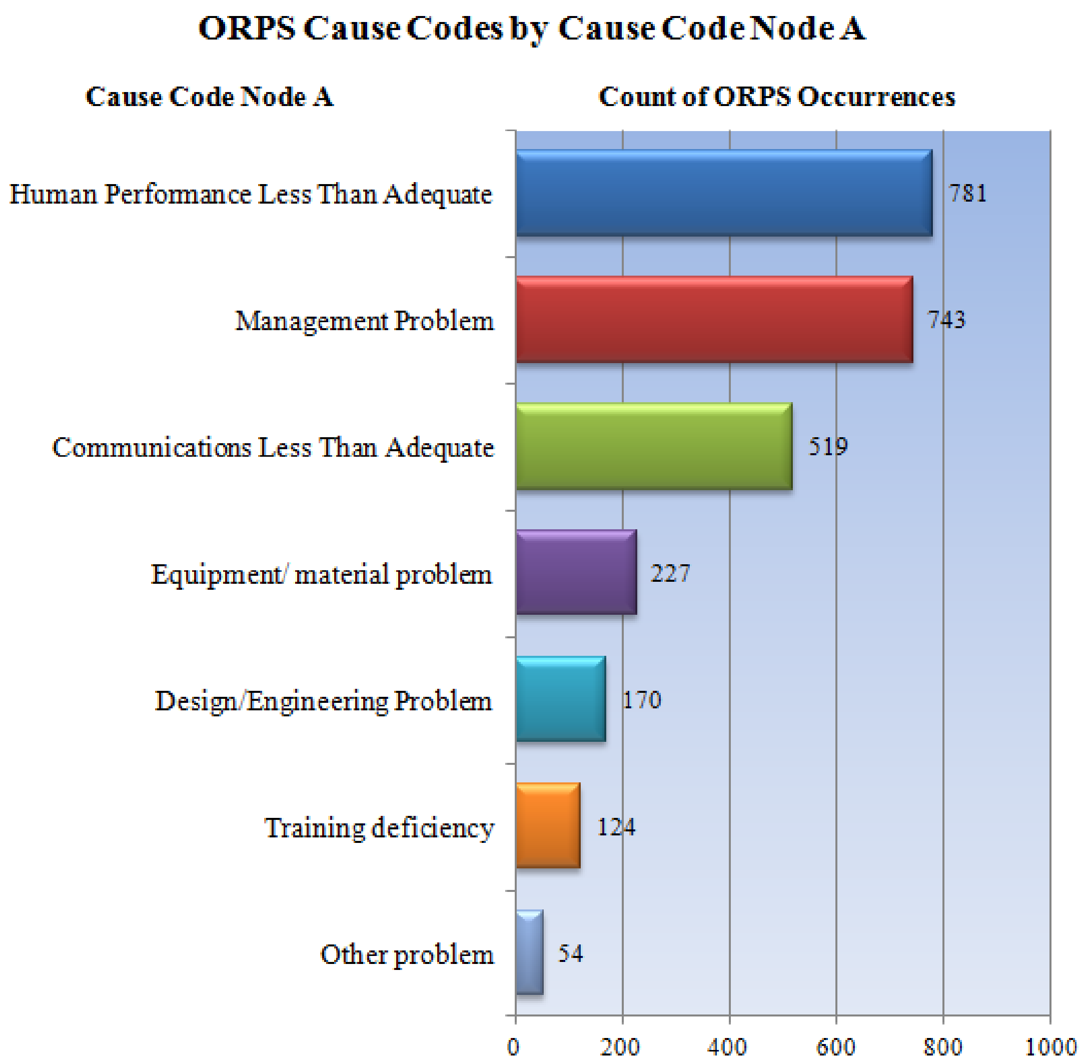


Figure F-1: Cause Codes by Cause Code Node A Grouping for DOE Defense Nuclear Facilities

At the highest level (Node A), ascertaining the underlying activity level WP&C issues or the nuances in the Cause Code assignment is difficult. To better understand the relationship between Cause Codes and activity-level WP&C, Figure F-2 shows the breakdown of Cause Codes by the second Cause Code tier (Node B). This step helps to clarify that *Management Methods Less Than Adequate* is the most frequently selected Cause Code, followed by *Skill Based Errors* and *Written Communication Content Less Than Adequate*. At this Cause Code level, a picture starts to develop, pointing to less than adequate management methods coupled with written communication deficiencies and skill-based errors. Interpreted together, these three Node B Cause Codes reflect compounding deficiencies with work package preparation, communications, and the improper skill-sets to perform an activity.

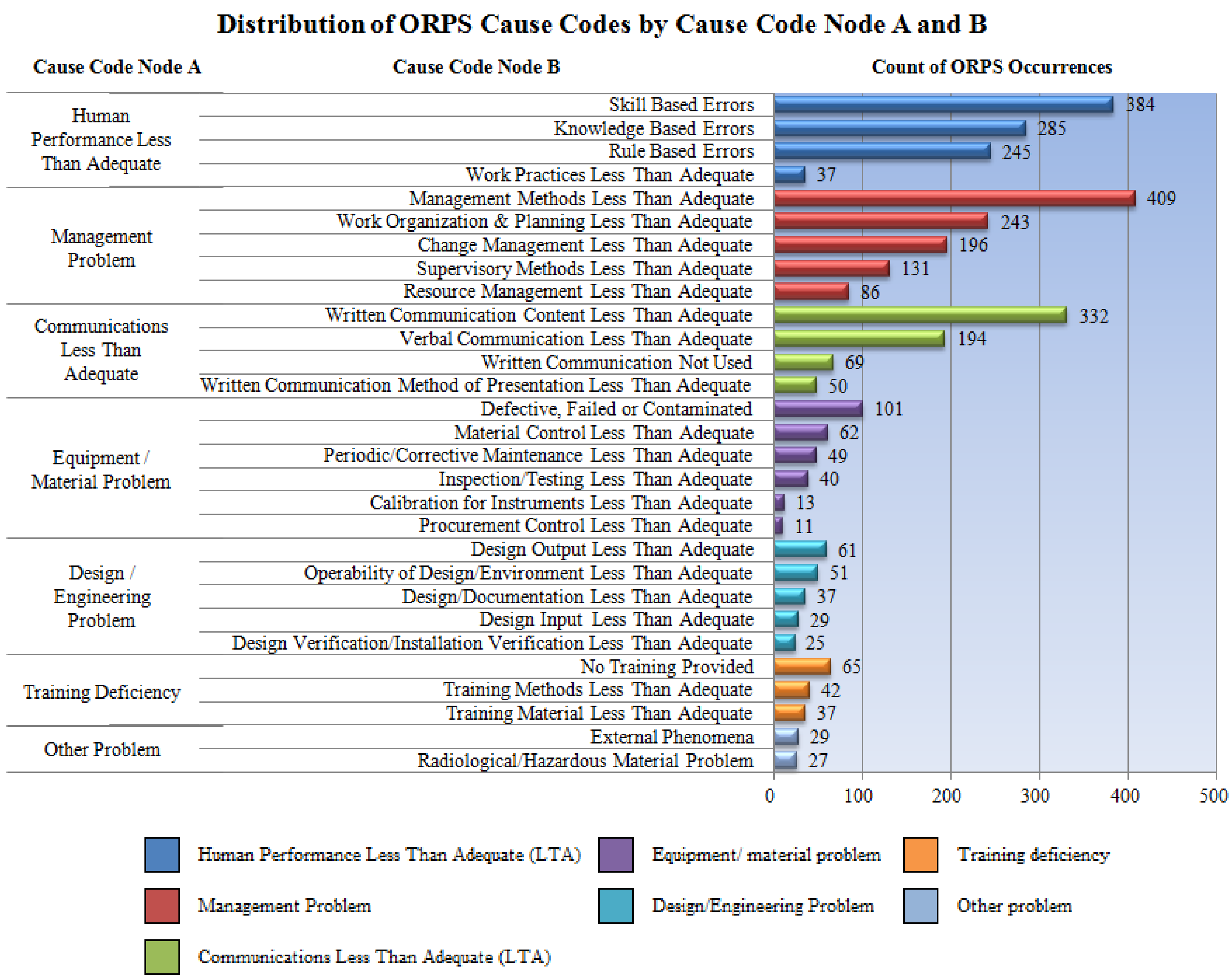


Figure F-2: ORPS Cause Codes Grouped by Cause Code Nodes A and B

At the lowest level of Cause Codes (Node C), the causes of activity-level WP&C become even more well defined. The top five lower-level Cause Codes all point directly to WP&C issues at the activity level. These five are: *Management policy guidance/expectations not well defined, understood or enforced*, *Communications incomplete/situation not covered*, *Check of work was less than adequate (LTA)*, *Communication between work groups less than adequate*, and *Incorrect performance due to mental lap.* The top ten lowest level Cause Codes are shown in Figure F-3 below.

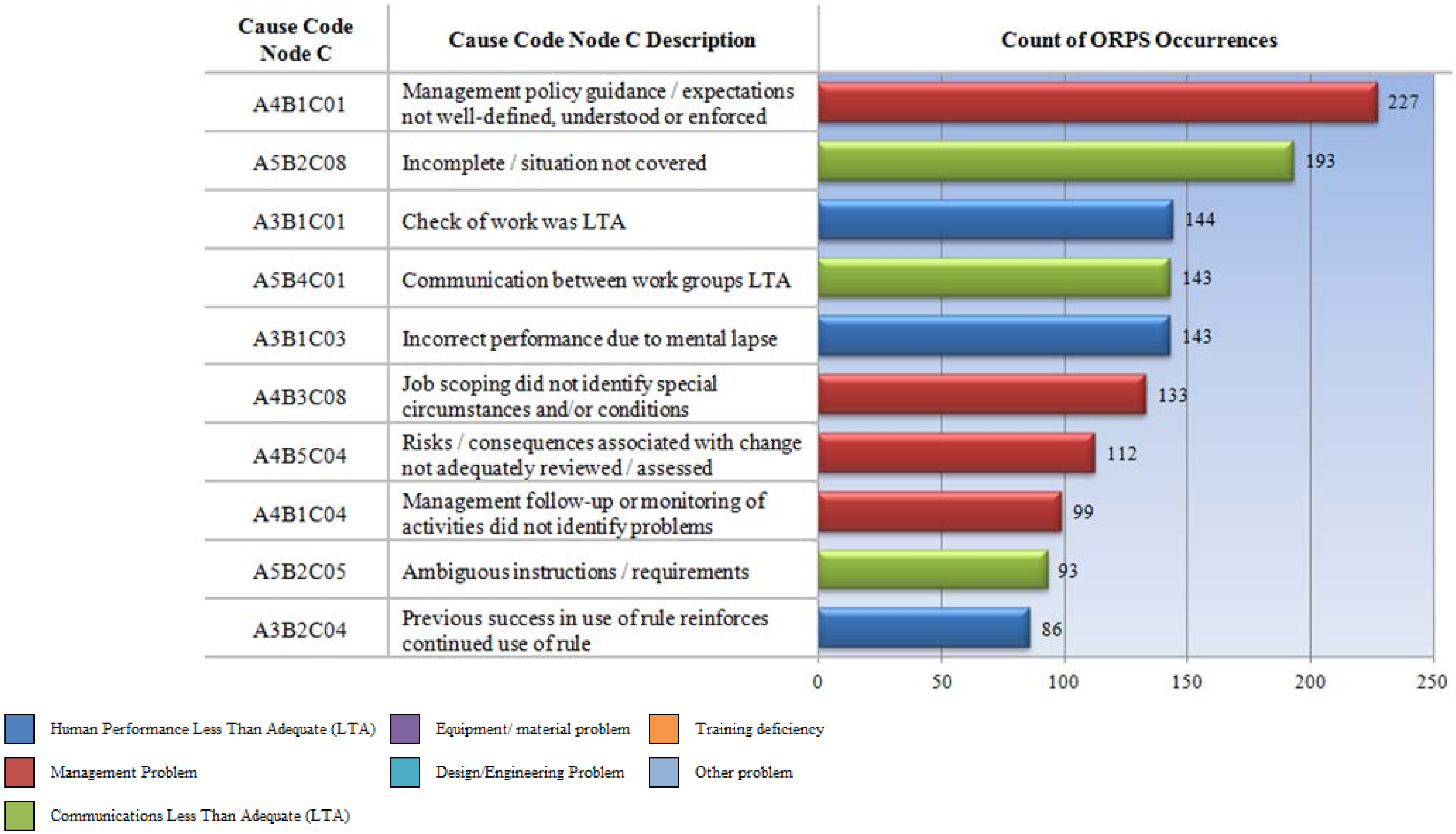


Figure F-3: Top Ten Cause Codes by Count of ORPS Occurrences

Cause Code Pairs

To better understand the causal relationships in activity-level WP&C-related occurrences, HSS performed an analysis by combining Cause Codes identified in ORPS reports into pairs. By evaluating both pairs and individual Cause Codes, the interplay between two causes can be evaluated to determine if certain combinations of causes point to specific activity-level WP&C deficiencies that might be hidden when evaluating only single Cause Codes.

Results

The following analysis presents the top five Cause Code pairs out of 4,711 unique pairs of Cause Codes as determined by an ORPS search. Also presented are qualitative analyses based on the review of representative ORPS reports followed by specific examples of applicable ORPS reports illustrating how these causes played a role in the reported events. Of note, all of the top five Cause Code pairs reference the Cause Code A4B1C01 (*Management policy guidance/expectations not well-defined, understood or enforced*). This is also the most frequently reported individual Cause Code.

Cause Code 1		Cause Code 2
A4B1C01 Management policy guidance/expectations not well-defined, understood or enforced	+	A5B4C01 Communication between work groups LTA
		A5B2C08 Incomplete/situation not covered
		A3B1C01 Check of work was LTA
		A4B1C04 Management follow-up or monitoring of activities did not identify problems
		A4B3C08 Job scoping did not identify special circumstances and/or conditions

Figure F-4: Cause Code Pairs

A4B1C01 (Management policy guidance/expectations not well-defined, understood or enforced), with A5B4C01 (Communication between work groups LTA).

The combination of Cause Codes that occurs most frequently is A4B1C01 (*Management policy guidance/expectations not well-defined, understood or enforced)* with A5B4C01 (*Communication between work groups LTA*). The review of ORPS reports with this Cause Code pair points to issues when unclear instructions are given, and the workers performing the activity do not communicate potential issues or do not feel that they can communicate issues. This scenario is particularly important considering that, when procedures or processes are unclear, workers are expected to ask questions and clarify instructions prior to conducting work. This Cause Code pairing suggests that, instead of clarifying work procedures, workers instead complete the work by improvising or relying on previous experience to perform the work safely. This places workers in an error-likely scenario where one or many barriers to injury or failure have been bypassed, ignored or defeated.

Examples:

Work Scope Exceeded during Demolition resulting in Worker Contacting Energized Electrical Conductor
NA--YSO-BWXT-Y12SITE-2011-0009

This occurrence at Y-12 highlights the Cause Code pair involving less than adequate management expectations and a lack of communication between work groups. In this event, workers contacted hazardous electrical energy when they exceeded the demolition scope of the work package to remove a conveyor. At the root of this occurrence was the failure to incorporate all parties in the utilities walkdown of the conveyor and the structures surrounding the conveyor. As a direct result, when the workers exceeded the scope of the work order, they did not understand the consequences, nor did they understand the potential dangers. Further exacerbating the situation was the transfer of supervision from one superintendent to another prior to work beginning, but after the utility walkdown occurred. The lack of written communication left the workers and the new superintendent without points of reference to determine if the work they were performing was, in fact, part of the work package.

All of these factors point to deficiencies with the immediate supervision of work and the overall contractor's supervision of work activities. Without a proper procedure for superintendent turnover, this work activity was inherently flawed the moment the work began. It demonstrates weaknesses in the management guidance, in that the new superintendent proceeded with work packages without fully understanding the hazards. Further, no one questioned whether the transition to a new superintendent was cause enough to walk down the job again.

Management Concern: Inadequate Implementation of Configuration Management
NA--LASO-LANL-TRITFACILS-2011-0001

This ORPS report was submitted as a result of four separate incidents at the Weapons Engineering Tritium Facility (WETF) at LANL. These incidents, while not necessarily events in and of themselves, all represent the first stages of errors that can lead to serious events. These incidents all reflect issues with management guidance and expectations and less than adequate communication between work groups.

The first procedure involves a work package where modifications to systems were made as documented, but procedures to return the system to operation were not followed. Although the system returned to operation successfully, no barriers were in place to prevent a malfunction or to check for a malfunction prior to returning to service. Furthermore, after the changes were made, the changes were not properly communicated to the different engineering groups to update design drawings and procedures as required.

The second procedure demonstrates a clear lack of communication between work groups, relating to temporary system modifications. A system modification was made as a result of a Potentially Inadequate Safety Analysis (PISA) that modified controls on seismic racks. When the Unreviewed Safety Question (USQ) determination was negative, the temporary modifications were not removed from the seismic racks. The lack of communication coupled with the less than adequate management policy and procedures allowed these controls to remain even after the USQ was determined to be negative, thus removing the need for the controls.

The third incident referenced in this report points towards management expectations and communication regarding modifications to work packages. A work package was approved for replacing a pressure transducer and for installing a leak test assembly. When the leak testing failed, a modification was made to the work package to point to a new work package document. No mention was made of the failed leak test and the second work package was conducted to fix the issue with the leak. By conducting work in this fashion, several necessary procedures were skipped and the documentation for the change was incomplete and did not match management expectations. Furthermore, the failure to communicate the results of the leak test in the work package documents resulted in unclear procedures and historical inaccuracies in the work performed logs.

The fourth incident highlights often simple communication gaps that could result in high consequences. The WCDs for material control were not being explicitly followed; therefore, the control of materials was briefly in doubt when material had been removed from cabinets. The logs required signatures from the technician at the time of removal, but these were left blank. Although no material was lost, this could have posed a danger if material had been forgotten or an emergency situation was encountered. The management expectations for filling out these forms each and every time were not clearly enforced.

A4B1C01 *(Management policy guidance/expectations not well-defined, understood or enforced)* and A5B2C08 *(Incomplete/situation not covered)*

The second most frequently reported Cause Code pair is the A4B1C01 (Management policy guidance/expectations not well-defined, understood or enforced) and A5B2C08 (Incomplete/ situation not covered) combination. This pair of Cause Codes places the responsibility for the safe completion of work on the shoulders of the worker performing the work. Without identification of potentially harmful situations and without defined expectations of the workers and front-line supervisors, the onus is placed solely on the worker performing the work to figure out how to perform that work safely. Although most of the time workers will be able to devise appropriate plans to complete the work safely, complex evolutions with multiple workers with different levels of understanding can further compound the lack of appropriate work planning.

Examples:

NCO Affected by Nitric Acid Vapor in Room 227 of 234-5Z (ARRA)
EM-RL--CPRC-PFP-2010-0003

This occurrence involves the removal of an overhead pipe that had been previously drained of nitric acid solution. During the work evolution, some remaining nitric acid spilled on both the containment apparatus and on a worker's powered air-purifying respirator. The result of the contact with the acid on the air-purifying device was immediate discomfort to the worker and potential exposure to nitric acid vapor. The fact-finding session after the accident identified that many members of the work team were not aware of precautions and barriers that were required to be in place to prevent this type of accident. Furthermore, as the work was being prepared and staged, the on-site work crew made changes to the work plan to accommodate a different approach to the work, resulting in many hazards being missed or improperly characterized. Without strict management guidance to stop work when the scope was exceeded, and without a complete walkdown of the new situations encountered, the work was allowed to be performed in an unsafe manner that led to an occupational exposure.

Degraded Condition of High Pressure Fire Loop (HPFL)
NA--PS-BWP-PANTEX-2011-0073

The degradation of the High Pressure Fire Loop (HPFL) was a direct result of an incomplete understanding of the HPFL system and the key points of interaction with the specified work package. While executing the work package, the HPFL and subsequent fire protection systems were isolated from the flow of water to allow the work to be conducted safely. As a result of this isolation, several buildings and facilities were unintentionally isolated from fire water coverage during the work evolution. This should have placed those facilities in a Limiting Condition of Operation (LCO) while the work in those buildings was being completed. The lack of communication of the maintenance work package to the broader site management daily review, coupled with the lack of understanding of the HPFL isolation impacts, allowed this event to affect facilities beyond the intended or understood work area. The actions taken by Pantex to prevent future occurrences similar to this one underscore the lack of understanding on how the HPFL was tied to multiple buildings, and the lack of understanding of the expectations for performing work on a safety significant system.

A4B1C01 *(Management policy guidance/expectations not well-defined, understood or enforced)* and A3B1C01 (*Check of work was LTA).*

The third most frequently reported Cause Code pair is the pair of A4B1C01 (Management policy guidance/expectations not well-defined, understood or enforced) and A3B1C01 (Check of work was LTA). This pair of Cause Codes is particularly interesting when considering the defense-in-depth methodology of having multiple barriers between workers and hazards. If management policies and guidance are the first administrative barrier to an occurrence, the check of work Cause Code would be the second-level barrier to an occurrence. What these occurrences have in common is the failure of multiple barriers, leading to an occurrence. Many of these types of occurrences, similar to those referenced below, point to activity-level WP&C issues in older procedures where complacency and the normalcy of the operation can result in a loss of attention to detail and rigor required for operating nuclear facilities.

Examples:

Supercompaction of Pressurized Containers Results in Near Miss and Subsequent PISA
EM-ID--BBWI-AMWTF-2010-0024

During this occurrence at the Advanced Mixed Waste Treatment Facility (AMWTF), a pressurized fire extinguisher inside a container was compacted in a pressurized atmosphere, resulting in an uncontrolled release of pressure. Before containers are allowed to be placed in the supercompactor, the contents must be visually inspected to ensure that no pressurized containers or prohibited items exist within the containers. It was this check that failed to identify the fire extinguishers prior to the compaction of the container. The procedure for visually inspecting items provided instructions on how to inspect containers, but did not provide specific directions on how to verify items contained in plastic packaging, which is where the fire extinguishers resided. This eventually led to less than rigorous adherence to the procedures and the confusion among visual inspectors as to the purpose and rigor to be used when inspecting the containers. This less than adequate check of work coupled with the less than adequate management guidance allowed a pressurized vessel into the supercompactor. This is an example of work being performed under a standing work procedure that was not being followed due to the routine nature of the task and the first-line management's treatment of the task as routine. This was further reinforced by the immediate reactions of the supervisor after the event. Before doing a root cause analysis of the light screen failure, and before reviewing the video of the compaction evolution, the supervisor allowed the supercompactor to return to service. It wasn't until the Continuous Air Monitors (CAM) alarmed that the supervisor stopped work to address the alarms.

Communication Cable Damaged During Excavation
NA--PS-BWP-PANTEX-2010-0007

During this occurrence, an underground communication cable was damaged as a result of the wrong work package being used to conduct the work. Several fire hydrants were being installed under individual work packages that were similar but contained different buried hazard analysis. The work packages were placed in the same folder in the filing system for easier storage and to keep similar work together. When the workers began excavation they struck a buried communications line and stopped work immediately. The improper work package was signed-off by eight workers who thought that the first worker checked for the accuracy of the plan and therefore they did not need to re-verify the work package. By not checking each other's understanding of the work package, the workers exacerbated the situation and an opportunity to catch the errors was lost. Management expectations that each work package be treated as a new task were ignored by both supervisors and workers, resulting in the workers and supervisors treating this work package like all the other excavation packages even though it defined specific hazards relative to the location. In addition, while the work was being started, the discrepancies in the work plan and the worksite were noted by the immediate supervisor, but he did not act in accordance with management directives to stop work when a situation became unclear. This occurrence presents multiple examples of lack of clear management expectations coupled with multiple missed opportunities to check and verify the work to be performed.

