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

December 2019

Office of Enterprise Assessments
U.S. Department of Energy

Table of Contents

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
INL	Idaho National Laboratory
ISM	Integrated Safety Management
LLNL	Lawrence Livermore National Laboratory
LO/TO	Lockout/Tagout
ORNL	Oak Ridge National Laboratory
ORPS	Occurrence Reporting and Processing System
PPE	Personal Protective Equipment
RWP	Radiological Work Permit
SME	Subject Matter Expert
SRNL	Savannah River National Laboratory
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 Laboratories January 2017 – July 2019

Summary

Scope:

This report documents the lessons learned from assessments at six U.S. Department of Energy (DOE) laboratories between January 2017 and July 2019, which examined activity-level work planning and control (WP&C). The six DOE laboratories were selected to ensure that a cross-section of laboratories was assessed; three of these laboratories were specifically selected to accommodate requests by DOE contractor and Federal managers. The laboratories are managed under DOE's Office of Science, Office of Environmental Management, Office of Nuclear Energy, and the National Nuclear Security Administration. The objective of each assessment was to evaluate the effectiveness of WP&C programs and activities. This report focuses on issues affecting multiple laboratories and identifies strengths and weaknesses, best practices, and recommendations, with the goal of promoting organizational learning and improving performance throughout DOE.

Significant Results for Key Areas of Interest:

Overall, WP&C processes in DOE laboratories have improved and evolved in the past three years. However, across the laboratories, weaknesses in several of the ISM Core Functions were identified, several of which were also prevalent during the previous WP&C review.

Contractor WP&C Programs and Implementation

The Office of Enterprise Assessments observed mature institutional WP&C programs and procedures at each of the laboratories assessed, and that each laboratory seeks to continually improve these WP&C processes though both internal assessments and external benchmarking of other DOE laboratories. WP&C processes at the laboratories have improved and evolved from that previously identified in the March 2016 *Office of Enterprise Assessments Lessons Learned From Targeted Reviews of Activity-Level Work Planning and Control* report; particularly with respect to integrating the integrated safety management (ISM) core functions into WP&C processes, the use of web-based data collection and analysis tools, and identification and integration of training requirements into work control documents (WCDs). A number of WP&C best practices were identified, as well as recommendations.

Nonetheless, at both the institutional and work-activity level, the assessments also revealed common weaknesses in each of the ISM core functions with respect to work definition, identification and analysis of work activity hazards, implementation of hazard controls, and performance of work within these controls. Key weaknesses included WCDs (particularly work scopes) that were inadequate, ineffective "skill of the craft" or "skill of the researcher" programs, and poor performance in validating training requirements before performing work. A number of workplace hazards and/or hazard controls continue to be missed or insufficiently analyzed, developed, or implemented. Environment, Safety and Health (ES&H) programs continue to evolve, but weaknesses were observed across the laboratories with respect to industrial hygiene exposure assessments, electrical lockout/tagout violations, and radiological control weaknesses in some aspects of air sampling and contamination control.

DOE Field Element WP&C Oversight

Although Federal oversight of laboratory WP&C was generally effective, there were several weaknesses identified, including: not ensuring contractor safety-related programs, such as contractor assurance

system and ISM system descriptions, were received, reviewed, and approved; not ensuring operational awareness activities sufficiently addressed research work and work planning activities; and DOE operating experience programs generally created few or no lessons learned for sharing with the site or DOE.

Best Practices:

The report summarizes seven best practices in WP&C identified in the source assessment reports. These best practices are:

- A robust machine shop certification process for experimental users in the DOE complex.

- A method of using Practical Factors to demonstrate and validate that the knowledge and skills required to perform a research task have been integrated into research activities.

- A Safe Conduct of Research principle requiring that all work ("every task, every time") be reviewed for safety, regardless of the level of work.

- The use of small single chip dosimeter and reader that allows for more frequent and effective tracking and management of high extremity exposures.

- A maintenance execution walkdown process that includes craft personnel who ensure that conditions have not changed and tools are available so that work is ready to be safely performed.

- A comprehensive process to address the electrical shock hazard presented by multiwire (Edison) branch circuits.

Recommendations:

This report provides recommendations to address the identified weaknesses. Recommendations address the following:

<u>DOE Field Managers</u>

- Identifying ways to reinvigorate field element operational experience program efforts to formally capture and share lessons learned.

- Using issue management or document tracking systems to ensure that safety-related contractor deliverables, such as new or required updates to contractor assurance system and ISM system descriptions, are received, reviewed, and approved.

