Independent Assessment of Work Planning and Control at Argonne National Laboratory

August 2022

Office of Enterprise Assessments
U.S. Department of Energy

Table of Contents

Acronyms

ACGIH	American Conference of Governmental Industrial Hygienists
ACTS	ASO Commitment Tracking System
AI	Artificial Intelligence
ALARA	As Low As Reasonably Achievable
ANL	Argonne National Laboratory
AMD	Applied Materials Division
APC	Assessment Planning and Conduct
ARIS	ATLAS Radiation Interlock System
ASO	Argonne Site Office
ATLAS	Argonne Tandem Linac Accelerator System
CAS	Contractor Assurance System
CFC	Chemical and Fuel Cycle Technologies
CFR	Code of Federal Regulations
CRAD	Criteria and Review Approach Document
CSE	Chemical Sciences and Engineering
CSL	Chemical Safety Level
CTA	Clean Transfer Area
DOE	U.S. Department of Energy
EA	Office of Enterprise Assessments
ECP	Employee Concerns Program
ESH	Environment, Safety, and Health Division
FR	Facility Representative
FY	Fiscal Year
HAMC	Hazard Analysis Memory Card
HPI	Human Performance Improvement
HPP	Health Physics Procedure
HPT	Health Physics Technician
IAS	Integrated Assessment Schedule
ISM	Integrated Safety Management
ISMS	Integrated Safety Management System
JSA	Job Safety Analysis
LabRAT	Laboratory Risk Assessment Tool
LOTO	Lockout/Tagout
NFPA	National Fire Protection Association
NWM	Nuclear and Waste Management
OFI	Opportunity for Improvement
OSHA	Occupational Safety and Health Administration
PHY	Physics Division
PM	Preventive Maintenance
PMO	Project Management Organization Division
PPE	Personal Protective Equipment
RI	Responsible Individual
RWP	Radiological Work Permit
SCMS	Office of Science Management System
SME	Subject Matter Expert
SOM	Site Office Management
SOP	Standard Operating Procedure
SOW	Skill of the Worker

TLV	Threshold Limit Value
TQP	Technical Qualification Program
WCD	Work Control Document
WMO	Waste Management Organization
WMS	Waste Management System
WO	Work Order
WP&C	Work Planning and Control
WSHPD	Worker Safety and Health Program Description

INDEPENDENT ASSESSMENT OF WORK PLANNING AND CONTROL AT ARGONNE NATIONAL LABORATORY

Executive Summary

The U.S. Department of Energy Office of Enterprise Assessments (EA) conducted an independent assessment of work planning and control (WP&C) at Argonne National Laboratory (ANL) in April 2022. This assessment evaluated the UChicago Argonne, LLC (UChicago) WP&C processes, the flowdown of safety requirements to subcontractors, elements of the ANL electrical safety program and contractor assurance system, as well as the Argonne Site Office (ASO) oversight of WP&C and the ASO employee concern program.

Since EA's previous assessment of WP&C at ANL in 2017, ANL has successfully implemented change management initiatives, such as the programs for human performance improvement and "improving how we work," achieving notable progress in restructuring and streamlining its WP&C processes. ANL's establishment of a WP&C Program Office, which reports directly to the ANL Chief Operating Officer and is responsible for the development and maintenance of the institutional WP&C program, supports effective change management and demonstrates UChicago commitment to continuous improvement.

EA identified the following strengths, including two best practices:

- UChicago's virtual micro-learning sessions effectively cover WP&C topics through focused, interactive 30-minute (or less) training sessions that enable ANL researchers, workers, and work planners to learn about specific WP&C topics of interest in an efficient and interactive manner. (**Best Practice**)
- UChicago's innovative artificial intelligence-enhanced knowledge mining process, which integrates keyword identification with draft work control documents (WCDs), enables WCD authors to link available lessons learned to applicable draft and active WCDs. (**Best Practice**)
- UChicago's Laboratory Risk Assessment Tool (LabRAT) is an effective tool that evaluates chemical hazards based on parameters such as chemical volumes, toxicity, and engineering/procedural controls; assigns a chemical safety level; and determines the need for an additional chemical risk assessment.
- The *ANL Electrical Safety Manual* risk assessment process for qualified electrical workers provides a required mechanism for employees to think about work tasks before taking actions. Applying this mechanism has significantly reduced the possibility of employee injury during electrical work.

EA also identified the following weaknesses:

- Work scopes and scope limits in some WCDs were not adequate, or work was performed outside the scope of the WCD. Performing work outside the scope of the WCD can expose workers to unidentified hazards.
- WP&C processes do not ensure that hazard controls are appropriately incorporated into WCD documents to facilitate ease of implementation and avoid the potential for human error. Inadequate implementation of hazard controls can result in increased risk to workers.
- Radiological work permits governing some observed work activities were not adequate for implementing site requirements for job specific contamination surveys and proper personnel monitoring during radiological work. This increases the potential of workers performing work outside the required radiological controls.

While ASO has established and partially implemented a generally comprehensive, integrated process for Federal line oversight, EA identified the following weakness:

- ASO does not adequately track and trend low-level issues. A lack of tracking and trending of low-level issues can result in missing pervasive issues and the identification of programmatic and systemic problems that warrant management attention.

In summary, UChicago has established a well-documented WP&C program and implementing procedures to address the requirements of 10 CFR 851, *Worker Safety and Health Program*, and 48 CFR 970.5223-1(c), *Integration of environment, safety, and health into work planning and execution.* The ANL WP&C program is effectively implemented, with a few identified weaknesses. ASO has implemented a satisfactory oversight program, but a weakness was identified in the tracking and trending of low-level issues. Until the concerns identified in this report are addressed or effective mitigations are put in place, potential vulnerabilities to the safe execution of work will exist.

INDEPENDENT ASSESSMENT OF WORK PLANNING AND CONTROL AT ARGONNE NATIONAL LABORATORY

1.0 INTRODUCTION

The U.S. Department of Energy (DOE) Office of Worker Safety and Health Assessments, within the independent Office of Enterprise Assessments (EA), conducted an assessment of work planning and control (WP&C) at Argonne National Laboratory (ANL), which is managed by UChicago Argonne, LLC, (UChicago). EA was on site during the weeks of April 11-14 and 25-28, 2022, and conducted this assessment within the broader context of ongoing assessments of WP&C implementation with a focus on electrical safety.

Consistent with the *Plan for the Independent Assessment of Work Planning and Control at the Argonne National Laboratory, April 2022*, EA assessed the WP&C program and the implementation of the integrated safety management system (ISMS) as defined in DOE Policy 450.4A, *Integrated Safety Management Policy*, and 48 CFR 970.5223-1(c), *Integration of environment, safety, and health into work planning and execution*; activity-level work performed by six ANL directorates; the flowdown of construction safety requirements to subcontractors; electrical safety; the contractor assurance system (CAS); the oversight of WP&C provided by the DOE Argonne Site Office (ASO), along with the ASO employee concerns program (ECP); and follow-up on a finding from EA's last assessment at ANL in 2017.

The six assessed ANL directorates are:

- Computing, Environment, and Life Sciences – Biosciences Division
- Energy and Global Security – Chemical and Fuel Cycle Technologies (CFC) Division, Experimental and Operational Facilities Division, Nuclear Sciences and Engineering Division, and Applied Materials Division (AMD)
- Photon Sciences – Accelerator Engineering Support Division and Advanced Photon Source Upgrade Project
- Physical Sciences and Engineering – Physics (PHY) Division and Chemical Sciences and Engineering (CSE) Division
- Infrastructure Services – Facilities Division (FAC), Nuclear and Waste Management (NWM) Division, and the Project Management Organization (PMO) Division
- Environment, Safety, Health, and Quality – Environment, Safety, and Health (ESH) Division (for observed industrial hygiene and health physics support services only).