A4B1C01 *(Management policy guidance/expectations not well-defined, understood or enforced)* and A4B1C04 *(Management follow-up or monitoring of activities did not identify problems)*

The fourth most referenced Cause Code pair grouping is A4B1C01 (Management policy guidance/expectations not well-defined, understood or enforced) and A4B1C04 (Management follow-up or monitoring of activities did not identify problems). The occurrences in this group often involve procedures that unnecessarily expose workers to hazards. Many of the occurrence reports state that managers did not follow up on corrective actions properly or did not supervise work while it was being performed. Direct observation of work by first-line supervisors or more complete communication of expectations directly resulted in several near-misses. It is important to note that, with many of these occurrences, the workers performing the work were unaware of the potential dangers of the work they perceived to safe, and it wasn't until the work evolution was completed or already in progress that serious safety issues were discovered.

Examples:

Failure to follow a prescribed hazardous energy control process - Procedural Compliance,
EM-CBFO--WTS-WIPP-2012-0004

This occurrence was the result of an improper lockout/tagout (LOTO) while performing a maintenance activity. Two maintenance technicians were performing a maintenance evolution on a ventilation system; while one worker was locking out the system, the other worker proceeded with the work by removing a cover plate on an electrical system, thereby violating the work package and LOTO guidelines. At the root of this occurrence was a lack of supervision of the task by first line supervisors and a lack of clear hazards analysis in the job plan. During the pre-job briefing the importance of proper LOTO was not emphasized by the supervisor, nor was the directive to have two persons always present when working on an electrical system (two-person rule). In addition to the event itself, the supervisors failed to enter the LOTO event in either the Facility Shift Manager Log or the Central Monitoring Room Log, thereby missing an opportunity to follow up on work procedure and work planning deficiencies associated with this work task.

Near Miss to Laser Exposure
NA--NVSO-NST-OFFNTS-2012-0001

The near miss to laser exposure occurrence at the Nevada Test Site involved several computer controlled systems that were interlinked that ultimately led to a laser being pulsed while an operator was in the room. The interrelated system was previously identified as an issue based on a similar occurrence; at that time, a method to prevent recurrence was implemented and normal operations were resumed. Each of the three laser subsystems was electronically linked and controlled via separate control rooms. At the time of this occurrence, the operator of the laser believed that previous preventive measures isolated each of the lasers from the others' control panels. The corrective actions previously put in place did not adequately address the safety hazards they were supposed to mitigate. Management did not adequately test the countermeasures to ensure that they prevented inadvertent firing of the laser, nor did they make clear the expectation that the system be tested prior to accepting the countermeasures. This set of management related causes created the proper atmosphere for the laser near miss, a finding that was confirmed by an extent of condition review conducted by the contractor.

A4B1C01 *(Management policy guidance/expectations not well-defined, understood or enforced)* and A4B3C08 *(Job scoping did not identify special circumstances and/or conditions)*

The fifth most referenced Cause Code pair is A4B1C01 (Management policy guidance/ expectations not well-defined, understood or enforced) and A4B3C08 (Job scoping did not identify special circumstances and/or conditions). These two Cause Codes illustrate the combination of less than adequate management expectations coupled with incomplete understanding of the work environment. These Cause Codes often describe occurrences in which workers encountered unfamiliar or out of scope circumstances and due to incomplete/ unenforced or misunderstood management guidance, the workers proceeded with out of scope, hazardous work.

Examples:

Multi-Canister Overpack Cask System Shipped Without Vent Plug Installed
EM-RL--CPRC-SNF-2012-0011

In this occurrence, the vent plug, a safety significant control on the Multi-Canister Overpack (MCO) Cask, was not installed on the cask prior to shipping to the Canister Storage Building (CSB). The root cause of this occurrence was determined to be the management policy guidance and expectations were not well defined, understood or enforced. This operation had been performed many times prior to this work evolution and was a well known and well understood process to close out an MCO cask for shipment. Management had, therefore, become lax in their observation of work and their adherence to specific procedures. As documented in the ORPS report, the Quality Control Inspector (QCI) became part of the work crew in order to meet schedule and quality pressures imposed after previous issues with MCO cask closures. This placed the QCI in a non-objective position and led to process steps being skipped and not visually verified in order to expedite the MCO cask closure. In addition to the management challenges, the procedures for closure of the MCO cask were written in such a way as to cross boundaries of labor contracts and personnel. This created unique challenges for both the QCI and the workers and ultimately led to a fragmented work process with added opportunities for failure. The final error in the MCO cask closure process was a failure of numerous workers and supervisors to stop work even though they had observed and mentioned deviations from the approved work plan. This occurrence demonstrates how even well-understood and well-written work procedures can be compromised when expectations are not well communicated and enforced.

Worker Crosses Barricade Tape in Building 331
NA--LSO-LLNL-LLNL-2012-0036

This occurrence details a seemingly minor violation of a temporary barrier in a facility adjacent to the work location specified in the work package. A security alarm technician crossed a yellow tape barrier to plug in an extension cord to perform work elsewhere in a facility. The technician crossed the tape barrier without a clear understanding of the conditions in the room behind the barrier and without any understanding of the hazards he might encounter. Prior to plugging in the extension cord, the technician asked an electrician if it was okay to enter the room and the electrician agreed. The room was taped off due to a potential for an oxygen deficient condition inside. The room also was roped off and entry criteria were established. Sometime after the initial barricade of the room, a second, unrelated condition led to temporary piping being run through the room. This action caused the first barrier to the room, the door, to be propped open by the piping. The expectation that the worker would stop when encountering warning tape was not effectively communicated by management to the alarm technician. As a result, the alarm technician did not feel he was entering a potentially hazardous environment. Furthermore, since the job scope had not defined the procedure to deal with unknown or abnormal conditions, the alarm technician relied upon the nearby electrician for authority to enter the room. As a result of this occurrence, an extent of condition review was conducted, resulting in the finding that the majority of workers supporting this work activity assumed that yellow tape meant “proceed with caution” and that red tape meant “danger.” This is yet another example of management policies and guidance not reaching those who are performing the work.

ORPS ISM Core Function Analysis

DNFSB/TECH-37 states that the implementation of activity-level WP&C is not complete at DOE defense nuclear facilities. In order to better understand the gaps in implementation, HSS conducted an analysis of ORPS to identify the ISM Core Functions most frequently identified as being deficient (Figure F-5). Appendix J provides a breakout of the WP&C ISM Core Functions by site.

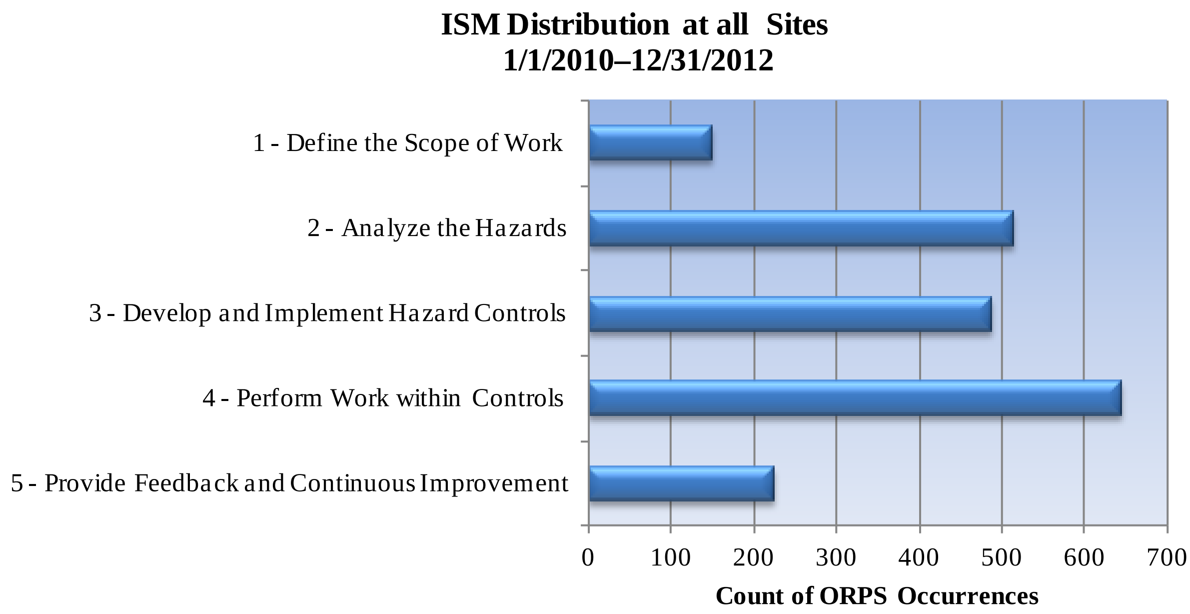
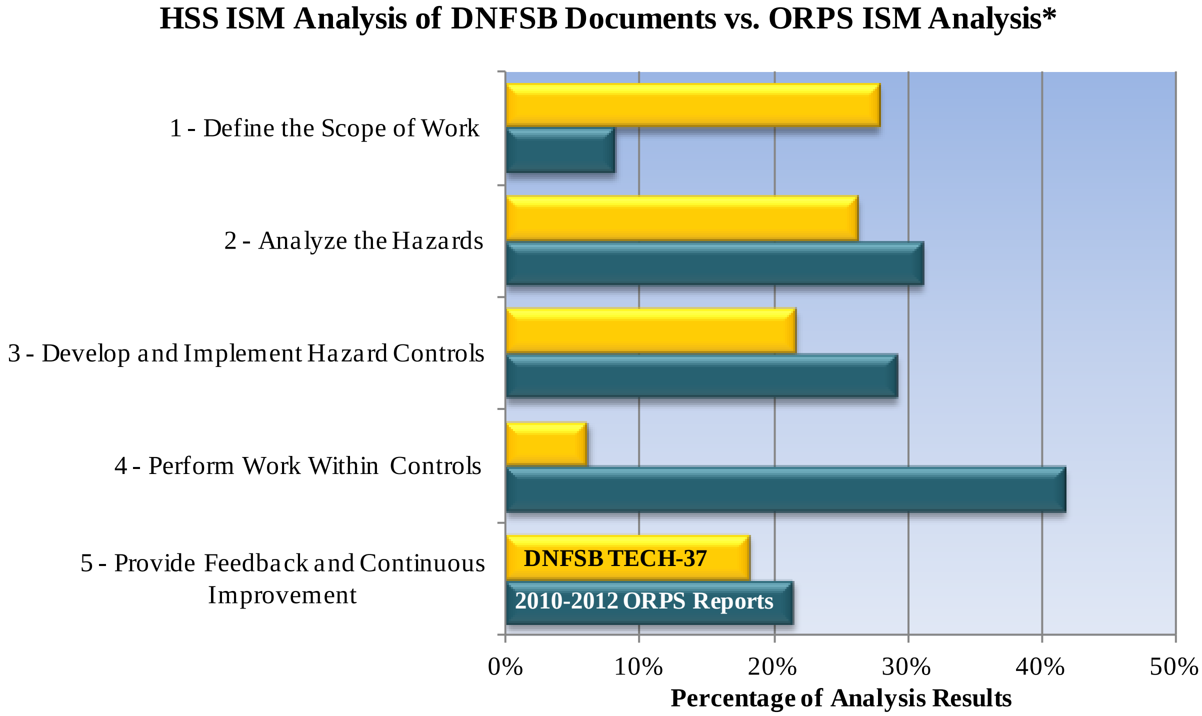


Figure F-5: DOE Defense Nuclear facilities ORPS Distribution by ISM Core Function

To further understand WP&C weaknesses through the analysis of ISM Core Functions, the results from Appendix D, *Analysis of Information from DNFSB/TECH-37 Results,* were compared to the analysis presented above at the ISM Core Function level. Figure F-6 compares ISM Core Function related weaknesses identified by the DNFSB to those identified in ORPS reports. For all but two ISM Core Functions, the DNFSB/TECH-37 and the ORPS review results are similar. However, for ISM Core Function 1 - *Define the Scope of Work* and ISM Core Function 4 - P*erform Work within Controls*, the DNFSB/TECH-37 and ORPS review results are very different; the two sets of results are opposites of each other and appear to point towards two different causes. Deficiencies related to ISM Core Function 1 - *Define the Scope of Work* tend to point towards planning and analysis deficiencies prior to work being conducted. This fits well within the DNFSB's analysis of lack of SME involvement in the planning process, and to some extent, failure to incorporate lessons learned into activity-level work planning. Deficiencies related to ISM Core Function 4 - *Perform Work within Controls,* point more toward the actual work activities being performed. These causal factors can be related to improper adherence to written procedures, failures to recognize barriers to hazards, and in some cases, performance of work without any work planning.

The DNFSB Staff Reviews indicated that pre-event management and planning issues were prevalent, while the ORPS reviews generated after the occurrence of a negative event reflect the performance of the work itself.



* DNFSB ISM Analysis Percentages are based on the number of observations made by the DNFSB whereas ORPS ISM percentages are based on the number of times the ISM Core Function was assigned out of the population of ORPS reports included in the ORPS section of this report.

Figure F-6: HSS ISM Analysis of DNFSB-identified deficiencies versus ORPS ISM analysis. Percentages of ORPS reports versus Percentages of DNFSB-identified deficiencies.

The differences between the DNFSB/TECH-37 breakdown and the ORPS breakdown can be attributed to differences in how these observations were realized. The DNFSB observations were often made prior to work being performed or as work packages were being prepared. The ORPS data, on the other hand, results from work that has already been performed.

Significance Category

The *Significance Category* field in ORPS is used to reflect perceived risk associated with a given occurrence. Risk determinations take into consideration the potential consequence of an occurrence in terms of health, safety, and security to personnel, the public, the environment, and the operational mission.

The scale of severity starts at Operational Emergency (OE) and ends at Significance Category 4 (SC4), the least severe type of occurrence. Recurring events are signified by the R, or recurring, designation.

The significance category also determines the degree of causal analysis performed by each reporting organization. Operational Emergency, Significance Category 1, and Significance Category R reports require a full root cause analysis, while Significance Category 2 and 3 require an apparent causal analysis (i.e., the most probable causes that explain why the event occurred). Significance Category 4 reports do not require the reporting organization to perform a causal analysis; however, some SC 4 reports do include causal analyses. Reporting organizations performed 25 root cause analyses and 1,107 apparent cause analyses for the ORPS reports used in the data set defined by the cause code search, which is 92 percent of the reports.

Included in Table F-3 is a listing of the number of ORPS reports at DOE defense nuclear facilities by Significance Category. Column two shows the number of occurrences included in the Cause Code analysis as filtered by the HSS methodology used in this analysis, while the third column displays the numbers of ORPS reports not included in the Cause Code analysis. Column four displays the total of both data sets. The table shows that the activity-level WP&C-related Cause Codes (column two) are applied to almost half of the ORPS reports at DOE defense nuclear facilities. Significance Category 4 ORPS reports are not required to contain a causal analysis. Therefore, the majority of those ORPS reports do not contain Cause Codes and are excluded from the Cause Code filtered data set. When Significance Category 4 occurrences are excluded, almost three quarters of the occurrences at DOE defense nuclear facilities display an activity-level WP&C component.

Table F-3: Count of ORPS Reports by Significance Category

ORPS Significance Category	Included in Cause Code Filtered Data Set	Not Included in Cause Code Filtered Data Set	Total
OE - Operational Emergency	2	6	8
SC1 - Significant Impact	2	0	2
SC2 - Moderate Impact	286	95	381
SC3 - Minor Impact	821	311	1,132
SC4 - Some Impact	104	838	942
R - Recurring	21	4	25
Total	**1,236**	**1,254**	**2,490**

When discussing Significance Category, it is also important to understand how events are proportionally distributed at each DOE defense nuclear facility. The main pattern that emerges from the analysis of the distribution of Significance Categories for ORPS occurrences with an activity-level WP&C component (Figure F-7) is Significance Category 2 and Significance Category 3 occurrences account for ninety percent of the total activity-level WP&C occurrence reports. These data demonstrate that the activity-level WP&C issues experienced at the DOE defense nuclear facilities do not always correspond with the most severe occurrences, nor do they always correspond with the least severe occurrences. The Significance Category assigned to an occurrence does not appear to be an indicator of whether or not that event had activity-level WP&C issues.

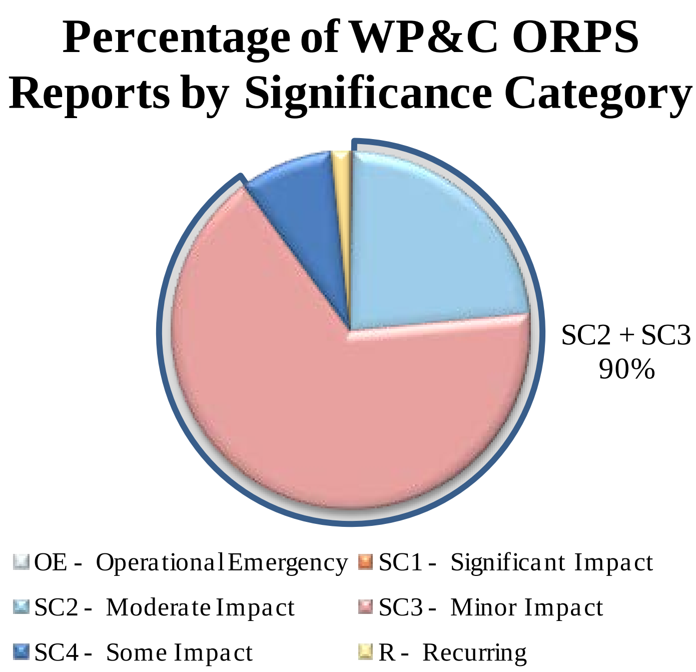


Figure F-7: Percentage of WP&C ORPS Reports by Significance Category

HQ Keywords

HQ Keywords are assigned daily to each ORPS report by the HSS ORPS Analysis Team. Each occurrence is read and discussed, and one or more HQ Keywords are assigned when a consensus is reached. These HQ Keywords represent descriptive operational areas that may have affected or been affected by the occurrence. They also provide deeper levels of understanding and enhanced search capabilities because of the limitations of narrative searches. Refer to Appendix K for a description of the HQ Keywords.

Work Planning and Control HQ Keywords

Analysis in the previous section used filtering of ORPS occurrences by WP&C-related Cause Codes. In this analysis, ORPS occurrences are organized and filtered by groups based on HQ Keywords. These groups reflect the key elements of WP&C at the activity level (e.g., Procedure/Document Deficiencies). Each of the groups comprised one or more HQ Keywords (e.g., 1B) as described below. The groupings developed here are generally consistent with the usage of WP&C terminology. The full set of ORPS occurrences categorized with these Keywords represents the second analytical data set.

Work Planning and Control HQ Keywords

- Procedure/Document Deficiencies
  - Loss of Configuration Management/Control (1B)
  - Inadequate Procedure (1G)
  - Inadequate Radiological Control Procedure (6J)
- Supervision/Management Issues
  - Management Issues (1R)
- Work Planning
  - Inadequate Job Planning – Electrical (1M)
  - Inadequate Job Planning – Other (1N)
  - Inadequate Radiological Control Job Planning (6H)
- Personnel Errors
  - Personnel Error (1Q)
  - Industrial Operations Issues (8F)
- Procedure Compliance
  - Operations Procedure Noncompliance (1E)
  - Criticality Procedure Noncompliance (1J)
  - Radiological Control Procedure Noncompliance (6E)
  - Explosives Safety Issue (3D)
  - Nuclear Weapons Safety Issue (11C)
  - Willful Violation (1T)

- Safety Compliance (OSHA/IH)
    - Safety Noncompliance (8H)
- Communications Deficiencies
    - Inadequate Oral Communication (1P)
- Safety Basis Compliance
    - Violation of Authorization Basis Elements (1C)
    - Missed/Late Surveillance (1D)
- Hazardous Energy Control
    - Lockout/Tagout Noncompliance – Electrical (1K)
    - Lockout/Tagout Noncompliance – Other (1L)
- Inadequate Maintenance
    - Inadequate Maintenance (1O)

The Keywords were distributed by WP&C grouping as displayed in Figure F-8.

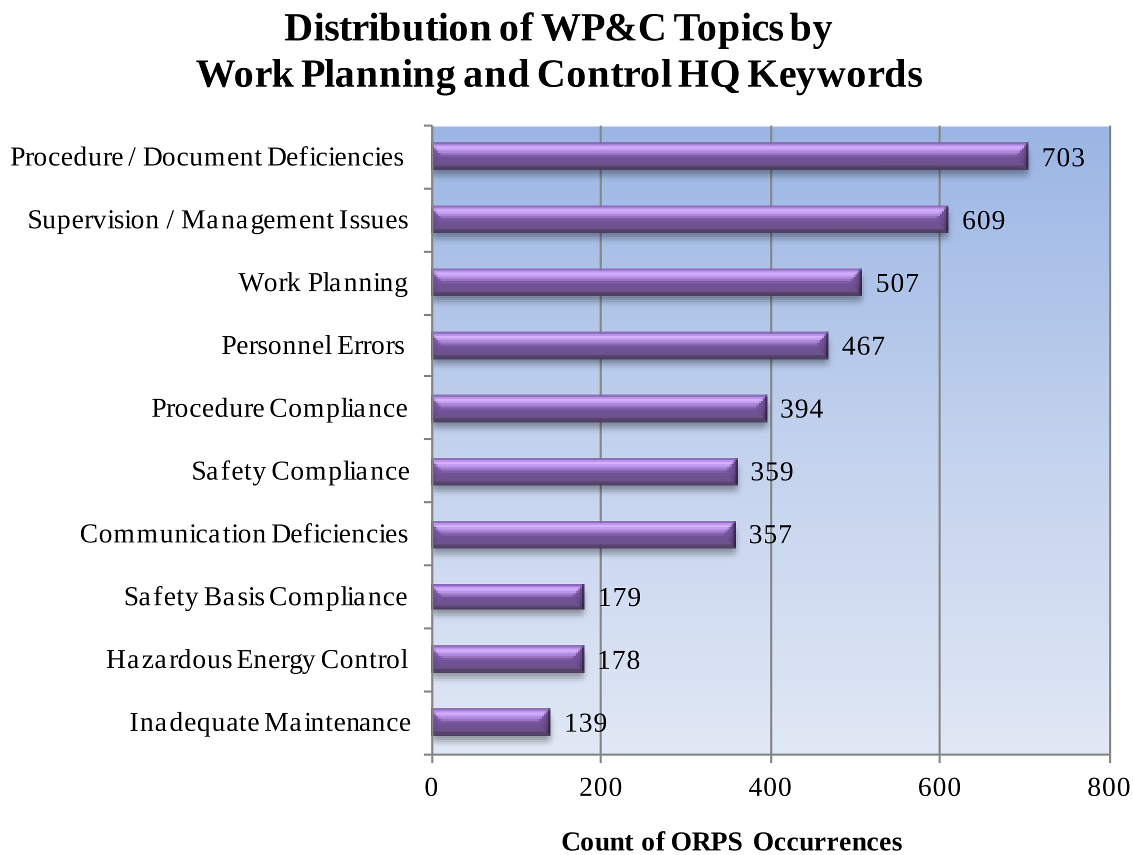


Figure F-8: Distributions of Work Planning and Control Occurrences by HQ Keyword Groupings

As depicted in Figure F-8, the Procedure/Document Deficiencies group has the greatest number of occurrences, followed by the Supervision/Management Issues group.

For each group, a representative ORPS report was summarized, along with comments on the event and how it pertains to WP&C. Appendix L contains charts showing the distribution of the WP&C HQ Keyword groups by DOE defense nuclear facility.