<u>Laboratory Managers</u>

- Developing effective skill of the craft/researcher work control processes.
- Focusing on hazardous energy control, with respect to involvement of subject matter experts, improved work control documentation, and documentation of hazardous energy controls.
- For research work activities, providing additional focus on work scope definition, with particular attention to broad-scope work documents, use of streamlined activity-based hazard analyses, and inclusion of work scope boundaries.

- For radiological work, providing additional focus and rigor on ensuring proper implementation of job-specific air sampling and contamination control for laboratory hoods located in radiological buffer areas.

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

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), Argonne National Laboratory (ANL), Savannah River National Laboratory (SRNL), Oak Ridge National Laboratory (ORNL), Fermi National Accelerator Laboratory, and Idaho National Laboratory (INL) from January 2017 through July 2019. The objective of each assessment was to determine the effectiveness of specific elements of the WP&C programs, as well as certain contractor assurance systems (CASs) and DOE field element oversight.

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

Background

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.

2.0 RESULTS

Each of the six laboratories had established WP&C programs that were mostly effective in performing research, maintenance, and operations work safely. There were, however, a number of performance issues identified pointing to areas for improvement. Collectively, there were five findings and 33 deficiencies. Three of the deficiencies relate to the overall institutional WP&C program. The other findings and deficiencies are depicted in Table 1 and binned against the Integrated Safety Management (ISM) Core Functions. The two Core Functions with the highest percentage of identified performance issues are Core Function 2, "Identify and analyze hazards associated with the work," and Core Function 4, "Perform work within controls" at 29% and 31%, respectively. Core Function 3, "Develop and implement controls" are 20% of the identified performance issues. The distribution of performance issues identified during WP&C assessments closely match the distribution of Occurrence Reporting and Processing System (ORPS) reports for the laboratories binned against the ISM Core Functions (see Section 2.5, Table 2).

Table 1: WP&C Performance Issues Identified by ISM Core Functions			
	# Findings	**# Deficiencies**	**%**
CF 1: Define the Scope of Work	0	4	11%
CF 2: Identify and Analyze Hazards	3	7	29%
CF 3: Develop and Implement Controls	1	6	20%
CF 4: Perform Work within Controls	1	10	31%
CF 5: Provide Feedback and Improvement	0	3	9%
Institutional WP&C Issues	0	3	

2.1 Institutional Work Planning and Control Programs

The objective of this section of the report is to identify the strengths and weaknesses of DOE laboratories in developing and approving WP&C processes to enable the safe performance of work. Institutional WP&C programs were assessed for all six of the laboratories addressed in this report.

Strengths

Overall, all of the laboratories had developed and implemented WP&C processes and implementing procedures for the areas assessed: Research, Operations, and/or Maintenance. Each of these institutional WP&C processes provided a useful means for implementing the five core functions of ISM. Several laboratories had already implemented, or were implementing, promising WP&C initiatives at the institutional level. SRNL, for example, had established a Conduct of Research Board to oversee the development and implementation of a wide spectrum of research work activities. Furthermore, most of the laboratories had developed procedures for implementing institutional WP&C processes at the division level. EA recognized each laboratory as a learning organization with respect to improving its research-related WP&C processes. In particular:

- LLNL was restructuring its entire approach to research WP&C based on lessons learned from previous accidents and mishaps, as well as incorporating opportunities for improvement identified through a laboratory-wide survey of WP&C programs.

- ANL was reassessing the most practical format for research work control documents (WCDs) based on benchmarking research WP&C processes at other DOE and commercial research laboratories.

Institutional processes for developing WCDs were generally well designed around the ISM core functions and incorporated a number of common positive attributes, such as:

- Reliance on a work planner or principal investigator knowledgeable of the work activity, hazards, and controls to facilitate development of the WCDs

- Use of a multi-disciplined-team approach to work planning

- Requirement to walk down the work site and activity as a work planning mechanism

- Involvement of line management in the preparation, review, and approval of WCDs.

Four of the laboratories had implemented one or more computer-based or web-based tools to facilitate the identification of applicable control sets, work authorization, worker concurrence, and in some cases, automated verification of worker training. ORNL, for example, had implemented an effective web-based tool for research work (Research Hazard Analysis and Control System). In two laboratories, the tools were limited in scope to assisting the researcher or work planner in documenting hazards and identifying the appropriate hazard controls through a search of Environment, Safety and Health (ES&H) procedures and databases. However, in more mature WP&C processes, a system for work document review and work authorization included identification that training requirements and worker training records were verified, and the system also generated the work documents. ANL, for example, had developed a web-based WP&C tool that produced a complete WCD, and another web-based tool had been implemented for work authorization and execution.

Each of the laboratories had developed and implemented a robust institutional worker training program that identified the appropriate training requirements for those hazards present, and tracked training requirements for workers based on hazards to which they might be exposed. Training programs often included orientation training and mentoring for new researchers, and on-the-job training programs.

