Lessons Learned from Assessments of Work Planning and Control at U.S. Department of Energy Sites

December 2022

Office of Enterprise Assessments
U.S. Department of Energy

Table of Contents

Acronyms ii

Executive Summary iii

1.0 Introduction 1

2.0 Methodology 1

3.0 Results 2

3.1 Institutional Work Planning and Control Programs 2

3.2 Implementation of Activity-Level Work Planning and Control Programs 4

3.3 Flowdown of Construction Safety Requirements to Subcontractors 6

3.4 Electrical Safety 7

3.5 Feedback and Improvement/Contractor Assurance System 7

3.6 DOE Field Element Oversight 8

3.7 Occurrence Reporting and Processing System Data Analysis 9

4.0 Best Practices 10

5.0 Recommendations 11

Appendix A: Supplemental Information A-1

Appendix B: Scope, Requirements and Guidance, and Assessment Sites B-1

Appendix C: Source Documents C-1

Acronyms

ANL	Argonne National Laboratory
CAS	Contractor Assurance System
CFR	Code of Federal Regulations
CRAD	Criteria and Review Approach Document
DOE	U.S. Department of Energy
EA	Office of Enterprise Assessments
ES&H	Environment, Safety and Health
FR	Facility Representative
IH	Industrial Hygiene
ISM	Integrated Safety Management
JHA	Job Hazard Analysis
LLNL	Lawrence Livermore National Laboratory
LOTO	Lockout/Tagout
OFI	Opportunity for Improvement
ORPS	Occurrence Reporting and Processing System
PAT	Pre-analyzed Task
PPE	Personal Protective Equipment
RWP	Radiological Work Permit
SME	Subject Matter Expert
SNL-NM	Sandia National Laboratories – New Mexico
SOW	Skill of the Worker
SRR	Savannah River Remediation, LLC
TQP	Technical Qualification Program
UCOR	United Cleanup Oak Ridge, LLC
WCD	Work Control Document
WP&C	Work Planning and Control

LESSONS LEARNED FROM ASSESSMENTS OF WORK PLANNING AND CONTROL AT U.S. DEPARTMENT OF ENERGY SITES

Executive Summary

The U.S. Department of Energy (DOE) Office of Enterprise Assessments (EA) conducted multiple independent assessments between January 2020 and August 2022 to evaluate the effectiveness of work planning and control (WP&C) programs to ensure the safe conduct of the work activities supporting DOE missions. This report documents lessons learned from these performance-based and programmatic appraisals, with attention to identified trends and significant issues affecting multiple DOE sites. Strengths, weaknesses, best practices, and recommendations are identified with the goal of promoting organizational learning and improving safety performance throughout the DOE complex.

EA conducted seven independent assessments of WP&C programs at DOE sites. The objective of each assessment was to determine the effectiveness of specific elements of the WP&C programs, as well as electrical safety programs, contractor assurance systems, and DOE field element oversight of WP&C; the flowdown of safety requirements to subcontractors was also assessed at selected sites.

The assessed sites demonstrated generally well-developed and effectively implemented programs. EA identified a number of specific strengths in site WP&C programs that represent best practices in DOE, including:

- The Lawrence Livermore National Security, LLC WP&C program at the Lawrence Livermore National Laboratory has strengths identified in six specific WP&C elements, including qualified work planners, the competent worker program, task-based job hazard analyses, pre-analyzed tasks, the integration of worker training requirements into work control documents (WCDs), and the WP&C tool, a web-based system used to develop new, or modify existing, WCDs. (Best Practices)
- The Savannah River Remediation, LLC work management Visual Management Tool at the Savannah River Site facilitates efficient work planning through an innovative computer-based system. Additionally, the work oversight processes, task-based observation and management field observation, are effective tools for identifying areas for improvement and future oversight opportunities. (Best Practice)
- The Four Rivers Nuclear Partnership, LLC Industrial Hygiene Work Permit process at the Paducah Gaseous Diffusion Plant is a practical and useful mechanism for identifying, analyzing, and documenting industrial hygiene hazards and controls in activity-level WCDs. (Best Practice)
- National Technology and Engineering Solutions of Sandia, LLC at the Sandia National Laboratories – New Mexico emphasizes the critical thinking approach as fundamental to WP&C, enabling staff to focus on identifying those risks at the work activity level that may have a low probability of occurrence but unacceptably high consequences to worker safety and health. (Best Practice)
- UChicago Argonne, LLC's (UChicago's) virtual micro-learning sessions at the Argonne National Laboratory (ANL) effectively cover WP&C topics through focused training sessions that enable ANL researchers and staff to learn about specific WP&C topics of interest in an efficient and interactive manner. In addition, UChicago uses an innovative artificial intelligence-enhanced knowledge mining process that integrates keyword identification with draft WCDs, enabling WCD authors to link available lessons learned to applicable draft and active WCDs. (Best Practice)
- United Cleanup Oak Ridge, LLC at the Oak Ridge Reservation has proactively developed and implemented a virtual radiological protection mockup capability that provides innovative, real-time quantitative evaluation of a trainee's radiological survey and personnel monitoring effectiveness. (Best Practice)

- DOE field elements at all assessed sites have established generally effective procedures for Federal line oversight of contractor WP&C practices, including for assessment planning and performance, operational awareness activities, issues management, and performance assurance.