Procedure/Document Deficiencies

The Procedure/Document Deficiencies group relates to occurrences whose procedures were identified as technically deficient, ambiguous, non-existent, or that do not reflect as-built conditions.

Worker Sprayed with Scalding Water during a Steam Condensate Line Repair
NA--LASO-LANL-SIGMA-2011-0004

This occurrence at LANL is an example of procedure/document deficiencies. A LANL pipefitter's abdomen was splashed with scalding water, resulting in a second-degree burn while he was tightening a union on a newly installed section of a steam condensate line in an equipment room. Subsequent inspection of the steam condensate line found additional isolation points downstream on a steam trap that had not been identified during the walkdown because of congestion of overhead piping in the area.

This event highlights several procedure/document deficiencies issues:

- Due to the age of the building, no "as-built" drawings were available;
- The congested piping arrangement that hid the steam condensation piping represented an undocumented configuration management problem; and
- Had proper diagrams of the area been available, the workers might have been able to identify the additional isolation points (Loss of Configuration Management/Control).

Supervision/Management Issues

The Supervision/Management Issues group relates to less than adequate pre-job briefings, less than adequate job site walkdowns, management expectations that are not clearly communicated, incorrect personnel assignments, or inadequate number of personnel assigned to a job.

Recurring Technical Safety Requirement Violations
EM-ID--ITG-AMWTF-2012-0005

This ORPS report at the Idaho Advanced Mixed Waste Treatment Project (AMWTP) is an example of supervision/management issues. Management determined that an increasing negative trend existed when AMWTP experienced its fourth Technical Safety Requirement (TSR) violation in less than 10 weeks. All maintenance on safety significant systems was suspended until a Nuclear Facility Manager review and approval could be completed.

All of these factors highlight not only work planning issues, but also supervisory and managerial deficiencies in the maintenance program at AMWTP. These are:

- Weaknesses with maintenance WCDs;
- Weaknesses in first-line supervisors;
- Insufficient attention to detail by both operations technicians and the shift supervisors; and
- Need for an action plan for training shift supervisors and plant shift managers.

Excavator Boom Contacts an Overhead Power Line
EM-RL--WCH-REMACT-2010-0006

An excavator driven by a subcontractor operator contacted an overhead power line. The excavator was being driven from one work location to another on an abandoned asphalt roadway, which went underneath a set of overhead power lines. The excavator operator stopped, as planned, before crossing under the lines to wait for a spotter to ensure proper excavator clearance. While waiting for the spotter, the operator maneuvered the excavator boom and bucket by lowering it to a "knuckled under" position. Due to the proximity of the excavator to the power lines, the maneuver caused the excavator boom to hit one of the overhead lines. The foreman had not explicitly mentioned hazards to the operator.

This demonstrates how management issues such as ambiguous instructions/requirements, training deficiencies, and less than adequate communications of hazards by first-line management can lead to undesired outcomes.

Work Planning

The Work Planning group relates to less than adequate job planning, less than adequate hazard analysis, required permits not obtained, less than adequate scope briefings, failure to conduct pre-job surveys, and the absence of SMEs in job planning.

TSR Violation: Staging of Transient Combustibles
EM-ORO--BJC-X10WSTEMRA-2011-0001

This occurrence at Oak Ridge is an example of inadequate work planning. During a surveillance walkdown, it was discovered that about 90 cubic feet of combustible debris had been staged approximately 24 feet from the exterior of the facility, resulting in a Technical Safety Requirement (TSR) violation. Combustible materials in excess of one 55-gallon drum are required to be stored in closed containers not less than 30 feet from the facility. This violation remained undetected for 59 days until discovered during the facility walkdown by the DOE Facility Representative.

This event highlights a number of deficiencies in work planning, including:

- No WCDs were given to the workers;
- The job scoping did not identify the special circumstances/requirements;
- The pre-job briefing did not address the 30-foot requirement; and
- There was no written approval by the facility manager authorizing the work.

Personnel Errors

The Personnel Errors group relates to systems or equipment left in an unsafe state, tasks that are performed without authorization, failures related to "skill of the craft," or human performance failures.

Near Miss Related to Rotor Assembly Falling During Transport
EM-RL--CPRC-200LWP-2011-0002

This occurrence at the Hanford Effluent Treatment Facility is an example of personnel errors. A near miss occurred when a rotor assembly fell off a cart while five employees were moving it into a building. As the workers were manually pushing the rotor and carts into the building, the front wheels of the rear cart hit the transition point into the building, causing the rear cart to stop. One end of the rotor slid forward and fell to the ground.

This event highlights a number of personnel errors:

- Personnel decided to use the carts in contradiction of the work package;
- No engineering analysis was performed to ensure that the carts were safe for moving rotors; and
- When the problem occurred, personnel did not understand the need to stop work until further evaluations could be conducted.

Procedure Compliance Issues

The Procedure Compliance Issues group relates to work being performed without/before authorization, procedure steps being skipped, working outside of the scope of a procedure, systems or components not in their required position or status, and mistakes being made while performing procedures.

Lack of Formality During High Pressure Fire Loop (HPFL) Testing
NA--PS-BWP-PANTEX-2012-0053

This occurrence at Pantex is an example of procedural non-compliance. Following performance of a pipe condition loop test on four sections of the high pressure fire loop (HPFL), technicians discovered that the diesel pump at Building (B) 15-25 pump house was running. Per the test procedure, the diesel pump was required to be impaired prior to starting the test. A subsequent investigation determined that the technician, who was reading procedural steps to the work crews, intentionally skipped the steps to isolate the B15-25 from the HPFL. The technician believed the step was not needed because power was already shut off to the B15-25 pump house as a result of an electrical outage in Zone 11.

This event highlights several procedure compliance issues:

- Work was not performed within the controls;
- Procedural steps were skipped; and
- Systems or components were not in the required position when the diesel pump was mistakenly allowed to continue running.

Safety Compliance Issues

The Safety Compliance (OSHA/IH) group relates to failure to comply with health and safety procedures, failure to use required safety equipment and personal protective equipment (PPE), and failure to obey safety signage.

Beryllium Contamination from Waste Handling Operations
NA--SS-SNL-4000-2010-0006

This occurrence at Sandia is an example of safety compliance issues. The waste sorting team became aware of significant Beryllium surface contamination. On the previous day, an operation had been conducted in that room that involved a drum with a single bagged Beryllium item. Because of the sealed condition of the packaging around the Beryllium item, the high swipe results were not anticipated and did not make sense. The actual source of the Beryllium contamination was later determined to be from another operation that was conducted in the room, in which a drum was opened and the contents removed, inspected, and repackaged into a “macro” drum. The workers themselves were not alerted to the hazard.

This event highlights several Safety Compliance (OSHA/IH) issues:

- The waste drum was not labeled for Beryllium;

- Beryllium was not identified as a hazard because the disposal request excluded its presence;
- No air sampling was performed for Beryllium although surface contamination had been detected; and
- The origin of the Beryllium in the waste package remains unknown.

Management Concern: Non-Compliance with Electrical Policy During Conduct of Work
NA--LASO-LANL-HEMACHPRES-2012-0006

While subcontractor personnel were verifying required work steps for a work package, a worker opened a 480-volt disconnect to an air compressor, removed the disconnect cover and verified zero energy without performing required LOTO and without wearing proper PPE. The worker then opened the panels to the interior of the air compressor to allow measurements to be taken on de-energized circuits.

In the performance of this work, the subcontractor violated the site safety compliance procedures by not performing the required LOTO and not wearing the proper PPE.

Communication Deficiencies

The Communications Deficiencies group relates to communications between work groups or lack of work coordination.

Near Miss - Worker contacted by metal tornado door
EM-CBFO--WTS-WIPP-2010-0010

This occurrence at WIPP is an example of communications deficiencies. A subcontractor electrician was working from an extended scissor lift to install conduit next to existing overhead piping. Unaware that the electrician was working on the other side of the tornado door, a site operator working on the mobile equipment task actuated the tornado door, raising it six feet and hitting the electrician's elbow.

The event highlights several communications problems:

- There was no communication between the two work groups;
- The pre-job briefing did not include all personnel who would be performing tasks in the area;
- A vague "Caution–Men Working" bi-fold without contact information was placed in the area, but was removed by the mobile equipment operator when he did not see anyone working in the area; and
- Work order instructions did not specify tagging-out tornado door movement.

Safety Basis Compliance

The Safety Basis Compliance group relates to failure to enter a limiting condition of operations, violation of Technical Safety Requirement (TSR), Basis for Interim Operation (BIO) or Justification for Continued Operation (JCO), failure to perform surveillances or functional checks within schedule.

TSR Noncompliance: Surveillance Requirement Not Met – 15 Containers Exceeded Material Limit
NA--LASO-LANL-TA55-2012-0018

This occurrence at LANL is an example of safety basis compliance issues. The facility operations director declared a noncompliance with the TSR for Material At Risk (MAR) surveillance for containers outside gloveboxes due to a surveillance test, specifically captured in the Documented Safety Analysis (DSA), that was performed after the prescribed surveillance period. The facility identified approximately 11,000 containers for which the surveillance had not been performed.

This report highlights several safety basis compliance issues:

- Due to verbal miscommunication, surveillance tests were only performed on the 2,000 containers with multiple items;
- Failure to identify legacy containers exceeding the MAR limit during the surveillance:
- Fifteen containers were identified that exceeded the MAR limit; and
- Inability to perform tests on the 11,000 other items because of resource limits.

Hazardous Energy Control

The Hazardous Energy Control group relates to LOTO procedure non-compliance, and failure to verify a safe work condition.

Failure to Follow Work Control and Hazard Control Processes
EM-ID--CWI-IWTU-2011-0012

This ORPS report at Idaho shows two examples of hazardous energy control issues. The nuclear facility manager was notified of work control deviations in the performance of two work orders. One specific deviation included performing an inspection of the Integrated Waste Treatment Unit maintenance crane with the crane administratively controlled but not LOTO. In the second case, a foreman noticed the work performed previously by their crew had not properly followed the requirements of their work order, and LOTO requirements were not evaluated.

This report highlights several hazardous energy control issues:

- A maintenance crane was not properly LOTO;
- Work had not been evaluated for LOTO requirements;
- The work order was not properly signed in;
- A pre-job briefing was not conducted before the inspection;
- The crew had failed to get approval before performing the work; and
- The pre-job briefing and workability walkdown steps were not signed.

Inadequate Maintenance

The Inadequate Maintenance group relates to incorrect equipment being moved or replaced, errors made during maintenance or troubleshooting, poor maintenance practices, less than adequate or no preventive maintenance, and work performed outside of authorized maintenance.

Management Concern: Electro-Dynamic Shaker Hose Failure
NA--LSO-LLNL-LLNL-2011-0025

This occurrence at Lawrence Livermore is an example of inadequate maintenance issues. A water hose in the Electro-Dynamic Shaker Building split and sprayed water on electrical equipment associated with the Shaker, causing a 1,200-amp circuit breaker to trip. The electricians determined that the circuit breaker was damaged beyond repair and would have to be replaced, causing expense and program delay.

This event highlights several inadequate maintenance issues:

- After the incident, the hose was examined and exhibited discoloration at the failure point, indicating its use and age;
- The hose made an unnecessary tight bend prior to entering the coupler fitting;
- The hose was unnecessarily in close proximity to the main equipment disconnect switch, so that when it failed, water sprayed and struck the switch before the employee could turn it off; and
- The hose configuration was originally a temporary installation; however, no follow-up or inspections on this installation took place, and the temporary installation became a permanent one.

Finally, HSS performed a review and analysis of selected occurrence reports submitted to ORPS involving WP&C deficiencies. Hundreds of ORPS reports were reviewed from within the Keyword-filtered data set. Of these, 20 representative reports were selected and analyzed in-depth for WP&C applicability, causal factors, and potential lessons learned, and then summarized. The complete summaries of these occurrences, including HSS's evaluation, are provided below.

The purpose of this review was to further identify WP&C deficiencies associated with specific activity level tasks described in actual events, deficiencies that cannot easily be determined through Keyword and Cause Code analysis alone. When reading and evaluating these occurrence reports, HSS focused on the description of the occurrence involving the activity-level work, what went wrong during the work activity, and the reporting organizations' causal analysis, corrective actions and lessons learned. Many of these occurrence report summaries are cited throughout this analysis report as supporting examples of WP&C deficiencies.

Evaluation of these ORPS reports indicates that the WP&C deficiencies identified by the reporting organizations in their causal analysis and their selection of Cause Codes and ISM codes are consistent with the deficiencies identified in DNFSB/TECH-37. Observations and areas for improvement from the review of these occurrence reports are provided below.

Observations and Areas for Improvement

- The potential impact to systems that support the facility safety basis and are governed by technical safety requirements needs to be fully understood. Job planners need to work with safety engineers and facility management regarding the impact of declaring systems inoperable to ensure that action statements for limited conditions of operation are implemented and any return to operability requirements (e.g., time) are fully understood and met.
- First line supervisors need to understand and fully communicate the work scope to the workers and convey management's expectations for performing the work correctly and safely.
- Supervisors should ensure that workers have the appropriate level of experience, training, or certifications to perform the task. A quality job and a safe job require properly trained individuals. Workers who feel they are unqualified or insufficiently trained to accomplish the task should notify their supervisor.
- Ensure WCDs address not only the physical hazards of performing the work, but also any potential impact to other systems or components, particularly those that are safety class.
- Ensure that hazard screening for activity-level work is commensurate with the level of hazards associated with the work.

- Include SMEs in the planning of activity-level work. SMEs can assist the planner by providing important details associated with system/equipment functionality, operation (e.g., controls/interlocks), or interaction with other systems.
- WCDs should identify all valves (e.g., vents and drains) that need to be operated to ensure that a safe-to-work condition exists. The position of valves or the status of components needs to be documented and tags used for identification of required position. Restoration procedures should identify the proper sequence for manipulating valves or changing equipment status to ensure that the operation is performed safely and hazardous energy is controlled.
- Ensure that configuration control of systems, equipment, and components is always maintained. This can be accomplished by following hazardous energy control procedures, annotating drawings, hanging status tags, maintaining records, and log keeping.
- Stop work and reassess hazards when unanticipated situations arise or if the job scope needs to be expanded. Working outside the original approved scope can introduce unanalyzed hazards or impact systems required for safety.
- Adequately control multiple work activities within the same area and ensure the hazards for all work activities are understood by all personnel working in the same area. This can be accomplished with improved communications between working groups, using a plan of the day (POD) (with scheduled meetings), and holding joint pre-job briefings (PJB).
- Procedures and WCDs are developed to provide the best consensus method for performing work. If the procedures or WCDs are determined to be inadequate or wrong, work should be stopped until they are corrected.
- Management needs to ensure that members of the work force understand that they are accountable and responsible for the work that they perform.
- First line supervisors need to ensure that they remain in their management position (e.g., role of oversight and job direction) and not become physically involved in the task such that they lose sight of the big picture. They should also ensure strict adherence to the WCDs and avoid trying to manage multiple or complex tasks from memory.
- Pre-job briefings should include lessons learned (if available) from similar work activities. Supervisors should involve the members of the work force in the briefings by querying them on the potential hazards of the job and PPE requirements, the right tools for the job, the applicable safety rules, and what to do if something goes wrong.
- The use of a post-job briefing should be considered for feedback and continuous improvement. Feedback from workers regarding what went right or wrong is beneficial for improving job efficiency and worker safety.

- Job planners need to incorporate lessons learned from similar work activities in the planning process.
- Include members of the work force in the development of any lessons learned or improvements to work practices. This will help reinforce lessons and add a sense of ownership of the work processes.
- Consider formalizing routine tasks by providing job aids (checklists) so that workers are less likely to forget to perform important steps or forget to make critical verifications.

Summaries of Occurrence Reports

The following serve as condensed operating experience summaries, providing a summary of the event, a perspective on what went wrong, and the reporting organization's causal analysis, lessons learned, and corrective actions relevant to WP&C. A summary section also identifies WP&C issues that were determined to be important takeaways for each event.

Table F-4 identifies the types of activity-level work associated with each occurrence report. The reports selected involve a wide spectrum of work disciplines (e.g., performing experiments, research, testing, maintenance, and manufacturing).

Table F-4: Occurrence Report Activity-Level WP&C Summary

ORPS Occurrence Report Title	Activity-Level Work
Worker Receives Minor Chemical Splash to Face and Hand	Performing an experiment in a laboratory.
Work Management Process Concerns with a Safety Class Lightning Protection System	Repair roof leaks and replace flashing.
Management Concern Regarding SF6 Venting Operations	Evacuating and venting the FXR accelerator of sulfur hexafluoride (SF_6).
TSR Violation - Surveillance Requirement not conducted prior to work being performed	Perform measurements for carbon tetrachloride.
Near Miss: Wiremen Work in Vicinity of 13,200 Volt Energized Line Outside the Scope of the Work Control Document	Core drill holes in an electric utilities manhole to install conduit.
Unauthorized Work Performed on Confinement Door	Repair work on confinement doors.

ORPS Occurrence Report Title	Activity-Level Work
Required Technical Safety Requirement (TSR) Action Not Met	Flush and internally inspect the fire suppression system.
Structural Steel Arch Truss (subassembly) Slowly Collapses While Staged for Installation	Stage a structural steel arch truss for lifting and placement.
Facility Is Evacuated After Sodium Excursion Caused Fracture of Secondary Piping and Release of Asbestos	Treating residual sodium from a past process.
Worker Sprayed with Scalding Water during a Steam Condensate Line Repair	Repair a leaking steam condensate pipe.
HEPA Vacuum Sludge Removal Performed without a Radiation Work Permit	Cleaning and removing sludge from a wet/dry HEPA vacuum.
Near Miss: Laser Unexpectedly Lases During Laptop Replacement Activity Resulting in Potential Worker Exposure	Change out a laptop and adjust mounting stand alignment on a laser.
Over pressurization of Reaction Beaker	Prepare an electrolyte material for a small experimental test.
Nitric Acid Spill in Building 9815	Inspection of a valve in an acid system.
Machining of Legacy Part Leads to Indeterminate Beryllium Exposure of Machinist	Machining a legacy part.
Lithium Fire and Explosion at Plasma Material Test Facility in Bldg. 6530	Conduct an experiment involving the Liquid Metal Integrated Test System.
Implementation Deficiency with “SNL's Fire Protection Impairment” Process for Bldg. 961P Activities	Leak testing of a containment tent.
Facility Evacuation Due to Presence of Smoke	Perform a welding operation.
Criticality Safety Issue Indicate Process and Communications Issues	Photograph items in a glovebox.
PUSQ- Lifting and Rotating Fixture	Install thread locking agents when tool making.

Worker Receives Minor Chemical Splash to Face and Hand (NA--LASO-LANL-PHYSCOMPLX-2012-0002)

Activity-Level Work: Performing an experiment in a laboratory.

Occurrence Summary: While performing an experiment, a Sensors and Electrochemical Devices worker received minor splashing to her forehead and right wrist from a 10% concentration of sodium hydroxide (NaOH). After she opened a valve releasing hydrogen gas into the plastic tubing apparatus, the system over pressurized, causing one of the rubber corks on a plastic graduated cylinder to pop off and discharge the NaOH, splashing her forehead and wrist. The group leader took the worker to an eye wash station where she flushed her eyes with water for about 10 minutes. She was transported to the Laboratory's occupational medicine facility for evaluation and treatment.

What Went Wrong: The worker was calibrating the flow controllers, which is a daily operational procedure. The calibration process requires detachment of a gas line between the mass flow controller and the test stand to a calibration gauge to be attached. The worker performed these steps and reconnected the line between the mass flow controller and the test stand without turning off the gas flow. Normally, gas flow is stopped during calibration. Because the switching valve was closed, pressure in the line increased to above the design release pressure of the gas washing bottle stopper (0.5 PSI) causing the rubber stopper to pop off, splashing one teaspoon of the scrubber's NaOH solution onto the worker’s forehead, into her eyes and onto her right wrist.

Causal Analysis Summary: Although the worker had performed flow controller calibration on a routine basis and was aware that hydrogen gas flow from the test stand should be stopped during calibration operations, she did not include that step in the process. This resulted in the system becoming pressurized and the rubber stopper popping off when 0.5 PSI of pressure reached it after the worker reconnected the calibrated flow controllers. The worker also did not replace her safety glasses upon completing the calibration process.

Because the calibration of the flow controllers is a routine task in the laboratory, combined with the slight change of configuration of equipment and the addition of NaOH into the process represented in this event, a checklist outlining the steps for calibration of flow controllers might have proven an effective barrier in preventing the event.

Facility Function: Laboratory - Research & Development

Activity Category: Research

Corrective Actions (relevant to WP&C): Develop and implement a flow controller calibration checklist.

Lessons Learned: None

WP&C Issues: This occurrence underscores the importance of considering the formalization of some routine tasks to ensure worker safety. Job aides, in the form of checklists, can make certain that important steps are not omitted. The worker in this occurrence might have been distracted by her previous troubleshooting activity and then did not isolate the gas flow and did not put on the required eye protection when performing the routine operation of calibrating the flow controllers. Considering and properly analyzing the introduction of any new hazards into the operation (e.g., the introduction of NaOH into this experimental series was a change from previous work conducted by the worker) is also important.

Work Management Process Concerns with a Safety Class Lightning Protection System (NA--LASO-LANL-TRITFACILS-2011-0006)

Activity-Level Work: Repair roof leaks and replace flashing.

Occurrence Summary: A facility's duty officer discovered that two air terminals that were part of a building safety class lightning protection system (LPS) were not upright on the roof. Workers had temporarily removed the two air terminals (lightning rods) during roofing repairs. The air terminals were re-mounted at the completion of the job using the wrong adhesive. The terminals are required to be operable at all times. Terminals in a horizontal position indicated a potential inoperable state.

What Went Wrong: During the job scoping walkdown, which the assigned person-in-charge (PIC) did not attend, the roofers identified one section of flashing and guttering that required replacement in an area that did not have lightning protection. When the work planner asked whether the work would impact the LPS, the response was that it would not. As the work progressed, the roofers identified a second section of flashing and guttering that required repair, which included a LPS installation. The roofers proceeded to remove the flashing, and upon doing so, the two terminals lay down and were horizontal on the roof. The roofers contacted the PIC and informed him of the change to the LPS. The PIC did not recognize the changed status of the LPS as being abnormal. The removal and remounting of these rods as part of the job was not identified in the planning walkdown because it was not anticipated to be necessary. The workers believed that removing and remounting the air terminals was incidental work and within the scope of the job.

Causal Analysis Summary: The direct cause in this event was that the silicone adhesive (versus the approved ML-rated polyurethane adhesive) used by roofers to re-attach the terminals failed, resulting in the terminals laying over and resting on the roof in a horizontal position. The apparent cause associated with the direct cause in this event was the mistaken understanding by the PIC that the roofers could re-attach the terminals using a silicone adhesive; a common practice amongst roofers. The PIC did not recognize that the LPS was a safety significant system and thereby incorporated specific requirements (e.g., ML-rated adhesive). Another apparent cause was the lack of a caution statement regarding the LPS (such as: pause work and notify the duty officer) included in the IWD in the event that the roofers identified additional sections of repair that would potentially impact the LPS.

Facility Function: Tritium Activities

Activity Category: Normal Operations

Corrective Actions (relevant to WP&C): Work planners will add a caution statement "DO NOT DISTURB any part of the LPS. If at any time during this evolution the LPS is damaged or disturbed in any manner THEN, PAUSE/STOP Work AND, CONTACT the PIC, CSE, & TOL."

Lessons Learned: This incident occurred due to improper scoping and planning of the work package, coupled with a lack of knowledge of the classification of the LPS by the PIC and workers involved. The package allowed additional roof repairs as the need was discovered, but did not address how any changes to the LPS were to occur. The PIC was not present at the scoping walkdown, which may have added to the lack of knowledge on the classification of the system.