Weaknesses

Although WP&C implementing procedures had been developed at each of the six laboratories, the assessment team found that a few institutional WP&C procedures were less than adequate at several of the laboratories. At one laboratory, for example, two similar but competing WP&C procedures for research activities had evolved independently over time, and guidance was lacking concerning the appropriate WP&C procedure to follow. At another laboratory, the institutional WP&C implementing procedures were lacking adequate guidance concerning work scope definition, hazard analysis, requirements for authorizing work, and processes for stopping work.

For three of the laboratories, the implementation of the institutional WP&C process resulted in WCDs that were unwieldy in size and scope, inefficient, and often not user-friendly. This issue was particularly true for research work, so these WCDs were seldom referred to or used by the research staff other than for orientation of new staff members or during mandated annual reviews.

Several of the laboratories did not have effective mechanisms for involving ES&H SMEs in the development and/or approval of WCDs, resulting in insufficient hazard analyses and/or improper identification of the most appropriate hazard controls. Three of the laboratories, for example, had not provided sufficient “triggers” or criteria to ensure that industrial hygiene, and other SMEs, were appropriately notified to conduct workplace exposure monitoring. As a result, appropriate exposure monitoring was not performed in some cases to determine whether workers were being overexposed to workplace contaminants. Moreover, in some cases a hazard control was missed, or in one example, an inappropriate control was included in the WCD.

Although most laboratories had a robust worker training program, at the work-activity level, only two laboratories had effective WP&C mechanisms in place for work supervisors to ensure that all workers/researchers and support staff (e.g., health physics technicians) had completed all required training identified in the WCDs before commencing work. For research activities, most laboratories did not have a mechanism for identifying worker training requirements in WCDs and linking those training requirements to hazards in WCDs, which would assist supervisors with readily verifying the training status of researchers assigned to the work activity. As a result, some work was performed without the work supervisor being able to verify that workers were adequately trained.

Five of the six laboratories did not have a WP&C process that effectively defines the work scope, hazards, and controls for low hazard laboratory work tasks, permitting such activities to be performed by skilled and knowledgeable research staff and with minimal WCDs. A common thread across each of the laboratories was the ongoing challenge to developing an effective "skill of the craft" or "skill of the researcher" program for addressing low hazard work activities that could be performed by trained and knowledgeable staff without reliance on detailed WCDs. The assessment teams observed several low hazard work activities being performed by workers who were not aware of the potential exposure hazards (e.g., welding fumes) or the required controls.

Four of the laboratories assessed had not developed and/or implemented a fully effective industrial hygiene exposure assessment process, which is required by 10 Code of Federal Regulations (CFR) 851, *Worker Safety and Health Program*, to ensure that worker exposures to ergonomic, biological, chemical, and physical hazards are evaluated and the appropriate hazard controls are implemented. Exposure assessment shortcomings varied among the laboratories, but included:

- Ineffective exposure assessment implementing procedures.
- Thresholds or "triggers" for when to perform an exposure assessment that were not well defined.
- WCDs that did not identify exposure assessment documents.
- Exposure assessments not being performed for all work or research activities in which there was a potential for worker exposures to chemical and physical hazards.
- For exposure assessments associated with broad work scopes, the inability to tailor a single exposure assessment to address the unique hazards or controls of individual experiments covered within the scope of the WCD.

2.2 Implementation of Activity-Level Work Planning and Control Programs

The objective of this section of the report is to identify the strengths and weaknesses in the laboratories' implementation of institutional WP&C programs at the work-activity level for research and operations and maintenance with respect to the five core functions of ISM. Lessons learned in this section of the report are based on observations of work and/or research activities.

2.2.1 Research

Implementation of the ISM core functions for a wide variety of research work activities was assessed at each of the six laboratories. Research-related radiological work was assessed at three of the laboratories operating nuclear facilities. Observed strengths and weaknesses are as follows:

Strengths

Collectively, the six laboratories assessed reflect a wide spectrum of research work activities and hazards. The vast majority of the observed research and operations work was performed safely and within the controls established and documented in WCDs.

Overall, all of the reviewed nuclear facilities used appropriate engineered controls to minimize worker exposures to both chemical and radiological hazards. These controls included hot cells, glove boxes, laboratory hoods, ventilation systems, and shielding, all of which were used effectively and extensively as the principal hazard mitigation or elimination control for both radiological and chemical hazards. A reliance on effective engineered controls was also observed in non-nuclear facilities and laboratories to reduce the workplace chemical, biological, and physical hazards to researchers. Engineered controls that effectively reduced the hazards to researchers included chemical fume hoods, glove boxes, and local exhaust ventilation systems. Access control devices, such as interlocks for access to laser labs and accelerators, were identified in each of the laboratories, and most chemistry laboratory doors were programmed to preclude badged entry unless workers had the appropriate laboratory training in hazards and controls for the work being performed. The application of effective engineered controls significantly reduces worker exposures to hazards.