EA also identified areas where improvements are needed. Site-specific issues are identified in each of the seven assessment reports. A summary is provided below:

- WP&C programmatic weaknesses were evident in three areas listed below:
    - "Skill of the worker" (SOW) programs: None of the laboratories assessed had been fully successful in applying SOW concepts to research work activities. Facility and maintenance SOW programs were generally well defined for various crafts (e.g., carpenters, pipe fitters) but did not always ensure that work performed as SOW was appropriately coordinated, authorized, and performed within the SOW established boundaries.
    - Activity-level hazard analysis: Programs for performing activity-level hazard analyses were established at each of the assessed sites; however, several activity-level hazard analysis concerns were identified with WP&C programs or procedures.
    - Ineffective WP&C processes and procedures for defining work scopes: Four of the seven assessed sites exhibited inadequate WP&C written programs, procedures, or instructions with respect to defining activity-level work scopes, work scope boundaries, and limitations.
- At several of the sites, workplace hazards were not consistently identified, adequately analyzed, or effectively controlled. This was specifically identified for work at heights and lockout/tagout.
- Silica hazards and controls continue to present a challenge in construction safety. Deficiencies were identified with not using the required American Conference of Governmental Industrial Hygienists threshold limit value for analyzing silica hazards, not using engineering controls, and/or not wearing required respiratory protection during silica dust-producing activities.
- The selection and tracking of key leading indicators for WP&C remains an issue for DOE and was identified as an area for improvement at two of the sites, and three other sites had not identified a specific set of leading and lagging metrics to monitor WP&C performance.
- Three of the seven assessed DOE field elements had weaknesses related to training and qualification of Federal staff performing oversight of contractor WP&C programs.

In summary, the assessed DOE sites had well-established institutional WP&C programs, processes, and implementing procedures. However, EA identified several institutional and performance issues that point to areas for improvement. The results of this lessons-learned report (common strengths and weaknesses, best practices, and recommendations) are based on a collective analysis of the seven independent assessments of WP&C programs. These results should be evaluated by DOE organizations and site contractors for applicability and possible implementation at their respective sites, supporting the continuous improvement of WP&C performance throughout the DOE complex.

Recommendations

This report provides recommendations to DOE field element managers and site contractors for improving WP&C programs. Selected recommendations are highlighted below; a complete list of recommendations is provided in section 5.0 of the report.

DOE Field Element Managers

- Conduct periodic self-assessments of the technical qualification program (TQP) to ensure that the TQP is appropriately implemented, including tracking of qualification status and establishing a formal continuous training program to provide adequate DOE field element oversight of WP&C.
- Conduct triennial self-assessments of the Facility Representative program to provide adequate DOE field element oversight of WP&C.

Site Contractors

- Benchmark Lawrence Livermore National Laboratory, which has developed a strong WP&C program. Many elements of the program can be applied to research, operations, and/or maintenance-type work.
- Ensure adequate tailoring of hazards and controls to specific work activities and avoid overreliance on general job hazard analyses. Areas of concentration should include work at heights and lockout/tagout.
- Establish clear contract flowdown safety requirements in subcontracts and conduct oversight to ensure that DOE and prime contract safety requirements are included in sub-tier contracts.
- Conduct periodic assessments to determine how well applicable lessons learned, areas for improvement, and worker feedback are captured, analyzed, shared, and subsequently implemented in applicable WCDs.

LESSONS LEARNED FROM ASSESSMENTS OF WORK PLANNING AND CONTROL AT U.S. DEPARTMENT OF ENERGY SITES

1.0 INTRODUCTION

The U.S. Department of Energy (DOE) Office of Environment, Safety and Health Assessments, within the independent Office of Enterprise Assessments (EA), conducted assessments of work planning and control (WP&C) at Lawrence Livermore National Laboratory (LLNL), the Savannah River Site, Paducah Gaseous Diffusion Plant, Portsmouth Site, Sandia National Laboratories – New Mexico (SNL-NM), Argonne National Laboratory (ANL), and the Oak Ridge Reservation from January 2020 through August 2022. The objective of each assessment was to determine the effectiveness of specific elements of the WP&C programs, as well as electrical safety programs, contractor assurance systems (CASs), and DOE field element oversight of WP&C; the flowdown of safety requirements to subcontractors was also assessed at selected sites.

The lessons learned presented in this report are based on a collective analysis of these assessments. The seven sites are under the direction of the National Nuclear Security Administration, the Office of Environmental Management, and the Office of Science. This report focuses on issues affecting multiple sites and identifies commonly observed strengths and weaknesses, best practices, and recommendations, with the goal of promoting organizational learning and improving performance throughout the DOE complex.

EA manages the Department's independent oversight program. This program is designed to enhance DOE safety and security programs by providing the Secretary and Deputy Secretary of Energy, Under Secretaries of Energy, other DOE managers, senior contractor managers, Congress, and other stakeholders with an independent evaluation of the adequacy of DOE policy and requirements and the effectiveness of DOE and contractor line management performance and risk management in safety and security and other critical functions as directed by the Secretary. DOE Order 227.1A, *Independent Oversight Program*, describes and governs the DOE independent oversight program. EA implements the program through a comprehensive set of internal protocols and assessment guides.

The members of the EA report preparation team, the Quality Review Board, and EA management responsible for this lessons-learned report are listed in appendix A. The scope of assessments directives and criteria and review approach documents and a table of assessed sites included in this lessons-learned report are listed in appendix B. In addition, the individual EA assessment reports providing the information source for the lessons learned described in this report, along with their hyperlinks to the individual published reports, are listed in appendix C.

2.0 METHODOLOGY

This report reflects an analysis of lessons learned from EA WP&C assessments completed between 2020 and 2022 at seven DOE sites. Appendix B describes the scope as well as requirements and guidance used in this lessons-learned report; Table B-1 shows the sites and key elements assessed, contractors, and DOE field elements and Headquarters program offices. The assessment reports are listed in appendix C. Collectively, these assessment reports included the observation and analysis of work activities (i.e., research activities, maintenance, operations, deactivation and demolition, subcontracted construction). Electrical safety, feedback and improvement (i.e., CAS), and DOE field element oversight of WP&C were evaluated at each of the seven sites. The flowdown of safety requirements to subcontractors was evaluated at four sites (LLNL, Savannah River Site, SNL-NM, and ANL).