2.0 METHODOLOGY

The DOE independent oversight program is described in and governed by DOE Order 227.1A, *Independent Oversight Program*, which is implemented through a comprehensive set of internal protocols, operating practices, assessment guides, and process guides. This report uses the terms "best practices, deficiencies, findings, and opportunities for improvement (OFIs)" as defined in the order.

As identified in the assessment plan, this assessment considered objectives and criteria from 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*. EA used elements of Criteria and Review Approach Document (CRAD) EA 30-07, Rev. 0,

Federal Line Management Oversight Processes, to collect and analyze data on ASO oversight activities related to WP&C. EA also used objectives and criteria from EA CRAD 32-02, Rev. 1 *Biological Safety Program*; EA CRAD 32-03, Rev. 1, *Industrial Hygiene Program*; HSS CRAD 45-35, Rev. 1, *Occupational Radiation Protection*; and EA CRAD EA-30-01, Rev. 1, *Contractor Assurance System*.

EA observed the planning and implementation of work activities in two primary areas: (1) research performed by the four research directorates listed above and nuclear operations conducted by NWM, and (2) maintenance activities conducted by the Infrastructure Services Directorate. EA also observed ESH support activities provided by the Environment, Safety, Health, and Quality Division in both areas. EA examined key documents, such as WP&C policies, plans, procedures, manuals, job hazard analyses, and work control documents (WCDs). EA also interviewed key personnel responsible for developing and executing the associated programs, observed 40 onsite work activities, and walked down relevant portions of specific facilities. EA used a written comment and response process with ANL to address issues identified during the assessment. Follow-on discussions among EA, ASO, and ANL were conducted to clarify and resolve issues. The members of the assessment team, the Quality Review Board, and management responsible for this assessment are listed in appendix A.

EA followed up on the corrective actions for the one finding (F-ANL-I-01) documented in the EA report, *Assessment of Work Planning and Control at the Argonne National Laboratory, August 2017*. Results of the corrective actions assessment are discussed in section 3.7 of this report.

3.0 RESULTS

3.1 Work Planning and Control Programs

This portion of the assessment evaluated whether ANL has established WP&C programs and processes at the institutional, directorate and/or divisional level to enable the safe performance of work.

3.1.1 ANL Institutional, Directorate, and/or Divisional WP&C Programs

ANL has established an effective sitewide WP&C institutional program. The ANL institutional program is adequately documented in LMS-MNL-10, *Argonne Work Planning and Control (WP&C)*, and the ANL *Integrated Safety Management System/Worker Safety and Health Program Description* (*ISMS/WSHPD)*. These documents provide an adequate framework to implement the guiding principles and core functions of integrated safety management (ISM) as defined in DOE Policy 450.4A and describe the common requirements for all ANL organizations. The institutional WP&C program allows each ANL organization flexibility to tailor its work process within this framework. Each observed directorate and/or division at ANL had a specific organization level WP&C manual to supplement LMS-MNL-10. Each of these organization level manuals was detailed and provided useful supplemental WP&C direction and information. Several types of WCDs that address the core functions of ISM and govern sitewide work performance were created using these institutional and organizational programs.

ANL's successful implementation of change management initiatives, such as the programs for human performance improvement (HPI) and "improving how we work," has enhanced the implementation of WP&C and supports continuous improvement of WP&C. Additionally, the establishment of a WP&C Program Office, which reports directly to the ANL Chief Operating Officer and is responsible for developing and maintaining the institutional WP&C program, supports effective change management and demonstrates ANL's commitment to continuous improvement.

Since the 2017 EA WP&C assessment, ANL has achieved notable progress in restructuring and streamlining its WP&C process. For example, WCDs have been adequately tailored to address the appropriate hazards and controls. Most WCDs are now much shorter and streamlined than the WCDs observed in 2017, and they address the needs of the workers more effectively. ANL has also developed and implemented a user-friendly, computer-based WP&C software program, entitled AWARE®, which helps work planners and responsible individuals (RIs) identify activity-level hazards and controls and develop WCDs. Except for radiological hazards and controls, which are analyzed and developed under the radiological work permit (RWP) process, research and nuclear operations hazards and basic control sets are addressed by and documented in WCDs using the AWARE® web-based software with its embedded hazard tree. Based on interviews with over 30 researchers and workers, and the EA team's observations, AWARE® is more useful in identifying hazards and controls, and considerably more user friendly, than the WP&C processes that were in effect in 2017. Additionally, completed WCDs can be easily modified when new or changed hazards are identified and WCD changes can be adequately controlled using LMS-MNL-10, appendix B, *WCD-EZ Work Control Process*. Interviewed personnel who have used the WCD-EZ process consider it valuable, and the EA team concurs that the process is an attribute to the WP&C program.

ANL has developed and employs several effective WP&C training tools for instructing work planners, RIs, subject matter experts (SMEs), managers, and workers. Training course WPC 303, *Work Planning and Execution*, provides introductory instruction on WP&C as well as detailed instructions for individuals involved in work planning. The ANL WP&C Program Office has also developed four WP&C "micro-learning" courses to assist work planners, RIs, SMEs, and workers in a wide variety of WP&C topics, including areas of past weak performance. Observed virtual micro-learning courses (WPC 304.1, *HPI in Action: Scope and Scope Limits*; WPC 304.3, *HPI in Action: Hazards and Controls*; and WPC 203, *Human Factors, A Team Approach*) provided in-depth information on important aspects of the WP&C process and were focused, respectful of participant time constraints (30 minutes or less in duration), interactive, and very well received. The ANL WP&C virtual micro-learning courses are cited as a **Best Practice**.

The ANL radiation protection program includes appropriate WP&C procedures that flow down institutional radiological requirements to the working level, consistent with LMS-MNL-10. The ANL *Radiological Safety Program Description* and implementing procedures provide an adequate ISM framework to support the planning and control of radiological work in key WP&C areas, such as developing RWPs and As Low As Reasonably Achievable (ALARA) reviews, performing radiological surveys, and conducting air sampling and monitoring.

Although ANL has made notable improvements in its institutional WP&C program, the skill of the worker (SOW) program is not sufficiently defined in LMS-MNL-10 and the reviewed directorate- or division-level WP&C manuals. An exception is the FAC/STE Work Planning Guide, Volume 1, which provides a definition of SOW. Most work performed as SOW is conducted within the Infrastructure Services Directorate, but a few research divisions have recently explored the application of SOW to their research activities. LMS-MNL-10 provides limited and conflicting requirements on SOW and little guidance on how to implement SOW. In addition, SOW requirements and guidance are also lacking in organization level manuals for research divisions currently implementing SOW activities. For example, the PHY WP&C Manual provides very minimal instruction on the application of SOW. Instructions and requirements for SOW in LMS-MNL-10 are lacking in the following areas (see **OFI-ANL-1**):

- Requirements for the content and level of detail required for SOW work scopes, work scope limits, and task descriptions are insufficient.

- No SOW screening criteria are included for readily identifying the type of work and limitations for performing work as SOW, such as level of risk (low, medium, high), use of safety permits and procedures, and work in radiological areas.
- Although LMS-MNL-10 cites DOE-HDBK-1211-2014, *DOE Handbook on Activity-Level Work Planning and Control Implementation*, for WP&C guidance (including SOW), the DOE handbook says work should not be performed as SOW when safety permits are involved. The observed SOW WCD 65912.2, *ATLAS Ion Source*, requires safety permits for radiation work, laser work, and work with open flames.
- Requirements and instruction on documentation of training, competency, and demonstrated proficiency in safely performing research SOW tasks are minimal.
- No instruction on procedure use when performing work as SOW is included.