WP&C Issues: This occurrence highlights how easily workers can rationalize the need to go beyond the scope of the WCDs. The integrated work document (IWD) did not address the removal and reattachment of the lightning terminals.

First line supervisors need to fully understand scope of the work and clearly communicate that scope and management's expectations for performing the work safely. Stop work authority needs to be communicated so that any potential changes can be properly assessed.

WCDs need to address not only the physical hazards of performing the work but also any potential impact to other systems or components, particularly those that are safety class.

When the job scope needs to be expanded or issues arise that were not part of the original scope of work that could impact completion of the work or the safety of the workers, then the job should be stopped. Working outside the original approved scope can introduce unanalyzed hazards or impact systems required for safety.

Management Concern Regarding SF6 Venting Operations (NA--LSO-LLNL-LLNL-2010-0029)

Activity-Level Work: Evacuating and venting the Flash X-Ray (FXR) accelerator of sulfur hexafluoride (SF_6).

Occurrence Summary: A worker complained of shortness of breath after leaving a work area where a second worker was venting SF_6 from the FXR accelerator. The exposed worker was not involved in the venting task and was performing diagnosis on electrical equipment. The evacuation process requires drawing down the system to a small positive pressure and then venting the system. In this case, however, a horizontal instrumentation on a "Tee" connection was pointed in the direction of the worker who was diagnosing the electrical equipment. An industrial hygienist determined that exposure limits were not likely exceeded.

What Went Wrong: The gas venting was performed while another worker performing an unrelated task was in the vicinity. The person doing the venting is normally the only one in the vicinity. Furthermore, venting was accomplished through an instrument line that pointed at the other worker rather than through a main line pointing down into a trench. The small diameter instrument line increased the discharge velocity, which loosened internal corrosion products in the system and directed it to the worker who was diagnosing electrical equipment.

Causal Analysis Summary: The venting was performed with a worker doing an unrelated task in the vicinity of the venting operation. The person doing the venting was not familiar with what the other worker was doing in the area. Additionally, venting was accomplished through an instrument line rather than main line. Venting is normally accomplished through the main line directed downward into a trench. Therefore, the diameter of vent line was a third the size of normal and the direction of vent line was pointing horizontal rather than vertically downward. The effect was that the area of the vent "nozzle" was only one-ninth the normal size, resulting in a proportionate increase in the discharge velocity of the gas, which loosened internal corrosion products in the system and, due to the direction of the vent, caused the discharge to reach the other worker.

The subject of possible exposure from the contents of the SF_6 gas system is not new in terms of identified hazards. The Facility Safety Plan and the Accelerator Safety Assessment Document identify the concern and state controls based on referenced analyses. However, the potential of a relatively high discharge velocity dislodging corrosion products was not considered, most likely because the conditions have not been encountered before.

Facility Function: Explosive

Activity Category: Maintenance

Corrective Actions (relevant to WP&C): Revise work control documentation to reflect long-term control changes based on improved hazard evaluation. Review facility pressure systems work to ensure that the scope of activities and potential change boundaries are understood and adequately matched to hazards.

Lessons Learned: When performing standard operations, even when hazards have been evaluated, it is important that workers are aware of personnel in the surrounding area. This incident points out that, even when performing an operation that has been done for many years, other workers in the area should be aware of what operations are being performed in the local area. The combination of the second worker in the area and the smaller than normal vent line contributed to the potential exposure of an employee in the work area.

WP&C Issues: This occurrence underscores the need to adequately control multiple work activities within the same area and ensure the hazards for all work activities are understood by all personnel working in the same area. The change in the venting path was not analyzed and deviated from past practices, resulting in a different outcome (e.g., higher discharge pressure, debris in the discharge, and not directed in a safe direction). The person performing the venting operation should have stopped work or questioned the different system alignment.

TSR Violation - Surveillance Requirement Not Conducted Prior to Work Being Performed (EM-CBFO--WTS-WIPP-2010-0004)

Activity-Level Work: Perform measurements for carbon tetrachloride.

Occurrence Summary: An industrial hygienist entered through a man-door in a bulkhead to perform carbon tetrachloride concentration measurements. In taking this action he did not comply with a posting requiring him to sign in with the organization responsible for controlling access. After entering, he violated a Technical Safety Requirement when he crossed a control point barrier before the required surveillances for carbon monoxide concentration had been performed.

What Went Wrong: The industrial hygienist (IH) succumbed to self-imposed time pressure to complete his task in order to be able to leave the site to tend to a personal emergency. The Job Hazard Analysis for sampling for carbon tetrachloride did not identify the carbon monoxide hazard that could be encountered in performing carbon tetrachloride monitoring in the controlled area.

Causal Analysis Summary: The IH succumbed to self-imposed time pressure to complete his task in order to be able to leave the site to tend to a personal emergency. Communications between the IH and the roving watch (organization responsible for controlling access) were less than adequate because the IH did not contact a roving watch to coordinate entry into the area. The IH may have been desensitized to verbatim compliance with the signage because he has accompanied roving watch personnel into the controlled area on numerous occasions, thus did not have to notify them of the entry.

The Job Hazard Analysis for sampling for carbon tetrachloride did not identify the carbon monoxide hazard that could be encountered in performing carbon tetrachloride monitoring in the controlled area, nor was an additional job hazard analysis performed that identified the hazard for this specific area. The procedure for sampling for carbon tetrachloride did not address (as a Precaution or Limitation) hazards that were likely to be encountered during carbon tetrachloride monitoring in the ventilation exhaust areas.

The requirements on the signage on the bulkhead door to be entered for access into the controlled area were dated, no longer required by procedure, and had not been enforced. This may have reinforced the idea that there were no requirements for notification prior to entering the area. Adding wording to the signage at the control point that entry is subject to TSRs or surveillances would have enhanced the message and may have discouraged the IH (and others) from improperly crossing the barrier.

Facility Function: Nuclear Waste Operations/Disposal

Activity Category: Normal Operations

Corrective Actions (relevant to WP&C): Industrial Safety and Health personnel will perform a Job Hazard Analysis for monitoring carbon tetrachloride levels in the controlled areas underground. Industrial Safety and Health personnel will revise the carbon tetrachloride monitoring procedure to identify potential hazards that are likely to be encountered in the exhaust drifts.

Lessons Learned: Self-imposed time pressures can have an impact on job duties. A worker needing to quickly finish a task deviated from the work controls that were in place. The worker did not communicate with appropriate personnel before entering a controlled area that required carbon monoxide monitoring before entry. Procedure changes need to be fully reviewed by all personnel prior to using the document. Supervisors need to ensure the current procedures in place are correct and the workforce can execute the procedure as written.

WP&C Issues: This occurrence underscores the importance of informing management of any personal conflicts that might add stress, time pressures, or distractions in performing the task. When planning work, it is important to make first line supervision aware of any potential resource issues that might have a negative impact on the task.

It is extremely important that the job hazard analysis for performing a work task is adequate.

Procedures for performing work tasks need to address all hazards of the job, including hazards that are likely to be encountered when entering the work area.

Wiremen Work in Vicinity of 13,200 Volt Energized Line Outside the Scope of the Work Control Document (NA--LASO-LANL-TA55-2011-0003)

Activity-Level Work: Core drill holes in an electric utilities manhole to install conduit.

Occurrence Summary: In this near-miss occurrence, wireman electricians drilled six 8-inch cores into an electric utilities manhole that contained energized 13.2-kV cables. The 13.2-kV lines were in a cable tray, approximately 3 inches from the wall of the manhole and approximately 3 inches lower than the location of the core holes. The electricians were not the correct workers for the job and the job was performed under an IWD that did not plan for or analyze the 13.2kV hazard.

What Went Wrong: The Person-In-Charge (PIC) of the work activities was managing two separate IWDs. From June through November 2010, he used the first IWD as a work management tool but as the months passed by, his daily use of the IWD diminished and it became a work authorization document under which he could assign work. The PIC forgot the details of the IWD and assumed he could safely assign the wiremen to perform core drilling and conduit installation under that IWD in proximity to energized 13.2 kV cables. Neither the PIC nor the wiremen used the IWD to confirm that the required controls were in place and functioning, nor did they use it to confirm qualification, training, and authorization. The PIC assigned four wiremen to perform the work but the wiremen were not the correct personnel.

Causal Analysis Summary: On the day the core drilling was performed, formal Integrated Work Management (IWM) was not implemented. This resulted in the wrong personnel performing work in close proximity to energized 13.2 kV cables. Informally, the wiremen considered de-energizing the 13.2 kV cables but they determined it would have a significant negative impact on facility operations and delay work execution so they decided that eliminating the hazard was not viable because of the impact. IWM is a formal and rigorous administrative process intended to execute work safely through formal work planning and execution. The scope of work was assumed to be covered by an existing IWD but that IWD was not used on the day the work was performed. The formal IWM process was not implemented and did not function as intended.

As work progressed over a period of months, the PIC shifted from using the IWD to working from memory and therefore his understanding of what was within the scope of the IWD changed until he believed the core drilling of the manhole was within the scope of the IWD.

The original manhole was new and empty; it did not have anything installed inside. The work planning for the first IWD was intended for that manhole. When the IWD was used to authorize the work in the manhole containing energized cables, the site hazards changed. This change was not formally evaluated.

The workers had not completed all training listed in the IWD. While not all training listed applied directly to the work the wiremen were performing, they had not completed all training that did apply. Examples include confined space training and general hazards training. Training did not function as intended. Note that the training in the IWD did not cover hazards associated with energized13.2 kV cable. Failing to validate training is an indicator of the failure to implement the IWM process.

Facility Function: Plutonium Processing and Handling

Activity Category: Construction

Corrective Actions (relevant to WP&C): Require an independent (not involved in the planning and execution) electrical safety officer review of all electrical work IWDs. Document all pre-job briefings that support moderate and high hazard work.

Lessons Learned: A question regarding jurisdiction should be considered an indicator of a potential safety concern and acted on accordingly. In this case, workers and union stewards should have paused work and elevated their concerns to their line management and the PIC. A worker's belief that he or she can perform work safely is not the same as being trained and qualified to perform the work safely. Balancing multiple work activities in a work environment that changes frequently requires a PIC to make frequent decisions on whether to stop work and generate new WCDs or to continue work under an existing WCD. It also requires a worker to continually remember which IWD they are working under for the task at hand. There may be a limit on the number of IWDs a PIC should manage at one time. There also may be a limit on the number of active IWDs a worker should work under in a given time period. These are constant challenges in jobs such as construction. This event provides an opportunity to evaluate the Electrical Severity Scoring Tool. While technically accurate, a score of zero does not indicate the overall safety significance of this event. There is an opportunity to clarify the interpretation and application of the penetration permit requirements as they relate to this event.

WP&C Issues: This occurrence highlights the importance of implementing the Integrated Work Management (IWM) process and strictly following the approved IWD. Errors in implementing the IWM process are difficult to detect and usually remain hidden until an event occurs.

Working from memory rather than following an approved plan can unintentionally circumvent barriers that were established as a result of the hazards analysis process, thus placing workers at risk.

It is important to ensure that the members of the workforce are correct for the task and are current regarding any training necessary to safely perform the work.

It is important that the members of the workforce also review and follow the IWD. In this event, the wiremen failed to review and use it. After being assigned to work on the manhole, they informally defined the work based on their understanding of the work assignment, perceiving that the IWD had little value. Although the work was performed safely, taking an informal approach assumes too much risk.

Unauthorized Work Performed on Confinement Door (NA--LASO-LANL-TA55-2012-0032)

Activity-Level Work: Repair work on confinement doors.

Occurrence Summary: An engineer noticed that unauthorized work was being performed on a confinement door, which is classified as a safety class structure, system, or component. The closing mechanism for the door had been removed to adjust the door seal covers, which was outside the scope of the work. The Technical Safety Requirement Limiting Conditions of Operation was entered in accordance with requirements. The function of the door was to be closed; it remained closed even though workers removed the closing mechanism during the unauthorized work; therefore, the functional integrity of the door was not compromised.

What Went Wrong: Work was being performed on two confinement doors by two crafts; two ironworkers (one journeyman and one apprentice) for work and welding on the door frames and two carpenters (both journeymen) for work on the doors. A journeyman ironworker was considered the worker with the most experience and, even though he was not in an official position of authority, was the person the other workers looked to for direction during the workday. A carpenter asked the ironworker what he could do and the ironworker told the carpenter to work on the door seal covers on the confinement door (not scheduled for work). Both the ironworker and the carpenter viewed the door seal covers as cosmetic and not affecting the function of the door; therefore, they did not consider adjusting them as work on the door. In order to make the adjustment, they had to remove the door closing mechanism, which is part of the credited operating system for the confinement door.

Causal Analysis Summary: The direct cause of the event was the workers doing unauthorized work on the second door because they did not consider adjusting the door seal covers as working on the door. The workers considered getting the job done the primary objective rather than performing the work in accordance with requirements.

Facility Function: Plutonium Processing and Handling

Activity Category: Maintenance

Corrective Actions (relevant to WP&C): None

Lessons Learned: Continual training for craft on credited systems ensures personnel understand potential impacts of work on those systems.

WP&C Issues: This occurrence highlights how easy it can be to justify working outside of the original scope of the work package. Because the covers for the door seals appeared to be only cosmetic and did not directly affect the function of the door, the workers did not consider adjusting them to be working on the door. If adjustments to the covers were necessary, that should have been brought to management's attention for evaluation so that a formal change to the work scope and work package could be addressed.

The journeyman ironworker was not the official position of authority and should not have been assigning work, particularly work that had not been evaluated for hazards or system impact and had not been approved.

Workers need to understand the limitations and potential consequences of working on safety class equipment/systems. If training is not appropriate, then the person-in-charge needs to ensure that the workers fully understand the scope of the work.

Required Technical Safety Requirement (TSR) Action Not Met (SC--PNSO-PNNL-PNNLNUCL-2011-0004)

Activity-Level Work: Flush and internally inspect the Fire Suppression System.

Occurrence Summary: A Technical Safety Requirement (TSR) associated with a Fire Suppression System (FSS) was not met, resulting in a noncompliance. The system had been declared inoperable to accommodate preventive maintenance (flushing and internal inspection) on the FSS; however, the system was not fully returned to operable status nor was a recovery plan transmitted to DOE within the required seven days.

What Went Wrong: Due to required coordination of staff resources and underestimated time frames to complete the work, pipe flushing activities took longer to complete than planned. When the schedule slipped, the outage was extended and updated outage notifications were issued. Compliance with the procedures was questioned and discussions were held. The TSR lacked a clear definition of the word "day" as it related to COMPLETION TIME, which led to the need to interpret what was meant by "day" to establish when the recovery plan was due or when the system would be made OPERABLE. In addition, adequate administrative processes were not implemented, procedure requirements were not followed, and job planning was less than adequate to assure TSR compliance.

Causal Analysis Summary: The direct cause was that procedural steps associated with the TSR were not followed by the System Engineer (SE) and Building Manager (BM). The procedure for FSS outages requires that the SE notify the BM whenever planned or unplanned outages may extend beyond seven days; this was not done. The Job Planning Package (JPP) development tool does not include TSR criteria for determining JPP weighted values. The JPP uses a "weight" score to determine the level of management review required before initiating the work. The weight (score) for the pipe flushing JPP was 62, notifying the facility manager that additional review was required. However, the score was based on physical hazards (e.g., beryllium, working at heights, radiological) that would have been encountered with the work activity. No score was applied for systems that have TSR considerations, so no TSR compliance was discussed.

Facility Function: Laboratory - Research & Development

Activity Category: Maintenance

Corrective Actions (relevant to WP&C): Implement compensatory measures to strengthen tracking and management of TSR required actions (i.e., update Plan of Day to include specific system tracking, issue timely orders on safety basis engineer involvement in declaring a system not operable and process to document initiation and completion time for TSR actions). Revise Work Control Procedure and Electronic Service Request, as necessary, to integrate TSR considerations and risks into the work planning process. Revise Building Fire Protection System Outage Procedure to clarify the requirements for management and notification of outages of TSR related systems; clarify the minimum frequency of rounds for the fire watch; when the fire watch will be maintained and when it may be discontinued; and assurance that scope changes or delays will be reevaluated. Revise the Technical Safety Requirements Administration procedure to institutionalize compensatory measures (e.g., safety basis engineer involvement in declaring a system not operable and the process to document initiation and completion time for TSR actions) and incorporate results of the extent of condition review as applicable.

Lessons Learned: A formal lessons learned article will be submitted to the DOE list server for distribution throughout the DOE complex.

WP&C Issues: This occurrence underscores the importance of understanding the potential impact to systems that support the facility safety basis and are governed by technical safety requirements. Job planners need to consider more than just the physical hazards when planning work. They need to work with safety engineers and facility management regarding the impact of declaring systems inoperable to ensure that action statements for limited conditions of operation are implemented and any return to operability requirements (e.g., time) are fully understood and met.

Structural Steel Arch Truss Slowly Collapses while Staged for Installation (EM-ID--CWI-RWMC-2010-0002)

Activity-Level Work: Stage a structural steel arch truss for lifting and placement.

Occurrence Summary: Ironworkers were preparing to rig and lift a 35,000-pound arch truss subassembly into place, when they heard a pop and the truss began to slowly collapse on its side. The truss subassembly had been completed earlier in the day and was staged to be hoisted onto its final assembly location. Sixteen workers were in the area at the time of the collapse, and all were generally at or beyond the fall radius of the truss. There were no injuries and property damage was limited to a total loss of the truss subassembly and minor non-structural damage to a mobile crane.

What Went Wrong: The erection crew failed to install a guy wire; this created imbalanced forces on the truss causing it to slowly collapse onto an unoccupied mobile crane. The foreman's direct involvement in installing guy wires took him out of the oversight and checker role to see that all guy wires were in place and he failed to ensure that all guy wires were connected.

Causal Analysis Summary: The primary cause of the truss collapse was the failure to install the northeast guy wire, which created imbalanced forces on the truss. The erection crew worked as a team and no specific ironworker was assigned to attach the guy wire to the anchor block. The foreman installed the northwest guy wire and then failed to connect the northeast guy wire as he went to help ground personnel attach the chokers on the crane block. Direct activity involvement took him out of the oversight and checker role to see that all guy wires were in place and he failed to ensure all guy wires were connected.

Safety documents were not updated for changes in design/hazards that had been identified in similar activities. Construction management was aware of the instability problems with the truss assemblies from a previous project, but did not address hazards/mitigations in the job safety analysis (JSA) or the work package.

Communication between engineering, management, and construction was less than adequate concerning the stability of the truss bays. Engineering was not requested to formally evaluate the instability problems encountered with other projects. Consequently, the hazards associated with single bolt purlin connections, inadequate cribbing, and the lack of vertical cross bracing during assembly resulted in crew-developed mitigating actions not being evaluated and documented.

Facility Function: Nuclear Waste Operations/Disposal

Activity Category: Construction

Corrective Actions (relevant to WP&C): Clarify construction crew roles and responsibilities for each individual in the pre-jobs and in the revision to the work order for the newly added hold points and performance signatures. Provide training on roles and responsibilities during pre-job briefings. Revise the work order and JSA to add additional hazards indentified to support snow canopy and retrieval enclosure assembly and erection. The changes will include cross bracing, supports, cribbing, and tie back locations.

Lessons Learned: Seemingly minor changes in personnel, process, and practices can have significant consequences. Previous job-site supervisors identified the assembly's instability on the ground and had incorporated the use of temporary bracing to stabilize the assembly during assembly and erection, a practice that had not been proceduralized nor had the erection process or this particular practice been evaluated by engineering. The practice was not continued by the current job site supervisor and crew assigned to this task at the time of the event; the crew consisted of a combination of those experienced in the previously constructed structures and some new journeyman workers and supervisor that were less experienced. Management and workers must be aware of the potential for significant consequences from seemingly small deviations in the work process and the lack of proceduralized mitigating actions for identified problems that may not have been analyzed. Multiple successful repetitions can lead to an incorrect assumption that allows process deviations with unexpected results.

WP&C Issues: This occurrence demonstrates that even though a process is perceived not to have changed, major changes (instability) may have occurred. All the ARP buildings are of the same basic design and the basic construction method has not changed. A design change between ARP II and ARP III was not fully recognized to have changed the stability of the trusses during the assembly phase. The potential for this event to happen had existed since the first truss assembly was constructed for ARP III. Some foremen recognized the issue and mitigated the unstable assemblies with cross bracing, but without such bracing, only one barrier (four guy wires attached) prevented this incident from happening earlier.

- All workers should be aware of or able to identify hazards in the work area. They should step back or stop work at the time the hazard is identified until mitigation has been implemented.
- The mitigation of hazards should be formalized to ensure it is passed on to other groups who could be involved with similar activities.
- Management must ensure that all process changes are fully identified and the associated hazards recognized and mitigated.
- It is important for foreman or first line managers to remain in their role of oversight and supervision and not get actively/physically involved in the workers’ actual tasks.

Facility is Evacuated after Sodium Excursion Caused Fracture of Secondary Piping and Release of Asbestos
(EM-ID--CWI-BIC-2011-0009)

Activity-Level Work: Treating residual sodium from a past process.

Occurrence Summary: While D&D personnel were treating passivated sodium in the Sodium Boiler Building, a pressure excursion occurred in the piping with sufficient force to fracture and separate a piece of a dead-leg, 12-inch pipe that extended outside the building. This ejected treatment solution from the piping and dislodged pipe insulation from the piping to the courtyard area between buildings. Personnel left the area upon hearing several loud noises and called the fire department. A release of asbestos had also occurred that exceeded reportable quantities. One individual was exposed to a fine mist of treatment solution; physicians reported no physical evidence of any injury and released the individual from observation.

What Went Wrong: Investigators believe that the most probable cause of the mechanical failure was a sodium-water reaction, exacerbated by the differential pressure on a large volume of water in the 12-inch header and the complex geometry of the secondary system. The large hydrogen gas generation from the sodium-water reaction products impacted a water slug that accelerated with great force and fractured the dead leg outside the building, causing it to fail and separate from the system and eject a large volume of treatment solution, water, bicarbonate, and hydrogen gas to the environment.

Causal Analysis Summary: The hazard analysis did not recognize the potential for water movement and alternate water flow paths, or that an external pipe was outside an exclusion area. It also did not recognize that a large inventory of water left in the system might react with the sodium and would be a potential hazard. The Engineering Design File (EDF) established process controls and limits to account for the unknown amounts and location of sodium by limiting the amount of water available for reaction. However, in addition to unclear dose limits when no reaction was detected, it failed to account for unexpected movement of the dose water to unmonitored portions of the piping, allowing for level rises and reactions causing massive movement of water. Furthermore, the lack of accounting for the volume taken up by the sodium bicarbonate, even with a proper dosing strategy, could have resulted in a totally filled line with a sodium reaction that would have resulted in overpressure.

The response to management self-assessment (MSA) recommendations was inadequate for extent of conditions: the work order did not incorporate the MSA recommendation to provide operator actions necessary to prevent undetected non-passivated sodium from being totally immersed in liquid dosing solution.

The procedures were exceedingly difficult to follow and, in some cases, conflicted with the requirements of the EDF. The procedures allowed excessive use of “Engineering direction” and failed to incorporate all lessons learned from the MSA. These deficiencies had the cumulative effect of creating error-likely situations for the system operators. The instructions in the written communication were unclear, uncertain, or interpretable in more than one way. Different procedures related to the same task contained different requirements. Conflicting or inconsistent requirements were stated in different steps of the same procedure. Requirements were stated in different units.

Facility Function: Balance of Plant - Infrastructure

Activity Category: Facility Decontamination/Decommissioning

Corrective Actions (relevant to WP&C): Revise Engineering Design File to incorporate lessons learned and address findings and issues from the excursion. Prepare a new Sodium Treatment Work Order to include lessons learned and address deficiencies identified during the independent investigation of the sodium excursion.