3.0 RESULTS

This section of the report summarizes the WP&C issues (findings and deficiencies) identified by EA at the seven assessed sites and provides a rollup description of the common strengths and weaknesses.

The WP&C programs at each of the seven sites were generally effective in the safe performance of relevant types of work. However, EA identified several institutional and performance issues that point to areas for improvement. Collectively, these assessments resulted in six findings and 42 deficiencies. One finding and four deficiencies are related to the DOE contractors' overall institutional WP&C programs. The other findings and deficiencies are depicted in Table 1 and grouped into the integrated safety management (ISM) core functions. The two core functions with the highest percentage of EA-identified performance issues are core function 2: identify and analyze hazards, and core function 4: perform work within controls, at 33% and 30%, respectively. These are followed closely by core function 3: develop and implement controls, at 23%.

Table 1 - WP&C Performance Issues Identified by ISM Core Functions

	# Findings	# Deficiencies	%
Core Function 1: Define the Scope of Work	0	3	7%
Core Function 2: Identify and Analyze Hazards	5	9	33%
Core Function 3: Develop and Implement Controls	0	10	23%
Core Function 4: Perform Work within Controls	0	13	30%
Core Function 5: Provide Feedback and Improvement	0	3	7%
Institutional WP&C Issues	1	4	

3.1 Institutional Work Planning and Control Programs

This portion of the lessons-learned review identifies the strengths and weaknesses at the DOE sites in developing and approving WP&C institutional processes to enable the safe performance of work.

Strengths

Overall, the assessed DOE sites had well-established institutional WP&C programs, processes, and implementing procedures for the work observed. Each WP&C process provided an effective means for implementing the five core functions of ISM. When compared to prior EA WP&C assessments, each of the seven sites in this report reflected several improvements and innovative approaches to their WP&C programs and procedures. For example:

- At ANL, UChicago achieved notable progress in restructuring and streamlining its WP&C process. Work control documents (WCDs) are now shorter, streamlined, and more effectively meet the needs of the workers.
- At SNL-NM, National Technology and Engineering Solutions of Sandia, LLC revamped its WP&C process to be more focused on defining, analyzing, and controlling those hazards that pose the greatest risk to workers.
- At LLNL, Lawrence Livermore National Security, LLC established protocols to integrate the input more effectively from Environment, Safety and Health (ES&H) subject matter experts (SMEs) into the WP&C process.

- At Paducah Gaseous Diffusion Plant, the Four Rivers Nuclear Partnership, LLC revised its WP&C program and procedures for better alignment with DOE-HDBK-1211-2014, DOE Handbook: *Activity-Level Work Planning and Control Implementation*.

Three of the seven assessed sites are predominately research laboratories with multiple divisions that have diverse missions and objectives. The institutional WP&C programs at each of these sites provided sufficient flexibility to enable research divisions to tailor their work processes and accommodate the diversity of research while adhering to the institutional WP&C requirements.

Radiological programs were assessed at four of the seven sites. Overall, EA concluded that WP&C processes are supported by formal radiation protection programs that include an extensive document hierarchy consisting of program plans, technical basis documents, and implementing procedures intended to flow down radiological requirements to the working level. The radiological programs at these sites were also well staffed with knowledgeable SMEs who were integrated into the WP&C processes.

All seven sites had developed and implemented electrical safety programs that were effectively embedded in the WP&C processes and implementing procedures for the areas assessed (research, operations, and maintenance). Each of these institutional electrical safety programs provided a useful means for implementing the five core functions of ISM. Electrical safety programs were effectively established for work activities and were appropriate for the risk associated with the identified electrical hazards. These programs were detailed and met or exceeded the requirements of 10 CFR 851, *Worker Safety and Health Program*, Subpart B, *Program Requirements*, including National Fire Protection Association 70E, *Standard for Electrical Safety in the Workplace®*, section 110.1, *Electrical Safety Program*.

Weaknesses

WP&C programmatic weaknesses were evident in three areas: "skill of the worker" (SOW) programs; activity-level hazard analysis; and ineffective WP&C program documents and procedures for defining work scopes.

EA's December 2019 WP&C lessons-learned report identified ongoing challenges with developing and implementing effective SOW programs at each of the assessed DOE sites. During this 2022 review, five of the seven sites displayed the same challenge. In particular, applying SOW to research activities remains a challenge; none of the three laboratories assessed had been fully successful in applying SOW concepts to research work activities. Facility and maintenance SOW programs were generally well defined for various crafts (e.g., carpenters, pipe fitters) but did not always ensure that work performed as SOW was appropriately coordinated, authorized, and performed within the SOW established boundaries. At one site, inadequate SOW definitions could have resulted in higher-risk work activities being performed without the necessary hazard controls in place.

Programs for performing activity-level hazard analyses were established at each of the assessed sites. However, at some of the sites, several activity-level hazard analysis concerns with WP&C programs or procedures were identified, including the following:

- A lack of WP&C processes to effectively assess risk to workers from unintended consequences during research activities
- Ineffective industrial hygiene (IH) exposure assessment programs and procedures to ensure that identified IH hazards were sufficiently documented and analyzed in accordance with the requirements of 10 CFR 851

- Programs that did not correctly identify relevant fall protection standards or specify when fall protection hazard analyses were required to be performed
- Job hazard analysis (JHA) processes that did not ensure the tailoring of hazard controls to specific industrial and radiological workplace hazards
- Lack of effective hazard analysis training programs.

Four of the seven assessed sites exhibited inadequate WP&C written programs, procedures, or instructions with respect to defining activity-level work scopes, work scope boundaries, and limitations.

3.2 Implementation of Activity-Level Work Planning and Control Programs

This portion of the lessons-learned review identifies the strengths and weaknesses at the DOE sites in implementing institutional WP&C programs at the work activity level with respect to the five core functions of ISM. Lessons learned in this section are based on observations of research, maintenance, and deactivation and demolition related work.