3.1.2 Research and Nuclear Operations WP&C Programs

Research and nuclear operations organizations have established generally adequate organization-level manuals. WP&C manuals developed at the directorate/divisional level provide detailed and beneficial WP&C requirements and guidance that is tailored to the research and nuclear operations conducted by those organizations. For example, the Biosciences Division WP&C Manual uses a frequently asked questions format to convey WP&C requirements and expectations for research conducted within that division. NWM procedure NWM-PROC-003, *WP&C Implementation*, adheres to the institutional WP&C requirements of LMS-MNL-10 while also addressing the unique requirements applicable to NWM, such as compliance with DOE Order 422.1, *Conduct of Operations*. Although Central Shops is part of NWM, its work is excluded from NWM-PROC-003; the assessment of the Central Shops WP&C process is addressed in section 3.1.3 of this report.

The research and nuclear operations organization level WP&C manuals implement AWARE® to conduct hazard assessments and identify controls. The AWARE® software program, for example, includes "triggers" to ensure that the appropriate Environment Safety and Health (ESH) SMEs are notified when the work planning team identifies hazards within their subject area. The reviewed documents appropriately included SMEs for the hazards identified by the work planning team.

Research safety review committees, when required by WP&C organization manuals, have been an effective mechanism for evaluating overall risks associated with research work activities. WCD safety reviews of observed research and nuclear operations work, performed by the AMD, CFC Division, Nuclear Sciences and Engineering Division, and CSE Division safety review committees, were effective in identifying activity-level work risks and defining hazard controls to avoid those risks. For example, independent safety reviews required by EGS-MNL-1, *Energy and Global Security Directorate Work Planning and Control Manual,* were effectively implemented for the observed work in the CFC Division. The independent reviews also provided a useful mechanism for a formal independent safety review resulting in improved WCDs. In another example, the AMD safety review committee was effective in identifying and analyzing the potential explosive vapor risk associated with the WCD 75315.0 experiment for the *Pope Nutsche Filter Dryer for Electrode Delamination*, resulting in additional electrical grounding for the dryer.

Several innovative ANL WP&C initiatives were observed in research activities. A radio frequency (RF) identification process has been implemented at most ANL research labs in order to identify and inventory hazardous chemicals remotely using RF technology. RF barcode tags attached to each laboratory chemical container can be scanned remotely to provide a laboratory chemical inventory accounting within

minutes. UChicago researchers use the Laboratory Risk Assessment Tool (LabRAT), developed through various university research projects, to effectively assess the risk of chemical hazards and chemical processes for research activities. LabRAT is a useful spreadsheet-based tool that enables researchers to evaluate the chemicals in use and assign a hazard score based on such factors as volume, toxicity, process conditions, and use of engineering controls and procedures. Based on the cumulative hazard score, a chemical safety level (CSL) risk is assigned (i.e., CSL-1, 2 or 3). Any chemical that is ranked as CSL-2 or higher requires an additional formal risk assessment. Additionally, the new Argonne Tandem Linac Accelerator System (ATLAS) Radiation Interlock System (ARIS) actively monitors radiation levels in the experimental and accelerator areas and provides real-time visual updates on current ion beam status and associated radiation levels. Recently, ANL opened an onsite "Safety Zone" personal protective equipment (PPE) exhibit area to assist workers in the selection of appropriate PPE.

Despite these positive WP&C initiatives, ANL lacks an effective mechanism to assess and document in WCDs the overall risk to worker safety and health from unintended consequences of multiple hazards identified in a research activity. (See **OFI-ANL-2**.) Section 3.1 of the ANL ISMS/WSHPD specifies that "unintended consequences are considered when screening hazards." ANL uses the LabRAT tool to assess activity-level chemical risk, which requires the performance of a failure mode analysis (e.g., "what-if" analysis) for those chemicals that exceed a pre-identified risk score; however, the LabRAT tool is designed only for hazardous chemicals and is not applicable to other hazards, such as pressure, thermal, and laser hazards. Some ANL research divisions implement an activity-level safety review process that identifies unintended consequences, but the process is not formalized or implemented for some ANL divisions and may not involve the workers performing the work. (See **OFI-ANL-2**.)

3.1.3 Infrastructure Services WP&C Programs

The reviewed divisions within Infrastructure Services (Facilities, NWM, and PMO) have effective organization-level WP&C processes and procedures. JSTD-135-W-T001, *IS/FAC & STE Work Planning Guide*, adequately describes work control processes for the Facilities Division and the PMO Rapid Response Program. Most maintenance work is accomplished with a work order (WO) and a hazard analysis memory card (HAMC), which is a hazard analysis checklist completed by workers that provides a useful reminder of potential hazards before work starts. Supervisors use form ANL-804, *Skill of the Worker*, to document the worker's qualifications, including training, education, and experience, for specific work (e.g., electrical testing and troubleshooting). For NWM Central Shops organization work, NWM-CS-PROC-009, *Safety Processes*, effectively describes the work process, including the SOW form and CS-DS-013, *CMS-CS Machine Tool/Equipment Safe Work Practices Evaluation/Qualification Summary*, to document worker proficiency/qualification.

ANL Institutional, Directorate, and/or Divisional WP&C Programs Conclusions

Since the 2017 EA WP&C assessment, ANL has achieved notable progress in restructuring and streamlining its WP&C process. ANL has an effective sitewide WP&C institutional program, as well as generally effective WP&C processes at the directorate and division level. The WP&C institutional program adequately implements DOE Policy 450.4A and provides the flexibility for ANL organizations to tailor their implementation within the institutional framework. ANL has also developed and employs several effective WP&C training tools, engages ESH SMEs in work planning, and uses safety review committees. Additionally, EA observed several innovative WP&C initiatives and one best practice involving ANL's virtual micro-learning sessions, which cover WP&C topics effectively. Despite these achievements, EA identified weaknesses in the areas of SOW definition and assessing and documenting in WCDs the overall risk from unintended consequences of activity-level work.

3.2 Work Planning and Control Implementation

This portion of the assessment evaluated the implementation of WP&C programs in research and nuclear operations organizations and Infrastructure Services.

3.2.1 Research and Nuclear Operations

ANL research and nuclear operations organizations implement WP&C by defining the scope of work, identifying and analyzing hazards, developing and implementing hazard controls, and performing work within those controls.

Defining the Scope of Work

WCDs for most observed research and nuclear operations work evolutions contained adequate work scopes and details to permit identification of hazards and requisite controls and met LMS-MNL-10 expectations. For example, CFC Division WCDs associated with four work observations (Molten Salt Viscometer, Molten Salt Density Measurements, Pyrochemical Development Operations, and General Laboratory Operations Small Scale Solvent Extraction) contained appropriate work scope definition statements, task delineation, and task scope limits. NWM Division WCD-AGHCF-25700, *General Routines in the CTA*, associated with one observed nuclear operations activity, provided an adequate work scope definition, including repackaging radioactive waste containers, equipment checks, general maintenance and equipment repair, and health physics routine survey activities. NSE WCD 67441.0, *Metal Additive Manufacturing via Laser Powder Bed Fusion*, associated with one observed research activity, adequately identified five sequential work tasks, and provided a brief but informative task description with scope limits for each of the five tasks.

Although most reviewed WCDs were adequate, work scopes and scope limits in two of the 17 WCDs associated with observed work activities did not include "clear limits of boundaries of the work activity", or "provide just enough information to describe the work without excessive detail" as recommended by LMS-MNL-10, section 3.1. (See **OFI-ANL-3**.) Specifically:

- The task scope for CSE Division WCD 31215.4, *Growth of Photo Synthetic Organisms, Preparation of Photosynthetic and Metal-Protein Complexes, and Light-Induced H2 and O2 Studies of Protein Hybrids*, provides a level of work scope detail and complexity which is excessive and inconsistent with the guidance of Section 3.1 of LMS-MNL-10 and training guidance of WPC303/403, *How to Plan and Execute Work*. Furthermore, the work scope limits of this WCD do not meet the guidance on work scope limits of either LMS-MNL-10 or WPC303/403.
- PHY WCD 65912.2, *ATLAS Ion Scope*, does not sufficiently define the work scope details for the activities being performed as SOW, reducing the worker's ability to identify hazards and controls. For example, one task is to "conceive, design, fabricate and implement upgrades to the ATLAS ion source," but the WCD provides no description of the upgrades, upgrade limitations, or potential hazards. Additional work scope detail for some tasks may be available in standard operating procedures (SOPs) associated with this activity, but such procedures are not incorporated into the WCD text or references.