Lessons Learned: The formal root cause analysis (Barrier Analysis) identifies a missed opportunity to prevent the event: a Management Self Assessment (MSA) Observation about unplanned movement of water into regions containing un-reacted sodium. Unlike a Finding, an Observation does not require a corrective action plan, and D&D's response to this observation was to lower the control rate for injecting treatment solution (dosing). Known after the fact is that controlling dosing did not prevent the resultant water hammer. The D&D engineering department, independent technical checkers of the Engineering Design Files (EDFs), and an independent assessment team missed the implications and probability of a water hammer. Had more focus been placed on the MSA Observation, perhaps to the level of attention required for a Finding, the project may have recognized the water hammer potential and instituted controls to prevent the event.

WP&C Issues: This occurrence highlights the importance of performing a thorough hazard analysis that addresses all possible/potential undesirable system interactions. The existing analysis did not recognize the potential for water movement and alternate water flow paths, or that an external pipe was outside an exclusion area. In addition, it did not recognize that a large inventory of water left in the system might react with the sodium and would be a potential hazard.

- Procedures need to be written clearly and not include ambiguous or conflicting directions. In this occurrence, the procedures were exceedingly difficult to follow and, in some cases, conflicted with requirements in other documentation. The procedures allowed excessive use of "Engineering direction" and failed to incorporate all lessons learned from a management self-assessment. These deficiencies had the cumulative effect of creating error-likely situations for the system operators.

- It is important that work orders incorporate recommendations and lessons learned from assessments or other occurrences that are relevant to the work activity. The work order did not incorporate the management self-assessment recommendations to provide operator actions necessary to prevent undetected non-passivated sodium from being totally immersed in liquid dosing solution.

Worker Sprayed with Scalding Water during a Steam Condensate Line Repair (NA--LASO-LANL-SIGMA-2011-0004)

Activity-Level Work: Repair a leaking steam condensate pipe.

Occurrence Summary: A pipefitter was sprayed with scalding water on his abdomen resulting in a second-degree burn. The worker was tightening a union on a newly installed section of a steam condensate piping when scalding water (condensate) built up in a steam trap and backed up through the newly installed union.

What Went Wrong: As pipefitters were completing the repair work, an unexpected system upset occurred on the steam condensate line, discharging condensate that built up in the steam trap located on a leg of piping that had not been identified during a system walkdown. A maintenance coordinator had closed the valve to the condensate holding tank to isolate a leak and did not properly control the valve's change of position. If the valve had remained open, it would have allowed the condensate build-up to discharge downstream to the condensate holding tank. Because the valve was closed, the condensate flowed upstream until it found an opening in the steam condensate system, which in this case was the newly installed union.

Causal Analysis Summary: The walkdown to identify the isolation points on the steam condensate line was hindered by overhead piping congestion and a leg of piping off the main steam condensate line on which isolation points (valve and steam trap) were missed.

The maintenance coordinator told the rest of the crew that he had closed the condensate holding tank valve; however, the workers did not recall that information. Neither an administrative lock nor a caution tag had been applied to or completed for the valve. The application of an administrative lock and caution tag on the condensate holding tank valve might have served as indicators for the walkdown participants to question their application and any special controls associated with the equipment. Because of these discrepancies, the condensate holding tank valve remained closed during the repair work, preventing the drainage of the condensate built-up to the condensate holding tank when the unexpected system upset occurred.

Because of the age of the steam system (commissioned in the 1950s), no as-built drawings were available for the workers to review before and during the work. The workers relied on system walkdowns to identify the isolation points for the work, but due to the circumstances noted above, these were missed. This event illustrates the need for work planners and operations personnel to consider the feasibility of a facility steam outage or other alternatives for any future steam leak repairs during the work planning phase.

Facility Function: Laboratory - Research & Development

Activity Category: Maintenance

Corrective Actions (relevant to WP&C): Maintenance Work Control management revised the MSS work planning procedure such that, if the normal depressurization path cannot be performed to within the LOTO boundary, work planners are to develop a plan using other methods to ensure system or component is adequately isolated, depressurized, and drained. Specifically, the revision instructs the work planner, when there is a potential for energy re-accumulation, atmospheric drain and/or vent between the component to be worked and source of pressure, to LOTO the component in the open position to de-pressurize the system. The LOTO will accommodate (1) boundary isolation leak; (2) steam trap accumulation; and (3) thermal expansion or contraction.

L**essons Learned:** When performing work on a low-pressure steam system, work planners should consider taking a complete system outage to ensure the facility system is de-energized and purged of any stored energy. They should also evaluate the adequacy of personal protective equipment to minimize the potential for worker exposure to hazardous energy while working on a pressurized system.

WP&C Issues: This occurrence highlights how easy it can be to engage in at-risk behavior. In this case, a maintenance coordinator was aware of the LOTO requirements, but did not recognize that closing the valve without a LOTO increased the potential risk for exposure to a thermal source.

- Altering the configuration of components or systems without following established controls can have an impact on job planning, particularly in the area of controlling hazardous energy. Proper documentation (e.g., tags) can ensure that workers will not have to rely on their recollection that configuration changes have been made.
- Whenever system walkdowns are inadequate to understand the system, or the as-built documentation is not accurate or unavailable, the need to conduct a system shutdown/outage should be considered during the planning process if there is doubt about the isolation points (barriers) for hazardous energy control and re-accumulation of energy.
- Involving subject matter experts in the planning process is always prudent to ensure that there is an adequate understanding of the system operation when determining hazards and barriers (e.g., the operation of the steam trap and system flow paths for hot condensate).

HEPA Vacuum Sludge Removal Performed without a Radiation Work Permit (NA--LASO-LANL-SHOPSFAC-2010-0001)

Activity-Level Work: Cleaning and removing sludge from a wet/dry HEPA vacuum.

Occurrence Summary: Subcontractor custodians were cleaning and removing sludge from a wet/dry HEPA vacuum without a required radiation work permit (RWP) and the work was not covered under their current IWD. The custodians said that it was common practice to remove sludge from the HEPA vacuum without a RWP, even though one is required for this activity. Routine uranium bioassay results for the two custodians showed no detectable activity.

What Went Wrong: The custodians did not understand the limitations of their work tasks or the need for specific radiological controls. The IWD only addressed the use of the HEPA vacuum, not cleaning it or that radiological controls needed to be followed to prevent personnel contamination or exposures. There was a lack of understanding of the custodial work tasks among many organizations, including the custodian's supervisor.

Causal Analysis Summary: The machine shop area is designated as a radiological controlled area. The HEPA vacuum was labeled as "Radioactive Material Radioactive Waste." The custodians used the HEPA wet/dry vacuum cleaner to pick up water/debris after mopping or in the event of spills in the shop. The use of the HEPA vacuum cleaner was identified in the custodial IWD. The personal PPE required for the vacuum's use included coveralls, modesty clothing, booties, and one pair of gloves.

One of the custodians stated that this work was currently and had previously been performed without an RWP. According to the custodian, after using the HEPA vacuum cleaner, they decant the water down the local radioactive liquid waste drain using a screen to collect the sludge. The HEPA vacuum filter is washed in the same drain. The sludge is then collected with a scoop and placed in a 5-gallon can for proper disposal. During this work, the custodians wear the PPE as noted in the custodial IWD, consisting of coveralls, modesty clothing, booties, and one pair of gloves.

The maintenance coordinator (MC) team leader stated that he was unaware of the details of using and emptying the HEPA vacuum cleaner. He indicated that he knew custodial and programmatic personnel used and drained the vacuum cleaner, but did not realize the vacuum cleaner was opened for draining until the custodian mentioned it during the walkdown. Neither the custodial supervisor nor the Prototype Fabrication Division management were aware that custodial and programmatic personnel had been cleaning and removing sludge from the HEPA vacuum until the custodian mentioned it. As a result, the cleaning and removal of sludge from the HEPA vacuum cleaner was not identified in the custodial or programmatic IWD. Furthermore, radiological personnel had not reviewed the work to determine if an RWP was warranted for the task.

Facility Function: Balance-of-Plant - Machine shops

Activity Category: Normal Operations

Corrective Actions (relevant to WP&C): The custodial IWD was revised to incorporate the cleaning and removal of sludge from the HEPA vacuum cleaner. The IWD referenced a RWP for the operations of the wet/dry HEPA vacuums.

Lessons Learned: None

WP&C Issues: This occurrence underscores the importance that supervisors fully understand the tasks being performed by their workers and the potential for exposure to hazards. The maintenance coordinator team leader was unaware of the details of using and emptying the HEPA vacuum cleaner and potential exposure to radioactive material. Also important is that the workers have a questioning attitude regarding their own safety and not simply continue to perform their tasks based on the mindset of “that’s the way it’s always been done.” The full scope of the work should have been evaluated for radiological controls and appropriate PPE in accordance with an approved radiological work permit.

Near Miss: Laser Unexpectedly Lases during Laptop Replacement Activity Resulting in Potential Worker Exposure (NA--LASO-LANL-FIRNGHELAB-2012-0004)

Activity-Level Work: Change out a laptop and adjust mounting stand alignment on a laser.

Occurrence Summary: A subcontractor and a process engineer were changing out a laptop and adjusting the mounting (jack) stand alignment on a Laser Marking Technologies 30 watt Neodymium-doped Yttrium Aluminum Garnet (Nd:YAG) laser system when they heard the laser unexpectedly operate and observed a flash of light. The Nd:YAG laser is a Class IV system with a Class I enclosure. The workers, who were not wearing protective eyewear, immediately closed the Class I enclosure door and donned protective eyewear. They re-opened the door to verify the laser had fired and, as the subcontractor adjusted the jack stand, they both heard the laser fire again and observed a flash of light in spite of the laser being in a configuration where the interlock should have prevented firing.

What Went Wrong: The laser unexpectedly lased while the enclosure door was open because a default setting in a software upgrade had disabled the interlock. The type of interlock (software-based versus hardware-based) was not evaluated by the workers or a laser safety officer before the work activity and, therefore, the possibility that it was a software interlock that could be impacted by the software upgrade was not considered.

Causal Analysis Summary: The work activity of replacing the laptop had never been performed before and was necessary because the original laptop, which is believed to be 8 to 10 years old, failed on March 13, 2012, which was also the last documented interlock check. The laptop replacement involved connecting the replacement laptop and verifying that the interface between the laptop and laser was operable. The replacement laptop contained the manufacturer's software upgrade that had a default setting, which disabled the interlock, allowing the laser to fire when the enclosure door was open.

The technical configuration of the laser was not understood from the time of initial setup until after the event. As a result, an accurate hazard analysis could not be performed. In this case, there was a long-standing belief that the Laser Marking Technology laser interlock was a hardwired magnetic circuit. In actuality, the interlock was a software interlock. Without the knowledge that the interlock was software-based and reflecting the belief that it was a hardware interlock, the potential impact of a software upgrade on the interlock was never perceived as a hazard and was not evaluated. The manufacturer's documentation did not provide technical information about the type of interlock on the laser marking system.

Facility Function: Explosive

Activity Category: Facility/System/Equipment Testing

Corrective Actions (relevant to WP&C): Update the Laser Laboratory Inspection Form to include a checkbox and verbiage such as "Has the laser owner or designee confirmed with manufacturer that any included software does not control the interlock?"

Lessons Learned: A complete understanding of the entire system, including the base equipment, ancillary equipment such as interlocks, software, and all components function together as a unit, is essential prior to troubleshooting, repairs, or upgrading equipment/software.

WP&C Issues: This occurrence underscores the importance of understanding the actual configuration and operation of equipment or system safety features. Without that level of understanding, a thorough hazards analysis cannot be accomplished.

- When testing the operation of safety features, ensure that workers know how the safety feature (e.g., interlock) actually functions. The operation of the interlock needed to be evaluated before the work activity was approved. Doing work based on beliefs that are not supported by facts can result in exposure to hazardous conditions.
- Work with the equipment manufacture to ensure that the operation of all safety features is understood and documented.
- Always wear personal protective equipment adequate for the task.

Over-pressurization of Reaction Beaker
(EM-SR--SRNS-SRNL-2012-0004)

Activity-Level Work: Prepare an electrolyte material for a small experimental test.

Occurrence Summary: The contents of a beaker over-pressurized and damaged the beaker and inner glass of an inert glovebox when a researcher prepared an electrolyte material for a small experimental test electro-chemical cell. The material quickly over-pressurized as it vigorously bubbled after the material was mixed in a beaker. No injuries occurred.

What Went Wrong: The researcher failed to respond to indications that the chemical reaction was not proceeding as planned and did not stop to reassess what was happening. Although the researcher was aware of uncertainty and potential consequences associated with the experiment, the researcher failed to account for these in the planning process.

Causal Analysis Summary: The uncontrolled exothermic reaction was caused by the researcher's overconfidence in evaluating the correctness of his knowledge. The chosen course of action was selected based on evidence that favored it and contradictory evidence was overlooked. The experimenter failed to respond to indications that the chemical reaction was not proceeding as planned. The experimenter was aware of uncertainty and potential consequences but failed to account for these in the planning. The criteria for rigor for first-time experiments did not exist.

The technical work documents lacked detailed information. The Electronic Hazard Analysis Program for experimental activity had no information on work being performed. The experimental design lacked specificity and had no bounding calculations or thresholds for activity. There was an over-reliance on experimenter skill of craft. The level of detail in written instructions was less than adequate.

Facility Function: Laboratory - Research & Development

Activity Category: Research

Corrective Actions (relevant to WP&C): Incorporate management expectation/requirements for R&D directions, new chemical experiments, peer review, and bounding release calculations for gloveboxes into training. Incorporate expectations for shielding experiments in gloveboxes and hoods. Conduct a review of Hazard Assessment Packages (HAPs) associated with positive pressure gloveboxes and determine if the HAPs are properly bounded.

Lessons Learned: When physical signs indicate that a reaction is not going as planned, workers should take a time-out to determine what is occurring and why it is occurring before proceeding.

WP&C Issues: This occurrence underscores the need to ensure that the design of experiments is specific and that bounding calculations have been performed. It is also very important not to rely totally on the skill of the experimenter and to ensure that instructions are written with adequate levels of detail, especially for first-time experiments.

Nitric Acid Spill in Building 9815
(NA--YSO-BWXT-Y12NUCLEAR-2011-0017)

Activity-Level Work: Inspection of a valve in an acid system.

Occurrence Summary: Approximately 50 gallons of 50% nitric acid spilled into the Building 9815 basement after restoration of the nitric acid system following the inspection of a valve.

What Went Wrong: A chemical operator was asked to drain the system before the maintenance workers removed and inspected the valve. The chemical operator assumed he should leave the drain valve open for safety reasons and did not seek guidance before taking that action. After inspection and re-installation of the valve, the LOTO was removed. During system restoration, two chemical operators discovered the open drain valve and that nitric acid had spilled into the basement.

Causal Analysis Summary: Maintenance craft personnel requested a chemical operator to drain the system prior to performing their job; however, they failed to notify the process supervisor of their request to open the valve. The chemical operator opened the valve and left it open, assuming that the valve should be left open for safety reasons to support the maintenance work. He was not directed to leave the valve open. The chemical operator failed to notify the Balance of Complex (BOC) shift manager of a deviation from the system alignment checklist and that the valve was left open.

Facility Function: Uranium Conversion/Processing and Handling

Activity Category: Inspection/Monitoring

Corrective Actions (relevant to WP&C): Conduct a briefing on establishing field conditions for component deviations. Conduct a briefing to ensure interface activities with operations are documented in work instructions.

Lessons Learned: Management should reinforce with employees that they should follow procedures and not deviate from requirements of performing work. Management should also remind employees to obtain guidance from supervisors when they are not sure about the proper steps to take in situations like this.

WP&C Issues: This occurrence highlights the importance of communicating any changes in system configurations to authorities.

- Altering the configuration of components or systems without following established controls can have an impact on job planning, particularly in the area of controlling hazardous energy. Out-of-position valves that are unknown to workers performing equipment/system restoration can result in unsafe consequences.
- WCDs should identify all valves (e.g., vents and drains) that need to be operated to ensure a safe-to-work condition exists. The position of valves or the status of components needs to be documented and tags used for identification of required position. Restoration procedures should identify the proper sequence for manipulating valves or changing equipment status to ensure that the operation is performed safely and hazardous energy is controlled.

Machining of Legacy Part Leads to Indeterminate Beryllium Exposure of Machinist (NA--LSO-LLNL-LLNL-2010-0004)

Activity-Level Work: Machining a legacy part.

Occurrence Summary: A journeyman machinist unknowingly machined a Beryllium part in a non-Beryllium work area. While working the part (identified as non-hazardous) on a lathe, the machinist noticed a change in the behavior of the legacy part. The machinist mentioned the anomalous behavior to a senior machinist who immediately recognized the behavior as characteristic of machining Beryllium. Surface samples were positive for Beryllium and a nasal swab of the affected machinist was positive for Beryllium.

What Went Wrong: The legacy part had lost its identity when it was separated from its bag and tag and other associated labels and, thereafter, was improperly handled as unclassified and nonhazardous.

Causal Analysis Summary: Management did not ensure that processes to control the legacy part were implemented and this resulted in misidentification of the hazards and classification and allowed the legacy part to be handled and machined without the necessary controls.

The customer incorrectly communicated the hazards and classification to the engineering shops. The Nuclear Weapons Engineering (NWE) coordinator lacked adequate process knowledge and instructions from the NWE De-Inventory leader to successfully perform the customer responsibility. The shop's defined work acceptance process was not followed; this work acceptance process lacked criteria on the quality of the information process. Strict adherence to the Integrated Work Sheet (IWS) controls in the Building 321A main bay was not maintained.

The NWE De-Inventory Project represents an adequate process designed to mitigate against various legacy part vulnerabilities and risks. This process incorporated continuous improvements including the use of lessons learned from past occurrences and incidents. Had the process been shared with workers and management in the machine shop, it could have averted the machining of beryllium.

Facility Function: Balance-of-Plant - Machine shops

Activity Category: Normal Operations

Corrective Actions (relevant to WP&C): Develop formal procedures that document the processes used to control or mitigate hazards/risks from legacy or unknown materials in the de-inventory project. Review current materials management procedures and processes with special attention paid to the identified assessment and corrective actions. The review will be used to identify gaps and deficiencies in materials management requirements for handling, marking, transporting, and documenting classified parts. This evaluation will be done by evaluating past assessments, issues, and comparing materials management requirements to existing implementing procedures.

Lessons Learned: Workers incorrectly assumed they had adequate knowledge to disposition this legacy item. A clear expectation to apply conservative decision making and a questioning attitude might have increased the likelihood and frequency of stopping activities when uncertain. Management of work activities had areas of organizational weakness that created a set of barrier failures at the interface of work request by the customer and work acceptance by the service provider. Latent organizational weakness in information management systems resulted in legacy material being misidentified.

WP&C Issues: This occurrence highlights the importance of analyzing hazards so that adequate barriers can be implemented for worker protection. Ensuring that hazardous materials are properly packaged and conspicuously identified is extremely important, as is having mechanisms in place for tracking these materials from one organization to another. Sharing lessons learned across organizations also is important to ensure that similar problems can be prevented.

Lithium Fire and Explosion at Plasma Material Test Facility (NA--SS-SNL-1000-2011-0007)

Activity-Level Work: Conduct an experiment involving the Liquid Metal Integrated Test System.

Occurrence Summary: At the Plasma Materials Test Facility, part of a test assembly containing liquid lithium in a vacuum chamber failed, resulting in a small flash fire and explosion. Three individuals in the vicinity of the vacuum vessel reported some degree of ringing in their ears, but a total of four individuals were sent to Medical for evaluation. The pressure from the explosion damaged the vacuum chamber and a panel of riveted wall siding and an exterior door.

What Went Wrong: Lithium was inadvertently flowed through the test loop, causing the lithium preheater to fail structurally. The failed preheater presented severe cracking that was consistent with liquid metal embrittlement resulting from interaction with hot liquid lithium. During follow-up, the accident investigation team (AIT) determined that the 1018 materials (i.e., mild steel) specified for use in the lithium preheater were susceptible to liquid metal embrittlement, as indicated by intergranular fracture surfaces observed through metallographic analysis. The failed lithium preheater allowed molten lithium to spray out and impinge upon the ceramic cooling annulus of electron beam gun 2. This caused the ceramic to fail resulting in a loss of containment of the coolant in the electron beam gun 2 cooling system. Molten lithium and coolant composed of water and polypropylene glycol (PG) were able to mix, resulting in a rapid release of pressure resulting from a steam explosion, a hydrogen explosion, or a combination of the two.

Causal Analysis Summary: The direct cause of the incident was the material failures in the lithium preheater and ceramic cooling annulus, which allowed a chemical reaction between molten lithium and water coolant. A design selection process allowed the specification of materials for the lithium preheater in too narrow of a design. An incomplete hazard analysis (HA) to identify hazards and controls to prevent the lithium and water from combining and initiating the chemical reaction was another root cause.

Each of the systems involved in the incident had been used previously to conduct tests. Based on this experience, personnel placed too much confidence in the past performance of the systems and did not consider failure modes. As a result, an incident occurred in which serious injury could have easily happened.

The 1658 Activity Level Work Approval and Authorization identified lithium as a low rigor, but only addressed handling the cask. It did not address processing with lithium (the work being performed). The operational team had a mental model of the lithium being contained in a 'closed loop', and did not identify it as a hazard. The test was improperly classified as “low hazard” in the Primary Hazards Screening (PHS) and “low rigor” in the WP&C process. Work control governing the setup work before the test lacked rigor and formality. The hazards encountered during setup in this case were performed outside of approved procedures, checklists, and WCDs.

The Fire Protection Assessment (FPA) performed for 6530 in 2008 mistakenly identified lithium batteries, rather than lithium.

Facility Function: Laboratory - Research & Development

Activity Category: Normal Operations

Corrective Actions (relevant to WP&C): Develop a Group 1650 Engineering Management Plan that describes the minimum requirements for design and review processes. Engineered safety principles will be integrated into this process, which includes documenting the analysis of hazards and hazard mitigation using engineering and administrative controls. Perform an awareness activity within the Center on recognizing and taking action when encountering an unexpected condition or situation. The Conduct of Operations Department will coach the management team on WP&C processes and changes annually through a formal briefing presentation.

Lessons Learned: Identifying and evaluating every serious potential hazard is a critical step when conducting a test that involves integration of multiple systems being used in new ways. Simply combining systems with the expectation that each component will work as expected is not adequate to protect workers. Each of the systems involved in this incident had been used previously to conduct tests. Based on this experience, personnel placed too much confidence in the past performance of the systems and did not consider failure modes. As a result, an incident occurred and while no personnel were seriously injured, serious injury could easily have happened.

The failure of the component was anticipated. However, the manner in which the component failed and the contact of the liquid lithium with other materials inside the vacuum chamber was not sufficiently considered or evaluated. The escaping liquid lithium contacted surfaces that failed due to the reactive nature of molten lithium. The surface failure of the cooling line resulted in the fire/explosion. Personnel in the area heard and felt the impact of the explosion with temporary symptoms such as ringing in the ears.

The EB1200 system was not used previously for work with molten lithium but tests with molten lithium had been conducted previously with the EB60 system. The Liquid Metal Integrated Test System (LIMITS) was viewed as a closed loop system. However, the failure of the preheater was a recognized possibility. Lithium was inadvertently allowed to flow through the loop during the pre-test activities, causing the preheater, at a much lower temperature than the lithium, to crack. Once the preheater failed, there was an open loop and lithium escaped.