3.2.1 Research

Implementation of the ISM core functions for a wide variety of research activities was assessed at three laboratories. Observed strengths and weaknesses are as follows:

Strengths

The three research laboratories assessed reflect a wide spectrum of research work activities and hazards and demonstrated generally effective WP&C for research and nuclear operations. Most of the observed research and operations work was performed safely and within the controls established in the organizations' work control procedures and was adequately documented in WCDs.

Research and support staff at all three laboratories are experienced, well qualified, and trained for their respective roles. The work control processes were generally implemented in a manner that reflected the hazard level and complexity of the specific work task. All three research sites had a generally effective process for the authorization and release of research work activities.

Two of the three laboratories used robust WP&C software systems to ensure consistency in the creation of WCDs. The staff at these sites are well trained and competent in the use of the systems.

Weaknesses

Observations at two of the three laboratories identified incomplete hazard analyses with either an incomplete list of potential chemical and physical hazards or incomplete IH exposure assessments included in the WCDs. Hazard analysis processes at one of the three laboratories focused on low probability/unacceptable consequences and did not properly identify hazards of routine laboratory work. This limited focus resulted in inadequate hazard analysis and control development for common laboratory hazards that may result in lower, but still unacceptable, consequences to workers.

Radiological practices associated with operations and radiochemistry work were evaluated at one of the laboratories. At this site, EA determined that radiological work permits (RWPs) governing operations work did not properly specify the need to perform job-specific contamination surveys for job coverage to demonstrate that RWP contamination limits were not exceeded during radiological work. Also, during observed research work at this laboratory, the RWPs lacked sufficient worker instruction to self-monitor

for both alpha and beta-gamma contamination potential on gloved hands and sleeves during transuranic glovebox work. Workers used the dual alpha-beta instruments in dual alpha-beta mode (rather than separate alpha and beta counting modes). Due to the much higher beta background, the use of dual alpha-beta mode would mask the presence of low levels of alpha contamination that are actually at levels of concern. Similar air sampling and contamination control weaknesses were identified at deactivation and demolition sites as discussed in section 3.2.3.

3.2.2 Maintenance

Implementation of the ISM core functions for maintenance work activities was assessed at four DOE sites. Observed strengths and weaknesses are as follows:

Strengths

Three of the four sites demonstrated generally effective WP&C implementation for maintenance activities. The work planning processes resulted in well-defined scopes of work.

All four sites were staffed with experienced and well-qualified managers, work planners, and craftsmen with appropriate safety and health SME support. Personnel were appropriately trained for their respective work. Sites used a graded approach to tailor the rigor of the planning process based on the hazards and complexity of the job. Work was appropriately authorized prior to performance. Prior to work start, generally effective pre-job briefings were provided that appropriately discussed the work to be performed, anticipated hazards, and controls. Overall, the workers at these sites demonstrated proficiency with their craft, and observed work was performed safely and within the established work controls.

Weaknesses

At three of the four sites, some hazards were not identified, adequately analyzed, or controlled. Specifically, workplace IH hazardous contaminants and chemical exposures were not identified, resulting in incomplete IH exposure assessments. Where contaminants of concern were identified, controls were periodically missed or inconsistently applied.

While observed work was generally performed within controls, EA identified specific instances where controls were not followed properly. For example, during work on a hot water heating pipe system, a single-source lockout/tagout (LOTO) was used when a complex lockout was required, and one LOTO specified the lockout of an incorrect valve.

3.2.3 Deactivation and Demolition

Implementation of the ISM core functions for deactivation and demolition (D&D) work activities was assessed at three DOE sites. Observed strengths and weaknesses are as follows:

Strengths

Two of three sites demonstrated generally effective WP&C implementation for D&D activities. The work planning processes generally resulted in well-defined scopes of work.

All three sites were staffed with experienced and well-qualified managers, work planners, and craftsmen with appropriate safety and health SME support. Personnel were appropriately trained for their respective work. The sites use a graded approach to tailor the rigor of the planning process based on the hazards and complexity of the job, and work is appropriately authorized prior to performance. Prior to work start,

generally effective pre-job briefings were provided that appropriately discussed the work to be performed, anticipated hazards, and controls. A contractor (United Cleanup Oak Ridge, LLC (UCOR)) at Oak Ridge Reservation used a reverse briefing methodology, in which the supervisor/foreman asked questions of workers and supplied answers or direction, if needed, to encourage group participation. Generally, the workers at these sites demonstrated proficiency with their craft, and observed work was performed safely and within the established work controls.

Weaknesses

At all three sites, some hazards were not identified, adequately analyzed, or controlled. JHA processes at two sites did not ensure adequate tailoring of hazards and controls to specific work activities, including overreliance on general JHAs. For example, at two sites, work at elevated heights was conducted without adequate controls due to the lack of proper hazard identification and control.

Similar to the weaknesses noted above for Research and Maintenance, one of the three sites did not identify IH hazards, including incomplete IH exposure assessments.

Radiological hazard control concerns were noted at two of the three D&D sites. At both sites, radiological control personnel did not properly follow established procedures for conducting removable contamination surveys during intrusive radiological work with potential for spread of contamination. At one of these sites breathing zone air samplers were also not properly placed in workers' breathing zones as required. At the other site, site breathing zone sampling was properly performed but job specific air samplers were not placed at the perimeter of the work areas to be representative of potential worst-case airborne concentrations, as required by procedures, nor did RWPs require such placement.

3.3 Flowdown of Construction Safety Requirements to Subcontractors

This portion of the lessons-learned review identifies the strengths and weaknesses at the DOE sites in properly flowing down construction safety requirements to subcontractors, including the implementation of WP&C for observed construction projects.