For radiological hazards, administrative controls appropriately supplemented the engineered controls, including the use of radiological work permits (RWPs), postings, access restrictions, radiological surveys and sampling, and dose tracking to aid in controlling contamination and external radiation exposures. RWP and As Low As Reasonably Achievable review processes were also effective for radiological hazard analysis and development of controls. At the nuclear facilities, internal exposure to airborne radioactive materials, such as transuranic isotopes, is a significant potential hazard in the event of a failure or breach of an engineered control or respirator. At the facility level, all the nuclear facilities had installed comprehensive networks of fixed-location radiation monitors, air samplers, and/or continuous air monitors in radiological processing areas.

An observed strength for laboratories at INL and ORNL performing research within a nuclear or radiological facility was improved communications between research and operations staff since the previous DOE *Office of Enterprise Assessments Lessons Learned From Targeted Reviews of Activity-Level Work Planning and Control – March 2016* report was issued. In particular:

- Use of pre-job briefings and well-defined roles and responsibilities for the research and operations staff have improved work scope communications.

- Daily briefings, facility status boards, and plan of the day meetings provided mechanisms for communicating, coordinating, and de-conflicting work activities.

- Two laboratories developed and used mockups when planning for complex hazardous work activities to improve planning, coordination, and training.

Most observed research and operations work was appropriately authorized, and the degree of work authorization was commensurate with the hazard (low, medium, or high) and/or with the hazard categorization of the facility in which the work was performed. In particular:

- For research and operations performed in nuclear or radiological facilities, the mechanisms for work authorization were robust and included shift supervisor authorization, plan of the day and plan of the week work authorization, and facility manager authorization and approval of the WCDs.

- For other research performed in laboratories, laboratory coordinators, principal researchers or investigators and laboratory managers provided various levels of work authorization.

Weaknesses

At all six laboratories, there were weaknesses associated with work scopes in research WCDs. Poorly defined work scopes contributed to hazards and controls in WCDs being poorly defined or missed. In addition, inadequate work scopes also resulted in workers/researchers working outside authorized work boundaries. Overall, inadequate work scope definition was the most significant research WP&C shortcoming. For example:

- A common weakness in each laboratory was that the work scopes identified in research WCDs often lacked specificity, sufficient detail, and/or assigned responsibilities to permit identification and analysis of all applicable hazards and controls associated with the work. Although researchers familiar with the experimental activity are more likely to recognize the experimental hazards and controls from unclear work scopes, visiting research staff, infrequent offsite users, and students with limited familiarity with the experiment are less likely to identify hazards and/or controls from work scopes that are not well defined.

- A lack of clear work scope definition was most common in those WCDs that attempted to envelop a wide spectrum of diverse work activities within a single WCD (i.e., broad-scope WCDs). In such WCDs, work scope breakdowns by task were rarely documented in the WCD due to the number of research activities bounded by the WCD. As a result, a collective set of hazards and controls was typically included in the WCD, but often the hazards and controls could not be linked to undocumented work tasks/steps of a specific research activity or experiment. Recognizing this challenge, one laboratory (ORNL) required an activity-based hazard analysis for each experiment enveloped by a broad-scope WCD, in order to tailor work scopes and link hazards and controls to each experiment enveloped within the WCD.

- Another common issue with research work scopes was the definition of research work scope boundaries and work scope "creep." At two of the laboratories, research work was not performed within the written work scope of the activity and was outside the boundaries of the WCD. In one case, during the assessment team's onsite data collection period, a researcher became contaminated while attempting to decontaminate a piece of equipment under a WCD that did not allow this type of work.

At all six laboratories, a number of activity-level hazards were missed and/or insufficiently analyzed from one or more research or operational work activities, thereby placing workers at increased risk of injury or illness. The hazards most frequently not identified and/or not adequately analyzed in WCDs, ranked in order of occurrence (most frequent to least), were:

- Chemical hazards
- Electrical hazards and related lockout/tagout (LO/TO) issues
- Radiological hazards
- Ergonomic hazards
- Fall protection
- Material handling (fork trucks and lifts)
- Cryogens
- Combustible dust hazards.