The ANL WP&C Program Office has recognized the need to improve the writing of work scopes and scope limits in research WCDs and has developed and implemented a micro-learning course, WPC 304.1, to address work scopes and scope limits. EA observed a presentation of this course and found it effective in communicating the ANL expectations for work scope and scope limits, but EA also noted that this course has not been presented to all ANL staff responsible for preparing work scopes and limits.

Identifying and Analyzing Hazards Associated with the Work

The research and nuclear operations related WCDs for observed work adequately identified and analyzed most hazards. The WP&C organizational processes adequately flowed down the LMS-MNL-10 requirements for defining hazards associated with activity-level work. WCDs generated by the AWARE® program adequately reflected the identified hazards associated with observed operations and research work. Five reviewed WCDs appropriately used the WCD-EZ process to identify new or changed hazards. Interviewed research and nuclear operations workers clearly understood the identified hazards. Radiological hazard analysis, which is not incorporated into the AWARE® program, is appropriately conducted through the RWP and ALARA review processes, defined in Health Physics Procedure (HPP) HPP-9.1, *Radiological Work Permits*, and LMS-PROC-93, *Reviewing Radiological Work to Keep Personnel Exposure as ALARA*. Radiological hazard analysis was performed effectively for all observed research and nuclear operations, and radiological controls were flowed into RWPs governing the work, with one exception, as discussed below.

Contrary to chapter 16 of NWM-MAN-400, *Conduct of Operations Manual*, SOP WMO-PROC-7, *On-Site Transport of Radioactive Containers*, does not contain complete instructions to ensure that the most recent container radiological survey data is properly updated in the Waste Management System (WMS) database, which is used for radiological hazard analysis during work planning. (See **Deficiency D-ANL-1**.) Not properly updating radiological data in the WMS database results in inaccurate radiological survey data being used for work planning and the potential for unanticipated worker exposures.

EA identified this deficiency during an observed radiological operation in Building 306 by the NWM Waste Management Organization (WMO). WMO had planned and authorized a WCD and RWP to cover the opening and visual inspection of a waste container that had been received at Building 306 from an ANL onsite waste generator in 2017 to validate its contents prior to shipping it for disposal in 2022. When EA noticed much higher dose rates recorded on the drum label than were discussed in the pre-job briefing, WMO performed a radiation survey that verified the higher dose rates and appropriately paused work. Discussions with WMO personnel determined that the job planning was based on WMS database entries from the generator's original waste package receipt survey, which was taken in 2017 prior to its transfer to Building 306 for storage, pending future disposal. Per SOP WMO-PROC-7, another package receipt survey was taken upon arrival at Building 306 that showed a greater than ten-fold increase of the container's direct radiation levels, indicating a possible shift in container contents during transport. A new container dose rate label was affixed to show the new results, which were properly documented on an ANL radiological survey report form. Although SOP WMO-PROC-7 requires notification of the foreman or person in charge and the chief health physics technician (HPT) when receipt survey results differ by more than 50% from surveys taken at the waste generator location, the WMS database was not updated with the new survey results, preventing proper work planning for this job. Furthermore, other than requiring a notification, SOP WMO-PROC-7 does not instruct the foreman or person in charge or the chief HPT to update the WMS database when such deviations are noted upon receipt.

Developing and Implementing Hazard Controls

Research and nuclear operations WCDs generally identified adequate hazard controls associated with the observed activities. LMS-MNL-10, section 3.3 and ANL organizational WP&C procedures specify adequate requirements for defining hazard controls associated with activity-level research and nuclear operations work. The WCDs for radiological and non-radiological research and operations work observed maximized the use of engineering controls (e.g., gloveboxes, chemical fume hoods, local exhaust ventilation systems). The radiological WCDs included extensive use of engineered controls, such

as gloveboxes and/or hoods, to mitigate internal exposures to radionuclides during three radiochemistry activities performed in contamination/high contamination area gloveboxes and two performed in open face contamination area hoods.

The ATLAS facility upgrade included well-designed engineering controls for potential external radiation exposure hazards, including protective enclosure cages and the recently upgraded interlock system (i.e., ARIS). ARIS continuously monitors and controls worker radiation exposures via an interlock system and radiation dose rate meters that automatically shut down the accelerator beam when preestablished cumulative dose and/or dose rate thresholds are detected.

ESH Radiological Protection Organization Health Physicists prepare generally adequate RWPs that ensure control of radiological hazards. Four of the six reviewed RWPs were consistent with HPP-9.1, *Radiological Work Permits (RWPs)*. Reviewed RWPs identified expected radiological conditions and included the appropriate radiological controls, such as PPE, dosimetry, control limits, and radiological training requirements. For example, RWP-2021-203-103 (covering observed target fabrication work) contained all appropriate radiological controls, including specific instructions for an unrestricted release survey before removal of any items from the hood. The RWP also included specific instructions for doffing outer gloves before removing hands from the hood, as well as contamination control survey requirements. However, contrary to HPP-9.1 section 8.2, steps 9.1 and 9.2, the RWPs for two other observed work activities were inadequate to ensure conduct of proper job-specific contamination surveys and proper personnel monitoring during radiological work. (See **Deficiency D-ANL-2.**) Lack of proper contamination surveys and personnel monitoring during work results in the inability to evaluate exceedance of RWP control limits and the potential for undetected spread of contamination. Specifically:

- The RWP for the Alpha Gamma Hot Cell facility Clean Transfer Areas (CTAs) did not include a requirement for job-specific radiological contamination surveys to ensure adequate contamination control and verify that contamination control limits were not exceeded during the performance of work, which is a requirement in HPP-9.2, *Contamination Control Requirements*. In addition, HPP-9.1, section 8.2, step 9.1 requires the RWP preparer "to determine the types of radiological surveys to be performed by HPTs." Although the RWP identified the CTA as a posted contamination area, the RWP did not contain any requirements for job-specific contamination surveys. Undetermined contamination levels during radiological work can result in unknowingly exceeding RWP control limits and unnecessary personnel contamination or exposure due to inadequate PPE for the work.
- The RWP for glovebox work in Building 205, Laboratory J-117 did not identify the need for separate alpha and beta personnel monitoring during glovebox work in order to properly detect the presence of any alpha contamination on the researchers' hands and/or shirt sleeves. HPP-9.1, section 8.2, step 9.2 requires determination of the appropriate type of personnel monitoring to be performed by the individual (researcher). This caused two separate researchers performing glovebox work in Building 205, Laboratory J-117, to incorrectly operate the Ludlum 4368 survey meters in dual alpha-beta mode when checking their hands for contamination, thereby masking the presence of alpha contamination at levels of concern by the high beta background. Despite Radiological Worker II training and the presence of an operator aid (instructions for using the portable frisking instruments), the researchers were not aware of the need to perform separate alpha and beta measurements using the Ludlum 4368, and neither the RWP nor the operator aid specifically required these separate measurements.

The research organizational WP&C processes for observed work generally ensures proper development and implementation of hazard controls for work activities. However, one WCD included attachments with embedded hazard controls that were not discussed in the work scope or identified in the "hazard analysis and controls" sections of the WCD. WCD 55679.1, *Thermal Aging of Advanced Materials*, identifies a WCD Attachment, *Quartz Sealing Procedure*, that contains a protocol for 10 pre-operational

safety checks (e.g., "ensure that passers-by will not have line of sight of the welding flame"). Only two of these 10 administrative controls are included in the WCD.

