Office of Enterprise Assessments
Assessment of Work Planning and Control at the Argonne National Laboratory

August 2017

Office of Worker Safety and Health Assessments
Office of Environment, Safety and Health Assessments
Office of Enterprise Assessments
U.S. Department of Energy

Table of Contents

ACRONYMS

ANL	Argonne National Laboratory
APS	Advanced Photon Source
ASO	Argonne Site Office
BIO	Biosciences Division
BSL	Biosafety Level
BSO	Biological Safety Officer
CAS	Contractor Assurance System
CDC	Centers for Disease Control
CFR	Code of Federal Regulations
CHA	Certified Hazard Analysis
CO	Carbon Monoxide
CO2	Carbon Dioxide
CORAL	Chemical Ordering, Reporting and Attribute Library
CRAD	Criteria and Review Approach Document
CS	Central Shops
DOE	U.S. Department of Energy
DPO	Differing Professional Opinion
EA	Office of Enterprise Assessments
ECP	Employee Concerns Program
EHCP	Experimental Hazard Control Plans
ES	Energy Systems
ESAF	Experimental Safety Assessment Form
ES&H	Office of Environment, Safety and Health
FAR	Functional Area Review
FR	Facility Representative
FMS	Facilities Management and Services
FY	Fiscal Year
HSE	Health, Safety & Environment Division
IBC	Institutional Biosafety Committee
IH	Industrial Hygiene
IS	Infrastructure Services
JHA	Job Hazard Analysis
MSD	Materials Science Division
NE	Nuclear Engineering Division
NFPA	National Fire Protection Association
OE	Operating Experience
OFI	Opportunity for Improvement
PEMP	Performance and Evaluation Management Plan
PI	Principal Investigator
PMA	Performance Management and Assurance
PPE	Personal Protective Equipment
PROC	Procedure
RF	Radio Frequency
RWP	Radiological Work Permit
SC	DOE Office of Science
SCMS	Office of Science Management System
SMART	Science Management Actions and Record Tracking
SME	Subject Matter Expert
SOP	Standard Operating Procedure
UChicago	UChicago Argonne, LLC

WAE	Work Authorization and Execution
WCD	Work Control Document
WP&C	Work Planning and Control

Office of Enterprise Assessments
Assessment of Work Planning and Control at the
Argonne National Laboratory

EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) Office of Worker Safety and Health Assessments, within the independent Office of Enterprise Assessments (EA), conducted an assessment of work planning and control (WP&C) at the Argonne National Laboratory (ANL). EA also examined the DOE Argonne Site Office (ASO) WP&C and contractor assurance system (CAS) oversight activities at ANL. U Chicago Argonne, LLC (UChicago) operates ANL, and ASO provides Federal oversight. EA conducted this assessment April 3-6 and April 24-27, 2017.

This assessment focused on the effectiveness of the ANL WP&C program, through activity-level observations at the Advanced Photon Science Division, the Materials Science Division, the Nuclear Engineering Division, Nanoscience and Technology Division, Energy Systems Division, Global Security Sciences Division and the Biosciences Division. This assessment also followed up on previous machine guarding issues at the Central Shops and certain findings from previous EA assessment activities.

Overall, EA observed that in the four ANL divisions surveyed, the ANL institutional WP&C process and associated electronic tools have provided a useful institutional framework for implementing the five core functions of DOE's Integrated Safety Management policy. Each division has developed divisional WP&C procedures for implementing the institutional requirements. Most activity-level hazards in observed experiments were appropriately captured and conveyed in work documents, and employees observed by EA were knowledgeable of hazards and controls and experienced in performing their tasks. Environment, Safety and Health coordinators were well-trained and experienced in the types of experimental research activities for which they support, enabling them to provide valuable peer review and assistance to line management in ensuring proper identification of hazards and controls. The APS machine shop certification process is one of the more robust certification processes for experimental users in the DOE Complex and EA identified it as a best practice.

However, for each division, EA identified potential shortcomings in the implementation of the institutional WP&C process at the division level. Many of these shortcomings may have been caused by lack of sufficient guidance in the institutional and/or divisional level WP&C procedures, particularly with work scope definition and the use and limitations of pre-defined hazard control sets. Other shortcomings identified include ensuring that all activity specific hazards in the biological lab spaces have been identified and analyzed by appropriate SME's, developing Work Control Documents that are user-friendly, lack of identification of training requirements for support staff, and ensuring that work activities are appropriately authorized prior to performance of work.

Generally, ASO has appropriate processes and well-qualified staff members in place for conducting oversight, including assessment planning and performance, operational awareness activities, issues management, and performance assurance analysis. ASO feedback through the Performance and Evaluation Management Plan process has improved CAS effectiveness and safety performance. The assessment planning tool developed by ASO to better target oversight activities is considered a best practice because it provides a systematic mechanism that considers performance and potential vulnerabilities when scheduling assessment resources. However, EA identified deficiencies related to the validation of contractor corrective actions for identified oversight issues, and the need for trending analysis of ASO oversight data to identify emergent issues and help focus oversight activities.

EA reviewed the corrective actions taken to address a Preliminary Notice of Violation associated with deficiencies in ANL's implementation of machine guarding requirements, following an August 2015 event involving a near amputation of a machinist's finger. ANL performed an adequate and well-documented causal factor analysis/evaluation, developed and implemented (with few exceptions) timely actions and plans to correct and prevent recurrence, and is tracking plans and actions to closure and planning and performing the appropriate effectiveness reviews. Although rare, some machines were still in service without the proper controls in place, and some machine tool workers, line supervision staff members, and/or machine shop custodians were unaware of the machine guarding requirements. ANL has added new corrective actions in its tracking system to address these issues.

EA also reviewed corrective actions addressing three previous EA findings regarding implementation of the ANL radiological controls program. Corrective actions included establishment, posting, and training relative to radiological controlled areas and establishment of robust air sampling requirements to ensure effective characterization of the airborne environment with respect to respiratory protection. EA determined that the laboratory had effectively completed corrective actions to address two of the three findings, but additional corrective actions are needed to effectively address the third finding. A review by ANL before this 2017 assessment also identified that additional corrective actions were needed to fully address the third finding, which was reopened, and was associated with the respiratory protection program.

Office of Enterprise Assessments
Assessment of Work Planning and Control at the
Argonne National Laboratory

1.0 PURPOSE

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 the Argonne National Laboratory (ANL). EA also examined the DOE Argonne Site Office (ASO) WP&C and contractor assurance system (CAS) oversight activities at ANL. U Chicago Argonne, LLC (UChicago) operates ANL, and ASO provides Federal oversight. EA conducted this assessment April 3-6 and April 24-27, 2017.

This WP&C program assessment was conducted within the broader context of EA's targeted assessments of programs at DOE sites that have high-consequence activities or whose performance may present significant risks in accordance with DOE Order 227.1A, *Independent Oversight Program*.

2.0 SCOPE

EA conducted this assessment in accordance with the *Plan for the Office of Enterprise Assessments Targeted Assessment of Work Planning and Control at the Argonne National Laboratory*, April 2017. This assessment evaluated the implementation of the WP&C program in the following organizations: Advanced Photon Source (APS), Materials Science Division (MSD), Nuclear Engineering (NE) Division and Biosciences Division (BIO), along with select biological program activities in the Nanoscience and Technology (NST) Division, Energy Systems (ES) Division, Global Security Sciences (GSS) Division. This assessment also included evaluation of elements of the DOE Office of Science (SC) ASO processes for oversight pertaining to WP&C and contractor assurance system (CAS) activities.

3.0 BACKGROUND

ANL is a science and engineering research national laboratory near Lemont, Illinois, outside Chicago. UChicago Argonne, LLC (UChicago) is the prime management and operating contractor at ANL for SC, and is a partnership of the University of Chicago and Jacobs Engineering Group Inc. ASO provides Federal oversight of ANL. Brief descriptions of the work control processes associated with the ANL Divisions reviewed by EA, namely BIO, MSD, APS, and NE, are provided in the following paragraphs as background to understanding EA's observations of the WP&C processes that are described in Section 6.0.

The experimental research of ANL MSD is focused in four primary areas: creating materials (bulk synthesis, crystal growth, film growth), characterizing materials (chemical, structural, and properties analysis), detailed studies of the physical phenomena in materials (low temperature physics, diffraction, and microscopy), and detailed studies in materials science theory. The MSD WP&C process, which is defined in MSD-PROC-5 *Implementation of Work Planning and Control*, mirrors the ANL institutional WP&C process and requires that work control documents (WCDs) use the web-based ANL WP&C process. MSD also requires the use of the web-based ANL WP&C process for work authorization and the generation of WCDs for each MSD experiment.

ANL's NE Division is one of several divisions within the Energy and Global Security Directorate of Argonne. The NE mission is to advance the design and operation of nuclear energy systems and apply nuclear energy-related expertise to current and emerging programs of national and international significance. NE conducts analytical and experimental research, concentrating in advanced nuclear

energy systems, nonproliferation and national security, and environmental management. EA sampled work being performed in buildings 205 and 211 by two of the six NE Division technical departments, including Nuclear Chemical Engineering and Instrumentation, Detection and Analysis. NE has also developed a local WP&C implementing procedure entitled NE-WPC-01, *Nuclear Engineering Division Local Work Planning and Control*, which describes the basic work control process to be used by NE for achieving compliance with the institutional WP&C requirements. This procedure, which was initially developed in 2012, has not been updated to reflect the current capabilities of ANL's web-based WP&C tools and NE's current practices and intentions to use these tools for work authorization and generation of WCDs.

The APS is a synchrotron light source that produces high-energy, high-brightness x-ray beams. More than 60 beamlines are housed in one or more sectors. Experimental work performed at the APS falls into one of two categories: non-experimental APS facility and beamline WP&C and experimental WP&C performed by various classes of resident and external users using an online tool, the Experimental Safety Assessment Form (ESAF). EA's focus for this assessment was on the experimental WP&C and the use of the ESAF process to generate Experimental Hazard Control Plans (EHCPs), which are the WCDs for the large number of experiments performed by external and resident users of the APS.

The Biosciences Division (BIO) WP&C process, BIO-PROC-14, *BIO Division Procedure for Developing and Approving Local Work Planning and Control Documents* defines local WP&C for BIO, addresses the requirements of LMS-PROC-200, *Local Work Planning and Control Implementing Procedures* and begins with the ANL WP&C electronic application system. All biological research at ANL involves review and approval through the ANL Institutional Biosafety Committee (IBC) in accordance with 10 CFR Part 851 Appendix A.7, *Biological Safety*. All biological research at ANL is regulated by the Centers for Disease Control (CDC), 10 CFR Part 851 Appendix A.7, *Biological Safety* and implemented according to the *Biosafety in Microbiological and Biomedical Laboratories*, 5th edition. The review of biological research is managed via the IBC and covers identification of existing and potential biological workplace hazards, assessment of risk, development and implementation of biological hazard controls, assurance that work is performed within established controls, and internal and CDC assessments. ANL biological work is risk categorized per the CDC's risk criteria as biosafety levels 1 and 2 (BSL-1 and BSL-2). The BSL-1 risk group is the basic level of protection and is appropriate for agents that are not known to cause disease in normal, healthy humans. The BSL-2 risk group is appropriate for handling moderate-risk agents that cause human disease of varying severity by ingestion or through percutaneous or mucous membrane exposure. This assessment covered biological work activities in the Biosciences (BIO) Division, Nanoscience and Technology (NST) Division, Energy Systems (ES) Division, and Global Security Sciences (GSS) Division. EA also assessed the ANL Safeguards, Security and Emergency Services Division in respect to its' limited interaction as it applies to emergency response involving biological agents at the University of Chicago Howard Taylor Ricketts Laboratory, which is a BSL-3 facility located on the ANL site but not under the management or jurisdiction of ANL.

4.0 METHODOLOGY

EA implements the independent oversight program through a comprehensive set of internal protocols, operating practices, assessment guides, and process guides. Organizations and programs within DOE use various terms to document specific assessment results. In this report, EA uses the terms "deficiencies, findings, and opportunities for improvement (OFIs)" as defined in DOE Order 227.1A. DOE line management and/or contractor organizations must develop and implement corrective action plans for deficiencies identified as findings. Other important inadequacies not meeting the criteria for a finding are also highlighted in this report and are summarized as deficiencies in Appendix C. These deficiencies should be addressed consistent with site-specific issues management procedures.

As identified in the assessment plan, this 2017 assessment considered requirements related to the ANL WP&C process and includes biological work activities. The criteria guiding this assessment were based on specific objectives, criteria, and lines of inquiry associated with activity-level WP&C contained in DOE Guide 226.1-2A, *Federal Line Management Oversight of Department of Energy Nuclear Facilities*, Appendix D, *Activity-Level Work Planning and Control Criterion Review and Approach Documents with Lines of Inquiry*.

In addition, EA collected and analyzed data on ASO oversight activities of the WP&C process and CAS and used elements of CRAD 45-21, *Feedback and Continuous Improvement Assessment Criteria and Approach - DOE Field Element*.

EA examined key documents, such as work packages, procedures, manuals, analyses, policies, and training and qualification records. EA also interviewed key personnel responsible for developing and executing the associated programs and observed research and programmatic work activities, along with routine meetings, such as plan-of-the-day meetings and briefings. The members of the EA assessment team, the Quality Review Board, and EA management responsible for this assessment are listed in Appendix A. The documents reviewed, personnel interviewed, and observations made during this assessment that are relevant to the findings and conclusions of this report are listed in Appendix B. Appendix C provides details about deficiencies. EA's assessment of the ANL institutional WP&C program and its implementation in four ANL organizations is provided in Sections 5.0 and 6.0, respectively, whereas Section 7.0 provides EA's assessment of the effectiveness of ASO oversight of the ANL WP&C program and CAS.

EA conducted a previous targeted assessment of activity-level implementation of radiological controls at ANL in 2014 (*Office of Enterprise Assessments Targeted Review of Radiological Controls Activity-Level Implementation at the Argonne National Laboratory Nuclear Facilities*, November 2014). For this 2017 assessment, EA examined the completion and effectiveness of corrective actions from the 3 findings described in the previous assessment. Results of the corrective action assessments are included in Section 7.0, Argonne Site Office Oversight, of this report.

5.0 INSTITUTIONAL WORK PLANNING AND CONTROL PROGRAMS

Objective:

The Organization has developed and approved WP&C processes to enable safe performance of work. (DOE Guide 226.1-2A, Appendix D, Objective WP&C1-1) (Criteria #3 and 6)

The Organization has established a management and organizational framework for (1) initiating, analyzing, planning, and approving activity level work and (2) authorizing, releasing, and safely performing activity level work. (DOE Guide 226.1-2A, Appendix D, Objective WP&C1-4) (Criterion #5)

Laboratory Wide Argonne Procedure LMS-POL-16, *Work Planning and Control*, and LMS-PROC-200, *Local Work Planning and Control Implementing Procedures*, define the ANL institutional policy for WP&C, as well as the requirements for the various Argonne organizations (Directorates, Divisions, etc.) to establish local WP&C implementing procedures suited to each organization's work. LMS-PROC-200 includes a limited set of institutional requirements that the local implementing procedures must both meet generally and specifically for each of the five core functions of Integrated Safety Management. Each of the ANL Divisions reviewed (MSD, NE, APS, and BIO) have developed and implemented procedures for implementing the requirements of LMS-PROC-200 for their work activities.