At five laboratories, hazard controls (i.e., engineered administrative, and/or personal protective controls) that were either missing or poorly worded in WCDs resulted in unclear work instructions or the appropriate hazard control being missed. For example:

- A number of reviewed WCDs identified some hazard controls indirectly or by reference, thereby requiring the work performer to seek other documents outside the WCD to identify the appropriate hazard control(s). For example, some research WCDs stated that the hazard control was to "use appropriate PPE [personal protective equipment]," or "follow the Safety Data Sheet (SDS)", or "see section 4.1.1 of the ES&H Manual."

- At two laboratories where the research activity was performed with operating procedures, neither the hazards nor the requisite controls were included at the procedural activity step as required by institutional WP&C procedures.

At other laboratories, a number of hazards controls that were not implemented as required by laboratory procedures resulted in increased risks to workers. For example:

- At two of the three laboratories assessed for radiological hazards and controls, job-specific air sampling was not being performed when required and/or effectively implemented and/or in accordance with requirements for proper sampler placement. Job-specific air sampling is required in addition to Continuous Air Monitors (CAMs) and fixed air samplers in certain situations to verify radiological postings and the adequacy of prescribed respiratory protection, and to measure airborne radioactivity in close proximity to workers' breathing zones and/or locations where breaches of contaminated systems may release radioactivity during work.

- Inaccurate hazard communication postings (e.g., noise hazards, health hazard communication postings, asbestos signage) were identified at half of the assessed laboratories.

- Workers in two laboratories were observed performing electrical troubleshooting of research-related equipment and electrical hazardous energy controls (e.g., LO/TO) without using the proper PPE.

- Operators in two laboratories were observed working while elevated above dangerous equipment without appropriate fall restraint or guarding.

Poor radiological contamination control practices were observed at two of the three laboratories where radioactive material was being used in open-faced hoods. In each case, the interior of the hoods were posted as a contamination areas, while the laboratories in which they were housed were posted as radiological buffer areas, meaning radiologically clean. Regulations require measures be taken to prevent spread of contamination from the hoods to the surrounding radiological buffer area. RWPs covering this type of laboratory work typically did not specify the contamination control and frisking requirements. Observed weaknesses included using arms to lean on potentially contaminated hood sashes, facial hair (beards) coming into contact with PPE, not following posted doffing instructions to prevent contamination of the buffer area when doffing outer gloves and sleeves, and not frisking potentially contaminated arms and the front of laboratory coats after exiting hood areas. At one laboratory, two Occurrence Reporting and Processing System (ORPS)-reportable personnel contamination events occurred during EA's visit: one event involved unprotected facial hair, and the other event was the result of a researcher performing decontamination work not authorized by the work instruction and RWP.

2.2.2 Maintenance

Implementation of the ISM core functions for maintenance work activities was assessed at three of the six laboratories. Observed strengths and weaknesses are as follows:

Strengths

At all three laboratories, the maintenance organizations are generally staffed with experienced and well-qualified managers, work planners, and craftsmen. Work planners use a computerized maintenance management system for creating work orders, developing work packages, etc. The laboratories use a graded approach to tailor the rigor of the planning process based on the hazards and complexity of the job. At two laboratories, workers are involved in the work planning process, including a walkdown of the job to better define the scope of work and associated hazards. All three laboratories identify and analyze hazards and controls for routine maintenance activities, including shop work, and ES&H SMEs provide appropriate support as needed.

Two of the laboratories demonstrated effective work planning and control for their maintenance activities. The work planning processes result in a well-defined scope of work. These laboratories effectively schedule work through plan of the week and plan of the day meetings, and the work is scheduled in advance and integrated with operations and research activities. Work is appropriately authorized prior to performance, and readiness to perform work is confirmed (e.g., training status, walkdown of the job area, available PPE). The foremen provide effective pre-job briefings prior to work start, and appropriately discuss the work to be performed, anticipated hazards and controls, emergency response, lessons learned, etc. The two laboratories demonstrated a strong commitment to the worker's right to pause or stop work if there was an issue with the job or the work package. For the most part, the workers at these two laboratories demonstrated proficiency with their craft and performed their work tasks safely and within the established work controls.

Weaknesses

Skill of the craft work (i.e., work that can be performed by qualified craft workers without additional instruction) is not well defined. Two of the laboratories have a screening process to separate skill of the craft work from work requiring additional guidance/supervision. However, the screening processes are not rigorous; consequently, there is a wide latitude in work that is considered skill of the craft. This lack of rigor can result in work being performed without a hazards review or the appropriate controls. A similar concern with limits and boundaries for skill of the craft work was identified in the 2016 WP&C lessons learned report.

There were some cases at all three laboratories where hazards were not identified or analyzed, and controls were not identified and/or properly implemented. In some instances, the laboratories did not conduct specific job task analyses for the work, instead relying on previously developed hazard analyses that covered a broad range of activities. At one laboratory, pre-job briefings did not address the appropriate PPE or controls, and the workers did not wear the appropriate PPE.