LMS-MNL-10 and reviewed organizational WP&C program documents do not specify requirements or provide guidance on when or whether hazard controls in WCD attachments should be incorporated into the hazard analysis and controls section of the WCD. EA identified similar weaknesses in 2017. Nevertheless, contrary to ANL *ISMS/WSHPD*, section 3.1, ANL WP&C processes do not ensure that hazard controls (embedded in WCD attachments) are appropriately incorporated into WCD documents or referenced to facilitate ease of implementation and avoid potential human error. (See **Deficiency D-ANL-3**.) Without identification of or specific reference to necessary hazard controls from WCD attachments, controls may be missed by workers, impacting safety.

Performing Work Within Controls

The observed research and nuclear operations work was generally performed within controls. The observed research activities were performed within the hazard control set documented within WCDs, including good contamination control practices during radiological work in open face hoods. Interviewed research staff members, technologists, and department managers were knowledgeable of the associated hazards and controls. The observed pre-job briefings were thorough and addressed work scope, hazards, and hazard controls.

3.2.2 Infrastructure Services

ANL Infrastructure Services implements WP&C for maintenance activities by defining the scope of work, identifying and analyzing hazards, developing and implementing hazard controls, and performing work within those controls.

Defining the Scope of Work

Infrastructure Services effectively defined the scope of work for the observed work and reviewed WCDs. The reviewed maintenance WCDs adequately described the scope of work to be accomplished for four observed work activities and the walkthroughs of shops: two preventive maintenance (PM) jobs, one troubleshoot and repair job, one rigging and lifting job, and the walkthroughs of the NWM Central Shops and the carpentry and paint shops. The WCDs for the two PM jobs (B440 air compressor and B241 air handler unit) included a WO that adequately described the work, the location, the specific equipment, the maintenance tasks to be performed, and equipment-specific lockout/tagout (LOTO) procedures. The LOTO procedures provided appropriate information, including the energy sources, name of the mechanics, required PPE, and location of LOTO stations. The LOTO procedure for the B440 air compressor also included photographs of the disconnect and valve locations. The WO for the troubleshoot and repair job (a sump pump) adequately described the location of the pump and the concern about the pump operation. The WCD for the rigging and lifting job (motor lift) adequately described the location and work activity.

Identifying and Analyzing Hazards Associated with the Work

Infrastructure Services effectively identified and analyzed the hazards for the observed work and documented them in WCDs. All observed work included an appropriate level of hazard analysis. HAMCs were used for all observed Facilities Division building maintenance jobs, and a Rigging Daily Safe Work Plan was completed for the rigging activity. The observed workers appropriately completed the HAMCs and identified appropriate hazards and controls for the PM jobs and for the troubleshoot and

repair job. The foreman of the rigging activity explained that the crew had identified safety improvements to the rigging job as the result of a pre-job mockup – a good example of including the crew in work planning and hazard identification.

Safety and health SMEs matrixed from the ESH Division to line organizations were appropriately involved with each observed job. Interviews with the safety and health representatives demonstrated that they were knowledgeable of the job hazards and provided technical support as needed. For example, one safety and health representative conducted an industrial hygiene survey for a fire brick machining activity in the NWM Central Shops using personal breathing zone air samplers. The air samples were collected and analyzed to verify that the hazard was adequately controlled to meet the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV).

Developing and Implementing Hazard Controls

Infrastructure Services effectively developed and implemented hazard controls in WCDs for the observed work. Appropriate controls were identified in WCDs for the observed work activities. For example, NWM Central Shops and the Carpentry Shop WCDs appropriately included robust engineering controls using the hierarchy of controls methodology (engineered, administrative, then PPE). These include a locked cage with two sets of interlocks on the controls for the brazing furnace in the NWM Central Shops to prevent inadvertent personnel contact and resulting burns. Also, both shops' WCDs adequately addressed machine guarding and placards on equipment, local exhaust ventilation systems, saw stops, and LOTO controls. The WCDs associated with the observed PMs included equipment-specific LOTO procedures identifying the minimum PPE required, notifications, confirmation of energy isolation, and zero energy checks.

Performing Work Within Controls

Infrastructure Services is generally effective in performing work safely and within controls by a proficient work force. Prior to the beginning of each observed work activity, the foreman conducted a crew briefing that adequately addressed work assignments, hazards and controls, and stop/pause work authority. The workers appropriately conducted a thorough inspection of PPE before use and demonstrated good communication techniques while performing the jobs.

The workers involved in the observed work were appropriately trained and qualified. The training records for four building maintenance workers showed that they were trained in the appropriate subjects (qualified electrical worker and LOTO). Both mechanics who worked on the B440 air compressor job were listed as qualified workers on ANL-804, *Skill of the Worker Documentation of Worker Proficiency*, for compressed air systems, including training for pressure safety orientation, qualified electrical worker, and LOTO. Additionally, the training records of one of the riggers involved in the motor lift activity included appropriate and relevant training courses, such as qualified rigger and signal person training, and professional crane, forklift, and JLG Lull forklift operator training.

During one preventative maintenance work evolution, EA identified a discrepancy between the labeled valve number and the valve number specified in the LOTO procedure, contrary to LMS-MNL-4, Section 11. When EA questioned the foreman about this discrepancy, the workers and foreman acknowledged that the valve number in the procedure did not match the infield valve number; however, the workers continued with the activity after they determined it was safe to proceed. (See **Deficiency D-ANL-4**.) The use of inaccurate LOTO procedures could result in the incorrect component being locked out and workers potentially being exposed to hazardous energy.

Work Planning and Control Implementation Conclusions

Research and nuclear operations WCDs for the observed work evolutions contained generally adequate work scopes with an appropriate level of detail to permit identification of hazards and requisite controls and met LMS-MNL-10 expectations. WCDs for the observed work generally ensure appropriate identification and analysis of workplace hazards and identification of adequate hazard controls. The observed research and nuclear operations work was generally performed within controls. However, weaknesses were identified in the areas of work and task scope complexity, updating of radiological data in the WMS database, adequacy of RWPs to ensure the conduct of proper job-specific contamination surveys and proper personnel monitoring during radiological work, and the incorporation of hazard controls (embedded in WCD attachments) into WCD documents.

For Infrastructure Services work, work scopes were adequately defined in WCDs, and hazards were adequately identified and analyzed. ESH SMEs were effectively involved, and the appropriate hazard controls were identified and implemented. Work was performed within established hazard controls by a proficient work force, with one exception when a procedure error was recognized.

3.3 Flowdown of Construction Safety Requirements to Subcontractors

This portion of the assessment determined whether ANL appropriately flows down DOE construction safety requirements to lower-tier construction subcontractors and evaluated the implementation of WP&C for observed projects.

3.3.1 DOE Requirements Flowdown

ANL appropriately flows down DOE construction safety requirements to subcontractors and lower tier subcontractors. ANL prime contract DE-AC02-06CH11357 appropriately includes DOE Acquisition Regulation (DEAR) Clause 970.5223-1, *Integration of Environment, Safety and Health into Work Planning and Execution*. The ANL prime contract also states that ANL is responsible for flowing down ESH requirements to subcontractors. ANL appropriately addresses DOE safety requirements in ANL construction subcontracts by including an appendix A, *Argonne Terms and Conditions*. Appendix A, section 84, *Environment, Safety and Health*, adequately addresses 10 CFR 851 safety requirements for subcontracted construction work, including a worker safety and health plan, a job safety analysis (JSA), a designated ESH representative, and daily inspections. The ANL construction subcontracts also include construction specification section 1499, *Special Safety Conditions*, which addresses specific safety topics such as free silica dust and ACGIH TLVs.

ANL oversees the review and approval of subcontractor worker safety and health plans, provides ESH SME support, and assigns a technical representative who provides daily oversight, including a field construction daily safety audit checklist. The interviewed technical representative for the observed ANL Rapid Response Department subcontracted work activities (B360 asbestos abatement and B200 air handling unit) was knowledgeable of the job hazards and controls.