To assist ANL divisions with the implementation of LMS-PROC-200 requirements, ANL has developed two useful electronic WP&C tools designed to facilitate hazard analysis, identification of applicable control sets, work authorization, worker concurrence, and automated verification of worker training. These tools are web-based applications and include the WP&C tool and the Work Authorization and Execution (WAE) tool. The output from the WP&C tool is a WCD containing the scope of work, a breakdown of tasks needed to perform the work, a list of hazards and controls applicable to each task, and a list of the workers who will be using the WCD. This tool provides value in identifying hazard categories (e.g., chemical solvents, physical hazards), selecting applicable standard control sets required by other institutional documents, and identifying the need for subject matter expert (SME) review in providing further evaluation and control specification. The WAE tool is also a valuable mechanism that provides the ability to formally document work authorization and worker concurrence for a given WCD, as well as automatically verifying that worker training required by the WCD is current before the work can be authorized. The WP&C tool and the WAE tool are used by each of the four ANL divisions assessed by EA, but to varying extents. At APS, in addition to using these tools, a similar but separate web-based WP&C tool was developed for the APS user community, which is addressed in Section 6.2. Although these tools are generally used effectively and as intended, EA identified some concerns about the use of these tools, which are further discussed in Section 6.0 of this report.

Overall, the ANL institutional WP&C process and associated electronic WP&C tools have provided a useful framework for implementing the five core functions of DOE's Integrated Safety Management policy. However, for each of these ANL divisions, EA identified potential shortcomings resulting from the implementation of the ANL institutional WP&C process at the division level. Many of these divisional shortcomings identified in the ANL divisions in Section 6.0 may have been caused by lack of sufficient guidance in LMS-PROC-200, particularly with work scope definition, the use and limitations of pre-defined hazard control sets, developing WCDs that are user-friendly, and identification of training requirements for support staff, and work authorization. The key WP&C implementation issues as identified through field observations discussed in Section 6.0 that indicate shortcomings in LMS-PROC-200 are as follows: (**OFI-ANL-I-01**.)

- Work scopes in six experimental work control documents (WCDs) across three divisions lacked specificity, sufficient detail, or assigned work responsibility to permit identification and analysis of all applicable hazards and controls associated with the work, resulting in three missed hazards. In LMS-PROC-200 there is limited discussion of expectations for work scope definition and task breakdown to ensure that the work scopes defined by local procedures are described sufficiently and to permit effective hazard identification and analysis.

- Pre-defined hazard control sets contained in WCDs do not typically require subject matter expert (SME) involvement, resulting in insufficient hazard analysis and definition of controls in some cases. Although pre-defined hazard control sets may facilitate the efficient use of limited SME resources, the criteria for when SME involvement should be required for individual work activities has not been effectively documented or communicated.

- Many WCDs are unwieldy in size and scope, inefficient, and not user-friendly. As a result, such WCDs are seldom referred to by the research staff, other than for an initial orientation or if an annual review of the WCD is required.

- WCDs often cite a number of references, such as standard operating procedures. However, none of the divisions reviewed provide guidance concerning the preparation, use, or review of these WCD reference documents, and one-third of the references that were reviewed (i.e. Standard Operating Procedures) identified one or more hazard controls that were not incorporated into the WCD.

- There are no mechanisms to ensure that support staff (e.g., Health Physics Technicians) have completed required training identified in the WCDs before commencing work, or that WCD assigned staff have read and concurred with the WCD before commencing work.

- Some WAE forms were not completed to document work authorization and/or were not consistent with the observed work in two of the divisions. One of the six MSD experiments observed, and approximately half of the NE experiments observed, did not have a completed WAE form consistent with the work scope.

- ANL Industrial Hygiene has not provided sufficient "triggers" or criteria in division level WP&C process procedures or communicated such criteria to ESH coordinators and research managers to ensure that Industrial Hygiene is appropriately notified to conduct workplace exposure monitoring as required by Attachment 6 (Industrial Hygiene) of the ANL Worker Safety and Health Program.

It should be noted that EA conducted a previous review of the ANL WP&C process in 2009 as part of an *Independent Oversight Special Review of Safety, Health, and Emergency Management Programs at Argonne National Laboratory (July 2009)*. The 2009 review was conducted during the early stages of implementation of a new ANL WP&C process which was developed in 2008, and served as the prototype for the WP&C process assessed during this review, although the current LMS-PROC-200 had not been developed at the time of the 2009 Oversight review. The 2009 Oversight review primarily observed research and experimental work activities in the Physics and Chemical Sciences and Engineering Division, and maintenance work activities in the Facilities Management and Services (FMS) Division, which were not reviewed during the current assessment. Although the focus of field observations was considerably different between the 2009 Oversight assessment and the current assessment, there were some parallels in observations of institutional WP&C programs as discussed later in this report.

In comparison to the 2009 DOE Independent Oversight Review of WP&C, there have been areas of considerable progress in the development and implementation of institutional WP&C processes as well as concerns identified in 2009 that continue to linger today. For example, in 2009 ANL divisions had not developed divisional WP&C implementation plans, nor were schedules developed and resources allocated to ensure that such plans would be completed. During this assessment, each of the ANL divisions reviewed had developed and implemented divisional WP&C implementation plans. In 2009, training and communication on the new WP&C process was informal and workers were not well informed on the new WP&C process and even less informed on the WP&C web-based tool. During this assessment, the WP&C web-based tool has evolved and the ANL staff was generally knowledgeable in the use of the tool to produce WCDs. However, the 2009 Oversight review also identified a number of institutional WP&C concerns that exist today particularly with respect to: integration of the IH workplace exposure assessment process into the WP&C process, identification of some WCD training requirements, lack of sufficient guidance for authorization and approval of WCDs, lack of guidance at the division and intuitional level on developing and integrating references (procedures and work instructions) into WCDs, and the need for the development of a "skill-of-the-researcher" process (or other mechanisms) to streamline WCDs. Additional comparisons with the 2009 Oversight review are provided in the following report sections.

6.0 WORK PLANNING AND CONTROL IMPLEMENTATION

EA observed work activities in four ANL divisions and Central Shops. For experimental research work performed in the MSD and the NE Division, both divisions rely heavily on the ANL institutional WP&C tools and therefore are addressed together in Section 6.1. Experimental research WP&C observations in the APS Division are addressed in Section 6.2 because EA focused almost entirely on the APS external

and resident user community, for which a different (but comparable) WP&C process that is more adaptable to large number of users of the APS is used. Biological research observations are presented in Section 6.3. Work observations in Central Shops are provided in Section 6.4.

6.1 MATERIALS SCIENCE DIVISION AND NUCLEAR ENGINEERING DIVISION

Objective:

The scope of work is described in sufficient detail to allow the work planning process to identify hazards associated with the work and to develop necessary schedules, priorities, and work instructions. (DOE Guide 226.1-2A, Appendix D, Objective WP&C2-1)(Criteria #2 and 3)

Each MSD experimental research WCD reviewed by EA contained a sufficient work scope description, including identification of laboratory equipment such that general hazard classifications and general hazard control sets could be identified. Several WCDs also delineated work scope boundary conditions in a section of the WCD on "Scope Limits," such as the WCD on "Synthesis and Crystal Growth of Inorganic Solid State Materials," which states, "This task does NOT encompass radioactive, biological, organometallic or nano-scale materials."

Within MSD, a range of experiments are typically performed and bounded by a single WCD. However, the details of any specific experiment are seldom documented in the WCD or in an attachment to the WCD. An exception is the new WCD for an "Anodizing Process" which includes detailed sequential experimental work steps which are provided in a standard operating procedure (SOP) attached to the WCD. In general, however, the wide variation in experimental work performed in MSD under the scope of one WCD often does not accommodate documenting the details for each experiment bounded by the WCD. In one case, the lack of an adequately detailed work scope at the experiment level resulted in hazards and controls being missed. In the WCD for the "Fabrication and Characterization of Thin Films and Simple Devices" observed by EA, neither the sequential experimental work steps nor the specific hazardous chemicals being used were documented in the WCD work scope. Since a range of chemicals are used in experiments bounded by this WCD, depending on the experimental objectives, hazardous chemicals are typically identified by their chemical or physical characteristics (e.g., "other acids with pH < 2 not identified above"), rather than by specific chemical names. In MSD experiments observed by EA, this mechanism of "control banding" was generally adequate to ensure that the appropriate controls were in place for the specific chemical observed and without having to identify the chemical. However, in the aforementioned experiment observed by EA, the appropriate controls for an industrial solvent, dimethylformamide (which was not identified by chemical name in the WCD work scope), were missed since the "control band" for "industrial solvents" was not included in the WCD. While MSD-PROC-5 states that "the vast majority of work in MSD requires a task based hazard analysis," 5 of the 6 WCDs reviewed by EA remain hazard-based because the tasks for individual experiments observed were not sufficiently described in the WCD work scope. (**Deficiency** and **OFI-ANL-I-01**.)

Similarly for NE, the overall work scope for broadly defined NE research activities (i.e. Pyrochemical Development Operations, Analytical Chemistry, etc.) were defined in the WCD Scope Summary section of each WCD reviewed. Most NE WCDs also defined two or more individual tasks as part of the overall work scope. With the exceptions noted below, work scope definitions were generally sufficient to permit identification of the key classes of hazards associated with the work. However, EA identified two cases in NE where important hazards were not analyzed and controls were not implemented, due to insufficient work scope definition. (**Deficiency** and **OFI-ANL-I-01**.)

In one observed work activity in NE, the WCD work scope definition lacked sufficient details of the work flow necessary for the IH to be able to determine important ergonomic hazards that EA noted when observing the work. During performance of X-141 Pyrochemical Development Operations, Task 2, for Metal Oxide Reduction, there were significant ergonomic stressors when removing cooled product from the stainless steel vessel. For this activity, the glovebox operator used a hammer and small chisel to break apart solid product in the vessel, and then repeatedly lifted and tilted the approximate 20 pound vessel while attempting to remove product fragments. The narrative description of work made no mention of these work steps for removal of cooled product from the stainless steel vessel. Management later procured a larger chisel for the operator to simplify the break up portion of the activity.

In another instance, a generic WCD was improperly assigned to govern work with unique hazards not addressed by the assigned WCD. In this case, the work activity included lifting hazards that were not identified or addressed in the WCD assigned to the work. The WCD, entitled "*Remove Items from a Drum*" was to be used to govern a task requiring assay of depleted uranium pouches via x-ray fluorescence. However during the pre-job briefing it was determined that the depleted uranium pouches weighing approximately 20 pounds each would have to be lifted out of the drums to accomplish the assay. The assigned WCD did not indicate any weight or lifting hazards or controls. The job was later postponed for unrelated reasons.

Objective:

All hazards that could adversely impact workers, the public, the environment, the facility, and its equipment are documented and analyzed for severity/significance. (DOE Guide 226.1-2A, Appendix D, Objective WP&C2-2)(Criteria #2, 4, 5, 7, and 8)

Overall, the MSD and NE researchers observed by EA were knowledgeable of hazards and controls and experienced in performing research activities. In addition, ESH coordinators assigned to support line management with WP&C in MSD and NE were well-trained and experienced in the same types of experimental research activities for which they support, enabling them to provide valuable peer review and assistance to line management in ensuring proper identification of hazards and controls.

A positive attribute of the WP&C tool observed in both MSD and NE is the "Task Hazard Relationship" field within the tool, which within MSD is used to explain when and how the researcher might encounter the hazard. For example, in Task No. 1 "Common Lab Work" in the WCD entitled "Fabrication and Characterization of Thin Films and Simple Devices" the presence of an aromatic hydrocarbon hazard is identified, inferring that this hazard may be present in one or more experimental work activities performed under this WCD. The Task-Hazard Relationship field for an aromatic hydrocarbon indicates a potential experimental task-hazard relationship by indicating that "some aromatic hydrocarbons (mostly toluene) may be used for processing, for example [for] dissolving polymers and small molecules for spin coating."

For most of the research activities in the MSD and NE laboratories, hazard classes (e.g., solvents) were appropriately identified in WCDs, such that the appropriate control set could be identified. For example, the NE Analytical Chemistry Laboratory WCD, Task 3, General Laboratory Operations had a comprehensive listing of laboratory hazards and control sets for a wide variety of physical, chemical, and radiological hazards present and used in the laboratory. Similarly, the NE WCDs for the Hands on Operation of Countercurrent Centrifugal Contactors and Operation of Microfluidic System, both performed in G-133, adequately conveyed the hazards associated with the observed work. EA did not identify any missed hazards for these experimental activities.

However, EA did identify two instances in which hazards were not identified or properly analyzed during other experimental activities in the MSD and NE laboratories. In MSD, an experiment was performed in the Surface Chemistry Group under the WCD entitled "Fabrication & Characterization of Thin Films" in which the solvent hazard class and controls associated with dimethylformamide, an organic solvent commonly used for chemical reactions, was missed as previously discussed. In a second example in NE, ergonomic hazards associated with working in all NE gloveboxes were missed. Throughout Building 205 and 211 gloveboxes are present in numerous individual laboratories and used by NE staff. The proper use of these gloveboxes is governed by a single WCD entitled "*Work Instructions for Radiological Gloveboxes in Buildings 205 and 211*." While ergonomic hazards are inherent to nearly all glovebox work, the WCD failed to identify ergonomic hazards during completion of the WPC tool hazards checklist, resulting in no standard control sets or requirements for SME review or involvement in analysis or control of this hazard. **(Deficiency)**

In a related concern, in two instances, industrial hygiene (IH) surveys were not conducted as required by the WCD for the work. In MSD, the WCD for the "Low Temperature, High Magnetic Field Characterization Systems" experiment being conducted by the Superconductivity and Magnetism Group required that an IH survey be performed to ensure that the magnetic field hazards associated with the superconducting magnets in Building 223 were analyzed and appropriately controlled. However, the IH survey was not performed at the time of this assessment. In NE, the WCD entitled "Processing of Radioactive Material in G-Wing Atmospheric Gloveboxes" indicated that an IH survey during bag-out work was needed to ascertain the extent of a radio frequency (RF) exposure hazard and also indicated the need for additional controls, such as safe distance from the equipment. NE, however, was unable to locate the required IH survey for the specific heat sealing equipment being used. Two workers performing the observed bag out were in close proximity to the heat sealing equipment throughout the work. **(Deficiency)**

Objective:

Controls are identified and implemented that effectively protect against identified hazards and approved activity-level WCDs can be performed as written. (DOE Guide 226.1-2A, Appendix D, Objective WP&C2-3)(Criteria #2, 3, 4, 5, 6, 7, and 8)

Within MSD and NE, engineering controls such as hoods and gloveboxes are used extensively and appropriately to mitigate many hazards associated with experimental work. EA observed the appropriate hierarchy of controls with engineered, administrative, and personal protective equipment (PPE) during all observed MSD and NE work evolutions. Use of the WP&C tool hazard identification process results in a draft WCD that lists the work scope, applicable hazards, and associated standard control sets for each hazard, as well as a requirement for hazard-specific SMEs to review and further refine controls as they deem necessary. For observed MSD and NE experimental work, the resulting WCDs included the appropriate standard control set for each hazard category identified. Each MSD and NE WCD was formally approved and contained electronic concurrence of required SMEs and the ES&H coordinator. For most hazards, pre-approved hazard control sets are available and incorporated into MSD and NE WCDs. The use of standard control sets adds an element of efficiency to the WP&C process, as indicated in MSD-PROC-5, which states "the use of unmodified control sets will eliminate the requirements for SME review in many cases."