Weaknesses in hazardous energy controls (e.g., LO/TO) have continued since the 2016 EA WP&C lessons learned report. Two of the three laboratories had LO/TO violations while EA was on site. At one laboratory, two LO/TO violations were observed regarding the use of administrative locks to protect the equipment status instead of personal locks. At another laboratory, a LO/TO violation occurred involving sign-in on the wrong LO/TO, resulting in the worker being potentially exposed to an uncontrolled electrical energy source.

2.3 Feedback and Improvement/Contractor Assurance System

The objective of this section of the report is to summarize the extent to which the five laboratories assessed for feedback and improvement demonstrated the continuous feedback and improvement process, including the CAS, to solicit and use corrective action, worker feedback, and lessons learned to improve work planning, hazards identification, and program and process implementation. Observed strengths and weaknesses are as follows:

Strengths

Three of the laboratories demonstrated mature and robust feedback and improvement programs. Lessons learned were leveraged using an established path from activity-level work into the continuous improvement programs in the CAS to be used in communications (Safety Toolbox topics), management oversight, and, if necessary, corrective action plans. These three laboratories were also effective in tracking key performance indicators related to activity-level work and trending data to determine the focus of their assessment strategies. Opportunities to improve Safety and Health programs were identified through these trend analyses at each of the three laboratories. The ability to improve safety and health performance was enhanced by involving all organizational levels from the personnel performing the work/research through the supervisor level and, ultimately, upper management.

External sources of lessons learned, such as those provided by DOE's operating experience program (i.e., OPEXShare), were also effectively used. Four of the laboratories demonstrated that they reliably use the content of OPEXShare in order to apply lessons learned from the greater DOE complex to investigate improvements to Safety and Health programs or to emphasize the value of programs already in place. Each of these four laboratories used different means to leverage OPEXShare into their lessons learned programs and systematically tracked current use.

Weaknesses

Two of the five laboratories that were assessed for feedback and improvement/CAS had programmatic weaknesses related to WP&C assessment strategies. These weaknesses included issues with effectively identifying gaps in incorporating ISM guiding principles and core functions in activity-level WP&C. These issues primarily were the result of not systematically evaluating WP&C through either self-assessments or independent assessments. Without these assessments, the opportunity to generate corrective action plans from the results of these WP&C assessments challenges gap closure for activity-level ISM discrepancies.

2.4 DOE Field Element Oversight

The objective of this section of the report is to summarize the extent to which four DOE field elements have overseen contractor WP&C-related programs and assessed implementation effectiveness. Observed strengths and weaknesses are as follows:

Strengths

DOE field elements at these laboratories have generally established effective procedures for Federal line oversight of WP&C, including for assessment planning and performance, operational awareness activities, issues management, and performance assurance analysis. The DOE field elements have well-qualified and technically competent oversight personnel, including SMEs and Facility Representatives. Feedback mechanisms to investigate employee concerns and differing professional opinions were typically effective. The results of DOE oversight of contractor activity-level WP&C were effectively used in performance feedback through performance evaluation and measurement plan and/or ISM system reviews.

Weaknesses

Two of the four assessed DOE field elements did not effectively ensure that contractor deliverables related to WP&C (e.g., CAS and ISM system descriptions) were submitted, reviewed, and approved.

DOE field elements commonly did not have robust operational experience/lesson learned programs, generating few to no lessons learned. One field element's operational experience program was not being implemented and did not include the promotion and sharing of operating experience.

2.5 Occurrence Reporting and Processing System Data Analysis

EA also reviewed the WP&C-related reports from the DOE ORPS that were generated for the six laboratories during the period of this lessons-learned review (i.e., two years of data before the date of each onsite assessment from January 2017 through July 2019). During this period, a total of 290 ORPS reports were generated across the six laboratories with respect to WP&C issues. Based on ORPS Headquarters Key Word categorization of individual ORPS reports, 68% of the WP&C ORPS reports were categorized as a "Work Process Deficiency", and 20% of the reports were categorized as "Inadequate Job Planning". Table 2, below, summarizes the ORPS results by laboratory and ISM core function. The EA issues (findings and deficiencies) identified during this period, when binned by ISM core functions (Chart 1), are similar in percentage and importance to the ORPS reports when binned by ISM core functions, as depicted in Table 2, with the most significant number of ORPS events in Core Function 2 and Core Function 4, followed by Core Function 3. The percentages for the five core function categories add up to more than 100% because ORPS reports may identify more than one factor as a contributor to an event.