3.3.2 Subcontracted Construction Work Planning and Control Implementation

ANL lower tier contractors implemented WP&C for observed construction activities by defining the scope of work, identifying and analyzing hazards, developing and implementing hazard controls, and performing work within those controls.

Defining the Scope of Work

The Rapid Response Projects' WCDs adequately define the scope of work. Lindblad is the primary construction subcontractor for two observed Rapid Response Project jobs. The subcontract task order provides a clear description of the work scope, including schematics and photographs. The work entry clearance form (a method for coordinating with the facility management) also describes the work location and work start and end dates. The B200 air handling unit asbestos removal job was limited to removed pipe insulation, and the B360 asbestos abatement job (performed by a lower-tier subcontractor,) involved the removal of asbestos-containing material (floor tile). When EA observed the B200 job site, no work was being conducted, and at the B360 job site, a worker was preparing a room for asbestos work.

The scope of work for the PMO Construction Management Department job (B203 ATLAS toilet renovation) is adequately defined in the JSA.

Identifying and Analyzing Hazards Associated with the Work

The subcontractors correctly identified all hazards, but they incorrectly analyzed one hazard. A daily safety checklist was developed for all three observed jobs, and relevant hazards were identified. The silica hazard associated with the PMO Construction Management Department job (B203 ATLAS Toilet Renovation) was appropriately identified. However, contrary to 10 CFR 851, ANL did not ensure that the subcontractor used the required ACGIH TLV for analyzing the silica hazards. (See **Deficiency D-ANL-5**.) Instead, the subcontractor applied the Occupational Safety and Health Administration (OSHA) silica tables for the work task even though DOE has adopted the ACGIH TLV, which is 50% lower than the permissible exposure limits (PELs) specified in the OSHA construction tables. Consequently, the subcontractor permitted a higher exposure than allowed by the ACGIH TLV.

Developing and Implementing Hazard Controls

The hazard controls for the Rapid Response projects jobs were appropriately selected. The WCD for the B200 air handling unit job consisted of a JSA that adequately addressed job hazards, such as hazardous energy LOTO (non-electrical), hot work permits, hand tools, and PPE. The WCD for the B360 asbestos abatement job included an asbestos abatement work plan that appropriately identified barriers, area posting, high efficiency particulate air filtration equipment, and PPE. The JSA for the B203 project identified adequate controls for the hazards associated with the scoped work.

Performing Work Within Controls

ANL subcontractors were generally effective in performing work within controls. The observed controls for the B360 job included fire rated plastic sheeting (fireproof polyethylene) to cover openings, decontamination showers, negative air ventilation exhausted to the outside, air monitoring inside the room and in the hallway, and an eye wash station. Respirators were appropriately assigned to individuals, cleaned at the end of the shift, and stored in plastic bags. The reviewed documentation (training, licenses, respirator training) confirmed that the asbestos abatement workers were properly trained and qualified. These controls were adequate for the work being performed.

Due to a concern about getting dust on nearby equipment, workers changed the B203 ATLAS toilet renovation job by adding a fireproof sheeting enclosure around the immediate work area but did not revise the WCD to show that the work was being done in an enclosure. Any change to work that affects the hazards requires a corresponding change to the WCD, per LMS-MNL-10, section 7.1. (See

Deficiency D-ANL-5.) Changing the work process without revising the WCDs can result in unanalyzed and uncontrolled hazards.

Flowdown of Construction Safety Requirements to Subcontractors Conclusions

ANL appropriately flows down DOE construction safety requirements to subcontractors and lower tier subcontractors. ANL performs appropriate oversight of subcontracted work. For the observed construction activities, WCDs adequately defined the scope of work and identified the appropriate work hazards. However, EA observed weaknesses in the analysis and control of silica hazards associated with the B203 ATLAS Toilet Renovation job.

3.4 Electrical Safety

This portion of the assessment evaluated the adequacy of the ANL electrical safety program, arc flash and electrical shock hazard warnings, implementation of electrical safe work practices during work performance, and electrical LOTO.

ANL has implemented an effective approach to electrical safety. The electrical safety program (*ANL Electrical Safety Manual*) effectively integrates the requirements of 10 CFR 851 (including National Fire Protection Association [NFPA] 70-2020, *National Electrical Code*, OSHA 29 CFR 1910 Subpart S Electrical, and NFPA 70E-2018, *Standard for Electrical Safety in the Workplace*). The *ANL Electrical Safety Manual* effectively incorporates the LOTO program and the requirements of NFPA 70E-2018, Article 120, *Establishing an Electrically Safe Work Condition*.

The electrical safety program appropriately establishes an electrical safety committee, staffed with SMEs and authorities having jurisdiction who are qualified in all aspects of electrical safety. The committee maintains the currency of the electrical safety program to ensure continued compliance with appropriate electrical codes and standards. The committee appropriately adjudicates any concerns or issues regarding electrical safety. Committee members serve in an advisory capacity to promote updates to the electrical safety training program to ensure that qualified and non-qualified electrical workers maintain their skills in and knowledge of electrical safe work practices.

The *ANL Electrical Safety Manual* includes a risk assessment process for the qualified electrical worker in which workers perform their own safety analysis before beginning any task. This self-analysis is a collection of 18 task-related questions to ensure that all electrical hazards are considered. Qualified electrical workers are trained and retrained on these 18 risk assessment questions. Additionally, an HAMC is used to identify all potential hazards at the work site and is reviewed with all workers during the pre-job briefing. Eight observed pre-job briefings demonstrated appropriate review and communication of the hazards and controls, including the applicable one-line diagrams, and switching procedures.

ANL employees are adequately informed of electrical arc flash and shock hazards. All observed 208-volt and greater three-phase electrical panels, disconnect switches, motor control centers, and switchgear have current arc flash and shock warning labels installed, as required by NFPA 70E-2018, section 130.5(H), *Equipment Labeling*. Arc flash and shock hazards information is appropriately communicated to all affected workers. Labels and procedures provide appropriate warnings and guidance to maintenance and operations personnel interacting with the electrical equipment. Warnings and guidance properly identify potential arc flash hazards and the associated arc flash boundary, potential shock hazards and associated shock hazard boundaries, and required PPE for working within arc flash and shock boundaries. Eight

observed work activities on de-energized electrical equipment demonstrated effective implementation of the ANL electrical safety and LOTO programs.

ANL adequately trains and qualifies electrical workers. Three reviewed training and qualification records confirmed that each electrical worker was properly qualified to perform work safely. All observed workers performed their assigned tasks in accordance with requisite electrical safety practices and procedures. All workers properly performed individual task risk assessments of electrical hazards throughout their task evolutions in accordance with the requirements of the *ANL Electrical Safety Manual*. All electrical maintenance personnel inspected and donned appropriate PPE for shock and arc flash hazards and implemented safe work practices, including zero voltage verification.

Electrical Safety Conclusions

The *ANL Electrical Safety Manual* effectively integrates the requisite electrical safety requirements. Arc flash and shock hazards information is appropriately communicated to all affected workers. The ANL electrical safety and LOTO programs are effectively implemented for electrical maintenance work activities.

3.5 Contractor Assurance System

This portion of the assessment evaluated whether ANL has established a CAS to plan and conduct risk-based assessments, analyze and manage WP&C related issues and associated corrective actions, and review performance (including feedback, improvement, and lessons learned).

ANL has established a generally effective CAS as required by clause H.42 of DOE Contract DE-ACO2-06CH11357. ASO approved the ANL CAS Description document on February 7, 2012. The ANL WP&C Program Office, Performance Management, Quality Assurance, and ESH organizations provide corporate processes, assessments, issues management tools, training, and periodic performance reports to support satisfactory CAS implementation.