Strengths

In general, construction safety requirements were adequately flowed down to subcontractors through contracts which included 10 CFR 851 and the Department of Energy Acquisition Regulation (DEAR) Clause 970.5223-1, *Integration of Environment, Safety, and Health into Work Planning and Execution*. Contract requirements included the development of a worker safety and health plan, a job safety analysis, a designated ES&H representative, and daily inspections. Contractors provided appropriate oversight of subcontractor work through review of contract submittals and daily oversight by subcontract technical representatives and safety professionals. All observed work was supported with a job safety analysis identifying hazards and controls, and work was appropriately integrated with the facility management. Daily crew briefings used effective tools, such as safety task analysis risk reduction talk cards, to highlight potential hazards and appropriate controls. Overall, crews conducted work within controls, including wearing the proper personal protective equipment (PPE).

Weaknesses

Although the flowdown of construction requirements was generally adequate, in two cases the contract flowdown from first-tier to sub-tier subcontractors did not include the appropriate safety and health requirements, such as noise protection. Improper flowdown of requirements can lead to sub-tier contractors not implementing DOE worker safety and health regulatory and contractual requirements.

Silica hazards and controls continue to present a challenge in construction safety. Deficiencies were identified with not using the required American Conference of Governmental Industrial Hygienists threshold limit value for analyzing silica hazards, and not using engineering controls and/or not wearing required respiratory protection during silica dust-producing activities. Workers could be exposed to silica dust above a safe level when exposures are unknown or when proper controls are not identified and/or used.

3.4 Electrical Safety

This portion of the lessons-learned review identifies the strengths and weaknesses associated with the implementation of electrical safety, including planning for potential hazardous energy control for observed work.

Strengths

For all seven sites, the electrical safety programs were well staffed with SMEs and authorities having jurisdiction who are qualified in all aspects of electrical safety. Additionally, employees were adequately informed of electrical arc flash and shock hazards. In general, electrical panels, disconnect switches, motor control centers, and switchgear with potential for arc flash either had current arc flash and shock warning labels installed on the equipment, or the electrical hazards were documented in the work package on a job-specific electrical task risk assessment or switching procedure. These labels provide warnings and guidance for the potential arc flash hazard, arc flash boundary, and the required PPE for anyone working on or operating equipment within the arc flash boundary or electrical shock limited and restricted approach boundaries of exposed energized electrical conductors or circuit parts. At four of the sites, the electrical safety program appropriately established an effective electrical safety committee.

Electrical work performance demonstrated the effective implementation of the electrical safety programs. Work activities were on de-energized electrical equipment using qualified electrical maintenance personnel who performed the work safely, appropriate to the risk associated with electrical hazards, and in accordance with the requirements of the electrical safety program.

Weaknesses

EA identified no common weaknesses in the area of electrical safety among the sites in this report.

3.5 Feedback and Improvement/Contractor Assurance System

This portion of the lessons-learned review identifies the strengths and weaknesses at the DOE sites in establishing CASs to plan and conduct risk-based assessments, analyze WP&C issues, manage corrective actions, review performance, collect worker feedback, and share lessons learned to continuously improve safe work processes.

Strengths

All seven sites had effective CASs with risk-based processes in place for selecting annual management and independent assessment topics related to WP&C. Assessments involving WP&C were generally robust, self-critical, and frequently included work activity observations by managers and SMEs.

Systematic and effective processes were in place for WP&C-related events and issue analysis, development of corrective actions, and completion of effectiveness reviews. All site contractors used mature issues management systems to assist in tracking corrective actions, extent-of-condition reviews,

and effectiveness reviews. In addition, six of the seven site contractors established corrective action review boards consisting of senior managers who review and track significant WP&C corrective actions.

Effective tools and processes were in place for collecting and reviewing performance information. At two sites, event causes and other identified issues were analyzed and grouped according to applicable ISM core functions, then tracked to provide valuable WP&C metrics. All site contractors provided periodic performance (e.g., monthly, quarterly) reports that include data that could be used as lagging WP&C indicators.

Worker feedback was collected during post-job reviews at all but one site. At one site, additional WP&C-related feedback was collected during semi-annual meetings with each division manager. All sites have worker feedback information available to them, and there is general agreement and understanding by senior managers and CAS managers that worker feedback is an essential element of organizational learning and continuous improvement in WP&C.

Site lessons-learned coordinators effectively collected and distributed DOE operating experience reports as well as locally generated lessons learned. Lessons-learned communications were well written and generally appropriate for the audience.

Weaknesses

In the area of assessments, three sites did not perform periodic assessments to determine how well applicable lessons learned, areas for improvement, and worker feedback are captured, analyzed, shared, and subsequently implemented in applicable WCDs. Periodic assessments can identify areas for increased focus and highlight areas for improvement in WP&C.

Regarding performance metrics, the selection and tracking of key leading indicators for WP&C is still an issue for DOE and was identified as an area for improvement at two of the sites, and three other sites had not identified a specific set of both leading and lagging metrics to monitor WP&C performance. All sites have suitable data available for such metrics, but some have not selected a specific set of metrics for tracking WP&C performance. Key leading indicators can help predict and prevent occurrences, whereas lagging indicators are used to monitor performance through actual events and past occurrences.

EA identified several instances of sites not effectively collecting, trending, and analyzing data for potential lessons learned. At one site, workers did not provide feedback on post-job review forms, and at two sites, available information was not collected, trended, or analyzed. At another site, workers who provided feedback did not have an easy way to access information regarding the review status and final disposition of their feedback. An effective lessons-learned program, with feedback collection and an analysis system, can result in continuous improvement in WP&C.

3.6 DOE Field Element Oversight

This portion of the lessons-learned review identifies the strengths and weaknesses of the DOE sites in overseeing contractor WP&C-related programs and assessing implementation effectiveness.

Strengths

DOE field elements at these sites have established generally effective procedures for Federal line oversight of WP&C, including for assessment planning and performance, operational awareness activities, issues management, and performance assurance. The results of DOE oversight of contractor

activity-level WP&C were effectively used in performance evaluation feedback, and measurement plan and/or ISM system reviews.