Table 2.
Summary of ORPS Reports for the Six Laboratories by ISM Core Functions
January 2015–July 2019 (Two Years of Data Prior to Each Assessment)

Lab	ORPS Report Total	ISM Core Function 1		ISM Core Function 2		ISM Core Function 3		ISM Core Function 4		ISM Core Function 5	
		#	%	#	%	#	%	#	%	#	%
1	78	10	13%	42	54%	36	46%	32	41%	16	21%
2	44	4	9%	18	41%	19	43%	22	50%	5	11%
3	17	0	0%	2	12%	1	6%	3	18%	0	0%
4	36	3	8%	9	25%	10	28%	13	36%	2	6%
5	14	3	21%	11	79%	9	64%	7	50%	4	29%
6	101	5	5%	5	5%	2	2%	9	9%	1	1%
TOTAL	290	25	9%	87	30%	77	27%	86	30%	28	10%

3.0 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.

EA identified one DOE field element oversight best practice and six laboratory best practices.

DOE Field Element Oversight Best Practice

- Feedback from the Argonne Site Office through the Performance and Evaluation Management Plan process has improved laboratory CAS effectiveness and safety performance. The assessment planning tool developed by the Argonne Site Office to target oversight activities is considered a best practice because it provides a systematic mechanism that considers performance and potential vulnerabilities when scheduling assessment resources.

Laboratory Best Practices

- The ANL Advanced Photon Source (APS) machine shop certification process is one of the more robust certification processes for experimental users in the DOE complex.

- The SRNL method of using Practical Factors (Prac Facs) to demonstrate and validate the knowledge and skills required to perform a research task has been integrated into research activities.

- ORNL requires that all work ("every task, every time") be reviewed for safety, regardless of the hazard level of the work. The 2014 Battelle publication, *The Safe Conduct of Research*, includes the principle that "hazards are identified and evaluated for every task, every time." UT-Battelle has institutionalized this principle in the Standards-Based Management System (SBMS) subject area on Work Control for both research and development and maintenance activities. For research and development activities, every Research Safety Summary, regardless of level of risk, must be reviewed by a Qualified Safety and Health Professional, as well as the point of contact and initiating principal investigator.

- INL's use of the small Landauer, Inc. nanoDot single chip dosimeter and Micro Star reader for high extremity dose work allows for more frequent and effective tracking and management of extremity exposures than can be accomplished with finger rings, which are read on a set periodicity (monthly) by an accredited offsite laboratory and serve as the permanent record of extremity exposure.

- The INL Advanced Test Reactor Maintenance Execution Walkdown Checklist "Ready" process helps ensure that work is ready to be performed and includes a walkdown by craft personnel to ensure that conditions have not changed and tools are available, among other things. This checklist has the dual benefit of ensuring that workers are involved in the WP&C process and that readiness to perform work is verified.

- INL has developed a comprehensive process to address the electrical shock hazard presented by multiwire (Edison) branch circuits. This comprehensive process includes the development of training and operating procedures by the engineering and maintenance organizations and ensures that all multiwire (Edison) branch circuits are identified, circuit breaker handle-ties are installed, and panels and circuit breakers are labeled or panels and circuits are re-wired to eliminate this condition.

4.0 RECOMMENDATIONS

These recommendations are based on the analysis of EA assessments as summarized in Section 2. Although the underlying deficiencies and weaknesses from individual reviews did not apply to every laboratory reviewed, the recommended actions are intended to provide insights for potential improvements at all DOE laboratories. Consequently, DOE organizations and laboratory 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 laboratory-specific program objectives:

DOE Field Managers

- Explore ways to utilize existing tools (e.g., OPEXShare), or create new tools, to enhance the field element operational experience program efforts to formally capture and share lessons learned.

- Use issue management or document tracking systems (either internally developed or commercially available) to ensure that safety-related contractor deliverables, such as new or required updates to CAS and ISM system descriptions, are received, reviewed, and approved.

Laboratory Managers

- For skill of the craft and/or researcher work, explore improving work screening requirements and establishing a list of specific routine jobs and research activities that can be accomplished as skill of the craft/research work; developing activity screening and binning based on scope of work complexity, consequences, and frequency to help determine the appropriate activity-level WCD; and developing a skill of the craft/researcher WP&C process that accounts for a worker's experience, skill, and training and streamlines WCDs while also ensuring that hazard analysis and pre-job briefings are conducted for all work.

- Provide additional focus on hazardous energy control. The following actions should be evaluated:

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

    - Ensure that maintenance work instruction/work packages predefine and document the following hazardous energy controls: hold points for LO/TO placement and removal verification, and sequenced LO/TO orders (sign off documentation) where applicable.