ANL plans and conducts a generally comprehensive set of assessments. The reviewed assessment schedules for fiscal year (FY) 2021 and FY 2022 demonstrate effective coordination of enterprise risk management processes used to assist in planning assessments as outlined in the ANL *Enterprise Risk Management Program Guidance* document. LMS-MNL-14, *Assessments*, establishes adequate processes and requirements for conducting assessments. Lead assessors are formally trained and requalified annually. ANL assessments include independent internal assessments, management assessments, and "parent company" (University of Chicago) external assessments of the CAS (one in 2019 and one in 2021).

In FY 2021 and 2022 (through second quarter FY 2022), ANL conducted 229 assessments, with 33 (14%) related to WP&C. Of those 33 assessments, 21 involved activity-based work observations. These observations often occurred virtually (via real time camera feed) due to COVID-19 restrictions. ANL also conducted management observation conversations (188 were conducted in FY 2021). These included visits to work sites/research laboratories and observations of work/research activities. The reviewed assessments included six management assessments, six independent assessments, and two third-party assessments. These assessments were robust and self-critical, with findings/corrective actions tracked in the issues management system (PRISM®). However, ANL does not perform periodic assessments to determine how well applicable lessons learned, OFIs, and worker feedback are captured, analyzed, shared, and subsequently implemented in applicable WCDs. (See **OFI-ANL-4**.)

ANL uses a systematic and effective approach for event and issue analysis, development of corrective actions, and tracking of corrective action status. LMS-MNL-5, *Performance Improvement*, provides requirements and guidance for managing event analysis, issues, extent-of-condition reviews, corrective actions, effectiveness reviews, strengths, OFIs, and lessons learned. The PRISM® issues management system effectively supports tracking of event/issue causal analyses, corrective action tracking, extent-of-condition reviews, lessons learned, OFIs, and effectiveness reviews. Three reviewed training records show that causal analysts are formally trained and qualified in accordance with LMS-MNL-5. Three reviewed Occurrence Reporting and Processing System (ORPS) reports demonstrated adequate causal analyses and corrective action development. ANL has appropriately established a corrective action review board consisting of senior managers to monitor, verify, and validate corrective actions.

ANL has generally effective processes and tools for reviewing performance. Periodic performance reviews and reports include effective weekly corrective action review board dashboards (issues management performance), monthly metric updates (quality, events, assessments, and issues), and quarterly laboratory performance updates. Event/issue causes are effectively analyzed, binned as functions of the five ISM core functions, and trended as metrics in periodic performance reports. However, these WP&C related metrics are lagging indicators because they are related to events that have already occurred. Even though ANL possesses an extensive collection of WP&C related data, they have not effectively used this information to identify key leading indicators. (See **OFI-ANL-5**.)

The Performance Assurance lessons learned coordinator appropriately distributes DOE operating experience lessons learned, event lessons learned, and results of extent-of-condition reviews to appropriately targeted organizations throughout ANL. These lessons learned communications are well written and appropriate for the audience. Lessons learned points of contact assist organizations with identification, review, and incorporation of lessons learned into work planning and execution. However, ANL does not collect and analyze findings and strengths noted in reports documenting management observations. Form ANL 764, *Management Observations Conversations*, used to document management observations, contains noted strengths and findings, which are not currently collected, trended, or analyzed for potential lessons learned. (See **OFI-ANL-6**.)

ANL developed and continues to improve an artificial intelligence (AI)-enhanced knowledge mining process. The first component of the process integrates keyword identification with draft WCDs accessible in the AWARE® application. Keywords are used to provide direct links to the DOE OPEXShare database and ANL's internal lessons learned repository to search for lessons learned applicable to individual draft WCDs. A second component supports ongoing work projects by recommending relevant new lessons learned. EA considers the AI-enhanced knowledge mining process to be a **Best Practice** because it provides an innovative method for determining the applicability of lessons learned to specific WCDs.

The ANL WP&C Program Office personnel collect and appropriately use most feedback information. They conduct semi-annual meetings with each division director to collect feedback on WP&C processes and tools to evaluate potential improvements for future implementation. They also continually collect feedback submitted by email from any ANL employee. They use this feedback as input to develop focused virtual micro-learning sessions on WP&C. Although a post-job review template exists, it is not consistently used to solicit worker feedback. Consequently, the WP&C Program Office cannot effectively conduct analyses of post-job reviews. (See **OFI-ANL-7**.) This worker feedback is an essential element of organization learning and continuous improvement in WP&C.

Contractor Assurance System Conclusions

ANL has established a generally comprehensive CAS that provides adequate corporate processes, assessments, issues management tools, and periodic performance reports. Independent internal assessments, management assessments, and external parent company assessments are robust and self-critical. ANL uses a systematic and effective approach for event and issue analysis, development of corrective actions, and tracking of corrective action status. ANL has effective processes for frequent performance review, and lessons learned communications are generally well-written and effective. An AI-enhanced process that integrates keyword identification in lessons learned with applicable WCDs was identified as a best practice. However, weaknesses were identified in the areas of assessing implementation of worker feedback and lessons learned, developing a set of leading indicators for WP&C, analyzing results from management observations, and collecting all post-job worker feedback.

3.6 Argonne Site Office

This portion of the assessment evaluated the adequacy of the ASO WP&C oversight process for overseeing and evaluating operations managed by ANL and the implementation of specific ASO programs, including assessments and operational awareness activities, issues management, and the ECP.

3.6.1 Argonne Site Office Oversight

ASO has procedures that describe an effective overall approach to oversight by establishing the functions, responsibilities, authorities, and processes for conducting safety oversight. The ASO oversight policy sets the framework for conducting ASO risk-based oversight using the Office of Science Management System (SCMS) Governance Model, which is described in Assessment Planning and Conduct (APC) #20, *Argonne Site Office Oversight Plan*. The ASO implementing procedures Site Office Management (SOM) #15, *Office of Science Management System (SCMS) Oversight of Contractors*, SOM #23, *SCMS Quality Assurance and Oversight*, and SOM #14, *SCMS Line Management Oversight*, adequately describe ASO's oversight process. ASO's differing professional opinion and lessons learned program areas were adequately implemented but there was confusion among ASO staff as to which staff member was primarily responsible for each program. The lessons learned program responsibilities were in transition during the assessment. This did not result in any program inadequacies.

Facility Representatives (FRs) and SMEs routinely conduct operational awareness oversight of assigned ANL facilities using a risk-based approach. Although the number of in-person oversight activities was reduced because of the maximum telework posture during the COVID-19 pandemic, FRs and SMEs maintained effective oversight by virtually attending weekly operations calls and ANL meetings, participating in incident reviews and causal analysis meetings, reviewing ANL WP&C packages, approving radiation clearances, attending pre-job briefs, performing oversight of onsite quality assurance reviews, approving drone aviation missions, and conducting bi-weekly site walkthroughs in hazardous areas. The FRs and SMEs planned and conducted oversight activities in the various WP&C subtopical areas, and oversight observations entered into the ASO Commitment Tracking System (ACTS) were adequately documented. Through interviews and observed walkthroughs with FRs and SMEs, the FRs demonstrated knowledge of assigned facilities, and both the FRs and SMEs performed effective operational awareness oversight.

ASO's procedure SOP-26, *Facility Representative Program*, adequately describes ASO's FR program. The staffing plan has been calculated on an annual basis and is fully implemented. Although ASO's FR program is adequately implemented and the deadline for the self-assessment was impacted by the COVID-19 pandemic, the FR program is one year overdue for the triennial self-assessment required by

SOP-26, *Facility Representative Program,* and DOE-STD-1063-2017, *Facility Representatives*. (See **Deficiency D-ASO-1**.) Timely self-assessments are critical in evaluating the performance of the FR program.

The ASO training program for oversight personnel is implemented effectively. Technical qualification program (TQP) participants are current in their training. The required 80 hours of continuous training for TQP participants are adequately recorded and tracked to ensure documentation of training. Additionally, ASO encourages staff members, including management, FRs, and SMEs, to participate in assessments at other Office of Science locations, allowing them to learn and share information that can benefit ASO and other laboratories.