However, EA also observed that the use of standard control sets does not ensure appropriate SME reviews are conducted when necessary because the criteria or "triggers" for when to involve SMEs in evaluating the adequacy of standard control sets generated by the WPC tool are not documented. In the vast number of experiments involving hazardous chemicals, chemical fume hoods, and/or gloveboxes, the appropriate gloves and lab coats are the primary control sets typically specified to contain the hazard and eliminate

chemical exposures to researchers. Based on interviews with ANL industrial hygienists, this pre-approved hazard control set provides a means of adequate protection for many hazardous chemicals used in small quantities. The ANL industrial hygienists also indicated that, based on the potential health hazard of the chemical or quantity and frequency of use, an exposure assessment may need to include personal sampling to validate the effectiveness of the hazard controls (i.e., fume hood and protective gloves). However, the criteria or "triggers" for when IH control sets should be validated though an IH exposure assessment has not been defined in the WP&C process and has not been communicated to the work force. In 2008, an MSD researcher was exposed to carbon monoxide (CO) while preparing a technical sample in a CO atmosphere contained within a glove bag within a chemical fume hood. When the glovebag was fully inflated, the chemical fume hood (which was part of the WCD control set for toxic gases) did not protect the researcher from an unacceptable breathing zone concentration of CO. The ANL investigation report noted that "small changes in the experimental conditions could have significant changes in worker exposure." The investigation report also noted that "SMEs (IH) were not consulted for the experiment." Attachment 6 of the ANL *Worker Safety & Health Program* document states that the divisional ESH coordinators and ESH/Quality Assurance representatives "arrange for health and safety reviews, and involve Argonne subject matter experts as needed for support or to conduct workplace exposure monitoring." However, the "triggers" or criteria for when IH needs to perform an exposure assessment to ensure that standard control sets (e.g., chemical fume hoods) are adequate to protect workers are not well documented and are not communicated to the research staff. **(Deficiency)**

According to some MSD and NE research staff members, many WCDs have become unwieldy and are seldom used by the research staff other than for initial orientation or if an annual review is required. An ANL safety culture perception survey of management and workers performed by an ANL subcontractor in August 2016 identified a similar concern in which WCDs were identified as one of the four key inefficiencies. These WCDs are "user-unfriendly," "unwieldy," and "inefficient" due to the following problems:

- The linkage of hazards and controls to a specific work activity or experiment is not always clear, as previously discussed.

- There were many instances where hazard controls contained in the WCD require the worker to research other procedures. For example, an administrative control for nanomaterials in one MSD WCD requires the researcher to "verify it meets LMS-PROC-83 Section 2 Exclusions." In most NE WCDs reviewed the following verbiage including "follow LMS-PROC-153," "follow MSDS," or "follow ESH 4.10," was used rather than specifying the actual controls.

- Three of the six MSD WCDs reviewed identify attachments containing hazard controls that may not be in the WCD or that conflict with the controls in the WCD. For example, in the MSD Experiment "Synthesis and Crystal Growth of Inorganic Solid State Materials" an RF furnace is used, requiring the performance of an IH survey to assess potential researcher exposures to the RF induced magnetic field and ultraviolet radiation. The IH survey was performed in 2008 and concluded that exposures to magnetic fields and ultraviolet radiation were below the American Conference of Governmental Industrial Hygienists (ACGIH) 8-hour Threshold Limit Values (TLVs). However, the exposures assumed that the furnace would never be operated at greater than 20% of the furnace's maximum output and that the furnace would never be operated without a sample load, because "without a sample load the radio-frequency field strengths would be significantly increased." Although the IH report is referenced as an attachment to the WCD, and the test results are summarized in the WCD, the WCD does not include any precautions concerning the furnace's maximum output being limited to 20% or operating the furnace without a load.

- Most WCDs contain typically low hazard activities commonly experienced by the public for which the same hazards and control sets are repeated in numerous WCDs (and sometimes in multiple tasks within the same WCD), and distract the work performer from the unique and more significant hazards and controls associated with the experiment. In each of the WCDs reviewed by EA the WCDs contained hazard and control sections for "Working in a Laboratory," "General controls for tools," "Knife/Blade," "Pliers," Screwdriver," "Wrench," or "Laboratory use of scalpels, razor blades and similar tools" that consume 10 to 20% of the WCD pages. The controls for "Working in a laboratory," such as safety glasses, shoes that cover the feet, and lab coat, are often repeated in each task within the same WCD.

Another DOE site is attempting to overcome similar challenges by relying on pre-authorized work tasks and enhanced job hazard analyses (JHAs) to streamline WCDs, with the goal of making WCDs more user-friendly. (See **OFI-ANL-I-01**.)

Most of the MSD WCDs reviewed identify and reference one or more SOPs. MSD does not have documented guidance that addresses the preparation, minimum content, or review and approval of SOPs that are typically prepared by one or more members of the research staff. Researchers typically refer to the SOPs and the hazards and controls in SOPs more than the WCDs in which the SOPs are referenced. EA identified the following concerns regarding the use of SOPs referenced in WCDs:

- One SOP identified hazard controls that were no longer applicable at ANL. For example, the SOP for an "STM Experiment under CO Atmosphere" includes medical surveillance requirements for researchers using CO or nitric oxide to ensure that "they are fit for duty to use this chemical." These medical surveillance requirements when working with CO or nitric oxide are not identified in the "Review Package" output from the WPC web-application for this experiment, and while such requirements may have been applicable following the Calendar Year 2008 CO overexposure incident, they are no longer required.

- Four of the 14 MSD SOPs reviewed by EA and referenced as attachments in the "Review Package" output from the WPC web-application (i.e., one-third of SOPs reviewed) contain hazards and/or hazard controls that are not listed in the "Review Package" or vice versa. MSD-PROC-5 does not provide sufficient guidance for when controls identified in an SOP (or other referenced document in a WCD) should be included as a hazard and control within the "Review Package". For example, the SOP for the Tunnel Diode Oscillator (an attachment to the WCD on "Low Temperature, High Magnetic Field Characterization Systems") has a section of General Warnings and Precautions. One warning addresses the potential asphyxiation hazard from the rapid release of a cryogen in case of a magnetic quench or equipment measure. A stated control is that "pit work in Lab B-018 is forbidden when dewars filled with liquid nitrogen are present." Although the WCD does identify the typical hazards and controls associated when working with cryogens, the prohibition of pit work in Lab B-018 when dewars are present is not identified in the "Review Package" and guidance is lacking in MSD-PROC-5 for when such precautions should be also be included in the WCD section that addresses cryogen use.

- None of the 14 MSD SOPs reviewed by EA indicated that they had been reviewed or approved by anyone other than the document originator(s). In most cases the only signature(s) or names on the SOPs were the name(s) of the originator(s). One WCD, for example, includes a SOP entitled "Chemical Carcinogens," which does not indicate a review by the ANL SME for Chemical Carcinogens to ensure consistency with the ANL requirements for chemical carcinogens.

ANL divisional WP&C implementing procedures (e.g., MSD PROC-5 *Implementation of Work Planning and Control,* and NE-WPC-01, *Nuclear Engineering Division Local Work Planning and Control*) do not describe how SOPs are to be prepared, reviewed, and approved to ensure that hazard controls within SOPs do not conflict with the control sets in WCDs. Section B.3 of LMS-PROC-200 states, "local procedures must also describe how permits, procedures, and the results of hazard analysis and identification of controls are reviewed to determine that the controls are not in conflict." **(Deficiency)**

In one NE work evolution involving a glovebox bag out, EA observed an HPT that was exposed to a potential RF field without having completed the prerequisite training for it specified in the WCD. EA determined this to be a systematic institutional gap associated with the WAE tool as it relates to ancillary support workers, who are not specifically listed as authorized workers on the WCD. Although the WAE tool ensures that division researchers authorized to work on a WCD are current with training requirements, the WAE tool will not check and validate the training status of ancillary workers assigned to support the WCD. In this evolution, the G-Wing glovebox WCD required RF/Microwave training due to an RF hazard during heat sealing. Although the NE independent worker for the WCD had completed this training, the health physics technicians working in the same area had not. This concern would extend to any support worker across ANL who is not specifically identified as an independent worker on the WCD. **(Deficiency)**

Radiological hazards are prevalent in much of NE's work. Radiological hazards are analyzed and controlled using radiological work permits (RWPs) that are developed in accordance with HPP-9.1, *Radiological Work Permits,* and maintained by the radiological organization. WCDs that include radiological hazards automatically flag engagement of a radiological SME in the WCD review and approval process. If an RWP is needed for the work, the SME either assigns an existing RWP to the WCD or develops a new RWP if no suitable existing RWPs are available. Much of the radiological work EA observed was governed by a single RWP across multiple WCDs. This is because the radiological hazards were similar despite differences in the experimental processes. RWPs are required to include a complete listing of all specific WCDs associated with the RWP. However, the only linkage of the RWP to the WCD is on the RWP itself, and the specific RWP that governs a particular WCD cannot be ascertained from the either the WCD or work authorization document, which do not include the RWP number. Interviewed NE personnel were not always sure which RWP governed their work, referring to one of several that are mainly used. (See **OFI-ANL-RAD-01**.)

Moreover, ANL does not have a requirement for workers on general RWPs that are valid for one year to confirm at the time of each work evolution which RWP governs their work. As stated above, interviewed NE personnel were not always sure which RWP governed their work, resulting in a potential for errors. Workers on general RWPs initially receive an RWP briefing and concur by signature that they understand and will comply with the RWP, and do not receive another RWP briefing unless the RWP is revised. Many workers have been briefed and are deemed qualified on any number of different RWPs, without being required to physically select and review the appropriate RWP for each work evolution. Unlike some DOE sites where workers must sign in and out of RWPs for each work evolution (manually or electronically), ANL does not have this requirement or another requirement for a worker to consciously decide which RWP they are working under for a given activity. The two minute drill operator aids that many workers wear on their lanyards do ask this question but not as part of any formal radiological control work process. (See **OFI-ANL-RAD-01**.)

EA also noted that RWPs for observed work governing localized contamination areas (CAs) (e.g., benchtops and hoods) did not specify any radiological contamination controls designed to prevent the inadvertent spread of contamination from these areas to the surrounding clean radiological buffer areas. Specifically, the need to doff outer gloves prior to removal of hands and associated frisking requirements for hands and potentially contaminated PPE were not included in the two RWPs governing multiple

localized contamination area work activities in Buildings 205 and 211, and as discussed below, EA observed these types of poor contamination control practices during work in one of the NE laboratories. EA also noted there was a lack of operating radiological survey equipment for use in some of the labs where radiological work was being performed, including X-141, and G-133, possibly contributing to the lack of frisking discussed in the next section. (See **OFI-ANL-RAD-01**.)

EA reviewed ANL's Radiological Worker 2 practical factors training, which includes both lab coat and full Tyvek dress out components. Although the lab coat practical helps to reinforce proper contamination control practices for localized CAs, it consists of a one-time arm entry and removal from the contamination area, and does not evaluate multiple partial body entries in and out of the hood or the associated need for hand and partial body frisks each time. (See **OFI-ANL-RAD-1**.)

Objective:

Work is conducted diligently in accordance with approved work instructions and within established controls. (DOE Guide 226.1-2A, Appendix D, Objective WP&C2-4)(Criteria #2, 3, and 5)

For both MSD and NE, EA found that use of the WP&C and WAE tools can be effective in facilitating WCD review and approval, worker concurrence of WCDs, verification of worker training, and formal work authorization. NE also uses pre-job briefings and/or pre-shift meetings to verify facility status and ensure readiness to perform scheduled work. The several NE pre-job briefings and pre-shift briefings that EA reviewed were found to be informative and effective.

MSD and NE local WP&C procedures call for use of the ANL WAE web application to document management authorization of work and workers' concurrence of WCDs before performing work. In one MSD experiment "Fundamental Studies of Electrocatalysis for Low Temperature Fuel Cells," only one of the three workers performing the experiment was on the Work Authorization form as an independent worker. EA discussed this concern with the ESH Coordinator, who later updated and corrected the problem. In NE, WAE forms were not completed to document formal work authorization and worker concurrence with the WCDs for approximately half of the observed work evolutions, as required by the local implementing procedures. In two of the cases, formal work authorization was attempted but was prevented by the WAE tool due to lack of required training for some of the WCD workers. The work was allowed to proceed despite the lack of the required authorization. NE did take corrective action by formally authorizing some of the other work without WAE authorization; however, these examples indicate lack of compliance with institutional and local requirements for work authorization and worker concurrence with approved WCDs. **(Deficiency)**

For some radiological work that EA observed, researchers practiced good radiological contamination control practices. In the Analytical Chemistry lab, personnel working in hoods properly removed outer gloves and performed radiological survey of their hands and arms following removal from the hood. However, in G-133, EA observed three instances of poor contamination control during work that was performed under the Operation of the Microfluidic System WCD (i.e., lab coat sleeves in contact with potentially contaminated hood sash, hand removal from hood to use keyboard in clean area without frisking hands, and lack of survey of potentially contaminated lab coat sleeves and torso area prior to proceeding to the automated hand and foot counter for lab exit). As discussed in the prior section, the RWP did not include these contamination control requirements, which are outlined in HPP-9.2, *Contamination Control Requirements*. (See **OFI-ANL-RAD-01**.)

During a G-Wing bag-out operation, placement of the bagged waste from the glovebox into the new vinyl sleeve at the bag-out port required considerable physical manipulation and effort because the diameter of the waste bag and new sleeve are similar. The constant tugging and handling of the bag sleeve to

manipulate the waste being bagged results in a higher potential for a bag breach, and despite the constant physical manipulation of the bag-out sleeve, workers did not monitor for contamination of hands, Tyvek PPE, or the bag-out sleeve during the work. (See **OFI-ANL-RAD-01**.)

Objective:

The WP&C processes are routinely evaluated by the organization's CAS and feedback and improvement processes and lessons learned are adequately captured and incorporated into the planning and performance of ongoing and future work activities. (DOE Guide 226.1-2A, Appendix D, Objective WP&C2-5)(Criteria #1, 2 and 3)

MSD and NE have incorporated various feedback and improvement mechanisms in their respective divisional WP&C processes. For example, NE's local WP&C procedure NE-WPC-01 identifies the requirement for periodic work package reviews, re-approvals, and the work stoppage process as the principal mechanisms for eliciting WP&C feedback, improvement, and lessons learned. In addition, while not required by the local procedure, the FM held a post-job review following the NE glovebox bag-out work.

MSD-PROC-5 requires that preparers of WCDs use the Argonne Lessons Learned website to find lessons learned related to the proposed work and include a brief statement in the WCD as to how it applies to the proposed work. Four of the six MSD experimental WCDs reviewed by EA identified at least one applicable lessons learned event. Within NE, although not required by the NE WP&C procedure NE-WPC-01, some NE WCDs included relevant lessons-learned information from similar work around the DOE complex.

For radiological work, the radiological protection organization has established a feedback and improvement mechanism through the Radiological Awareness Reporting process defined in HPP-1.3, *Radiological Awareness Report Program*. Individual reports are compiled into a quarterly summary report, the results of which are communicated at quarterly meetings with senior Lab management, line management, and the as low as reasonably achievable committee. Radiological Awareness Reporting-type programs are intended to identify sub-Occurrence Reporting and Processing System level radiological concerns and are typically found at sites with more mature radiation protection programs in place. The two most recent quarterly reports indicate that the program was proactively used to identify radiological concerns, each of which are tracked, trended, and entered into the site Issues Management Tracking System for disposition.

MSD and NE Work Planning and Control Programs Conclusion

The local WP&C processes developed by MSD and NE were generally consistent with the institutional WP&C requirements in LMS-PROC-200. Overall, key personnel were involved in the WP&C process, and MSD and NE researchers observed by EA were knowledgeable of hazards and controls and experienced. In addition, ESH coordinators assigned to support line management with WP&C were well-trained and experienced in the same types of experimental research activities for which they support, enabling them to provide valuable insights and assistance to line management in identification of hazards and controls. A positive attribute of the WP&C tool observed in both MSD and NE is the "Task Hazard Relationship" field within the tool, which is used to explain when and how the researcher might encounter the hazard during the work. Engineering controls such as hoods and gloveboxes are used extensively and appropriately within MSD and NE to mitigate many hazards associated with experimental work. EA observed the appropriate hierarchy of controls with engineered, administrative, and personal protective equipment (PPE) during all observed work evolutions.

However, EA identified potential shortcomings resulting from the implementation of the ANL institutional WP&C process within MSD and NE. Many of these appear to be caused by lack of sufficient guidance in LMS-PROC-200 and/or divisional level WP&C procedures, particularly with work scope definition, the use and limitations of pre-defined hazard control sets, developing WCDs that are user-friendly, identification of training requirements for support staff, and ensuring that work activities are appropriately authorized prior to performance of work.