WP&C Issues: This occurrence underscores the importance of conducting a comprehensive hazard analysis to evaluate potential hazards associated with conducting a test that involves the integration of multiple systems. The interaction of each system could introduce unanticipated hazards and these must be adequately analyzed to protect the workers.

- Hazard screening for activity-level work needs to be commensurate with the level of hazards associated with the work (e.g., working with lithium is not a low hazard).
- The setup of work controls must be accomplished using formalized procedures and checklists.
- All failure modes associated with each of the integrated systems need to be considered when implementing hazard controls and mitigating strategies.

Implementation Deficiency with Fire Protection Impairment Process (NA--SS-SNL-1000-2012-0001)

Activity-Level Work: Leak testing of a containment tent.

Occurrence Summary: After leak testing with smoke a containment tent that housed a chamber containing depleted uranium and leaving the chamber in the building overnight, the impaired smoke detectors were not reactivated after testing, leaving the material and facility potentially at risk. The testing was conducted under a Facilities Fire Protection (FP) Impairment Permit that should have considered turning the FP system on/off each day.

What Went Wrong: Workers failed to reinstate the fire protection system (i.e., smoke detectors) after completing the smoke test of the containment tent. The impairment permit did not identify that the impaired systems be turned on/off each day.

Causal Analysis Summary: The FP impairment process was improperly implemented, as the FP process requires that the FP system be turned back on in a timely manner once work has ended. Facilities deviated from the normal process on the duration of the FP impairment permit. The permit process allowed two permits at the same time, and allowed an open-ended permit. The FP detection system (smoke detector) was originally installed in the small shed based on initially defined operational hazards. The work planning did not coordinate with all departments involved in task. The integration of work activities was not fully understood at time of selection of the FP system.

Facility Function: Laboratory - Research & Development

Activity Category: Normal Operations

Corrective Actions (relevant to WP&C): Conduct and document a formal Readiness Review for facilities to ensure integration of work activities is fully understood and accomplished. Update the impairment process to include a daily review of all impairments to ensure the impairment is closed out and documented. Conduct training of the craftsmen on impairment handling.

Lessons Learned: None

WP&C Issues: This occurrence underscores the importance of ensuring that the required status of safety class systems is properly evaluated in the planning process to ensure that permits accurately reflect any required return-to-service conditions. In this occurrence, the material and the facility were left potentially at risk.

Facility Evacuation Due to Presence of Smoke (SC--PNSO-PNNL-PNNLNUCL-2010-0002)

Activity-Level Work: Perform a welding operation.

Occurrence Summary: A building was evacuated because of smoke in the basement in which ongoing permitted hot work (welding) was taking place. Investigators determined that the smoke was from the filter media in a portable ventilation unit used to support the welding activities. A hot particle from the welding activities had been drawn into the portable ventilation unit and ignited the filter. Only a small portion of the filter burned. The fire self-extinguished due to the fire retardant material of the filter.

What Went Wrong: Work planners did not recognize that a spark could be entrained and enter the ventilation unit (not equipped with screens or spark arrestors) and a ventilation unit was used that was potentially contaminated from previous service applications. The decision to use the portable ventilation unit was made after the initial work planning and was not reviewed by a fire protection engineer before the unit was put into service for this application.

Causal Analysis Summary: Management and planning staff failed to recognize that the portable ventilation unit could draw in sparks or embers based on its setup and placement; as a result, a spark arrestor was not included as part of the ventilation unit. They failed to recognize that a better choice for ventilating near welding, cutting, grinding, or open flame activities would have been a portable ventilation unit equipped with screens or spark arrestors that had not been previously used in a radiologically contaminated environment (i.e., the unit had a potentially contaminated filter).

The hazard mitigation process failed to identify that drawing sparks or embers into the portable ventilation unit was a possibility. Due to excessive heat build-up in the work area, a decision was made to use the ventilator units to move additional air and reduce heat build-up. This change was not reviewed by the Fire Protection Engineer.

Facility Function: Laboratory - Research & Development

Activity Category: Construction

Corrective Actions (relevant to WP&C): Update the Welding, Cutting, Grinding, and Open Flame Operations Subject Area to address using portable ventilation units near hot work.

Lessons Learned: Work planning did analyze the hazard associated with welding, and spark-rated filter units were purchased for the welding activity. When the determination was made that additional general area ventilation was needed, blower units without spark arrestors were placed in service. The portable ventilation unit with the HEPA filter should not have been used without the vendor-approved spark arrestors. When engineered controls are incorporated into a work activity, a review by knowledgeable staff must be completed to ensure additional hazards are not overlooked.

WP&C Issues: This occurrence highlights the importance of evaluating the hazards produced by the work activity and implementing appropriate barriers. The welding operation produced sparks and embers that could easily be drawn into portable air handling/ventilation equipment. This was not adequately evaluated. In addition, the use of a ventilator unit containing a filter that was potentially contaminated with radiological material introduced another hazard that was not evaluated. Involving subject matter experts (e.g., fire protection engineer) is extremely important in the planning process or any time changes are made to the scope or method of performing the work.

Criticality Safety Issue Indicate Process and Communications Issues (NA--LASO-LANL-TA55-2011-0018)

Activity Level Work: Photograph items in a glovebox.

Occurrence Summary: A worker took items out of canisters and moved them into one end of a glovebox to allow them to be photographed, which inadvertently exceeding the posted Criticality Safety Limit Approval (CSLA). The room was evacuated and access was controlled until Safety Basis Criticality Safety Group personnel could assess the situation. It was determined that no hazard existed at that point and the room was released for normal operations.

What Went Wrong: The worker was not authorized to perform work within this particular glovebox and he removed the items from the slip-top canisters that are an administrative control used for staging and pass-through operations. Removing the items from the canisters was a criticality issue and placing them together for photography was an over-mass criticality issue. Handling or processing the items outside of the containers was outside the scope of the evaluation. The worker also used an angle-iron delimiter to prop items for photographing; however, the delimiter was an engineered control that was credited in the criticality safety analysis and provided a physical boundary.

Causal Analysis Summary: The worker saw the posted CSLAs on the glovebox, but failed to read them before placing his hands in the glovebox. In the worker’s usual work environment, his gloveboxes did not have multiple Local Area Network Materials Accounting System (LANMAS) locations; each glovebox was its own location. He also often worked with amounts that were less than accountable and, therefore, did not require a LANMAS transaction before moving from one location to another. He was not trained and qualified to perform LANMAS transactions, as is common for many glovebox workers. His usual gloveboxes did not have angle iron delimiters. The worker was not authorized to perform work in the glovebox where this event occurred.

Group leaders or first line managers (FLM) ensure personnel are trained to the requirements of the CSLA and/or material at risk (MAR) limits before authorizing them to be designated to receive material into a location. Typically, the group leader or FLM would walkdown the hazards of the location with personnel and then sign off on the Authorization Form for Workers to Receive Material per Location, which authorized them to receive material at the listed locations. From there, the form would be delivered to the group office and filed. This procedure and form were, in practice, being used to authorize individual workers to perform work in general in gloveboxes. The form had no allotted space for the individual workers to sign and they did not receive a copy of it. The information on who was authorized to work in each glovebox was not kept in a maintained database, but rather on these paper forms in a file. The form was being used for glovebox work authorization, which was beyond its intended scope.

At the time of this event, the facility had two plans of the day (PODs), an institutional POD (IPOD) that was formalized and well understood and implemented, and a programmatic POD that was informal. Investigators could not locate any work document that governed the implementation and use of the programmatic POD. Some work groups used the programmatic POD to track all activities, including tasks like photography. The programmatic POD had no required attendance, and as such, the programmatic POD had been known to be canceled for days at a time, even with minor work activities still occurring. Photography was a common task for MET-2 and had routinely been captured in the past under General Foundry Activities on the programmatic POD.

Facility Function: Plutonium Processing and Handling

Activity Category: Normal Operations

Corrective Actions (relevant to WP&C): Formalize and publish a Glovebox Owner List and revise Nuclear Criticality Safety administrative procedure to clarify roles and responsibilities for glovebox work authorization.

Lessons Learned: This event exemplifies the importance of a robust training certification process for complex operations in which the consequences of a human error could be significant. If multiple organizations manage personnel under the same certification process, then line management from each organization should participate, as voting members, on a consolidated Oral Board. Executing the certification process organizationally, separately from one another, enables inconsistencies in the acceptance measures and/or standards presented to the candidates. Managers must also be sensitive to potentially broad spanning “certified worker” duty areas. As such, management needs ensure that the proficiency requirements for each worker must cover the key attributes associated with the entire authorized duty area. Workers who cannot demonstrate proficiency across the entire duty area, through their daily assignments, must be afforded a smaller duty area(s) commensurate with their normal duties.

WP&C Issues: This occurrence highlights the importance of a robust training certification process for complex operations in which the consequences of a human error could be significant. Group leaders or first line managers need to ensure that personnel are trained to the requirements of the CSLA and MAR limits before authorizing them to be designated to receive material into a location or work in a glovebox.

- The status of who is authorized to work in a particular glovebox was not being managed to the highest level of formality. The information on who was authorized to work in each glovebox was not kept in a maintained database, but rather on paper forms in a file.
- Work involving the movement of material subject to criticality controls was being performed with less than adequate rigor. Although photography work would fit under an informal (programmatic) POD, the actual handling of the material to be photographed needed to be addressed within a formalized (institutional) POD.

PUSQ - Lifting and Rotating Fixture
(NA--PS-BWP-PANTEX-2012-0082)

Activity-Level Work: Install thread locking agents when tool making.

Occurrence Summary: A Positive Unreviewed Safety Question (PUSQ) was declared because the failure mode of a locking mechanism was of a different type than evaluated or documented in the Documented Safety Analysis. The locking feature on a specific lifting and rotating fixture malfunctioned while in use. Further evaluation determined that a pivot pin had disengaged, rendering one of the two rotational locks inoperable. The two rotation lock mechanisms operate independent of each other as a redundant design feature. Operations utilizing the lifting and rotating fixture were paused in the affected facilities.

What Went Wrong: The toolmaker did not apply the thread locking agent to the pivot nut and pivot fastener per the design definition and procedures. Other instances of missing or incorrect application of the thread locking agent were identified. Ultimately, the lack of thread locking agent resulted in the pivot nut backing off during use and in turn, this caused the fatigue failure of the pivot fastener.

Causal Analysis Summary: Investigation of the lifting and rotating fixture revealed that none of the pivot fasteners or pivot nuts were installed with thread locking agent as required by the design definition and related procedures. It is believed that the failed pivot fastener was subjected to bending loads caused by normal use of the rotational locking mechanism after the pivot nut had partially backed off the pivot fastener. Over the life of the tool (approximately 10 years), the pivot nut joint could have loosened during use, subjected the pivot fastener to repeated bending loads, and been repeatedly re-torqued during repairs and annual preventive maintenance. Although the exact number of loading cycles is unknown, fatigue failure of the fastener is supported by the physical evidence obtained during evaluation of the tool.

The toolmaker training and qualification program is expected to provide sufficient knowledge and skill to perform the job but it is not expected to prevent all human error. The tool maker did not adhere to MNL-352164, Appendix A, Section A.6, which includes the requirement to verify threaded fasteners are sufficiently engaged; do not appear to have backed out; and are not bent or broken, not missing, and not suspect/counterfeit. The training frequency and effectiveness (performance) need evaluation. This issue is more widespread than a single copy or a single tool design. Thread locking agent training appears to be linked to the qualification program for area mechanics but does not appear to be linked to the requirements for all toolmakers. Based on a review of the precursor events, thread locking agent training does not appear to be effective. Missing or incorrectly applied thread locking agent is more widespread than one copy of the lifting and rotating fixture and more widespread than just the lifting and rotating fixture design.

The tooling quality inspection should have identified that the pivot fastener was not included on the PX-3170-T but application of thread locking agent on the pivot fastener was required in accordance with the design definition. Inspection of the physical tooling at the end of the fabrication/modification process would not reveal the lack of thread locking agent; the inspection should occur in the craft shops.

Facility Function: Balance of Plant – Infrastructure

Activity Category: Normal Operations

Corrective Actions (relevant to WP&C): Evaluate pre-job briefings in Production Tooling Support craft shops to ensure all tasks are identified, discussed, and understood by the tool makers and shop supervisors. Use HPI error prevention tools such as the TWIN (Task demand/Work environment/Individual capability/human Nature) Analysis. Evaluate post-job briefings in Production Tooling Support craft shops to ensure all work identified in the work package and design drawing is completed and any feedback for improvement is addressed. It is a documented process to close the loop when work cannot be completed as written in the work package or work order process. It helps ensure that, when the work is conducted again in the future, the problems are addressed and the toolmakers do not face the same problems again. Evaluate work order planning to ensure the level of detail provided in the work order is adequate to support fabrication/modification/repair of tooling in accordance with the design definition.

Lessons Learned: Effective thread locking agent application is essential for safety equipment that requires it. Reliance on torque or the application of a thread locking agent alone to prevent rotational loads from loosening a fastener can lead to equipment failure. Changes in customer interpretation of DSA document safety requirements should be clearly communicated to control owners.

WP&C Issues: This occurrence highlights the importance of conducting adequate pre-job and post-job briefings to ensure that work is performed in accordance with the applicable WCDs. Performing quality control inspections during tool making is also important to ensure that fasteners are properly torqued and required thread locking is completed.

Appendix G: HPI Analysis

Analysis of Human Performance Improvement

Introduction

The goal of Human Performance Improvement (HPI) is to facilitate the development of a facility structure that recognizes human attributes and develops defenses that proactively manage human error and optimize the performance of individuals, leaders, and the organization.

Human error is not a cause of failure alone, but rather the effect or symptom of deeper trouble in the management system. A review of human performance is a review of an individual's abilities, tasks, and operating environment to determine if the organization supports them for success.

The significance, or severity, of a particular event lies in the *consequences* suffered by the physical plant or personnel, not the error that initiated the event. The error that causes a serious accident and the error that is one of hundreds, with no consequence, can be the same error that has historically been overlooked or uncorrected.

The *Anatomy of an Event Model* (Figure G-1) illustrates the elements that exist before an event occurs and is a useful model to understanding the analysis of an event from an HPI perspective. The elements analyzed are the flawed defenses that allowed the event to occur or did not mitigate the consequences of the event; the error precursors that existed; the latent organizational conditions that allowed those to be in existence; and finally the vision, beliefs and values of management and workers.

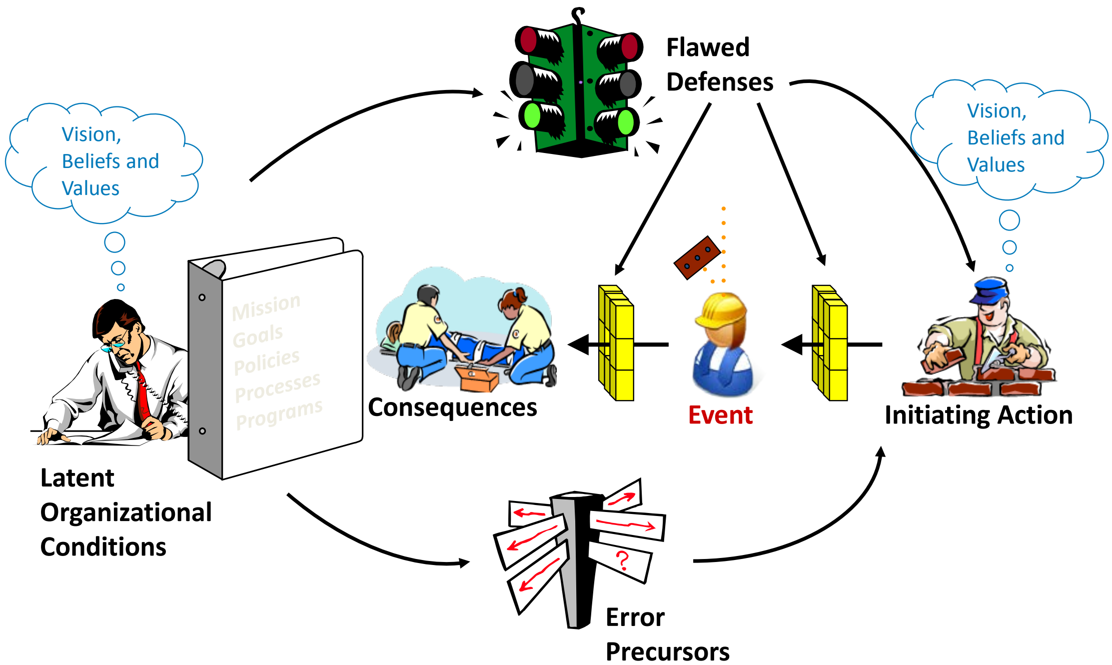


Figure G-1: Anatomy of an Event Model

The HPI analysis sought to understand the nature of the human error associated with the ORPS occurrences reviewed, and to identify potential management system weaknesses implicated by human performance errors. This is important because analysis of events in many different types of industry has shown that between 60% and 90% of major accidents have some types of human error as a contributing cause. Of these human errors, only about 30% are due to the active mistake or error of an individual, and the remaining 70% are due to weaknesses that exist in the organization management systems that support or direct the work.

In most cases, for a significant event to occur, multiple breakdowns in management systems and defenses must first occur. Whereas human error may trigger an event, it is the number and extent of flawed management systems defenses that dictate the severity of an event. The existence of many flawed defenses is directly attributable to weaknesses in the organization or management control systems.

Data Set

HSS evaluated human performance attributes contained within ORPS occurrences having an activity-level WP&C component.

Methodology

Cause codes within each ORPS report were reviewed to identify correlations to human error precursors codes contained in *Accident Investigation and Prevention, Volume I: Accident Analysis Techniques* (DOE-HDBK-1208-2012; July 2012).

Results

Table G-1 presents the frequency distribution and rank order of the human error precursors identified from the set of 50 ORPS reports analyzed. Groupings of human error precursor codes correspond to four key human performance attributes:

<u>Task Demands</u>: Specific mental, physical, and team requirements to perform an activity that may either exceed the capabilities or challenge the limitations of human nature of the individual assigned to the task; for example, excessive workload, hurrying, concurrent actions, unclear roles and responsibilities, or vague standards.

<u>Individual Capabilities</u>: Unique mental, physical, and emotional abilities of a particular person that fail to match the demands of the specific task; for example, unfamiliarity with the task, unsafe attitudes, level of education, lack of knowledge, unpracticed skills, personality, inexperience, health and fitness, poor communication practices, or low self esteem.

<u>Work Environment</u>: General influences of the workplace, organizational, and cultural conditions that affect individual behavior; for example, distractions, awkward equipment layout, complex tagout procedures, at-risk norms and values, work group attitudes toward various hazards, or work control processes.

<u>Human Nature</u>: Generic traits, dispositions, and limitations of being human that may incline individuals to err under unfavorable conditions; for example, habit, short-term memory, fatigue, stress, complacency, or mental shortcuts.

Table G-1: Human Error Precursors Identified for Activity-Level WP&C Occurrences

Task Demands		Individual Capabilities	
73	Unclear goals, roles, or responsibilities	101	Imprecise communication habits
54	Interpretation of requirements	79	Lack of knowledge (faulty mental model)
50	Lack of or unclear standards	56	Indistinct problem-solving skills
7	Simultaneous, multiple actions	8	Unsafe attitudes
1	Repetitive actions/Monotony	5	Lack of proficiency/Inexperience
1	Irreversible actions	5	Unfamiliarity with task/First time
5	Time pressure (in a hurry)	4	New techniques not used before
4	High workload (large memory)	0	Illness or fatigue; general poor health or injury
Work Environment		**Human Nature**	
35	Unexpected equipment conditions	50	Inaccurate risk perception
10	Distractions/Interruptions	25	Assumptions
10	Changes/Departure from routine	17	Mind-set (intentions)
10	Hidden system/equipment response	12	Mental shortcuts or biases
3	Lack of alternative indication	11	Habit patterns
2	Work-arounds	7	Complacency/Overconfidence
1	Confusing displays or controls	3	Stress
0	Personality conflict	0	Limited short-term memory

Analysis of the ORPS occurrences indicates that the most frequently cited human error precursors were:

- Imprecise communication habits
- Lack of knowledge (faulty mental model)
- Unclear goals, roles, or responsibilities
- Interpretation of requirements
- Indistinct problem-solving skills
- Lack of or unclear standards
- Inaccurate risk perception
- Unexpected equipment conditions
- Assumptions
- Mind-set (intentions)

As a result of these human error precursors, breakdowns in the following management systems may occur:

- Planning, Scheduling, Procedures, and Work Practice organizational weaknesses indicated by the number of Worker Task Demand errors including interpretation of requirements; unclear goals, roles, or responsibilities; and lack of clear standards.
- Organizational Interfaces, Supervisory Involvement, and Communications organizational weakness indicated by the number of lack of knowledge, imprecise communications habits, and indistinct problem-solving skill errors.
- Frequency of Design or Process Change, Planning and Scheduling organizational weaknesses indicated by the number of inaccurate risk perception and interpretation of requirements errors.

Appendix H: Analysis of HSS Safety Culture Assessments

In its November 30, 2012, response letter to DNFSB, DOE recognized that a clear delineation of roles, responsibilities, authorities, and accountability is crucial to activity-level WP&C and important in promoting a strong organizational culture. Consequently, safety culture deficiencies may underlie WP&C deficiencies, and process issues associated with WP&C may be the result of (or be masked by) underlying safety culture issues that render even sound WP&C processes ineffective.

Accordingly, as part of this analysis effort, HSS analyzed safety culture reviews conducted throughout 2011 and 2012 on the following five major nuclear projects and one site:

- Hanford - Waste Treatment and Immobilization Plant (WTP);
- Los Alamos National Laboratory - Chemistry and Metallurgy Research Replacement (CMRR) Project;
- Y-12 National Security Complex - Uranium Processing Facility (UPF) Project;
- Savannah River Site - Salt Waste Processing Facility (SWPF) Project;
- Idaho Cleanup Project - Sodium Bearing Waste Treatment (SBWT) Project; and
- Pantex Plant.

These safety culture reviews were broad in scope and principally focused on engineering design and construction activities, with limited sampling of operating activities. However, "work process" (defined in the assessment reports as "the process of planning and controlling work activities is implemented so that safety is maintained"), was one of nine traits evaluated in the safety culture assessments that are viewed to be necessary in the promotion of a positive safety culture. HSS reviewed this information to determine whether it revealed useful insights about WP&C, and whether these insights aligned with results from the principal data sources applied in this analysis effort. Summary results highlighted cost and schedule pressures, cultural differences among project contractors, communications issues, limited opportunity to learn from operational experiences and lessons learned, an unwillingness to raise concerns, and, in some cases, a fear of reprisal if issues were raised. A summary of results recorded for the work process safety culture trait includes:

- Inconsistent application and communication of rules and procedures between facilities/buildings; inadequate planning, scheduling, and coordination of work;
- Ineffective organization of procedures, with deviations constantly being written;

- Combining procedures from different contractors on the same project can cause confusion. Cutting and pasting some information while leaving other information out results in poor WCDs;
- Schedule pressures and other factors (such as inadequate planning, frequently shifting priorities, poor communications, and inadequate work packages) result in instances where safety rules, procedures, and practices are not followed;
- The organization of procedures to be used is not effective and deviations are constantly being written;
- During construction, significant issues include work packages that are not complete and not followed, issues that are not closed-out, and line management not taking ownership of issues; and
- Issues with work formalization include needed improvement in the use of post-job briefs and the association of lessons learned into daily work activities.

Review of the safety culture assessment reports combined with discussions with safety culture assessment team members validated the hypothesis that safety culture assessment methods can yield useful insights about WP&C. Of particular note, the assessments revealed that misalignment often exists between management and operational staff about how work is actually performed.