SOP-12, *Issues Management*, requires ASO personnel to document identified issues in ACTS, which has limited tracking and no trending functionality. Although some issues are entered into ACTS, it is not consistently used to track and trend low-level issues, contrary to SOP-12, D.2.e. (See **Deficiency D-ASO-2**.) A lack of tracking and trending of low-level issues can result in missing pervasive issues that warrant additional management attention. ASO has access to PRISM®, and FRs and SMEs use the system to check the status of corrective actions for issues identified through ANL assessments.

3.6.2 Argonne Site Office Employee Concerns Program

The ASO ECP SCMS, *Employee Concerns Program*, adequately describes the ECP process, which is consistent with DOE Order 442.1B, *Department of Energy Employee Concerns Program*. ASO has implemented the required aspects of the ECP, including assigning an ECP Manager who ensures that annual ECP data is entered into the DOE Headquarters ECP database. Although ASO did not have any ECP cases within the past three years, the ASO ECP manager was providing adequate oversight of the ANL ECP.

Argonne Site Office Conclusions

ASO has established, and partially implemented, a generally comprehensive, integrated process for Federal line oversight. ASO conducts adequate operational awareness oversight, has an effective TQP, and has implemented a satisfactory ECP. However, weaknesses were identified in scheduling the FR program triennial self-assessment, and tracking and trending of low-level issues.

3.7 Follow-up on 2017 EA Finding

EA previously assessed WP&C at ANL in 2017, as documented in the EA report *Assessment of Work Planning and Control at the Argonne National Laboratory, August 2017*. This current EA assessment examined the completion and effectiveness of the corrective actions for the one finding cited in the 2017 assessment. The finding (F-ANL-I-01) identified a risk of creating an oxygen-deficient atmosphere when using inert gases, and the lack of sufficient "triggers" in the WP&C process to ensure that ESH SMEs are appropriately notified in order to conduct workplace reviews and industrial hygiene exposure monitoring.

EA concluded that both issues associated with the 2017 finding have been adequately resolved. Since the 2017 EA assessment, ANL has developed a manual, LMS-MNL-19, *Oxygen Deficiency Hazard (ODH)*, which provides useful instructions to work planning staff on methods for calculating the potential for an oxygen-deficient atmosphere when new inert gases are introduced into the workspace. In addition, the AWARE® hazard identification tree includes administrative controls to identify when a potential oxygen-deficient atmosphere hazard may be present. Triggers have also been incorporated into AWARE® to automatically notify the appropriate ESH SME when a potential oxygen-deficient atmosphere hazard is identified in the WP&C process that may require their review. EA observed a number of WCDs and workplace examples of potential oxygen-deficient hazards/spaces in which the triggers and/or manual were used effectively.

4.0 BEST PRACTICES

Best practices are safety-related practices, techniques, processes, or program attributes observed during an assessment that may merit consideration by other DOE and contractor organizations for implementation. The following best practices were identified as part of this assessment:

- The ANL 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.

- ANL's development of an innovative AI-enhanced knowledge mining process that integrates keyword identification with draft WCDs enables WCD authors to link available lessons learned to applicable draft and active WCDs.

5.0 FINDINGS

No findings were identified during this assessment.

6.0 DEFICIENCIES

Deficiencies are inadequacies in the implementation of an applicable requirement or standard. Deficiencies that did not meet the criteria for findings are listed below, with the expectation from DOE Order 227.1A for site managers to apply their local issues management processes for resolution.

Argonne National Laboratory

Deficiency D-ANL-1: SOP-WMO-PROC-7 does not provide sufficient instructions to ensure that any changes to a container's radiological survey data are updated in the WMS database. (NWM-MAN-400)

Deficiency D-ANL-2: RWPs for two observed work activities were inadequate to ensure conduct of proper job-specific contamination surveys and proper personnel monitoring during radiological work. (HPP-9.1, section 8.2, steps 9.1 and 9.2)

Deficiency D-ANL-3: ANL WP&C processes do not ensure that hazard controls embedded in WCD attachments are appropriately incorporated into WCD documents to facilitate ease of implementation and avoid the potential for human error. (ISMS/WSHPD)

Deficiency D-ANL-4: ANL did not ensure that the LOTO procedure was accurate prior to performing preventative maintenance. There was a discrepancy between the labeled valve number and the valve number specified in the LOTO procedure. (LMS-MNL-4, section 11).

Deficiency D-ANL-5: ANL did not ensure that the subcontractor used the required ACGIH TLV for analyzing the silica hazards or revised the WCD to reflect the changed work process. (10 CFR 851 and LMS-MNL-10, section 7.1)

Argonne Site Office

Deficiency D-ASO-1: ASO did not self-assess its FR program within the required triennial period; ASO is one year past due for this self-assessment. (SOP-26 and DOE-STD-1063-2017)

Deficiency D-ASO-2: ASO does not adequately track and trend low-level issues. (SOP-12, D.2.e)

7.0 OPPORTUNITIES FOR IMPROVEMENT

EA identified eight OFIs to assist cognizant managers in improving programs and operations. While OFIs may identify potential solutions to findings and deficiencies identified in assessment reports, they may also address other conditions observed during the assessment process. These OFIs are offered only as recommendations for line management consideration; they do not require formal resolution by management through a corrective action process and are not intended to be prescriptive or mandatory. Rather, they are suggestions that may assist site management in implementing best practices or provide potential solutions to issues identified during the assessment.

Argonne National Laboratory

OFI-ANL-1: Consider expanding current ANL skill of the worker requirements and guidance consistent with DOE-HDBK-1211-2014, appendix A, and benchmarking Lawrence Livermore National Laboratory's SOW program (refer to *Work Planning and Control Assessment at the Lawrence Livermore National Laboratory*, August 2020).

OFI-ANL-2: Consider applying the "Critical Thinking" approach (used by the Sandia National Laboratories Division 1800 organization) to research WP&C at the activity level. Consider exploring how Sandia National Laboratories' approach could contribute to more effectively identifying, analyzing, and documenting potential failure modes and mitigating controls in WCDs.

OFI-ANL-3: Consider requiring the use of peer review "checks" of draft WCDs and the completion of the WPC 304.1 micro-learning course for all work planners.

OFI-ANL-4: Consider conducting periodic independent assessments to determine how well applicable lessons learned, OFIs, and worker feedback are captured and subsequently implemented through changes to WCDs. Similar assessments conducted by the lessons learned coordinator at Four Rivers Nuclear Partnership, LLC at the Paducah Gaseous Diffusion Plant may provide useful examples.

OFI-ANL-5: Consider identifying a set of leading indicators for monitoring WP&C performance to supplement the lagging indicators already in use. Review of WP&C related metrics developed by Lawrence Livermore National Laboratory WP&C program management may be useful.

OFI-ANL-6: Consider collecting and analyzing findings and strengths documented on ANL-764 forms (management observations conversations) for potential lessons learned. Reviewing the collection and analysis of management observation findings by Lawrence Livermore National Laboratory may be useful.

OFI-ANL-7: Consider consistently collecting and using worker feedback from post-job reviews to enable identification of WP&C related organizational weaknesses and to contribute to continuous learning and improvement of WP&C. Reviewing the feedback collection and analysis processes used at Lawrence Livermore National Laboratory may be useful.

Appendix A
Supplemental Information

Dates of Assessment

Onsite Assessment: April 11-14 and 25-28, 2022

Office of Enterprise Assessments (EA) 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 Assessment
Kimberly G. Nelson, Acting 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
Christopher E. McFearin
Christian M. Palay
Michael A. Kilpatrick

EA Assessment Team

Harrichand Rhambarose, Lead
Charles C. Kreager
Kimberly G. Nelson
Joseph M. Dobbins
Roby D. Enge
James R. Lockridge
Dennis K. Neitzel
Terry B. Olberding
Mario A. Vigliani