6.2 Advanced Photon Science

Objective:

The scope of work is described in sufficient detail to allow the work planning process to identify hazards associated with the work and to develop necessary schedules, priorities, and work instructions. (DOE Guide 226.1-2A, Appendix D, Objective WP&C2-1)(Criteria #2 and 3)

The scope of work for user experiments is described in some detail in the user's proposal, which is prepared online by the user, describes the user's experiment (abstract), and identifies the experimental team. This process is an effective WP&C mechanism for accommodating the large number of APS users while ensuring that worker safety and the APS safety envelope is maintained.

Although the EHCP is prepared by and for the users, in both experiments observed by EA, the EHCP's co-mingle work scope associated with user activities with work scope associated with APS beam line personnel (who are not users) without delineating the work scope boundaries and responsibilities of the user. The APS procedure on WP&C states that the ESAF process (and subsequent EHCP) is employed by users for experimental activities, not for non-experimental beamline activities. According to this APS procedure, beamline WP&C activities should be addressed though the Argonne WP&C web-application rather than the EHCP. However, in the two experiments observed by EA, this was not the case. In one instance, the EHCP experimental description for the "X-Ray Diffraction Experiments on Shock Polycrystalline Titanium and Zirconium" states that lithium fluoride crystals will be mounted to a projectile that will impact zirconium samples in the target chamber; a detector system will be used to obtain data; and that the experiments will include the use of a laser velocimeter. However, the EHCP does not specify which of these activities is the work scope of the user and which is the work scope performed by the beamline operator. In the second instance, a review board comment in the EHCP for the Dynamic Compression Sector (DCS) powder gun experiment states, "Use proper PPE when working with hazardous materials. The need for use of PPE extends to the setup/maintenance/trouble shooting/disassembly of equipment containing or [that] may have contained hazardous materials." Although users may be involved in working with hazardous materials, according to the beamline staff, it is the beamline staff members and not the users who are responsible for WP&C activities regarding maintenance/trouble shooting/disassembly of equipment containing hazardous materials.

Identification of a clearly defined work scope, including clear definition of boundaries of work scope and roles and responsibilities is a requirement of LMS-PROC-200. These requirements have been applied to APS facility work through the APS procedure on *Work Planning and Control at the APS*, but have not been adequately applied to user experimental and non-experimental work in the ESAF process. **(Deficiency)**

Objective:

All hazards that could potentially adversely impact workers, the public, the environment, the facility, and its equipment are documented and analyzed for severity/significance. (DOE Guide 226.1-2A, Appendix D, Objective WP&C2-2)(Criteria #2, 4, 5, 7, and 8)

The web-based ESAF process enables the users to identify material hazards and hazard classes though a series of online questions. Both the listing of hazardous materials and the hazard classes are documented in the EHCP and are posted at the experimental site. In the two APS user experiments reviewed, the material hazards and the hazards classes were consistent with the observed experiments.

Objective:

Controls are identified and implemented that effectively protect against identified hazards, and approved activity-level WCDs can be performed as written. (DOE Guide 226.1-2A, Appendix D, Objective WP&C2-3)(Criteria #2, 3, 4, 5, 6, 7, and 8)

APS heavily relies on and emphasizes the use of engineering and administrative controls for the APS beam lines to prevent user exposures to x-rays. Engineering and administrative controls were effective in preventing exposure, including hutch door interlock systems and search and secure procedures in the hutches before opening the beam shutters. In addition, since many of the experimental hutches are supplied with liquid nitrogen from remote and local nitrogen dewar stations, oxygen deficiency calculations have been performed by the APS ES&H staff at these locations to ensure adequate occupancy and ventilation conditions. Oxygen level monitoring instrumentation has been installed outside each hutch at these locations with both audible and visual alarms, in the case of an oxygen deficient atmosphere.

EA observed one of the APS machine shops available to any authorized users to support experimental preparations. To obtain authorization to use specific machine tools in a User Shop, APS Procedure APS 13.1.13 *LOM/User Machine Shops* requires the user to receive a Shop Coordinator-provided general orientation to the User Shop and pass machine-specific examinations to demonstrate that he/she can use the specified machine(s) properly and safely. Additional requirements for the user to gain access to the shops are defined in APS procedure APS 131331*LOM/User Machine Shops*. EA considers the APS machine shop certification process a best practice. It is one of the more robust certification processes for experimental users in the DOE Complex. **(Best Practice)**

EA reviewed the APS user orientation and training programs and found them to be adequate mechanisms for helping users to understand the hazards and controls associated with working in APS and their assigned experiments. The programs require all APS users, including resident and general users, to complete four courses associated with general orientation to ANL and APS, cybersecurity, and general employee radiation training. In addition, the programs require an APS sector-specific orientation to be completed for each beamline where a user will work. The programs require additional user training if needed based on the training requirements identified in the EHCP for the user's experiment. EA participated in two sector orientation classes provided by the hosts for sectors 12 and 35 and found the training to be useful and targeted to a user's specific experiments. The APS procedure *User Training* provides a checklist of the minimum topics to be covered in sector orientation. However, there are no WP&C mechanisms to ensure that the EHCP and experimental authorization are read and understood before performing work. One of the requirements for local WP&C implementing procedures, according to Section B.5 of LMS-PROC-200, is to describe "how workers acknowledge their understanding of the work and its associated hazards and controls." **(Deficiency)**

Although the EHCPs, which are produced through the electronic ESAF process, are useful for identifying general classes of experimental hazards and controls and in validating that experiments are conducted within the APS safety envelope, in the two experimental EHCPs reviewed by EA, a dozen hazard controls in the EHCPs lacked specificity and cannot be implemented by users as written. For example, the following hazard control statements could not be followed as written without additional instruction or

information: "an SOP for use of corrosives may be required," and "additional training may be required for specific chemicals." (See **OFI-ANL-APS-01**.)

EA identified limited quantities of hazardous chemicals in use at one of the APS User Shops, but neither an eyewash station nor a safety shower was installed in the event of a worker exposure to hazardous chemicals or airborne particulate materials. According to LMS-PROC-139, *Emergency Eyewashes and Safety Showers*, emergency flushing equipment (eyewash and/or flushing equipment) is required where there is a potential for injurious exposure to the eye or body from hazardous materials, such as eye irritants, organic solvents and particulate materials, all of which were present in this user shop. EA discussed this deficiency with APS ES&H, but at the time of the assessment the number of user shops that were required to have eye wash stations was unclear. (See **OFI-ANL-APS-02**.)

One of the user benefits in performing experiments at APS is access to one or more APS chemistry and/or electronic labs to assist in preparing experimental setups. Although users at the APS are often granted limited access to APS Chemistry and Electronic labs (i.e., wet and dry labs), EA identified two vulnerabilities with this practice. First, the limitations and boundaries for the chemicals or equipment that the user is permitted to use within the labs are not documented in the EHCP and are not discussed during sector orientation. Secondly, there is no APS procedure that defines the mechanisms (EHCP, sector training, etc.) as to how users are to be trained on the hazards and controls of the activities that they may be performing in the labs, and there are no APS-generated WCDs that identify hazards and controls in any specific APS chemistry or electronics lab to which the users can refer for guidance when selecting the appropriate hazard controls. For example, when preparing samples for the DCS powder gun, users are likely to use small quantities of acetone in the associated Chemistry lab. However, there is no training or WCD that provides the user with guidance on the hazards of acetone, the selection of the appropriate PPE (gloves), or whether the acetone can be used on the bench top or must be used in a hood. In general, mechanisms have not been implemented at APS to ensure that users are informed and trained on the hazards and controls associated with their laboratory work activities, as required by Section B.2 of LMS-PROC-200 and Section 2 of *ANL Integrated Safety Management System Description.* **(Deficiency)**

Objective:

Work is conducted diligently in accordance with approved work instructions and within established controls. (DOE Guide 226.1-2A, Appendix D, Objective WP&C2-4)(Criteria #2, 3, and 5)

Authorization for user work experiments at the APS is comprehensive and begins with a review and approval of the user's research proposal, and then requires the completion of the ESAF/EHCP by the experimenters, and review and approval by both APS Safety and a Divisional ESH Coordinator. Prior to the start of an experiment, an Experimental Authorization Form, including endorsements, must be posted at the site of the experiment. For the two APS experiments observed by EA, this process had been completed as required.

EA also reviewed the work authorization process for work performed by AES Electro-Mechanical Electronics technicians, who are APS electrical and mechanical technicians who perform routine maintenance on equipment and structures within the APS facility. According to the technicians interviewed by EA, over 90% of their work tasks are performed as Skill-of-the-Worker – i.e., work that can be performed by workers who possess the necessary proficiency, skill, training, and experience to perform a given task without the need for enhanced work planning, a formal procedure, or direct supervision. The APS requirements for Skill-of-the-Worker are documented in APS procedure *Work Planning and Control at the APS*, which is consistent with the ANL requirements for *Skill-of-the-Worker* as described in LMS-PROC-65. According to APS procedure *Work Planning and Control at the APS*, work performed as Skill-of-the-Worker is defined, controlled, and approved though the APS online work

request process. During the daily pre-job briefing, held the day before the work is performed, the work tasks are discussed with the selected workers, and a decision is reached as to whether the work tasks meet the criteria for Skill-of-the-Worker. If so, a description of the work, work location, hazards, and controls are documented on the electronic Pre-Job Briefing Log and an understanding of the worker's tasks are affirmed and documented on the log. This work authorization process is sufficient to ensure that Skill-of-the-Worker work scopes are adequately bounded and that the work scope, hazards, and controls are understood before work is authorized.

Overall, experimental work observed by EA was performed within the requirements and controls of the applicable EHCP. A few isolated non-compliances with following EHCPs were identified by EA, discussed with the EHS Coordinator, and resolved.

Objective:

The WP&C processes are routinely evaluated by the organization's CAS and feedback and improvement processes and lessons learned are adequately captured and incorporated into the planning and performance of ongoing and future work activities. (DOE Guide 226.1-2A, Appendix D, Objective WP&C2-5)(Criteria #1, 2 and 3)

APS relies on feedback and improvement processes for continual improvement in APS WP&C processes. For work performed as Skill-of-the Worker, the pre-job briefing form includes a series of questions that review previous and similar work activities, and opportunities for work activity feedback are available during the work request close-out process. For experimental work, users are asked to complete an *APS End of Experiment Form* for feedback on experimental activities. Another feedback mechanism is a *Basic Energy Science Questionnaire* sent to all users once a year. The number of user responses to these questionnaires provides a substantial volume of feedback (i.e., 500 to 600 responses per year). The feedback form *End of Experiment Form* is reviewed though the APS Safety Office, and suggestions for improvement are evaluated by the APS staff.

APS Work Planning and Control Implementation Conclusion

APS has developed and implemented an experimental WP&C process that provides an adequate mechanism for assessing hazards of proposed user experiments and for authorizing a user experimental activity. Overall, experimental work observed by EA was performed within the specified controls. A best practice within the APS is the robust machine shop equipment certification program that helps ensure that users are adequately trained and proficient on machine shop equipment prior to use. However, the scope definition for user experiments is not well-defined and sometimes activities for users are co-mingled with activities for beamline operators. In addition, the scope and limitations of user activities in APS chemistry and electronics labs are not well-defined, and there are no effective mechanisms to ensure that users are instructed in the hazards and controls associated with work in the labs.

6.3 Biosciences Division

Objective:

The scope of work is described in a comprehensive biological safety program that has been established and implemented including organizational structure and administration that defines the scope of work, objectives to meet the requirements of 10 CFR Part 851 Appendix A.7 Biological Safety, CDC, National Institutes of Health (NIH), World Health Organization (WHO), and other international, Federal, State and local guidelines and assess the containment level, facilities, procedures, practices, and training and

expertise of personnel. (48 CFR 970.5223-1(c)(1) and (5); 10 CFR 851.20; DOE Order 422.1 Att. 2; DOE Order 433.1B Att. 2; DOE Policy 450.410; and 10 CFR 851 Appendix A.7)

All biological research activities at ANL are regulated via the Centers for Disease Control (CDC) and DOE 10 CFR 851. Laboratory-wide Argonne Policy and Procedure LMS-POL-16, *Work Planning and Control*, and LMS-PROC-200, *Local Work Planning and Control Implementing Procedures*, define the ANL institutional policy for WP&C. The Biosciences Division WP&C process, BIO-PROC-14, *BIO Division Procedure for Developing and Approving Local Work Planning and Control Documents* addresses the requirements of LMS-PROC-200, which requires each organization to establish local work planning and control implementing procedures suited to each organization's work.

ANL established an IBC as described in the CDC, *Biosafety in Microbiological and Biomedical Laboratories*, 5th edition and in 10 CFR Part 851 Appendix A.7, *Biological Safety*. The IBC approves the scope of BSL-1 and BSL-2 research and objectives to meet regulatory requirements. The scope involves identifying activity/task specific hazards and associated work controls and submitting registration documentation to the DOE, CDC and NIH for approval. The process includes coordination between the biological safety officer (BSO), Principal Investigators (PIs), Facilities Management & Services, and Health, Safety and Environment organizations. ANL appointed a technically qualified BSO to manage and implement the Biological Safety Program. The ANL Chief Operating Officer appointed members external to ANL to the IBC, via nomination by the BSO, adding expertise that exceeds the requirements for an IBC. EA reviewed the BSL-1 and BSL-2 registration process through the implementation of research projects, interviews with the PIs, and walkthroughs of the lab spaces associated with projects listed in Appendix B.

The Biological Safety Program and the IBC processes are well-established, comprehensive, and effective, supporting the DOE mission with the Departmental goals of developing cost-competitive, sustainable biofuels; biological energy; and work for others projects in biomedical cancer research via nanotechnology. The work scopes documented for all the research projects observed by EA involving BSL-1 and BSL-2 activities are well-defined and meet DOE internal and external regulatory requirements.

Objective:

Identification and analysis of the severity/significance of potential biological hazards have been documented in accordance with 10 CFR 851. (10 C.F.R. § 851.21; 10 CFR 851 Appendix A.6(a))

The ANL BSL-1 and BSL-2 biological research projects are regulated by the CDC, *Biosafety in Microbiological and Biomedical Laboratories*, 5th edition and *10 CFR Part 851 Appendix A.7 Biological Safety* and approved by the CDC and NIH (when applicable). The CDC requires strict planning, review, and approval of all biological work via the IBC. The BSO manages and facilitates collaboration of these activities with the PIs, Facilities Management & Services and the Health, Safety and Environment organization to meet the requirements of the CDC, 10 CFR 851 and the ANL BIO-PROC-14 and LMS-PROC-200 and implemented with the ANL WP&C electronic application system. BIO-PROC-14 is used by the BIO Division Director and BIO staff to (1) develop work planning and control (WCD) documents and obtain approval for these documents prior to conducting any new research or support work, (2) modify and obtain approval of modifications of existing work, and (3) review existing WCD documents to ensure work is done within the approved safety envelope.

All biological research projects observed by EA have well-defined operations, procedures, and facilities that have been comprehensively evaluated to identify all biological hazards. EA observed examples of identification and analysis of biological hazards via the lab research listed in Appendix B.

However, WP&C processes in the Biosciences Division and other divisions performing biological research do not require the involvement of safety and health SMEs (for example IHs) to identify and mitigate non-biological (chemical) hazards before work is approved, leading to unrecognized hazards. For example, the HSE organization SMEs were not notified through the WP&C electronic system of the existence of the inert and compressed gases in the biological labs and compressed gas storage in building spaces serving those labs. Inert gases can cause oxygen deficient atmospheres, and involvement by SME's would help to ensure the proper controls are in place during use, and also ensure that exposure monitoring is performed as required by the ANL Worker Safety and Health Program. While the ANL facility-level work-control process (PROC-200) and 10 CFR 851.21 *Hazard Identification and Assessment* require the identification of hazards and assessment of exposures, the divisional WP&C program did not meet this intent. The four specific examples are provided below address hazards that should have been identified during the activity-level WP&C process:

- Building 446: Biological research activities in Building 446 have not been assessed by IH to determine the risk of oxygen deficient atmospheres in cases of unintended release or failure of equipment/valves in labs that use oxygen depleting gases to determine whether oxygen deficiency alarms are needed.