Weaknesses

Two of the seven DOE field elements overseeing contractor WP&C-related programs and assessing implementation effectiveness had weaknesses related to training and qualification. One of the DOE field elements did not effectively track or monitor the Facility Representative (FR) qualification program to ensure that FRs complete qualifications. The other DOE field element did not implement a formal continuous training program for personnel in the technical qualification program (TQP), periodically requalify TQP qualified personnel, or conduct periodic self-assessments of the TQP for effectiveness.

Two of the seven DOE field elements overseeing contractor WP&C-related programs and assessing implementation effectiveness did not conduct a triennial self-assessment of the FR program.

3.7 Occurrence Reporting and Processing System Data Analysis

This portion of the lessons-learned review evaluates WP&C-related data from the DOE ORPS for the seven sites (specific to the contractor being assessed) during the period of this review (i.e., two years of data before the date of each onsite assessment from February 2018 through August 2022).

EA identified a total of 346 applicable ORPS reports for the seven sites. Table 2, below, summarizes the ORPS results by site and ISM core function. The EA issues (findings and deficiencies) identified during this period, when grouped by ISM core functions (Table 1), are similar in distribution and importance to the ORPS reports when grouped by ISM core functions, as depicted in Table 2, with the most significant number of ORPS events in core functions 2, 3, and 4. The percentages for the five core function categories may not add up to 100% because ORPS reports may identify more than one factor as a contributor to an event.

The ORPS data also indicates that a large portion (21%) of events involved a subcontractor indicating an additional focus on subcontractor contract requirement flowdown and safety oversight may be needed.

Table 2 - Summary of ORPS Reports for the Seven Sites by ISM Core Functions February 2018 – August 2022 (Two Years of Data Prior to Each Assessment)

Site	ORPS Report Total	ISM Core Function 1		ISM Core Function 2		ISM Core Function 3		ISM Core Function 4		ISM Core Function 5	
		#	%	#	%	#	%	#	%	#	%
1	89	15	17%	45	51%	46	52%	48	54%	7	8%
2	63	10	16%	25	40%	26	41%	24	38%	61	97% (Note 1)
3	26	1	4%	3	12%	2	8%	2	8%	3	12%
4	16	0	0%	6	38%	7	44%	7	44%	0	0%
5 (Note 2)	101	1	1%	2	2%	1	1%	2	2%	0	0%
6	27	2	7%	6	22%	6	22%	4	15%	4	15%
7	24	3	13%	6	25%	5	21%	7	29%	0	0
Total	346	32	9%	93	27%	93	27%	94	27%	75	22%

Note 1: Appears inconsistent (high) with other site/laboratory data
Note 2: Out of 101 ORPS reports, Site 5 only reported two occurrences as having issues related to the ISM core functions.

4.0 BEST PRACTICES

A best practice is a safety-related practice, technique, process, or program attribute observed during an appraisal that may merit consideration by other DOE and contractor organizations for implementation because it: (1) has been demonstrated to substantially improve safety or security performance of a DOE operation; (2) represents or contributes to superior performance (beyond compliance); (3) solves a problem or reduces the risk of a condition or practice that affects multiple DOE sites or programs; or (4) provides an innovative approach or method to improve effectiveness or efficiency. This lessons-learned report summarizes the following best practices that were identified in the assessment reports.

Lawrence Livermore National Laboratory

- Lawrence Livermore National Security, LLC's WP&C program has strengths identified in six specific WP&C elements, including qualified work planners, the competent worker program, task-based JHAs, pre-analyzed tasks (PATs), the integration of worker training requirements into WCDs, and the WP&C tool.
    - The WP&C tool is a core web-based system that enables work planners, working in conjunction with responsible individuals and SMEs, to develop new, or modify existing, WCDs. This tool provides a mechanism to identify task-based hazards and PATs; ensures consistency with institutional ES&H requirements; and includes the Facility Activity Schedule, an innovative scheduling tool that makes it easy to determine whether a work package has been scheduled and released.
    - The qualified work planner program requires that work planners possess broad knowledge and experience in ES&H, facility operations and program work activities, and work with responsible individuals and maintenance supervisors to develop WCDs using the WP&C tool.
    - The competent worker program establishes requisite worker skills, knowledge, experience, and training such that WCDs can focus on unique tasks, hazards, and controls.
    - Task-based JHAs are documented, task-level hazard analyses that form the core of the WCD and include hazards and controls, boundary conditions, prerequisites, action statements, pre-job talking points, and task notes.
    - PATs are ES&H-approved, task-based JHAs for specific work that can be incorporated into a WCD without change, may be customized as needed, and provide a consistent set of controls for the same tasks, improving the efficiency of planning new work that may involve tasks that have been previously analyzed.
    - Worker training requirements are integrated into WCDs to provide a mechanism for work supervisors to ensure that workers are current in the training required to perform each work task. The training requirements and status in the matrix are updated nightly.
- The Integrated Health of the Program analysis process effectively integrates CAS and field office oversight results to provide both laboratory and DOE field element senior management with valuable insights regarding performance within functional areas.

Savannah River Site

- The work management Visual Management Tool facilitates efficient work planning through an innovative computer-based system that was developed in house by Savannah River Remediation, LLC (SRR).

- The work oversight processes, task-based observation and management field observation, are effective tools for identifying areas for improvement and future oversight opportunities.
- SRR requires construction subcontractors to develop a process in their worker protection programs to self-assess safety during work activities using focused observation checklists. SRR provides online resources to facilitate the development of focused observation checklists matching a subcontractor's scope of work.

Paducah Gaseous Diffusion Plant

- The Four Rivers Nuclear Partnership, LLC Industrial Hygiene Work Permit process is a practical and useful mechanism for identifying, analyzing, and documenting IH hazards and controls in activity-level WCDs.