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

- For research work activities, examine providing additional focus on work scope definition, including:

    - For broad-scope work documents use multiple WCDs, each with a focused work scope, hazards, and controls.

    - Explore using streamlined activity-based hazard analyses to define the work scope, hazards, and controls associated with each type of experiment enveloped within the WCD.

    - Evaluate including work scope boundary conditions to help the researcher with defining work activities that are beyond the current work scope.

- For work involving radiological hazards, evaluate providing additional focus and rigor on ensuring proper implementation of job-specific air sampling and contamination control for laboratory hoods located in radiological buffer areas. This rigor might include targeted training in these areas for RCTs and radiological workers, and/or additional specificity in the RWPs governing this work.

- Revise and improve CAS mechanisms, including:

    - Ensure that the organization has well-defined roles for managing the overall assessment process. Include a focus on coordinating lessons learned from OPEXShare and other sources.

    - Reinforce expectations for developing and using lessons learned, specifically including activity-level worker involvement in collecting and communicating lessons learned, in planning work.

Appendix A
Supplemental Information

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Appendix B
Scope, Methodology, Requirements, and Guidance

Scope and Methodology

This report reflects an analysis of lessons learned from EA WP&C assessments completed between 2017 and 2019 at six DOE national laboratories. The assessed laboratories, along with the key elements reviewed, associated contractors, local DOE field offices, and DOE Headquarters program offices, are listed in Table 2 of this appendix. DOE published WP&C assessment reports for each of these six laboratories (see Appendix C). Collectively these six reports included observation and analysis of research activities at all six laboratories, research-related radiological work in nuclear facilities at three laboratories, and maintenance work at three laboratories. The CAS was assessed at five of the laboratories, and DOE field element oversight of WP&C was evaluated at four laboratories.

The scope of the assessments included elements from the following 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*

- DOE Handbook DOE-HDBK-1211-2014, *Activity-Level Work Planning and Control Implementation*

- CRAD EA-30-01, *Contractor Assurance System*

- CRAD EA-32-03, *Industrial Hygiene Program Criteria and Review Approach Document*

- CRAD 45-21, *Feedback and Continuous Improvement Inspection Criteria and Approach – DOE Field Element*

- CRAD EA-45-35, *Occupational Radiation Protection Criteria Review and Approach Document*.

Requirements and Guidance

Upper tier requirements for WP&C programs at the assessed laboratories 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. CAS and DOE field element oversight requirements are primarily contained in DOE Order 226.1B, *Implementation of Department of Energy Oversight Policy*.

Table 2. Facilities, Contractors, and DOE Offices Assessed

Assessment Site	Key Elements Assessed	Contractor	DOE Field Element	DOE Headquarters Program Office
Lawrence Livermore National Laboratory	New WP&C process implemented in three research directorates Feedback and Improvement/CAS Federal Oversight	Lawrence Livermore National Security, LLC	Livermore Field Office	National Nuclear Security Administration
Argonne National Laboratory	Research WP&C and radiological work in nuclear facilities Federal Oversight	UChicago Argonne, LLC	Argonne Site Office	Office of Science
Savannah River National Laboratory	Research WP&C Feedback and Improvement/CAS Federal Oversight	Savannah River Nuclear Solutions, LLC	Savannah River Operations Office	Office of Environmental Management
Oak Ridge National Laboratory	Research WP&C, radiological work in nuclear facilities, and Maintenance WP&C Feedback and Improvement/CAS	UT-Battelle, LLC	Oak Ridge National Laboratory Site Office	Office of Science
Fermi National Accelerator Laboratory	Research, Operations, and Maintenance WP&C Feedback and Improvement/CAS	Fermi Research Alliance, LLC	Fermi Site Office	Office of Science
Idaho National Laboratory	Research WP&C, radiological work in nuclear facilities, and Maintenance WP&C (with emphasis on Electrical Safety) Feedback and Improvement/CAS Federal Oversight	Battelle Energy Alliance, LLC	Idaho Operations Office	Office of Nuclear Energy

Appendix C
Source Documents

- EA Report, *Assessment of Work Planning and Control at the Lawrence Livermore National Laboratory – June 2017*
- EA Report, *Assessment of Work Planning and Control at the Argonne National Laboratory – August 2017*
- EA Report, *Assessment of Work Planning and Control at the Savannah River National Laboratory – November 2017*
- EA Report, *Work Planning and Control Assessment at the Oak Ridge National Laboratory – May 2019*
- EA Report, *Work Planning and Control Assessment at the Fermi National Accelerator Laboratory – July 2019*
- EA Report, *Work Planning and Control Assessment at the Idaho National Laboratory – October 2019* (Pending)