- Building 446 Lab B119: The ventilation elephant trunk ("snorkel") was not inspected as required by ANL's LMS-PROC-210, *Ventilation for Hazard Control* which requires periodic testing and maintenance. Another lab ventilation hood contained chemical containers that were blocking or within the 6" ventilation flow boundary which can interfere with hood performance and effectiveness and contradicts the requirements referenced in the LMS-PROC-210, section 3.2.4, *Operation and Use of Ventilation Equipment* and the incorporated by reference American National Standards Institute/American Industrial Hygiene Association AIHA Z9.5-2012, *Laboratory Ventilation*. This can result in worker exposure to chemicals during research activities.

- Building 362: IH had not analyzed the use of cryogens and inert gases in labs E324 and E308 to determine the risk of oxygen deficient atmospheres in cases of unintended release or failure of equipment/valves and to determine if oxygen deficiency alarms are needed, as required by 10 CFR 851. The ES Division WP&C procedure, *"Energy Systems Work Planning and Control Procedure,"* implements the PROC-200 and requires the identification of hazards and the determination of acceptable control strategies related to each task using the ANL WP&C web-application.

- Building 400 Sector 19: EA observed a work activity that involved dispensing liquid nitrogen into a 4-liter dewar at the liquid nitrogen dispensing station in which an IH hazard analysis was not performed as required by 10 CFR 851.

In three other examples below, facility-level deficiencies were identified that should have been addressed with SME involvement during the design process of the building or workspace:

- Building 446 Service Corridor: Building 446 includes oxygen depleting gas systems as part of the facility, including service corridors that house all the gas cylinder supplies to the Building 446 laboratories and hard-piped gas distribution systems into individual laboratories from the cylinders. EA observed a carbon dioxide (CO2) delivery system in the service corridor that contained a CO2 cylinder with a siphon tube and another cylinder without an ejector tube attached to an incompatible SwitchPro Automatic Switchover System, which is designed to handle gases. Per the manufacturer's specification, SwitchPro Automatic Switchover Systems are designed to provide a continuous supply of gas from a cylinder or a bank of cylinders. Out of the two cylinders, only one was listed in the Chemical Ordering, Reporting and Attribute Library (CORAL). High pressure CO2 cylinders contain

liquefied CO2 at room temperature. The siphon tube allows ejection of liquid CO2, while the cylinder without a siphon tube only allows drawing CO2 in vapor phase. The Division representatives were not aware or familiar with types of compressed gas cylinders available for CO2 and limitations of the Automatic Switchover System, and they had inadvertently attached the incorrect CO2 cylinder to the Automatic Switchover System, which does not meet the requirements of National Fire Protection Association (NFPA) 55 (2013), *Compressed Gases and Cryogenic Fluids Code*, Section 7.1.1.1 which discusses has systems being designed for intended use by competent persons. The CO2 delivery system setup had no WCD or work order to connect the CO2 cylinders to the Automatic Switchover System and had not been evaluated by industrial safety SMEs.

- Building 446 Loading Dock: The compressed cylinder storage lacked ventilation. NFPA 55, Section 6.16 requires compressed gases and cryogenic fluid storage areas to have mechanical exhaust ventilation or fixed natural ventilation, where natural ventilation is shown to be acceptable for the materials stored. Following EA's observation, the industrial safety SME assessed the storage area and determined that the storage area had inadequate ventilation.

- Building 200 Loading Dock: Compressed gas cylinder storage areas did not have mechanical exhaust ventilation as required by NFPA 55 (2013), Section 6.16 and was not evaluated by ANL industrial safety SMEs. Additionally, the loading dock area lacked signage for stored gases and the associated hazards, as required by NFPA 55 (2013), Section 6.12.1 which requires hazard identification signage at all entrances to locations where compressed gases are produced, stored, used, or handled.

ANL's chemical inventory system, CORAL, is well-designed and searchable by various parameters, including chemical class, building, room, quantity, etc. However, some chemicals are not included in the inventory, including carcinogenic, reproductive and acutely toxic chemicals that are present in Building 446, Lab 119, and an inaccurate number of CO2 cylinders were listed for a service corridor in Building 446. The CORAL administrators are resolving this issue by adjusting the sensitivity of the RF scanners used to inventory chemicals, and reinforcing user training.

In summary, the WP&C processes effectively identifies and analyzes the severity/significance of potential biological hazards and has been documented in accordance with the CDC, 10 CFR 851, BIO-PROC-14, and PROC-200 requirements; however not all non-biological hazards have been adequately identified and analyzed. The divisional-level WP&C processes do not require safety and health SME involvement in hazard identification, leading to hazards not being identified, analyzed, or controlled. (See **F-ANL-I-01**.)

Objective:

Controls are identified and implemented that effectively protect against biological hazards, and approved activity-level WCDS can be performed as written. 48 CFR 970.5223-1(b)(5), (6), and (7) and (c)(2) and (3); 10 CFR 851 Appendix A.7(a)(2); 10 CFR 851.26(a)(1); 10 CFR 851.22(a) and (b); DOE Order 422.1 Att. 2; DOE Order 433.1 B Att. 2; DOE Policy 450.4A)

Building 440: EA reviewed the Nanoscience and Technology Division BSL-2 research activity documentation, assessed the lab space and interviewed staff during lab walkthroughs, including the following IBC applications and WCDs: *Membrane Channel Protein Complexes for Energy Materials Applications,* (IBC# 2014-0039) and *Probing of Induced Cellular Signaling Using Ferromagnetic Nanoparticles,* (IBC# 2015-0056). The Nanoscience and Technology Division work control documents and activity specific lab procedures include a full review by a certified industrial hygienist, who is located in the organization. The IH reviews and signs off on activity specific procedures after hazard identification, analysis and controls are established for laboratory work activities. The WP&C process in this Division is working well and ensures safety and health SMEs are automatically included in the

review of all lab activities. This decreases the likelihood for hazards to not be identified, analyzed and controlled. (See OFI-ANL-I-02.)

Building 446: The loading dock compressed gas cylinder storage area lacked physical separation of incompatible flammable and oxidizing gas hazards as required by NFPA 55, Section 7.1.11.1, which requires compressed gas cylinders, containers, and tanks and systems in storage or use to be separated from materials and conditions that present exposure hazards to or from each other. The loading dock also lacked hazard identification signage required by NFPA 55, Section 6.12.1, which requires hazard identification signs to be placed at all entrances to locations where compressed gases are produced, stored, used, or handled in accordance with NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*." After EA's observation, the ANL SME assessed the storage area and determined that flammable gases and oxidizing gases in cylinders were not physically separated by 20 feet as required, and signage was inadequate. The SME and building manager relocated the cylinders per the required 20 feet separation and initiated compensatory action for the inadequate ventilation and the signage issue.

Building 203: Cylinders on the loading dock were not capped or securely attached as required by NFPA 55 (2013), Section 7.1.10.1. An IH ventilation survey was not performed to verify an adequate exhaust flow rate. EA notified the ASO POC of this observation.

EA interviewed several IH staff in the HSE organization who discussed their recent ideas to streamline and incorporate hazard analyses, IH surveys, reports, and other safety and health information into one electronic location. This would facilitate staff and management easier access to the information across ANL organizations. Currently, safety and health information is not easily accessible to all management and staff when needed. (See OFI-ANL-I-03.)

In summary, the ANL BSL-1 and BSL-2 work activities have documented controls that are implemented effectively to protect against biological hazards, and the approved activity level WCDs can be performed as written. Several work activities demonstrate an innovated approach and exceeded minimal regulatory requirements. Despite these strengths, EA identified two exceptions in the implementation of gas cylinder storage areas regarding NFPA 55 and NFPA 704 requirements that didn't meet the WP&C intent of having SME analysis and assessment of compressed has cylinder storage areas.

Objective:

Work is performed in accordance with approved work instructions and within established hazard controls for all biological work activities and facility operations. (48 CFR 970.5223-1(c)(4); DOE Order 422.1 Att. 2; DOE Order 433.1B Att. 2; DOE Policy 450.4A; 10 CFR 851.20(a)(4) and (b)(2)(iii); 10 CFR 851 Appendix A.6(c) and A.7(a)(1)(ii))

EA observed work in the ES Division involving research of enhancing transportation biomethane production from municipal sludge digesters in BLDG 362, Labs E324 and E308. The PI implemented a hierarchy of controls that exceed regulatory requirements. Examples include the implementation of an internal requirement to not allow immunocompromised workers into any BSL-2 laboratory, a "work alone system" involving a well person check every 30 minutes, change out of all fittings and tubing weekly before the parts fail which reduces the chance of exposure to substances within the equipment, third level containment during transportation of biological materials on site and replacing glass flasks with plastic where applicable.

In summary, work observed in the biological labs is being performed in accordance with approved work instructions, within established controls and implement a hierarchy of controls that exceed minimal safety

requirements.

Objective:

A formal process is established and implemented to gather feedback and implement continuous improvement of biological safety program elements, implementation, and the adequacy of hazard identification, prevention, abatement, and controls. DOE Order 226.1B Attachment 1; 10 CFR 851 Appendix A 7, Biological Safety; 10 CFR 851.20(a)(5) and (a)(8); 10 CFR 851.22(a); 10 CFR 851.22(b)(1) through (b)(4)).

The ANL Performance Management and Assurance (PMA) organization is an independent group that uses a formal surveillance process to evaluate the implementation of requirements and performance of ANL programs. When ANL programs are evaluated, SMEs and program owners participate in developing the scope of the surveillances with the PMA group. During surveillances, the PMA reviews procedures, policies, methods of hazard identification, prevention, abatement, and the implementation of controls through interviews, work observations, and objective evidence. The surveillances result in identification of strengths, issues, and improvement opportunities that are assigned to specific SMEs for correction and closure. EA reviewed the PMA latest surveillance report (PMA-FY16-SURV-14, Surveillance Report, *Argonne Bloodborne Pathogens (BBP) Occupational Exposure Control Plan*), which evaluated the implementation of the Bloodborne Pathogens Occupational Exposure Control Plan. EA determined that the PMA surveillance process adds an independent review, providing value-added results, feedback, and continuous improvement opportunities and meets the intent of DOE Order 226.1 and 10 CFR 851 feedback and improvement criteria. However, the scopes of surveillances do not always address chemical safety or comprehensive work planning and control processes within the scopes, as evidenced by the examples of WP&C findings and opportunities for improvement found by EA during this assessment. (See OFI-ANL-I-04.)

Biological Work Planning and Control Implementation Conclusion

ANL has established and implemented a comprehensive biological safety program. The IBC is well-integrated and functioning within the ANL organizations that perform biological work. The identification of existing and potential biological hazards, assessment of risk, development and implementation of hazard controls, and assurance that work is performed within established controls is mature. However, not all non-biological hazards in the biological lab and building spaces have been identified and assessed. The divisional-level WP&C processes do not require SME involvement in hazard identification, leading to some hazards not being identified, analyzed, or controlled. Conversely, the Nanoscience and Technology Division includes SMEs in the WP&C process differently from other Divisions by having a certified IH embedded as staff. Thereby, they are automatically included in the review of WCDs. This results in less likelihood for hazards to not be identified and assessed, and for controls not to be in place. ANL may benefit from considering implementation of a similar model across the Laboratory.

6.4 Central Shops – Programmatic Divisional Machine Shops Follow-up

Objective:

A structured issues management and corrective action system is established. For higher significance findings, a documented causal factor analysis/evaluation, timely actions and plans to correct and prevent recurrence, tracking plans and actions to closure, and performing effectiveness reviews must be completed. (CRAD 30-01, DOE Order 226.1B, CRD 2.b (3)(b))

After an August 2015 event involving a machinist who experienced a near amputation while operating a band saw at the ANL Central Shop, ANL performed an incident investigation that identified several underlying causes, with the primary cause related to improper machine guarding. Subsequent to ANL's thorough analysis of causal factors, corrective actions were taken by ANL. Corrective actions reviewed by EA to address the cause(s) of the event and prevent recurrence included the following:

- ANL evaluated all machine tools on site (roughly 800) to ensure proper guarding was in place and available to users; of these roughly 30% were deemed deficient. Missing guards were replaced or fabricated and unnecessary (older, less modifiable equipment) was disposed. Revisions were required to LMS-PROC-78, *Machine Guarding and Operation*, and Operator aids (guarding guides and pre-operational checklists) were developed specific to each machine to demonstrate the proper configuration of the machine guards. The above actions, with some exceptions (further described below), were adequately implemented.

- Skill-of-the-Worker Documentation of Worker Proficiency was completed/revised, all users for each machine were evaluated to ensure they knew how to configure and use the machines and guards, and a list of qualified personnel is associated with each machine. This action/revision significantly improved ANL's ability to determine, demonstrate, and document Central Shops workers' qualification to safely operate designated equipment.

- Initiatives are currently underway and include conduct of certified hazard analysis (CHA) and JHA for the FMS/Infrastructure Services (IS) machine shops (seven complete, seven in draft, and several awaiting determination). An EA review of the issued CHA(s) and JHA(s) indicated quality product, which has improved this division's ability to identify equipment-specific tasks, hazards, and requisite controls. Additionally, IH has initiated testing of local ventilation trunks at FMS/IS shops, including posting testing dates and approval for use. Plans include the addition of these tests to the preventive maintenance schedule/database (FMAX). While these actions have significantly improved formalization of the hazard analysis process, roughly 50% of CHA(s) and JHA(s) remain to be completed and/or issued. Additionally, EA observed a machining activity where the worker and supervision were unaware of non–ionizing radiation hazards associated with Electric Discharge Machining (EDM). For this class of equipment, the CHA or JHA is not complete, one of the owner's manuals states, "Forbidden for persons with Pacemakers," and a second unit is labeled with a pictogram of a heart with partial stethoscope-like device with a red circle with a line through it. No known measurements or comparison with the American Conference of Governmental Industrial Hygienists Threshold Limit Value for magnetic fields has been conducted by ANL to determine potential hazard.

The timeliness of corrective actions was appropriate and consistent with documentation (primarily spreadsheets) used as closure evidence for the ANL Corrective Action Review Board, which serves as the site's mechanism to determine completion. Additionally, all actions are contained within the ANL Issues Management Tracking System. While many actions have been deemed complete, some actions still remain open (on schedule), including retrofitting older equipment with emergency stop and anti-restart capabilities. EA observed over twenty milling machine operations, band saw cutting, and lathe shaping activities where the machine guarding was appropriate. In these observations, machine operators used good work practices, the appropriate PPE, and conducted the work in accordance with the requirements and without incident.

ANL intends to determine the effectiveness of the corrective actions through reviews to be conducted by the PMA division, which includes a predetermined implementation period as specified in the Issues Management Tracking System. However, several management assessments with topics closely aligned to effectiveness of corrective actions, i.e., machine tool inventory, asset management, and lathe lead screw

guarding, have already been conducted by a qualified person(s) (i.e., ANL Principal Safety Engineer) who can validate the effectiveness of an individual corrective action in preventing recurrences. LMS-PROC-89, *Fact Finding and Incident Investigation*, and LMS-PROC-4, *Issues Management and Corrective Preventive Action*, require documentation of this analysis process and the results of the management assessments to be maintained in the Issues Management Tracking System. EA reviewed the associated data base and determined, that through linkage to various spread sheets it is in keeping with institutional requirements.