Sandia National Laboratories – New Mexico

- National Technology and Engineering Solutions of Sandia, LLC's emphasis on the critical thinking approach as fundamental to WP&C has enabled staff to focus on identifying those risks at the work activity level that may have a low probability of occurrence but unacceptably high consequences to worker safety and health. This practice has led to a better understanding and identification of failure modes, unacceptable consequences, mitigation and control measures, and the definition of acceptable risks.

Argonne National Laboratory

- UChicago Argonne, LLC's WP&C Program Office's virtual micro-learning sessions effectively cover WP&C topics through focused, 30-minute (or less), training sessions that enable ANL researchers and staff to learn about specific WP&C topics of interest in an efficient and interactive manner.
- UChicago Argonne, LLC developed an innovative artificial intelligence-enhanced knowledge mining process that integrates keyword identification with draft WCDs, enabling WCD authors to link available lessons learned to applicable draft and active WCDs.

Oak Ridge Reservation

- The UCOR virtual radiological protection mockup capability provides innovative, real-time quantitative evaluation of a trainee's radiological survey and personnel monitoring effectiveness. UCOR uses a computerized mannequin and radiological survey equipment with radio frequency technology that allows trainees to practice various radiological scenarios with realistic meter responses.

5.0 RECOMMENDATIONS

These recommendations are based on the analysis of EA assessments as summarized in section 3 of this report. Although the underlying deficiencies and weaknesses from individual reviews did not apply to every site reviewed, the recommended actions are intended to provide insights for potential improvements at all DOE sites. Consequently, DOE organizations and contractors should evaluate the applicability of the following recommended actions to their respective facilities and/or organizations and consider their use as appropriate in accordance with Headquarters and/or site program objectives:

DOE Field Element Managers

To promote the effective performance of oversight by a technically competent and qualified staff:

- Conduct periodic self-assessments of the TQP to ensure that the TQP is appropriately implemented, including tracking qualification status and establishing a formal continuous training program to provide adequate DOE field element oversight of WP&C.
- Conduct triennial self-assessments of the FR program to provide adequate DOE field element oversight of WP&C.

Site Contractors

To strengthen WP&C programs:

- Benchmark LLNL, which has developed a strong WP&C program. Many elements of the LLNL program can be applied to research, operations, and/or maintenance-type work.
- Ensure that the programs include the appropriate standards and specify when a hazard analysis must be performed, including the fall protection program.
- Incorporate guidance from DOE-HDBK-1211-2014, DOE Handbook: *Activity-Level Work Planning and Control Implementation.*

To enhance WP&C programs for research work activities:

- Include a process for identifying and evaluating the critical work tasks within a research experiment (tasks with the greatest hazards), identify the potential adverse consequences and hazard controls to mitigate the consequences, and document an assessment of the overall risk to the researchers (e.g., the "critical thinking" risk assessment approach to WP&C used by SNL-NM Center 1800 researchers).
- Verify that the research WP&C process incorporates a mechanism for documenting an exposure assessment for each experiment that addresses the potential biological, chemical, physical, and ergonomic hazards of the experiment.

To strengthen WP&C implementation, emphasize the identification and analysis of hazards and development of controls in the following areas:

- Ensure adequate tailoring of hazards and controls to specific work activities and avoid overreliance on general JHAs. Areas of concentration should include work at heights and LOTO.
- Ensure that IH exposure assessments are complete and accurate, and that workplace contaminant, chemical exposure, and physical hazard controls are identified with consistent hazard controls specified and implemented.

For work involving radiological hazards, provide additional focus and rigor in the following areas:

- Ensure that job-specific air sampling is properly conducted and representative of worst-case conditions at posted radiological boundaries during intrusive work. At some sites, RWPs specifying perimeter or job-specific air sampling may need to be improved to achieve this objective.
- Ensure that contamination control practices for areas, equipment, and personnel, including removable contamination surveys and frisking, are adequate to detect the potential spread of contamination beyond posted radiological boundaries during intrusive work, and to verify that RWP contamination limits are not exceeded.

To improve SOW programs:

- Develop a SOW program tailored to research work. This recommendation was also included in EA's December 2019 WP&C lessons-learned report.
- Clearly define what work can be accomplished as SOW.
- Ensure that all work has some level of hazard analysis, work release, and pre-job briefing.
- Ensure that all workers are trained and qualified to perform SOW activities.
- Incorporate guidance from DOE-HDBK-1211-2014, DOE Handbook: *Activity-Level Work Planning and Control Implementation*, appendix A.

To improve the performance of subcontracted work:

- Establish clear contract flowdown safety requirements in subcontracts and conduct oversight to ensure that DOE and prime contract safety requirements are included in sub-tier contracts.
- Increase oversight for subcontracted work for those areas where the DOE requirements are more stringent than the Occupational Safety and Health Administration requirements (e.g., silica).
- Ensure that subcontractors understand the DOE requirements (e.g., American Conference of Governmental Industrial Hygienists silica requirements).
- Ensure (in the following order) that proper engineering controls, administrative controls, and appropriate PPE are applied to eliminate or mitigate workplace hazards.
- Increase personal and area IH monitoring on the jobsite.

To strengthen the CAS and feedback and improvement performance:

- Conduct periodic assessments to determine how well applicable lessons learned, areas for improvement, and worker feedback are captured, analyzed, shared, and subsequently implemented in applicable WCDs.
- Develop specific metrics for WP&C performance, including key leading indicators.
- Collect, trend, and analyze available job performance information, such as worker feedback, for potential lessons learned.