Appendix I: Work Planning and Control Cause Codes

Denotes Work Planning and Control Cause Code

Cause Code Node A		Cause Code Node B		Cause Code Node C	
A1	Design/ Engineering Problem	B1	Design Input Less Than Adequate	A1B1C01	Design input cannot be met
				A1B1C02	Design input obsolete
				A1B1C03	Design input not correct
				A1B1C04	Necessary design input not available
		B2	Design Output Less Than Adequate	A1B2C01	Design output scope LTA
				A1B2C02	Design output not clear
				A1B2C03	Design output not correct
				A1B2C04	Inconsistent design output
				A1B2C05	Design input not addressed in design output
				A1B2C06	Drawing, specification or data error
				A1B2C07	Error in equipment or material selection
				A1B2C08	Errors not detectable
				A1B2C09	Errors not recoverable
		B3	Design/ Documentation Less Than Adequate	A1B3C01	Design/documentation not complete
				A1B3C02	Design/documentation not up-to-date

Cause Code Node A		Cause Code Node B		Cause Code Node C	
				A1B3C03	Design/documentation not controlled
		B4	Design Verification/ Installation Verification Less Than Adequate	A1B4C01	Independent review of design/documentation LTA
				A1B4C02	Testing of design/installation LTA
				A1B4C03	Independent inspection of design/installation LTA
				A1B4C04	Acceptance of design/installation LTA
		B5	Operability of Design/ Environment Less Than Adequate	A1B5C01	Ergonomics LTA
				A1B5C02	Physical environment LTA
				A1B5C03	Natural environment LTA
A2	Equipment/ material problem	B1	Calibration for Instruments Less Than Adequate	A2B1C01	Calibration LTA
				A2B1C02	Equip. found outside acceptance criteria
		B2	Periodic/Corrective Maintenance Less Than Adequate	A2B2C01	Preventive maintenance for equipment LTA
				A2B2C02	Predictive Maintenance LTA
				A2B2C03	Corrective Maintenance LTA
				A2B2C04	Equipment history LTA
		B3	Inspection/Testing Less Than Adequate	A2B3C01	Startup testing LTA
				A2B3C02	Inspection/testing LTA
				A2B3C03	Post-maintenance/Post-modification testing LTA
		B4	Material Control	A2B4C01	Material handling LTA

Cause Code Node A		**Cause Code Node B**		**Cause Code Node C**	
			Less Than Adequate	A2B4C02	Material storage LTA
				A2B4C03	Material packaging LTA
				A2B4C04	Material shipping LTA
				A2B4C05	Shelf life exceeded
				A2B4C06	Unauthorized material substitution
				A2B4C07	Marking/labeling LTA
		B5	Procurement Control Less Than Adequate	A2B5C01	Control of changes to procurement specification/purchase order LTA
				A2B5C02	Fabricated item does not meet requirements
				A2B5C03	Incorrect item received
				A2B5C04	Product acceptance requirements LTA
		B6	Defective, Failed or Contaminated	A2B6C01	Defective or failed part
				A2B6C02	Defective or failed material
				A2B6C03	Defective weld, braze or soldering joint
				A2B6C04	End of life failure
				A2B6C05	Electrical or instrument noise
				A2B6C06	Contaminant
A3	Human Performance Less Than	B1	Skill Based Errors	A3B1C01	Check of work was LTA
				A3B1C02	Step was omitted due to distraction

Cause Code Node A		Cause Code Node B		Cause Code Node C	
	Adequate (LTA)			A3B1C03	Incorrect performance due to mental lapse
				A3B1C04	Infrequently performed steps are performed incorrectly
				A3B1C05	Delay in time cause LTA actions
				A3B1C06	Wrong action selected based on similarity with other actions
				A3B1C07	Omission/repeating of steps based on assumptions for completion
		B2	Rule Based Errors	A3B2C01	Strong rule incorrectly chosen over other rules
				A3B2C02	Signs to stop were ignored and step performed incorrectly
				A3B2C03	Too much activity was occurring and error made in problem solving
				A3B2C04	Previous success in use of rule reinforces continued use of rule
				A3B2C05	Situation incorrectly identified or represented results in wrong rule used
		B3	Knowledge Based Errors	A3B3C01	Attention was given to wrong issues
				A3B3C02	LTA conclusion based on sequencing of facts
				A3B3C03	Individual justified action by focusing on biased evidence
				A3B3C04	LTA review based on assumption that process will not change
				A3B3C05	Incorrect assumption that a correlation exists between two or more facts
				A3B3C06	Individual underestimated the problem by using past events as basis
		B4	Work Practices Less Than Adequate	A3B4C01	Individual capabilities to perform work LTA
				A3B4C02	Deliberate violation

Cause Code Node A		Cause Code Node B		Cause Code Node C	
A4	Management Problem	B1	Management Methods Less Than Adequate	A4B1C01	Management policy guidance/expectations not well-defined, understood or enforced
				A4B1C02	Job performance standards not adequately defined
				A4B1C03	Management direction created insufficient awareness of the impact of actions on safety/ reliability
				A4B1C04	Management follow-up or monitoring of activities did not identify problems
				A4B1C05	Management assessment did not determine causes of previous event or known problem
				A4B1C06	Previous industry or in-house experience was not effectively used to prevent recurrence
				A4B1C07	Responsibility of personnel not well defined or personnel not held accountable
				A4B1C08	Corrective action responses to a known or repetitive problem was untimely
				A4B1C09	Corrective action for previously identified problem or event was not adequate to prevent recurrence
		B2	Resource Management Less Than Adequate	A4B2C01	Too many administrative duties assigned to immediate supervisors
				A4B2C02	Insufficient supervisory resources to provide necessary supervision
				A4B2C03	Insufficient manpower to support identified goal/objective
				A4B2C04	Resources not provided to assure adequate training was provided/maintained
				A4B2C05	Needed resource changes not approved/funded
				A4B2C06	Means not provided to assure procedures/documents/records were of adequate quality and up-to-date
				A4B2C07	Means not provided for assuring adequate availability of appropriate materials/tools

Cause Code Node A		Cause Code Node B		Cause Code Node C	
				A4B2C08	Means not provided for assuring adequate equipment quality, reliability, or operability
				A4B2C09	Personnel selection did not assure match of worker motivations/job descriptions
				A4B2C10	Means/method not provided for assuring adequate quality of contract services
		B3	Work Organization & Planning Less Than Adequate	A4B3C01	Insufficient time for worker to prepare task
				A4B3C02	Insufficient time allotted for task
				A4B3C03	Duties not well-distributed among personnel
				A4B3C04	Too few workers assigned to task
				A4B3C05	Insufficient number of trained or experienced workers assigned to task
				A4B3C06	Planning not coordinated with inputs from walkdowns/task analysis
				A4B3C07	Job scoping did not identify potential task interruptions and/or environmental stress
				A4B3C08	Job scoping did not identify special circumstances and/or conditions
				A4B3C09	Work planning not coordinated with all departments involved in task
				A4B3C10	Problem performing repetitive tasks and/or subtasks
				A4B3C11	Inadequate work package preparation
		B4	Supervisory Methods Less Than Adequate	A4B4C01	Tasks and individual accountability not made clear to worker
				A4B4C02	Progress/status of task not adequately tracked
				A4B4C03	Appropriate level of in-task supervision not determined prior to task
				A4B4C04	Direct supervisory involvement in task interfered with overview role

Cause Code Node A		Cause Code Node B		Cause Code Node C	
				A4B4C05	Emphasis on schedule exceeded emphasis on methods/doing a good job
				A4B4C06	Job performance and self-checking standards not properly communicated
				A4B4C07	Too many concurrent tasks assigned to worker
				A4B4C08	Frequent job or task “shuffling”
				A4B4C09	Assignment did not consider worker's need to use higher-order skills
				A4B4C10	Assignment did not consider effects of worker's previous task
				A4B4C11	Assignment did not consider worker's ingrained work patterns
				A4B4C12	Contact with personnel too infrequent to detect work habit/attitude changes
		B5	Change Management Less Than Adequate	A4B5C01	Problem identification methods did not identify need for change
				A4B5C02	Change not implemented in a timely manner
				A4B5C03	Inadequate vendor support of change
				A4B5C04	Risks/consequences associated with change not adequately reviewed/assessed
				A4B5C05	System interactions not considered
				A4B5C06	Personnel/department interactions not considered
				A4B5C07	Effect of change on schedules not adequately addressed
				A4B5C08	Change-related training/retraining not performed or not adequate
				A4B5C09	Change-related documents not developed or revised
				A4B5C10	Change-related equipment not provided or not revised

Cause Code Node A		**Cause Code Node B**		**Cause Code Node C**	
				A4B5C11	Changes not adequately communicated
				A4B5C12	Change not identifiable during task
				A4B5C13	Accuracy/effectiveness of change not verified or not validated
A5	Communications Less Than Adequate (LTA)	B1	Written Communication Method of Presentation Less Than Adequate	A5B1C01	Format deficiencies
				A5B1C02	Improper referencing or branching
				A5B1C03	Checklist LTA
				A5B1C04	Deficiencies in user aids (charts, etc.)
				A5B1C05	Recent changes not made apparent to user
				A5B1C06	Instruction step/information in wrong sequence
				A5B1C07	Unclear/complex wording or grammar
		B2	Written Communication Content Less Than Adequate	A5B2C01	Limit inaccuracies
				A5B2C02	Difficult to implement
				A5B2C03	Data/computations wrong/incomplete
				A5B2C04	Equipment identification LTA
				A5B2C05	Ambiguous instructions/requirements
				A5B2C06	Typographical error
				A5B2C07	Facts wrong/requirements not correct
				A5B2C08	Incomplete/situation not covered

Cause Code Node A		Cause Code Node B		Cause Code Node C	
				A5B2C09	Wrong revision used
		B3	Written Communication Not Used	A5B3C01	Lack of written communication
				A5B3C02	Not available or inconvenient for use
		B4	Verbal Communication Less Than Adequate	A5B4C01	Communication between work groups LTA
				A5B4C02	Shift communications LTA
				A5B4C03	Correct terminology not used
				A5B4C04	Verification/repeat back not used
				A5B4C05	Information sent but not understood
				A5B4C06	Suspected problems not communicated to supervision
				A5B4C07	No communication method available
A6	Training deficiency	B1	No Training Provided	A6B1C01	Decision not to train
				A6B1C02	Training requirements not identified
				A6B1C03	Work incorrectly considered “skill-of-the-craft”
		B2	Training Methods Less Than Adequate	A6B2C01	Practice or “hands-on” experience LTA
				A6B2C02	Testing LTA
				A6B2C03	Refresher training LTA
				A6B2C04	Inadequate presentation
		B3	Training Material	A6B3C01	Training objectives LTA

Cause Code Node A		Cause Code Node B		Cause Code Node C	
			Less Than Adequate	A6B3C02	Inadequate content
				A6B3C03	Training on new work methods LTA
				A6B3C04	Performance standards LTA
A7	Other problem	B1	External Phenomena	A7B1C01	Weather or ambient conditions LTA
				A7B1C02	Power failure or transient
				A7B1C03	External fire or explosion
				A7B1C04	Other natural phenomena LTA
		B2	Radiological/ Hazardous Material Problem	A7B2C01	Legacy contamination
				A7B2C02	Source unknown
		B3	Radiological/ Hazardous Material Problem	A7B3C01	Legacy
		B4	Radiological/ Hazardous Material Problem	A7B4C01	No Cause is Applicable

Appendix J: ISM Core Functions by DOE Defense Nuclear Facility

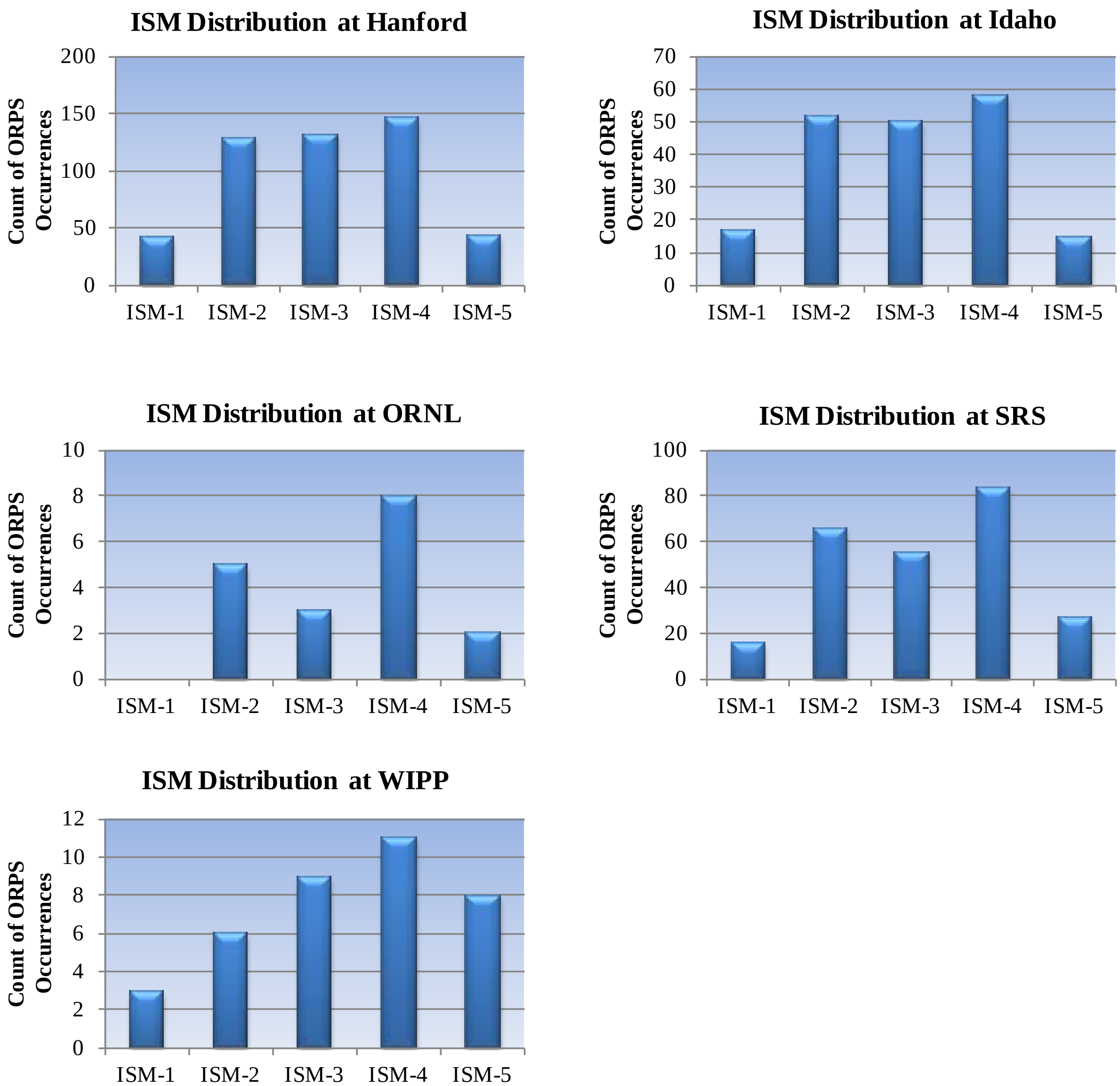


Figure J-1: Distribution of ORPS ISM Core Functions by EM Site

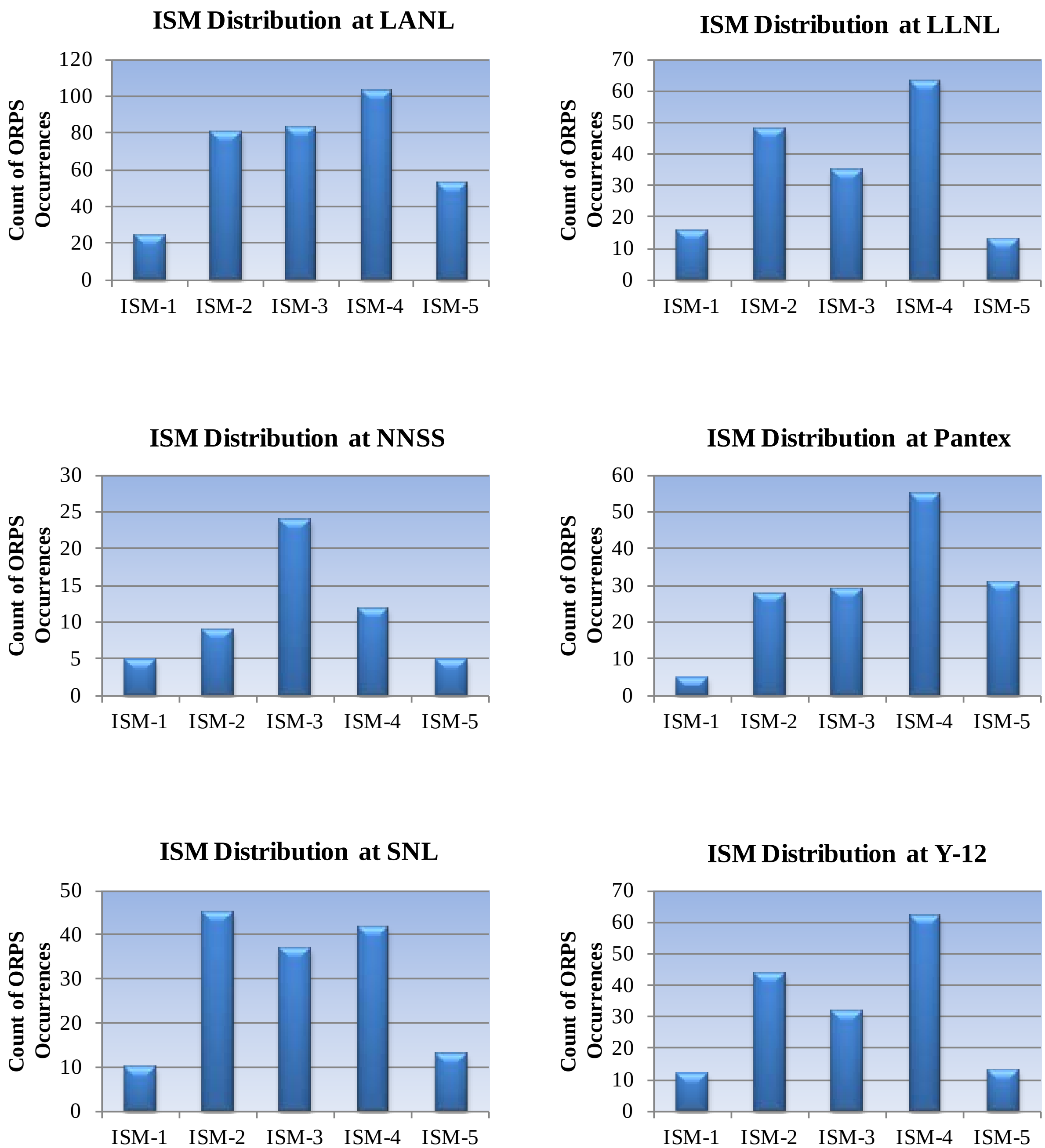


Figure J-2: Distribution of ORPS ISM Core Functions by NNSA Site

The predominant ISM Core Function selected at almost all sites is 4 - *Perform Work within Controls.* This reinforces the fact that ORPS primarily focuses on events that have already occurred and, therefore, is more likely to identify issues with work execution deficiencies.

Appendix K: HQ Keywords

1. Inadequate Conduct of Operations

A. Inadequate Conduct of Ops (Misc.)
B. Loss of Configuration Management/Control
C. Violation of AB Elements
D. Missed/Late Surveillance
E. Operations Procedure Noncompliance
F. Training Deficiency
G. Inadequate Procedure
H. Inadequate Safety Analysis/USQ
I. Safety System Actuation/Evacuation
J. Criticality Procedure Noncompliance
K. LOTO Noncompliance (Elect)
L. LOTO Noncompliance (Other)
M. Inadequate Job Planning (Electrical)
N. Inadequate Job Planning (Other)
O. Inadequate Maintenance
P. Inadequate Oral Communication
Q. Personnel Error
R. Management Issues
S. Incorrect/Inadequate Installation
T. Willful Violation

2. Environmental

A. Radioactive Release
B. Underground Storage Tank Release
C. Compliance Notification (from regulator with a violation)
D. Compliance Notification (from or to without a violation)
E. Hazardous Material Release
F. Potable Water Release

3. Fire Protection & Explosives Safety

A. Fire Protection Equip Degradation
B. Fire Suppression Actuation
C. Facility Fire
D. Explosives Safety Issue
E. National Fire Protection Association (NFPA)/ Life Safety Code Issue
F. Explosion
G. Wildland Fire

4. Instrumentation/Controls

A. I & C Equipment
B. Criticality Equipment
C. Monitor/Analyzer
D. Computer Software
E. Computer Hardware

5. Mechanical/Structural

A. Freeze Protection Failure
B. Seismic Qualification Deficiency
C. Ventilation System/Fan
D. Mechanical Equipment Failure/Damage
E. Structural Deficiency/Failure
F. Corrosion/Material Degradation/EOL
G. Glovebox Failure
H. HEPA Filter
I. Container/Package Failure

6. Radiological

A. Clothing Contamination
B. Facility/Equip/ Site Contamination
C. Skin Contamination
D. Airborne Radiological Release
E. Radiological Control Procedure Noncompliance
F. External Exposure
G. Intake
H. Inadequate Radiological Control Job Planning
I. Radiological Control Training Deficiency
J. Inadequate Radiological Control Procedure
K. Offsite Spread of Contamination

7. Electrical Systems

A. Emergency Diesel Generator Failure
B. Electrical Distribution
C. Power Outage
D. Electrical Wiring
E. Electrical Equipment Failure

8. OSHA Reportable/Industrial Hygiene

A. Electrical Shock
B. Indoor Air Contamination
C. Industrial Hygiene Exposure
D. Injury
E. Fatality
F. Industrial Operations Issues
G. Industrial Equipment
H. Safety Noncompliance
I. Safety Equipment Failure
J. Near miss (Electrical)
K. Near miss (Other)
L. Notice of Violation or Non-Compliance

9. Safeguards/Security Issue

A. Fitness for Duty Issue
B. Material Accountability Issue
C. Miscellaneous Security Issue
D. Theft/ Sabotage

10. Transportation

A. Shipping Regulation Noncompliance
B. Vehicle Accident
C. Industrial Equipment Movement Incident
D. Notice of Violation or Non-Compliance from Local, State or Federal Agency
E. Shipping Incidents / Accidents

11. Other

A. Chemical Reaction/Pressurized Drum
B. Emergency Management System Failure
C. Nuclear Weapons Safety Issue
D. Natural Phenomena
E. Suspect/Counterfeit Items
F. Inadequate Design
G. Subcontractor
H. Procurement Deficiency/Defective Items
I. Visiting Scientist/Researcher or Student Employee
J. Tenants on DOE Property
K. Excessed Equipment / Material
L. Supplier
M. Outside Agency or Organization/ Site Visitor
N. Waste Handling Operations

12. EH Categories (select only one)

A. Authorization Basis
B. Conduct of Operations
C. Electrical Safety
D. Environmental Release/Compliance
E. Equipment Degradation/Failure
F. Fire Protection & Explosive Safety
G. Industrial Operation
H. Injuries Requiring Medical Treatment Other Than First Aid
I. Lockout/Tagout (Electrical & Mechanical)
J. OS/IH
K. Near Miss (Electrical & Mechanical)
L. Nuclear Criticality Safety Concerns
M. Radiological Control
N. Rad. Skin Contaminations/Uptakes/ Overexposures
O. Safeguards & Security
P. Shipping QA
Q. Vehicular Accidents
R. Suspect/Counterfeit Items – Defective Items
Z. Other than Above

13. Management Concerns

A. HQ Significant
B. Accident Investigation - Type A
C. Accident Investigation - Type B
D. Accident Investigation – Other
E. Facility Call Sheet
F. Operating Experience Summary Article
G. Suspect/Counterfeit Items - Defective Items Data Collection Sheet

14. Quality Assurance

A. Program Deficiency
B. Training & Qualification Deficiency
C. Quality Improvement Deficiency
D. Documents & Records Deficiency
E. Work Process Deficiency
F. Design Deficiency
G. Procurement Deficiency
H. Inspection & Acceptance Testing Deficiency
I. Management Assessment Deficiency
J. Independent Assessment Deficiency
K. Safety Software Deficiency
L. No QA Deficiency

Appendix L: Work Planning and Control HQ Keywords

The following charts display the distribution of WP&C-specific HQ Keyword groups corresponding with the ORPS summaries and observations found in the Work Planning and Control HQ Keywords section. Although WIPP's percentages are high in several of the charts, they refer to only 30 ORPS occurrence reports.