EA observed roughly 300 machines either in use or through area walkdowns at both locations under the control of FMS/IS, Central Shops (building 363 and satellite locations), and programmatic divisional machine shops. Of these machines, EA noted six pieces of equipment that lacked the requisite operator aids or were deemed unsafe but still available for use and/or being used. LMS-PROC-78, *Machine Guarding and Operation*, section 3.2.6 subpart 1.3 states that machines are not to be used if the preoperational guide is unavailable. These observations were: **(Deficiency)**

- A pedestal grinder/polisher at the APS Central Shop satellite optics machine shop without the proper pre-operational guide. The guide was placed shortly after it was noted as missing.

- At Building 212 Division Programmatic Shop, a lathe in the CL-126 shop was adjusted/set up by a technician. When questioned, the individual did not fully understand the provision about not using equipment without the preoperational guide present and thought the manufacturer's user's guide was sufficient. This individual further stated the lathe was used routinely. Health Safety and Environment Division (HSE) management notified the area's equipment custodian that the equipment was not properly guarded, potentially unsafe, and should not be in service.

- Three other pieces of equipment at the Programmatic division staff shops at Building 212 (Hot Rolling Mill, Cold Rolling Mill, and Large Shear) did not have approved guarding guide/pre-operational check lists. Additionally, the Hot Rolling Mill had been previously identified during the site-wide review as having inadequate guarding, including unprotected areas. According to interviews with area workers, all four machines had been recently used.

- An abrasive cutoff machine in the Building 212 H-Wing High Bay Programmatic division's staff shop was observed by EA, as well as an individual from HSE, which had loose guarding such that it could no longer provide adequate protection. After this observation, the machine shop custodian placed the cutoff machine out of service.

ANL initiated prompt interim actions to address EA observations, including placing potentially unsafe equipment out of service, replacing missing operator aids, and in two cases suspending worker qualifications pending retraining.

Central Shops – Programmatic Divisional Machine Shops Follow-up Conclusion

Overall, ANL performed an adequate and well-documented causal factor analysis/evaluation, developed and implemented (with few exceptions) timely actions and plans to correct and prevent recurrence, and is tracking plans and actions to closure and planning and performing the appropriate effectiveness reviews. Although rare, some machines were still in service without the proper controls in place, and some machine tool workers, line supervision staff members, and/or machine shop custodians were unaware of the machine guarding requirements.

7.0 ARGONNE SITE OFFICE OVERSIGHT

EA's review of Federal oversight focused on the evaluation of the ASO oversight programs and procedures and how effectively they evaluated ANL's CAS and WP&C implementation.

Objectives:

DOE field element line management has established and implemented effective oversight processes that evaluate the adequacy and effectiveness of CASs and DOE oversight processes. (DOE Order 226.1B)

DOE Oversight processes must evaluate contractor and DOE programs and management systems, including site assurance systems, for effectiveness of performance (including compliance with requirements). Such evaluations must be based on the results of operational awareness activities; assessments of facilities, operations, and programs; and assessments of the CAS. (DOE Guide 226.1-2A)

Oversight processes are tailored according to the effectiveness of CASs, the hazards at the site/activity, and the degree of risk, giving additional emphasis to potentially high consequence activities. (DOE Order 226.1B 4b (5))

ASO has established a line management oversight process that is aligned with SC expectations that includes the development of a partnership agreement with ANL and UChicago leadership. The partnership agreement renewed in January 2017 relies on ANL's development of an effective CAS that ASO oversight can leverage, along with its own independent oversight, to evaluate safety performance at the laboratory. ASO implemented this approach through the inclusion of a SC-developed clause, H.42, *Contractor Assurance System*, in the DOE contract with UChicago.

ASO documents its oversight process through the required use of SC Management System (SCMS) programs and procedures, supplemented by ASO-specific plans and procedures (see Appendix B). These documents appropriately address the requirements for conducting Federal oversight. The ASO oversight-related documents have undergone annual reviews, with the most recent revisions made in 2016 to reflect improvements identified in ASO self-assessments.

EA identified the creation of a new Performance Assurance Specialist position in the ASO manager's office as a positive effort for strengthening oversight. The role of this position is to focus on ensuring that the ANL CAS and CAS tools continue to be enhanced, integrated, and used to provide meaningful performance information in a timely manner. According to the ASO manager, this position was created to help ensure that the ANL CAS continues to improve and to support ASO's ability to fully understand the safety posture of the laboratory.

ASO uses several methods to provide feedback resulting from its oversight activities to ANL, including:

- Quarterly and annual reviews of ANL's progress in meeting the Performance and Evaluation Management Plan (PEMP) goals and objectives
- ASO participation in the annual SC laboratory review of the ANL
- Evaluation of updates to key ANL programs, such as CAS, Worker Safety and Health Program, and Integrated Safety Management System Description
- Conveying results of walkthroughs, surveillances, and assessments through formal and informal communications

- Providing feedback to UChicago during the annual CAS effectiveness review meetings.

EA evaluated PEMPs from FY15, 16, and 17 and found clear goals and objectives were established for safety and CAS performance. The associated performance evaluation reports, as well as the FY16 SC Annual Laboratory Plan Feedback for ANL, provided a detailed assessment, both positive and negative, of the ANL performance against the established goals and objectives and associated issues that needed to be addressed, including concern for increasing injury rates, poor WP&C implementation, and safety organizational effectiveness. The ANL performance feedback was reflected in the SC/ASO performance ratings and award fees per the PEMP criteria. ANL took actions in response to the SC/ASO performance evaluation report feedback, such as establishing Corrective Action Review Boards for higher risk issues, assessing the Lab's organizational structure regarding safety responsibilities leading to a lab-wide reorganization in May 2017, improving the electrical safety program, and commissioning an "Electrical Common Cause Analysis" for continuing electrical and lockout/tagout incidents in early 2017. ASO has overseen ANL occupational injury and illness recordkeeping activities to ensure that occupational injuries are classified and reported accurately to DOE, and ASO plans to continue its periodic recordkeeping awareness to ensure the injury rates are reflective of ANL safety performance. ASO oversight and performance feedback to ANL has resulted in tangible improvements to the ANL CAS and safety programs.

In response to the August 2015 accident that nearly resulted in the amputation of a worker's finger, ANL conducted extent of condition reviews and found lab-wide noncompliances with machine guarding requirements, including a 35% rate of noncompliance in one division and a lab-wide noncompliance rate of 19%. In 2003 and 2007, the laboratory identified and corrected machine guarding noncompliances throughout the laboratory; however, the CAS was not effective in identifying that these corrective actions did not prevent recurrence of machine guarding noncompliances found during the 2015 machine guarding extent of condition reviews. ASO operational awareness activities in the ASO Science Management Actions and Record Tracking (SMART) system documented the identification of machine guarding issues prior to the 2015 accident, but ASO did not perform a trending analysis of the ASO SMART (which has been re-named the AIM sharepoint issue management system) entries to determine if machine guarding noncompliance was an emergent or lab-wide issue needing attention (see ASO deficiency below regarding the trending of oversight issues).

ASO participates in an annual ANL CAS effectiveness evaluation led by two UChicago Board of Governors directors. EA reviewed the ASO performance analysis input to the FY2016 and FY2017 CAS evaluations and the documentation of the resulting evaluation results and found that ASO is appropriately influencing actions to drive CAS improvements.

ASO has tracked, reviewed, and formally approved key ANL management systems on an annual basis, including ANL's Worker Safety and Health Program and Quality Assurance Program Plan, in September and November 2016, respectively. However, the ANL Integrated Safety Management System Description was last reviewed and updated in 2013 even though ASO directed that annual reviews and updates of the Integrated Safety Management System Description be provided. In addition, the ANL CAS requires the UChicago Board of Governors to provide an annual letter of assurance to ASO regarding the determination of the CAS effectiveness; however, there was no evidence that a letter was provided. ASO has not been fully effective in ensuring that ANL has met these management system deliverables. (See **OFI-ASO-01**.)

The ASO Oversight Plan and SOP-15, *Assessments*, documents appropriately provide for tailoring the amount and type of ASO assessments and surveillances to the risk, emergent issues, level of CAS maturity, and line management direction. The tailoring is primarily accomplished in how ASO schedules and participates in assessments as follows:

- ASO led and conducted independent assessments, referred to as functional area reviews (FARs).
- ASO led joint assessments with ANL
- ANL led joint assessments with ASO
- ASO observed ANL assessments.

In FY11, the first year ANL developed a CAS, ASO conducted 21 independent FAR assessments. As the ANL CAS matured and the ASO/ANL partnering activities materialized, independent FAR assessments were reduced to zero in both FY14 and FY15. Concurrently, ANL conducted assessments with ASO involvement increased to 25 in FY15. The number of FARs that ASO conducted in FY16 increased to three, and ASO-led joint reviews rose to five, providing some additional independent oversight data, as well as opportunities for ASO oversight personnel to maintain the skills necessary to lead independent assessments. ASO's assessment activities generally provide sufficient oversight of contractor safety programs and implementation performance. But because they did not note potential trends in machine guarding issues, a potential opportunity to conduct FAR assessments on this topic over that period may have been missed.

ASO prepares a trending report quarterly that looks at the last five years of the DOE Noncompliance Tracking System (NTS), Occurrence Reporting and Processing System, Computerized Accident/Incident Reporting System, and Lesson Learned data. The FY17 Argonne Trend Report provided useful information on ANL safety performance trends as well as ANL performance benchmarked to SC-wide performance which supported the basis for performance feedback to ANL in the PEMP performance evaluation report. However, ASO has not conducted trending analysis of ASO-identified oversight issues (e.g., machine guarding noncompliances) to provide insights to emergent trends (performance and compliance) that may require additional oversight focus, or to provide timely feedback to ANL on laboratory performance as required by the SCMS *Quality Assurance and Oversight* Procedure 2, *Analyzing, Charting, and Reviewing Performance Trends*, ASO *Oversight Plan* and SOP-12, *Issues Management*. **(Deficiency)**

Objective:

The DOE field element line oversight program includes written plans and schedules for planned assessments, focus areas for operational oversight, and reviews of the contractor's self-assessment of processes and systems. (DOE Order 226.1B 4b(2))

The ASO Oversight Plan and SOP-15, *Assessments*, appropriately outlines the procedures preparing an annual integrated assessment schedule that includes ASO FARs, self-assessments, and program reviews and how ASO will participate (lead or observe) ANL-scheduled assessments. The ASO ES&H Division recently developed an assessment planning tool for risk ranking ANL safety program areas so ASO management can make informed decisions regarding how best to target their oversight efforts. This tool takes into consideration the past assessment activities, the ANL performance trend, an assigned confidence and risk rank based on ASO oversight results, and a management modifier. The results are used to make informed decisions on upcoming ASO oversight assessments. EA reviewed the completed assessment tool for determining the FY17 integrated assessment schedule and found the scheduled oversight activities were appropriately targeted. In addition, EA also sampled assessment activities identified by the assessment planning tool and found the sample was accurately reflected in the FY17 schedule. EA considers this assessment planning tool a best practice because it provides a systematic mechanism that considers current safety performance and potential vulnerabilities when scheduling assessment resources. (**Best Practice)**

ANL assessment scheduling did not screen division input to the integrated assessment schedule for value or whether the division's planned management assessments appropriately address identified higher risk areas. In addition, ANL had not conducted 43% of its assessments (primarily management assessments) as planned in FY16. ANL plans to provide additional monitoring to track assessment schedule performance. ASO has also encouraged ANL to use the ASO assessment planning tool to ensure its scheduled assessments clearly address risk, safety performance, and regulatory compliance and add value to understanding ANL's safety performance.

Requirements for self-assessments are included in the ASO Oversight Plan and SOP-15, *Assessments*, including self-assessment of ASO procedures on an annual basis and on ASO's oversight performance on a quarterly basis. As noted above, ASO self-assessments were scheduled in ASO SMART and were conducted as scheduled in FY16. In addition, ASO provided oversight of ANL self-assessments (management assessments) by observing or participating in the assessments.

ASO prepares an Annual Performance Plan that provides annual Integrated Safety Management goals and objectives for its work activities (safety oversight). ASO reports quarterly on its progress against the established goals. These goals are appropriate, and the reports sufficiently track performance.

ASO demonstrated a commitment to assessing WP&C by including requirements in the ASO Oversight Plan and ASO SOP-26, *Facility Representative Program*, to observe work and implementation of WP&C. EA reviewed the ASO issue management data entries for FY16 and FY17, along with two weekly summary reports to ASO management, and found that they included WP&C-related oversight activities (e.g., plan-of-the-day meetings, plan-of-the-week meetings, pre-job briefings, participation in experimental reviews, WP&C reviews, and work observations). ASO WP&C-related assessments included an independent FAR evaluating WP&C effectiveness, in November 2015, and ASO observed two ANL surveillances of WP&C in FY15-16 and an ANL independent assessment of laboratory-wide WP&C implementation in FY17. The two surveillances sufficiently addressed the ANL laboratory and specific divisional WP&C requirements. The FY17 ANL-wide independent assessment was comprehensive and provided relevant recommendations to improve ANL WP&C.

ASO conducts operational oversight of biological research work activities. One of the Facility Representatives (FRs), a certified industrial hygienist with significant experience in biological safety, is assigned to oversee divisions with bioscience experiments, and is an ex-officio member of the IBC. The two FY16 ANL IBC meeting minutes indicate that the IBC is active in the review of applications for new/revised experiments, use of biolabs, incidents, and conduct of safety inspections of biolabs (including the DOE biosafety FR on IBC reviews and biolab inspections). ASO operational awareness data indicates that there is robust oversight of biological research activities at the laboratory.

Objective:

The DOE field element has an issues management process that is capable of categorizing findings based on risk and priority, ensuring relevant line management findings are effectively communicated to the contractors, and ensuring that problems are evaluated and corrected on a timely basis. (DOE Order 226.1B 4b(4))

Criterion:

DOE line management verifies corrective actions are complete and performed in accordance with requirements before findings identified by DOE assessments or reviews are closed (CRAD 45-21)

ASO SOP-12, *Issues Management*, adequately provides for the documenting, tracking, and closing ASO-identified oversight and self-assessment issues. ASO used the SMART software to document oversight activities and the resulting issues through December 2016. ASO now uses the sharepoint AIM software for issue management tracking. Facility Representatives and SMEs document their operational awareness activities and issues identified for that activity. For assessment and surveillance activities, the resulting issues are entered by the Facility Representatives or SMEs. EA found ASO has satisfactory processes in place to communicate oversight issues to contractor management by various formal and informal mechanisms.

ASO SOP-12 requires FRs and SMEs to track and validate ANL issue closure and for ASO management to review the status of open issues quarterly. Closure validation and effectiveness reviews of ASO-identified issues were not adequately conducted or timely for FY15 and FY16 as required by DOE Order 226.1A, Section 4.b.(4) and d, and ASO SOP-12 because: **(Deficiency)**

- ASO safety oversight personnel did not consistently track, validate, and evaluate effectiveness of ANL corrective actions and provide timely feedback throughout the last two FYs as required.

- An April 2017 ASO surveillance to validate correctives actions from the last two FYs was conducted jointly by FRs and SMEs , but the surveillance did not provide evidence as to what ASO assessment report and/or issue corrective actions were specifically validated or evaluated for effectiveness and did not convey useful feedback information.

ASO was adequately involved with overseeing ANL corrective actions for three findings (Finding-1, -2 and -3) from EA's previous radiological control assessment (*Office of Enterprise Assessments Targeted Review of Radiological Controls Activity-Level Implementation at the Argonne National Laboratory Nuclear Facilities*, November 2014). For the most part, ANL had adequately addressed the findings, and had closed them, but the second finding needed additional action to establish definitive periodicity for respirator filter change-out frequencies, including single use or some other justifiable specified frequency, for protection against high-derived air concentration actinide radiological environments. ANL conducted a management assessment just before this EA assessment, which confirmed this additional action was needed to fully address the second finding. New corrective actions were added to the ANL tracking system to address these issues. Corrective actions for the previous air sampling concerns were robust, with significant efforts expended to improve the radiological air monitoring program, including new airflow studies for sampler placement and proper definition and instruction for use of the various types of air sampling, such as retrospective, job specific, and lapel air sampling.