Appendix A
Supplemental Information

Office of Enterprise Assessments Management

John E. Dupuy, Director, Office of Enterprise Assessments
William F. West, Deputy Director, Office of Enterprise Assessments
Kevin G. Kilp, Director, Office of Environment, Safety and Health Assessments
David A. Young, Deputy Director, Office of Environment, Safety and Health Assessments
Kevin M. Witt, Director, Office of Nuclear Safety and Environmental Assessments
Kimberly G. Nelson, Director, Office of Worker Safety and Health Assessments
Jack E. Winston, Director, Office of Emergency Management Assessments
Joseph J. Waring, Director, Office of Nuclear Engineering and Safety Basis Assessments

Quality Review Board

William F. West, Advisor
Kevin G. Kilp, Chair
Joseph Lewis
Shannon L. Holman
Michael A. Kilpatrick

Lessons Learned Report Preparers

Thomas M. Wirgau, Lead
James C. Cantwell
Roby D. Enge
Terry E. Krietz
Joseph Lischinsky
James R. Lockridge
Daryl D. Magers
Dennis K. Neitzel
Terry B. Olberding
Mario A. Vigliani

Appendix B
Scope, Requirements and Guidance, and Assessment Sites

Scope

The scope of the assessments included elements from the following U.S. Department of Energy (DOE) directives and criteria and review approach documents (CRADs) to determine whether the policies, procedures, and operational performance met DOE objectives for effectiveness in the areas examined:

- DOE Guide 226.1-2A, *Federal Line Management Oversight of Department of Energy Nuclear Facilities*, Appendix D, *Activity Level Work Planning and Control Criterion Review and Approach Documents with Lines of Inquiry*
- CRAD EA-30-01, *Contractor Assurance System*
- CRAD EA-30-07, *Federal Line Management Oversight Processes*
- CRAD EA-32-03, *Industrial Hygiene Program*
- CRAD EA-45-35, *Occupational Radiation Protection Criteria Review and Approach Document*.

Requirements and Guidance

Upper-tier requirements for work planning and control (WP&C) programs at the assessed sites flow down from DOE Acquisition Clause 48 CFR 970.5223-1(c), *Integration of Environment, Safety, and Health into Work Planning and Execution*. This clause requires contractors to manage and perform work by a process that (1) defines the scope of work; (2) identifies and analyzes hazards associated with the work; (3) develops and implements hazard controls; (4) performs the work within controls; and (5) provides feedback on the adequacy of controls and continues to improve safety management. Contractor assurance system (CAS) and DOE field element oversight requirements are primarily contained in DOE Order 226.1B, *Implementation of Department of Energy Oversight Policy*. Electrical safety, construction safety, industrial hygiene, and other worker safety-related requirements are included in 10 CFR 851, *Worker Safety and Health Program*.

Assessment Sites

The table below lists the assessment sites, along with key reviewed elements, contractors, and DOE field elements and Headquarters program offices.

Table B-1 - Assessment Sites, Key Reviewed Elements, Contractors, and DOE Field Elements and Headquarters Program Offices

Assessment Site	Key Reviewed Elements	Contractor	DOE Field Element	DOE Headquarters Program Office
Lawrence Livermore National Laboratory	WP&C processes implemented in Research and Maintenance Electrical Safety Construction Subcontractor Safety (flowdown of safety requirements) Feedback and Improvement/CAS Federal Oversight	Lawrence Livermore National Security, LLC	Livermore Field Office	National Nuclear Security Administration
Savannah River Site	WP&C processes implemented at the F and H Tank Farms Electrical Safety Construction Subcontractor Safety (flowdown of safety requirements) Feedback and Improvement/CAS Federal Oversight	Savannah River Remediation, LLC	Savannah River Operations Office	Office of Environmental Management
Paducah Gaseous Diffusion Plant	WP&C processes implemented for deactivation work Electrical Safety Feedback and Improvement/CAS Federal Oversight	Four Rivers Nuclear Partnership, LLC	Portsmouth/ Paducah Project Office	Office of Environmental Management

Assessment Site	Key Reviewed Elements	Contractor	DOE Field Element	DOE Headquarters Program Office
Portsmouth Site	WP&C processes implemented for deactivation and demolition work Electrical Safety Feedback and Improvement/CAS Federal Oversight	Fluor-BWXT Portsmouth, LLC	Portsmouth/ Paducah Project Office	Office of Environmental Management
Sandia National Laboratories – New Mexico	WP&C processes implemented in Centers 1800 - research and 4700 - maintenance Electrical Safety Construction Subcontractor Safety (flowdown of safety requirements) Feedback and Improvement/CAS Federal Oversight	National Technology and Engineering Solutions of Sandia, LLC	Sandia Field Office	National Nuclear Security Administration
Argonne National Laboratory	WP&C processes implemented for research and nuclear operations and maintenance Electrical Safety Construction Subcontractor Safety (flowdown of safety requirements) Feedback and Improvement/CAS Federal Oversight	UChicago Argonne, LLC	Argonne Site Office	Office of Science

Assessment Site	Key Reviewed Elements	Contractor	DOE Field Element	DOE Headquarters Program Office
Oak Ridge Reservation	WP&C processes implemented for deactivation and demolition work Electrical Safety Feedback and Improvement/CAS Federal Oversight	United Cleanup Oak Ridge, LLC	Oak Ridge Office of Environmental Management	Office of Environmental Management

Appendix C
Source Documents

- EA Report, *Work Planning and Control Assessment at the Lawrence Livermore National Laboratory – August 2020*
- EA Report, *Independent Assessment of Work Planning and Control at the Savannah River Site F and H Tank Farms – October 2021*
- EA Report, *Independent Assessment of Work Planning and Control at the Paducah Gaseous Diffusion Plant – November 2021*
- EA Report, *Independent Assessment of Work Planning and Control for Deactivation and Demolition Work at the Portsmouth Site – March 2022*
- EA Report, *Independent Assessment of Work Planning and Control at Sandia National Laboratories – New Mexico – May 2022*
- EA Report, *Independent Assessment of Work Planning and Control at Argonne National Laboratory – August 2022*
- EA Report, *Independent Assessment of Work Planning and Control for Cleanup Work at the Oak Ridge Reservation - November 2022*