Procedure/Document Deficiencies

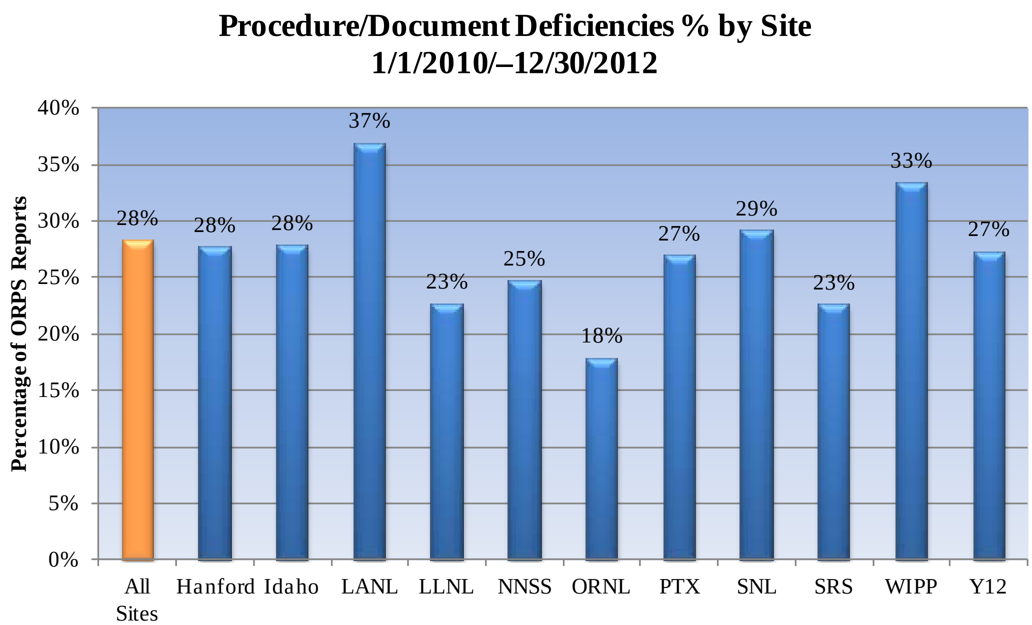


Figure L-1: Work Planning HQ Keyword Group Procedure/Document Deficiencies Percentages by Site

Supervision/Management Issues

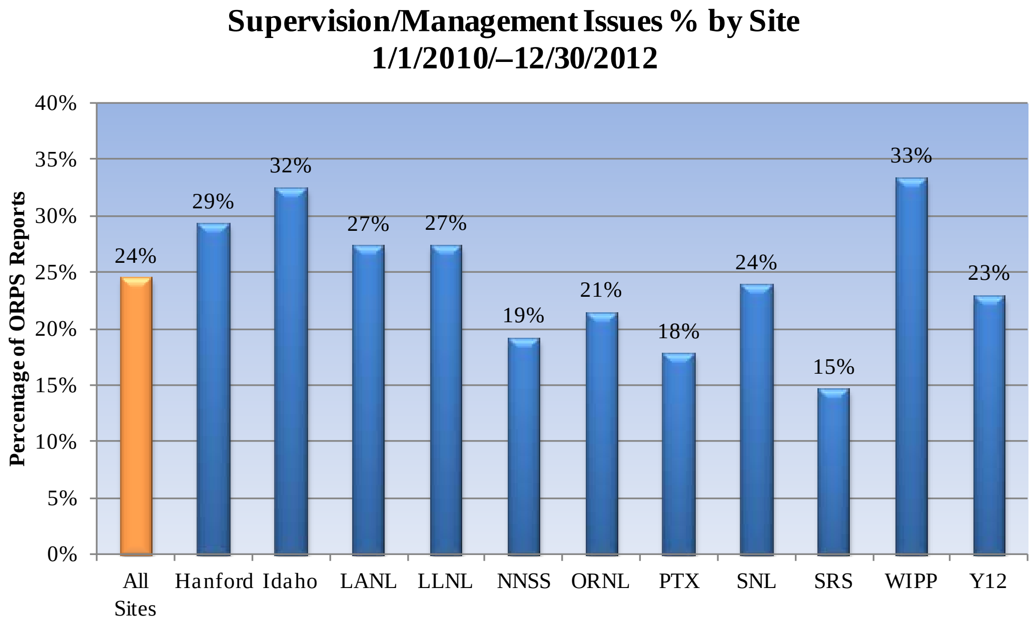


Figure L-2: Work Planning HQ Keyword Group Supervision/Management Issues Percentages by Site

Work Planning

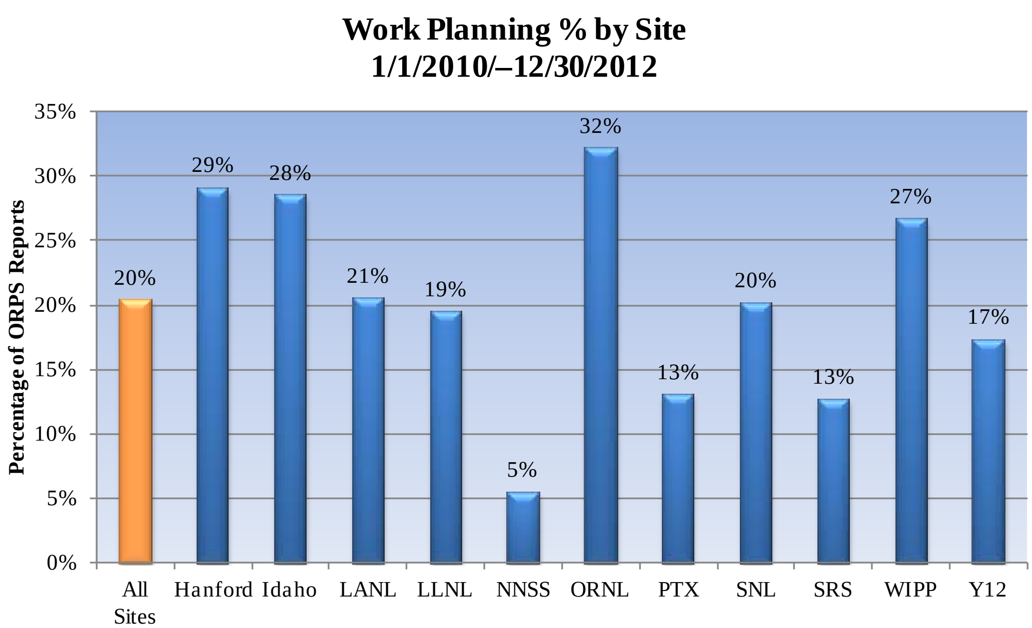


Figure L-3: Work Planning HQ Keyword Grouping Work Planning Percentages by Site

Personnel Errors

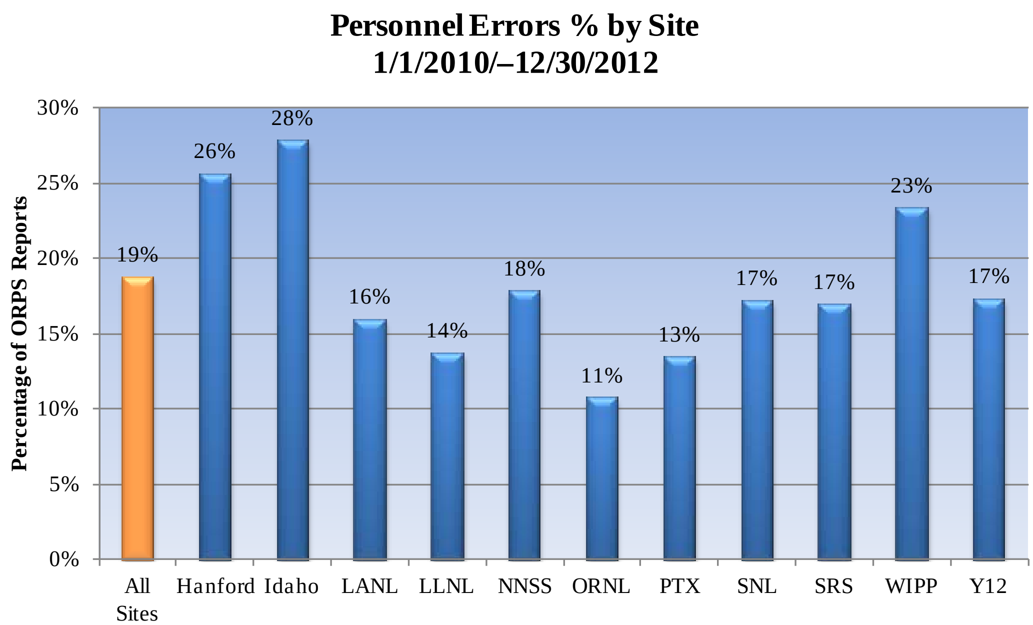


Figure L-4: Work Execution HQ Keyword Grouping Personnel Errors Percentages by Site

Procedure Compliance Issues

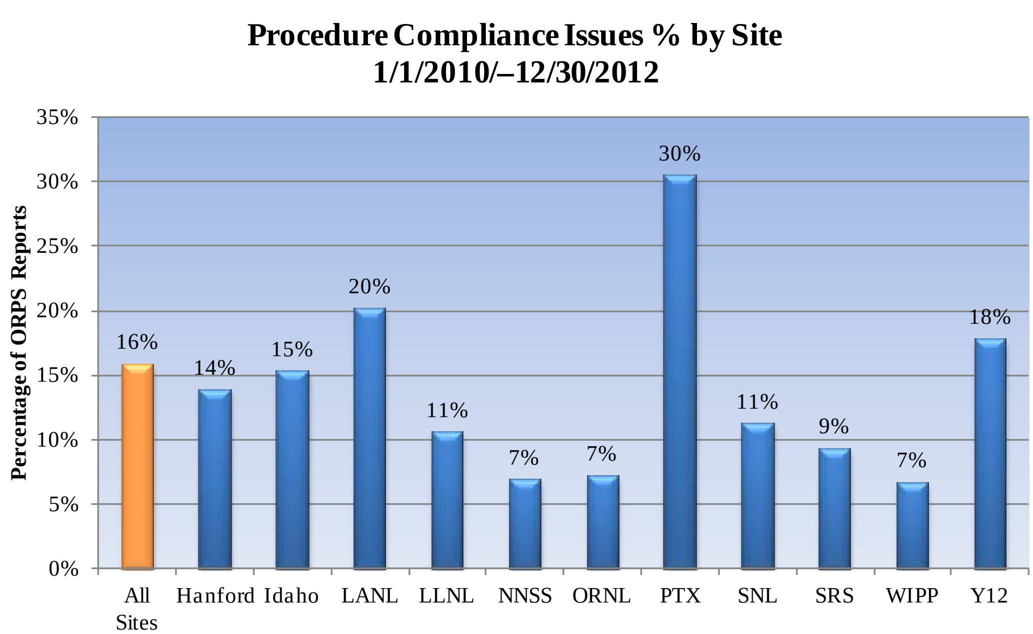


Figure L-5: Work Execution HQ Keyword Grouping Compliance Issues Percentages by Site

Safety Compliance Issues

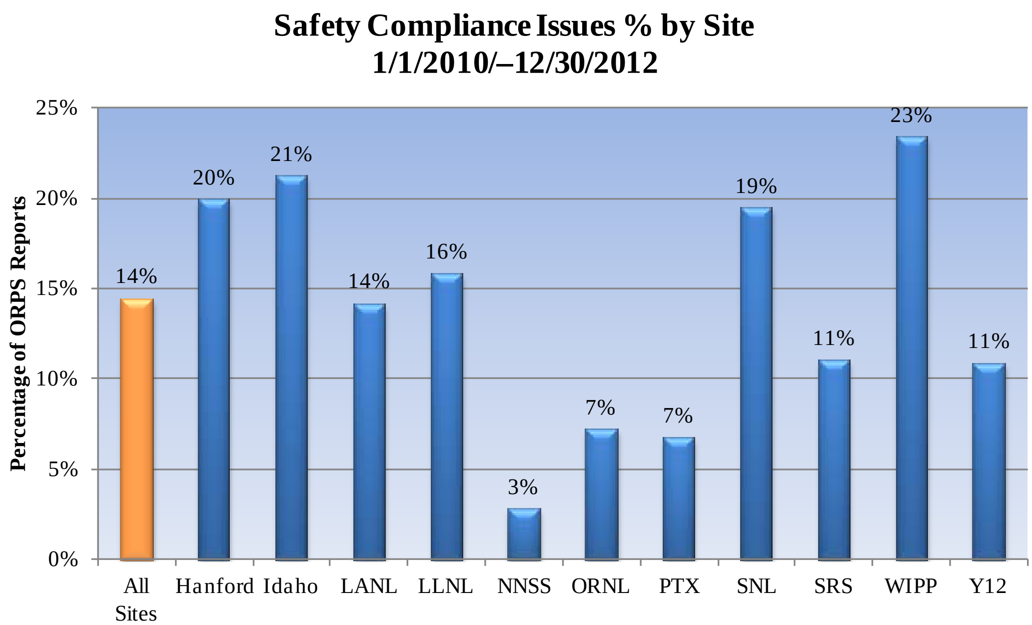


Figure L-6: Work Execution HQ Keyword Grouping Safety Compliance Issues Percentages by Site

Communication Deficiencies

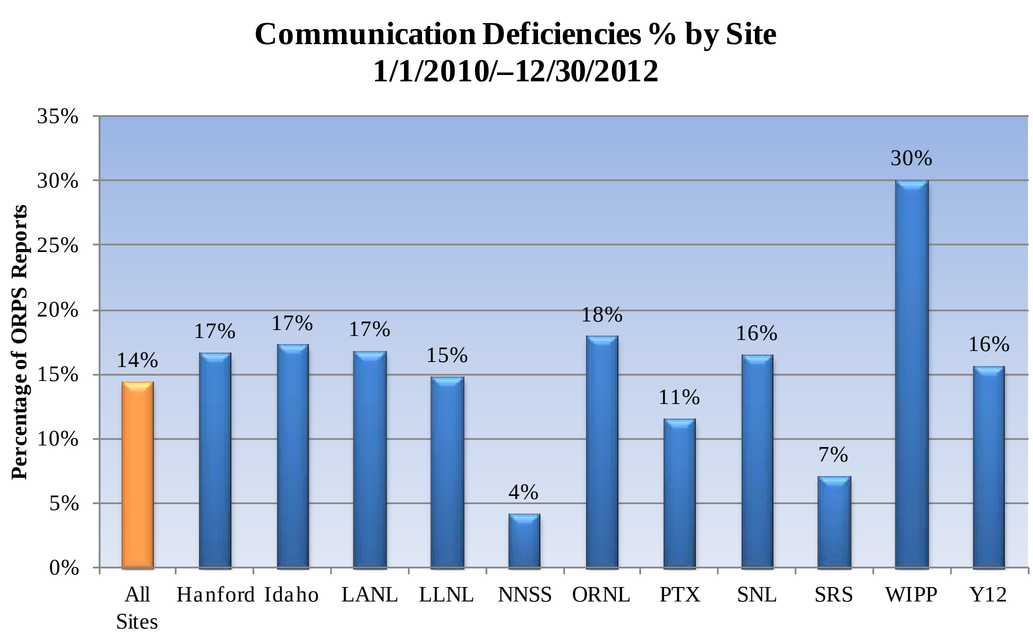


Figure L-7: Work Planning HQ Keyword Grouping Communication Deficiencies Percentages by Site

Safety Basis Compliance

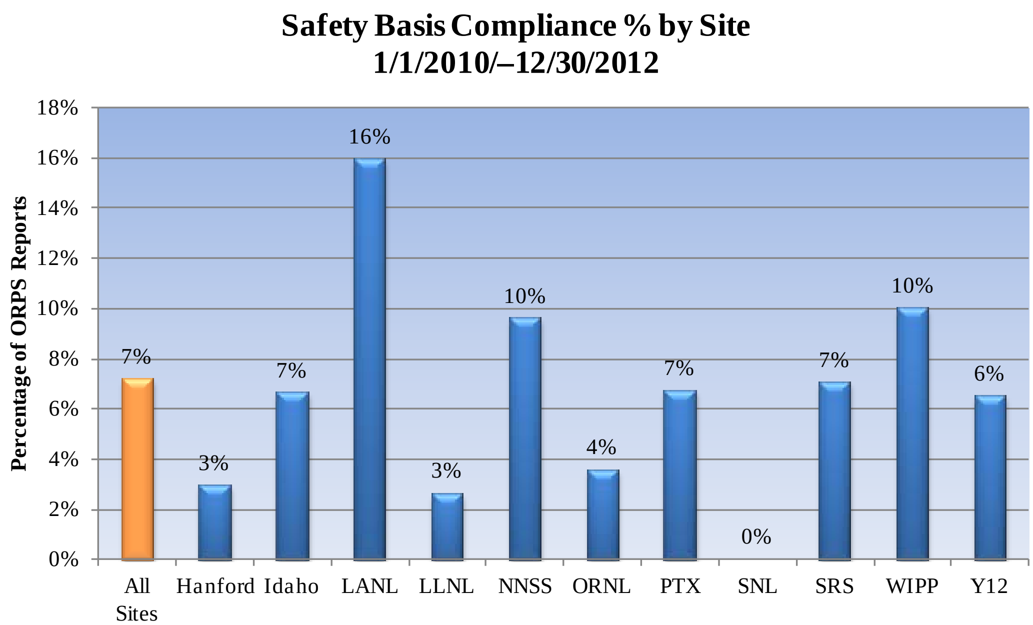


Figure L-8: Work Execution HQ Keyword Grouping Safety Basis Compliance Percentages by Site

Hazardous Energy Control

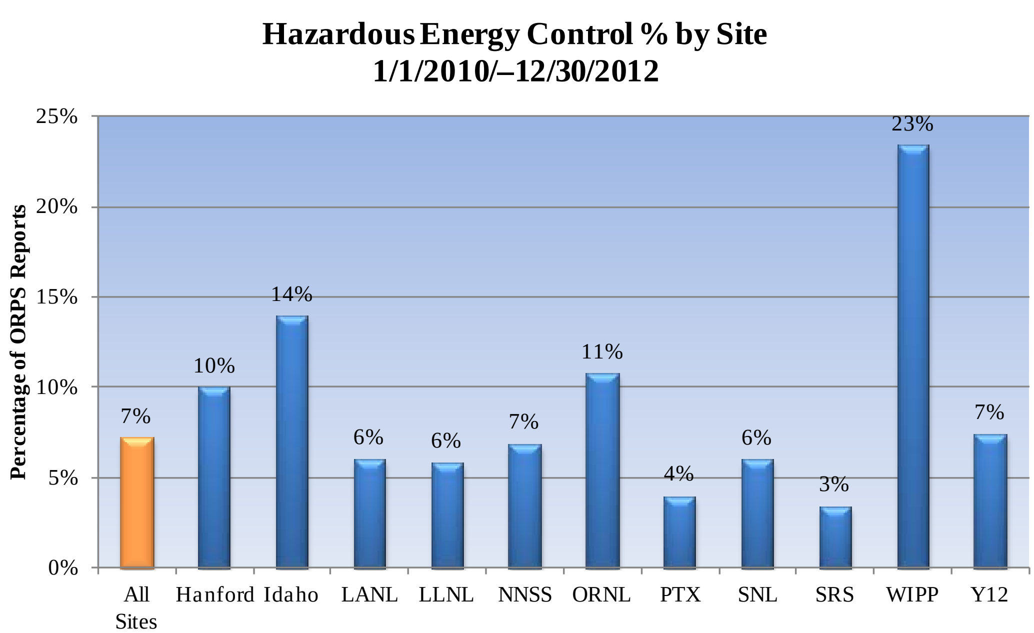


Figure L-9: Work Execution HQ Keyword Grouping Hazardous Energy Control Percentages by Site

Inadequate Maintenance

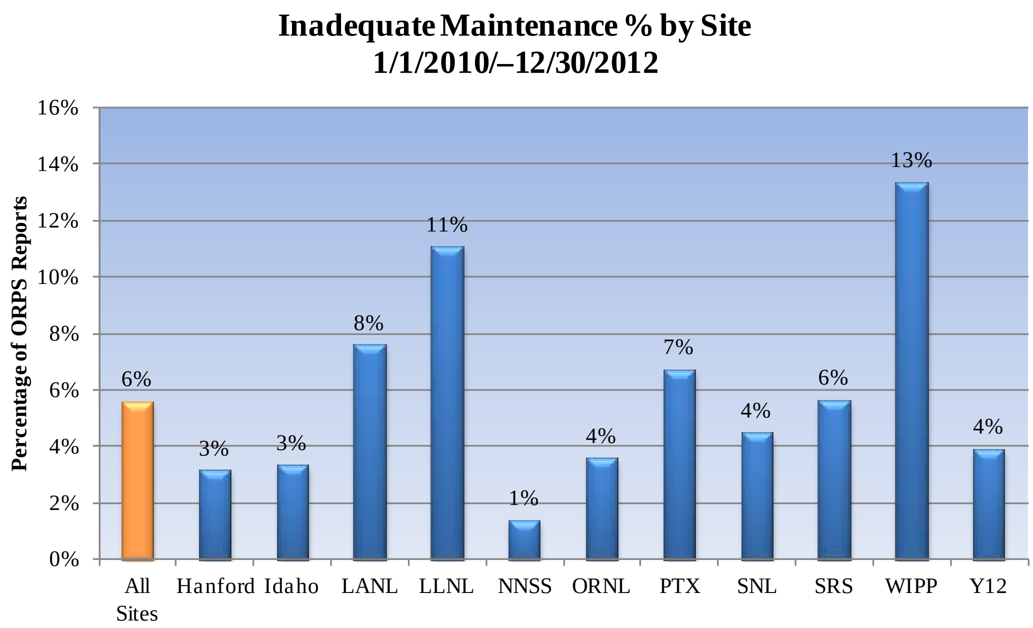


Figure L-10: Work Execution HQ Keyword Grouping Inadequate Maintenance Percentages by Site

Appendix M: HSS Analysis Team Members and Quality Review Board

HSS Analysis Team

Stephen Domotor (HSS, Office of Analysis)
Glenn Searfoss (HSS, Office of Analysis)
Phil Wilhelm (HSS, Office of Analysis)
Dave Pegram (HSS, Office of Analysis)
Larry Stirling (HSS, Office of Analysis)
David Risley (Project Enhancement Corporation)
Roger Stone (Project Enhancement Corporation)
Jay Traverso (Project Enhancement Corporation)

HSS Quality Review Board

Date of Review: April 16, 2013

Board Members

William Eckroade
Thomas Staker
Andrew Lawrence
Patricia Worthington
Michael Kilpatrick
George Armstrong
Robert Nelson
Thomas Davis