Objectives:

The DOE field element has implemented an effective Facility Representative program. (DOE Order 422.1)

Maintain sufficient technical capability and knowledge of site and contractor activities to make informed decisions about hazards, risks, and resource allocation; provide direction to contractors; and evaluate contractor performance. (DOE Order 226.1B)

ASO has well-qualified and technically competent staff and management and has implemented an effective FR program. SCMS ES&H Oversight, Procedure 2, *Facility Representative Oversight*, and ASO SOP-26, *Facility Representative Program*, is generally consistent with DOE-STD-1063-2011, Facility Representatives, and adequately describes their duties, responsibilities, and authorities.

ASO completed a determination of FR coverage, consistent with the DOE FR standard, in February 2017, that identified the need for 5.7 total FR full-time equivalents. The ASO Manager approved the current level of five FRs as "sufficient to provide adequate oversight of Argonne facilities due in part to the high experience level of 4 of the FRs coupled with resource leveraging provided to the FRs by additional Subject Matter Experts in the ASO Environment, Safety and Health Division." The current FR staffing satisfactorily covers nuclear and accelerator facilities with primary and backup FRs. The most recent report (fourth quarter 2016) regarding ASO FR performance indicators indicates 100% of the FR positions were filled and qualified and 71% of FR time was spent performing duties in their assigned facilities (DOE goal is greater than 65%). The FRs are supervised by a qualified Senior Technical Safety Manager. ASO conducted the required triennial FR program self-assessment in March 2015. This assessment included an FR from the Fermi Site Office as well as ASO personnel, and determined that the FR program satisfactorily implemented the requirements of DOE-STD-1063. The self-assessment was comprehensive, and the results identified improvement opportunities.

The current fully qualified FRs have technical backgrounds and extensive relevant experience appropriate to the nuclear, accelerator, IH, and industrial/construction hazards found at ANL. ASO annually provides ANL direction on its expectations for working with the DOE FRs and SMEs and providing unencumbered access to laboratory facilities. During observed facility walkdowns, all FRs had access to their assigned facilities. The FRs demonstrated familiarity with the facilities processes, procedures, and personnel, and understood operations and systems including those that were important to safety. During the walkdowns, the FRs attended plan-of-the-day and plan-of-the-week meetings, experiment review activities, pre-job briefings, and other WP&C activities. The FRs interviewed by EA were knowledgeable of their stop-work authority and demonstrated an effective relationship with the Laboratory management. There were no scheduled FR meetings with the ASO Manager while EA was on site; however, the ASO Manager conveyed through interviews that her monthly meetings with the FRs provided meaningful information regarding laboratory safety performance.

The FR technical qualification and training program is adequately described in ASO SOP-26 and the ASO Oversight Training Program. ASO provided documentation that all FRs were currently qualified. EA specifically reviewed two qualification cards for FRs: one re-qualification and one initial qualification. The qualification cards adequately followed the SC and ASO-specific functional area qualifications for non-Defense Nuclear Facilities. ASO has demonstrated development of FRs for additional management opportunities to include using former FRs as managers in the Building 350 Transition Office and other leadership roles supporting the ASO Manager. In addition to FRs, the three SMEs qualified under the technical qualification program provide support to FRs in the oversight of WP&C elements and assessment of programmatic areas.

Criteria:

An effective differing professional opinion (DPO) process or program has been established and implemented. (DOE Order 442.2)

An effective employee concerns program (ECP) has been established and implemented. (DOE Order 442.1A, CRAD 45-21)

An operating experience (OE) program has been developed and implemented, and an OE Program Coordinator has been designated. (DOE 0 210.2A 4a)

The ASO DPO process is adequately documented in the SCMS ES&H Description. This procedure requires employees to use the DOE Order 442.2 process when those differences of opinion cannot be resolved using routine processes. The ASO Oversight Plan, Section 10.0, provides additional detail for

when and how to formally submit a DPO. Discussions with ASO personnel indicated that they were aware of the DPO process.
The SCMS Employee Concern Program and the ASO Oversight Plan adequately describe the ECP. The SC Chicago Integrated Support Center is responsible for managing the ECP process for receiving, managing, and tracking resolution of safety concerns from ANL/ASO and five other SC laboratories. During walkthroughs with ASO personnel, EA observed that posters were displayed in a sample of ASO and ANL buildings, with contact information for submitting concerns. ASO has a designated and trained employee concern coordinator to help resolve employee concerns submitted by ASO/ANL workers. Based on an interview with a Chicago Integrated Support Center manager, few safety-related concerns have been submitted by Argonne or the other five SC laboratories covered by the support center.

The ASO OE program is adequately described in procedure ASO SOP-11, *Lessons Learned*. The ASO OE coordinator has over 20 years of experience in occupational safety and health, is a member of the DOE OE Committee, and participates in DOE OE conference calls. The ASO coordinator routinely interacts with the ANL lessons learned coordinator and has assessed the ANL OE program. Argonne was a significant contributor to the DOE-wide Lessons Learned database, developing and sharing nine lessons learned from 2016 to present. The ASO OE coordinator saw a need for a DOE-wide OE document on the control of hazardous energy related to windmilling (free rotation of equipment such as fan blades) and provided the draft OE document to the Office of Environment, Health, Safety and Security for its use.

Argonne Site Office Oversight Conclusion

Overall, ASO has appropriate processes in place for Federal line oversight, including assessment planning and performance, operational awareness activities, issues management, and performance assurance analysis. ASO is following SC oversight methodology, which is integrated with the laboratory's CAS processes. Such processes as the ECP and DPO are in place to resolve employee issues. ASO has adequate processes in place to evaluate the laboratory's safety performance and effectiveness of the CAS. ASO feedback through the PEMP process has improved CAS effectiveness and safety performance. The assessment planning tool developed by ASO to better target oversight activities is considered a best practice because it provides a systematic mechanism that considers current safety performance and potential vulnerabilities when scheduling assessment resources.

The creation of a new Performance Assurance Specialist position in the ASO manager's office is a positive effort for strengthening ASO oversight and driving improvement of the ANL CAS and its integration with the ASO oversight mechanisms. ASO has well-qualified and technically competent staff members and management and has implemented an effective Facility Representative program. In addition to Facility Representatives, SMEs provide support to the Facility Representatives oversight of WP&C elements and supporting safety functional areas, resulting in the identification of issues for improvement. ASO WP&C oversight activities include independent assessments and operational awareness reviews of WP&C at the activity level, and have observed ANL assessments of WP&C. Identified deficiencies with ASO oversight include the need to improve corrective action validation for oversight issues and the need for trending analysis of ASO oversight data to identify emergent issues and help focus oversight activities.

8.0 FINDINGS

Findings are deficiencies that warrant a high level of attention from management. If left uncorrected, findings could adversely affect the DOE mission, the environment, the safety, or health of workers and the public or national security. DOE line management and/or contractor organizations must develop and implement corrective action plans for EA appraisal findings. Cognizant DOE managers must use site-

and program-specific issues management processes and systems developed in accordance with DOE Order 227.1A to manage these corrective action plans and track them to completion. In addition to the findings, deficiencies that did not meet the criteria for a finding are listed in Appendix C, with the expectation from DOE Order 227.1A for site managers to apply their local issues management processes for resolution.

F-ANL-I-01: In the biological laboratories, not all the non-biological hazards were identified or assessed as required by 10 C.F.R. 851.21 and PROC-200.

- The activity specific biological lab use of inert gases has not been analyzed by IH to determine the risk of oxygen deficient atmospheres in cases of unintended release or failure of equipment/valves and to determine whether oxygen deficiency alarms are needed.
- The current institutional electronic work control method is intended to ensure that safety and health SMEs are brought into the process to provide comprehensive identification and hazard analyses and establish appropriate work controls for all potential hazards within the biological labs, as required by the ANL institutional WP&C procedure PROC-200 and the BIO specific BIO-PROC-14. However, the safety and health SMEs were not provided sufficient "triggers" or criteria in the WP&C electronic process or communicated such criteria to ES&H coordinators and research managers to ensure that Industrial Hygiene and other industrial safety SMEs are appropriately notified to conduct workplace identification and analysis of lab space hazards and perform exposure monitoring. Similar issues regarding ventilation controls also suggest lack of safety and health SME involvement may present challenges to identifying hazards at the facility design level. This issue has led to hazards not being identified, analyzed, and controlled, as depicted in the observations described above regarding the lack of hazard analyses of the risk of potential oxygen deficient atmospheres, nitrogen pouring activities, and compressed gas storage/signage issues.

9.0 OPPORTUNITIES FOR IMPROVEMENT

EA identified some OFIs to assist cognizant managers in improving programs and operations. While OFIs may identify potential solutions to findings and deficiencies identified in appraisal reports, they may also address other conditions observed during the appraisal process. EA offers these OFIs 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.

ANL

OFI-ANL-I-01: Strengthen the institutional WP&C requirements in LMS-PROC-200 and guidance for developing local WP&C procedures to more closely follow the guidance provided in the DOE Handbook, DOE-HDBK-1211-2014, *Activity Level Work Planning and Control Implementation*, and WP&C successes achieved at other DOE sites. Specific activities to consider include:

- Consider conducting a gap analysis of LMS-PROC-200 requirements against the guidance contained in DOE-HDBK-1211-2014, *DOE Handbook on Activity Level Work Planning and Control Implementation*, and revise LMS-PROC-200 with additional requirements applicable to local implementing procedures for each core function.
- Consider incorporating the activity hazard analysis approach being implemented at the Lawrence Livermore Nuclear Laboratory as defined in Procedure DES-2012, *LLNL Work Planning and*

Control Program, as an effective method for identifying and analyzing hazards and linking hazards to tasks. Such an approach may provide insight into improvements in linkage of controls with hazards and work tasks.

- Consider the approaches that Lawrence Livermore Nuclear Laboratory is using to streamline WCDs through the use of pre-authorized tasks, competent workers, and enhanced JHA-based WCDs, as described in Lawrence Livermore National Laboratory procedures on these topics and DOE-HDBK-1211-2014, *DOE Handbook on Activity Level Work Planning and Control Implementation*.

OFI-ANL-I-02: Consider whether an organizational structure that ensures safety and health SME's are automatically included in reviewing work activities would better serve the WP&C processes in all Divisions. The Nanoscience and Technology Division WCDs include a full review by a certified industrial hygienist, who is located in the organization. The IH reviews and signs off on all activity specific procedures after hazard identification, analysis and controls are established for laboratory work activities. The WP&C process in this Division is working well to ensure safety and health SMEs are automatically included in reviewing all lab work activities which results in less likelihood for hazards not to be identified and analyzed and controls not to be in place.

OFI-ANL-I-03: Consider options to streamline and incorporate hazard analyses, IH surveys, reports, and other safety and health information into one electronic location which would allow staff and management easier access to the information across ANL organizations. Currently, safety and health analyses and records are not easily accessible to all management and staff when needed.

OFI-ANL-I-04: Consider a chemical safety surveillance topic area, including work planning and control processes within the scope of the PMA formal surveillance process to evaluate the implementation of requirements and performance of ANL programs.

OFI-ANL-RAD-01: Increase efforts to improve specificity of RWPs with regard to both worker selection of appropriate RWPs before work and the specific contamination controls workers are expected to follow to minimize the potential for inadvertent spread of contamination to clean areas. Specific actions to consider include:

- Identify the specific RWP governing the work in each WCD or work authorization document.
- Develop a method by which workers formally document which RWP they are following for each WCD work evolution (i.e., two minute drill card modification or similar).
- Establish a work prerequisite in RWPs or WCDs to ensure sufficient quantities of operable radiological survey equipment must be available for worker use during all radiological work Revising HPP-9.1, *Radiological Work Permits*, to include additional information for Health Physicists on the need to specify worker contamination controls (contamination monitoring, etc.) in RWPs that govern work in localized CAs and during radiological bag-outs.
- Expand the training for Radiological 2 hood practical factors to address multiple hand and arm entries into localized contamination areas and the expected contamination controls and frisking expectations.

OFI-ANL-APS-01: Consider modifying the ESAF process so that the EHCP WCD is a more useful, user-friendly, standalone mechanism for communicating work scope, hazards, and controls to users. Also, consider requiring all users to read and understand the EHCP WCD before starting work on an experiment though enhanced Sector training to address this requirement.

OFI-ANL-APS-02: Consider reviewing the need for emergency eyewashes and showers in all APS user machine shops.

ASO

OFI-ASO-01: Consider including all required contractor management system deliverables in the document tracking system and follow up when deliverables are not received.

Appendix A
Supplemental Information

Dates of Assessment

Onsite Assessment: April 3-6 and 24-27, 2017

Office of Enterprise Assessments (EA) Management

Glenn S. Podonsky, Director, Office of Enterprise Assessments
William A. Eckroade, Deputy Director, Office of Enterprise Assessments
Thomas R. Staker, Director, Office of Environment, Safety and Health Assessments
William E. Miller, Deputy Director, Office of Environment, Safety and Health Assessments
C.E. (Gene) Carpenter, Jr., Director, Office of Nuclear Safety and Environmental Assessments
Kevin G. Kilp, Acting Director, Office of Worker Safety and Health Assessments
Gerald M. McAteer, Director, Office of Emergency Management Assessments

Quality Review Board

William A. Eckroade
John S. Boulden III
Kevin L. Dressman
Thomas R. Staker
William E. Miller
Michael A. Kilpatrick

EA Site Lead for ANL

Greg M. Shoenebeck

EA Assessors

Kevin G. Kilp, Team Leader
Terry E. Krietz
James R. Lockridge
Joseph Lischinsky
Nimalan Mahimaidoss
Valerie M. Steele
Mario A. Vigliani

Appendix B
Key Documents Reviewed, Interviews, and Observations

Documents Reviewed

ANL

- Argonne National Laboratory *Worker Safety and Health Program*, Rev. 11, July 11, 2016
- Argonne National Laboratory, *Integrated Safety Management System Description*, Rev. 7,
- LMS-POL-16, *Work Planning and Control*
- LMS-PROC-200, *Local Work Planning and Control Implementing Procedures*
- WP&C Hazard Tree
- LMS-PROC-65, Skill-of-the-Worker
- LMS-PROC-139, Emergency Eyewashes and Safety Showers
- APS Safety Assessment Document, Section 5.0, Safety Envelope
- APS Procedure 3.1.124, Work Planning and Control at the APS
- APS Procedure 3.1.25, APS Experimental Safety Reviews
- APS Procedure 3.1.101, User Access Framework
- APS Procedure 3.1.103, User Training
- APS Procedure 3.1.13, LOM/User Machine Shops
- EHCP for APS Experiment ID 164541, Crystal Orientation Effects of MOVPE Growth of GaN
- EHCP for APS Experiment ID 164333, X-Ray Diffraction Experiments on Shocked Polycrystalline Titanium and Zirconium
- MSD-PROC-5, Implementation of Work Planning and Control, Re. 1
- MSD-50018-2017.0, Anodizing Process
- MSD-70021-2013.1, Low Temperature, High Magnetic Field Characterization Systems
- MSD-11003.4, Fundamental Studies of Electrocatalysis for Low Temperature Fuel Cell Cathodes
- MSD-11015-2017.0, Li-ion, N-ion, Mg-ion Batteries, Assembly, Disassembly, and Testing
- MSD-1100302013.3, Fundamental Studies of Electrocatalysis for Low Temperature Fuel Cell Cathodes; Ultra High Vacuum Characterization
- MSD-30010-2013_ESB-1.1, Synthesis and Crystal Growth in Inorganic Solid State Materials
- MSD-80012-2013-001.3, Fabrication and Characterization of Thin Films and Simple Devices
- NE-WPC-01, *Nuclear Engineering Division Local Work Planning and Control*
- Argonne National Laboratory, *Radiological Safety Program Description*
- LMS-PROC-140, *Radiological Work Permit*
- HPP-9.1, *Radiological Work Permits*
- HPP-9.2, *Contamination Control Requirements*
- WCD 48172.0, *Hands-on Operation of Countercurrent Centrifugal Contactors with In-Line/On-Line Instrumentation Measurements*
- WCD 45833.0, *Transfer equipment / material in or out of Bigfoot and Glovebox containment facilities*
- WCD 26532.3, *Maintenance work in contamination areas in the LINAC facility and building 211 radiological laboratories*
- WCD 45817.0, *Operation of Microfluidic System for Precipitation Experiments*
- WCD 45392.2, *Analytical Chemistry Laboratory General Analytical Operations*
- WCD 19596.2, *Pyrochemical Development Operations*
- WCD 19039.3, *Work Instructions for Radiological Gloveboxes in Bldg. 205 and 211*
- WCD 41073.1, *Removal of Items from a Waste Drum*

- WCD 48492.0, *Processing of Radioactive Material in G-Wing Atmospheric Glove Boxes*
- RWP 2017-205-041, *Work in a contamination area with no engineering controls (e.g., benchtop contamination area, room*
- RWP 2017-205-042, *Work in a contamination area with engineering controls (e.g., hood, glovebox)*
- RWP 2017-205-043, *Work in a Radiation Area*
- RWP 2017-211-004, *Work in a contamination area without engineering controls (e.g., benchtop, room))*
- Central Shops Request for Exception to Internal or External Requirement, LMS-PROC-78, March 14, 2017.
- Central Shops Skill of the Worker Documentation of Worker Proficiency, March 14, 2017
- ES&H Manual, Chapter 7, Section 7.1 Control of Hazardous Energy and Lockout/tagout.
- ITS-59454, Severe Finger Laceration during Machine Shop Operations (RPT-28864), Additional Corrective Actions to include those still under development by the CARB, April 18, 2017
- ITMS Status Report of Issues and Actions, February 15, 2017
- FMS-PROC09-01, Central Shops Local Work Planning and Control Procedure
- Lesson Learned "Severe Finger Laceration during Machine Shop Operations - Argonne National Laboratory", January 4, 2016
- LMS-PROC-4, Issues Management and Corrective and Preventive Action Rev. 7, June 21, 2016.
- LMS-PROC-78, Machine Tool and Equipment Operations, Rev.11, March 10, 2017.
- LMS-PROC-89, Fact-Finding and Incident Investigation, Rev. 10, October 28, 2015.
- Machine Shop Corrective Action Presentation, April 3, 2017.
- *Contractor Assurance System Description*, Revision 2, 1/17/12
- *Assessments Program Description, 1/10/14*
- Integrated Safety Management System Description, Revision 7, 8/13/13
- *Worker Safety and Health Program*, Revision 11, 7/11/16
- LMS-PROC-200, *Local Work Planning and Control Implementing Procedures*, Revision 6, 9/8/16
- *Quality Assurance Program Plan*, Revision 8, 8/30/16
- *Institutional Biosafety Committee Meeting Minutes*, 2/11/16 and 9/22/16
- PMA-FY17-IA-01, *Independent Assessment Report, Work Planning and Control*, 3/1/17
- PMA-FY14-SURV-021
- PMA-FY15-SURV-018, *Work Planning and Control Surveillance*, 7/13-24/15
- PMA-FY15-MA-01, *Argonne's Issue Management Process and IMTS,*
- PMA-FY16-SURV-14, *Argonne Bloodborne Pathogens Occupational Exposure Control Plan*, 9/29/16
- ESQ-FY16-MA-007, *Respirator Protection Program*, 11/17/16
- Letter from ANL Regulatory Compliance Specialist to ASO Enforcement Coordinator, subject: Closure Package, NTS—ASO-ANLE-ANLEFMS-2016-0003, *Electrical Incident Reported When Plugging in Portable Fan*, 4/5/17
- Corrective Action Plan, *Office of Enterprise Assessments Review of the Argonne Radiological Protection Program*, 2/24/15
- ESQ-FY16-037-1, *Argonne National Laboratory Radiological Protection Program Readiness Review*, 5/24/16
- PMA-FY16-IA-07, *Validation of the Corrective Actions for the Office of Enterprise Assessments Review of the Argonne Radiological Protection Plan*, 3/16/17
- ESQ-FY17-MA-31, *Effectiveness Review of Corrective Actions Taken for the Office of Enterprise Assessments Review of the Argonne Respiratory Protection Program,*

ASO

- ASO *Integrated Safety Management System Description*, Revision 3, 10/18/16
- ASO *Functional, Responsibilities, and Authorities Document*, Revision 4, 11/30/16
- ASO *Oversight Plan*, Revision 4, 12/31/16
- ASO *Oversight Training Program*, Revision 1, February 2017
- ASO Standard Operating Procedure (SOP)-11: *Lessons Learned*, Revision 2, 10/27/16
- ASO SOP-12: *Issues Management*, Revision 3, 12/30/16
- ASO SOP-15: *Assessments*, Revision 2, 12/30/16
- ASO SOP-22: *Contractor Performance Evaluation Management Procedure*, Revision 2, 6/9/16
- ASO SOP-26: *Facility Representative Program*, Revision 16, 12/30/16
- Office of Science Management System (SCMS) *Managing the Integrated Safety Management System*, Revision 2.2, 11/19/13
- SCMS Quality Assurance and Oversight, Revision 5.3, 5/10/16
- SCMS *Line Management Oversight*, Revision 5.3, 4/25/16
- SCMS *Environment Safety and Health Oversight of Contractors*, Revision 4.0, 8/12/14
- SCMS *Federal Technical Capability Program*, Revision 1.0, 12/17/14
- SCMS *Employee Concern Program*, Revision 2.3, 6/4/15
- ASO *Integrated Assessment Schedule for FY17*, 1/27/17
- ASO *Integrated Assessment Schedule for FY15/16*, 2/16/17
- *SC-ISC Service Plan*, 7/12/16
- Table, ASO Documented Observations in FY15/16 of Work Planning and Control
- Table, ASO Documented Observations in FY15/16 of Biological Safety Laboratory
- Report, *ASO Self-Assessment on Corrective Actions Closure Effectiveness Review*, 8/2-15/16
- Memorandum from Deputy Director for Field Operations to Director, Office of Science (SC-3), subject: *Approval of Equivalency for Department of Energy (DOE) Order 226.1A, Implementation of Department of Energy Oversight Policy, Contractor Requirements Document*, 5/6/10
- Memorandum from SC-3 to SC-3 Federal Staff, subject: Proper Federal Oversight, 3/18/13
- *ASO ESHD Assessment Planning Tool – Risk Ranking* Spreadsheet, 10/7/16
- DOE Contract Number DE-AC02-06CH11357, Clause H.42 *Contractor Assurance System*
- Letter from ASO Manager to ANL Director, Subject: *10 CFR 851 Worker Safety and Health Program*, 9/29/16
- Letter from ASO Manager to ANL Director, Subject: *Department of Energy Approval of Argonne National Laboratory's Quality Assurance Program Plan*, Rev. 8, dated August 26, 2016, 11/30/16
- Position Description for ASO Facility Representatives
- ASOISS-319, *OFIs from Recent EA Report on Lessons Learned from Targeted Reviews of WP&C [OFI]-1*, 9/20/16
- ASOISS-320, *OFIs from EA Targeted Review of WP&C –[OFI] 2*, 3/31/16
- ASOISS-321, *OFIs from EA Targeted Review of WP&C [OFI]- 3*, 3/11/16
- ASOISS-336, *OFI from EA Fire Protection Assessment – Report issued August 2015*, 4/4/17
- ASOACT-2718 *Walkthrough 211 - Respirator assessment field observation* (ASO observation of ESQ-FY16-MA-007)
- Memorandum from ASO Manager to SC Director for Safety and Security Policy, subject: *Argonne Site Office Facility Representative Performance Indicators Report, Fourth Quarter 2016*, 2/2/16
- Memorandum from ASO ESH Division Director to ASO Manager, subject: *Argonne Site Office Facility Representative Re-Qualification of Eric Turnquest*, 7/13/16
- Memorandum from ASO ESH Division Director to ASO Manager, subject: *Argonne Site Office Facility Representative Initial Qualification of James Piatek*, 9/17/16

- Letter from ASO Manager to ANL Director, subject: *Argonne Site Office (ASO) Facility Representative/Subject Matter Expert Program Expectations*, 10/21/16
- Memorandum from ASO ESH Division Director to ASO Manager, subject: *Argonne Site Office (ASO) Determination of Facility Representative Coverage*, 2/24/17
- Presentation, *Assessment Integration Argonne and ASO Approach*, 4/27/16
- Spreadsheet, *ASO ESHD Assessment Planning Tool – Risk Ranking*, 10/7/16
- Presentation Slides, *1st Meeting FY2017 Performance Evaluation for Goals 4 through 8 of UChicago Argonne, LLC for the Management and Operation of Argonne national Laboratory, Presented by ASO Manager*, 4/3/17
- Partnership Agreement between ASO, UChicago Argonne, LLC and Argonne National Laboratory, 1/1/17
- Intra-Laboratory Memo from, ANL HSE Division Director to Distribution, subject: *Electrical Common Cause Analysis*, 3/23/17
- *UChicago Argonne, LLC Board of Governors Contractor Assurance System Review Committee Report*, 9/8-10/15
- UChicago Argonne, LLC Board of Governors Contractor Assurance System Review Committee, *CAS Review Outbrief Presentation*, 9/26-28/16
- A*SO Perspectives, FY16 Contractor Assurance System Review*, 9/27/16
- FY16 ASO *Annual Performance Plan*
- FY17 ASO *Annual Performance Plan*
- 1Q FY17ASO *Argonne Trend Report*, 1/13/17
- FY16 PEMP
- FY17 PEMP
- 1Q FY17 PEMP report, *Self-Assessment of Performance*
- *ANL FY16 Annual Laboratory Plan Feedback*
- FY15 Office of Science *Performance Evaluation report of the UChicago Argonne, LLC for Management and Operations of Science and Technology at the Argonne National Laboratory*
- FY16 Office of Science *Performance Evaluation report of the UChicago Argonne, LLC for Management and Operations of Science and Technology at the Argonne National Laboratory*
- Email from ASO Facility Representative to ANL and Subcontractor Construction Safety Points of Contact, subject: MDL Safety Walk, 4/4/17
- Email from ANL IMTS to ASO ESH Division Director, subject: *Issues – Past 7 days*, 4/3/17
- Email from ANL IMTS to ASO ESH Division Director, subject: *Issues Closed – Last 7 Days*, 4/3/17
- Draft OE-3 2017-2 on Controlling Hazards from Windmilling Equipment
- Email from ANL FMS Operations Manager to ASO Facility Representative, subject: *HVAC Safety Document*, 3/31/17
- NWM-FY16-MA-021, *Integrated Safety Management System as Part of the Management and Organization SMP*, 9/19-30/16
- ACT-ASO-16-26, *Work Planning and Control IA* (ASO oversight notes on ANL independent assessment of WP&C)
- ACT-3229 through 323 (Oversight activity on ANL WP&C assessments at MSD, Physics and lab-wide)
- ASOACT-2529, *Observation of PMA Surveillance on WPC*, 7/17/15
- ASOACT-2718, *Walkthrough 211 – Respirator assessment field observation*, 10/28/15
- Letter from ASO Contracting Officer to ANL Director, subject: *DOE Order 456.1A, "The Safe Handling of Unbound Engineered Nanoparticles," July 15, 2016*, 7/22/16
- Letter from ANL General Counsel to ASO Contracting Officer, subject: *DOE Order 456.1A, "The Safe Handling of Unbound Engineered Nanoparticles," July 15, 2016*, 7/22/16, 8/19/16

- Letter from ANL Senior Attorney to ASO Contracting Officer, subject: *DOE Order 456.1A, "The Safe Handling of Unbound Engineered Nanoparticles," July 15, 2016*, 7/22/16, 1/30/17 (conveys ANL Corrective Action Plan to be compliant with DOE Order 456.1A)
- Letter from ASO Manager to UChicago Vice President for Research and for National Laboratories, subject: *Concerns About Argonne's Radiation Protection Program and Safety Programs*, 7/1/11
- Letter from ASO Manager to ANL Director, subject: *Nuclear Maintenance Assessment FY2016*, 4/25/16
- Letter from ASO Manager to ANL Director, subject: *Functional Area Review (FAR) of the Emergency Response Organization (ERO) at Argonne National Laboratory*, 4/29/16
- Letter from ASO Manager to ANL Director, subject: *Functional Area Review (FAR) Report for the Laser Safety Program at Argonne National Laboratory*, 4/26/16
- Letter from ASO Manager to ANL Director, subject: *Functional Area Review Report of NPDES Permit Compliance Program at Argonne National Laboratory*, 7/6/16
- Letter from ASO Manager to ANL Director, subject*: Functional Area Review Report on Environmental Management System (EMS) at Argonne National Laboratory*, 11/21/16
- Letter from ASO Manager to ANL Director, subject: *Functional Area Review Report of Unneeded Materials and Chemicals Management at Argonne National Laboratory*, 2/1/17

Interviews

ANL

- ANL Industrial Hygienists
- ANL BSO
- APS ESH Coordinators
- APS Deputy ALDs
- APS Safety Officer
- APS Users, Beamline Operators, Sector Managers
- APS-AES Mechanical Operations and Maintenance Technicians
- BIO PIs
- Biological Transportation and Security Staff
- ES PIs and Biological Research Staff
- GSS PIs and Biological Research Staff
- MSD ESH Coordinators
- MSD Principal Investigators
- MSD Research Associates & Visiting Scholars
- MSD Postdoctoral Researchers
- MSD Staff Scientists
- NE Division ES&H Manager and Coordinator
- NE Section Managers and Facility Managers
- NE Researchers
- NST PIs and Biological Research Staff
- ANL Radiological Control Managers and Health Physics Staff
- FMS/IS Central Shops Management
- FMS/IS Work Control Specialist
- FMS/IS Welding Engineer
- Central Shops Machinists
- Central Shops Mechanic
- Central Shops Welders

- Central Shops Line Supervisors
- Divisional Machine Shop Equipment Custodians
- Divisional Machine Shop Workers
- Divisional Machine Shop Line Supervisors
- HSE Occupational Hygiene and Safety Manager
- HSE Principal Safety Engineer
- HSE Corrective Action Manager for Accident Investigation
- ES&H Director
- Performance Management and Assurance Manager
- Assessment Manager
- IMTS Manager

ASO

- ASO Manager
- ASO Deputy Manager
- ASO ES&H Division Director
- ASO Performance Assurance Specialist
- ASO Facility Representatives (five)
- ASO Subject Matter Expert (health physics)

Observations

ANL

- APS Experiment ID 164541, Crystal Orientation Effects of MOVPE Growth of GaN
- APS Experiment ID 164333, X-Ray Diffraction Experiments on Shocked Polycrystalline Titanium and Zirconium
- APS Sector Orientations
- APS User Machine Shop
- APS Chemistry and Electronics Laboratories
- MSD Experiment Walkdown; Anodizing Process
- MSD Experiment; Low Temperature, High Magnetic Field Characterization Systems
- MSD Experiment; Fundamental Studies of Electrocatalysis for Low Temperature Fuel Cell Cathodes
- MSD Experiment; Li-ion, N-ion, Mg-ion Batteries, Assembly, Disassembly, and Testing
- MSD Experiment; Fundamental Studies of Electrocatalysis for Low Temperature Fuel Cell Cathodes; Ultra High Vacuum Characterization
- MSD Experiment; Synthesis and Crystal Growth in Inorganic Solid State Materials
- MSD Experiment; Fabrication and Characterization of Thin Films and Simple Devices
- NE Research X-141, Pyrochemical Development Operations
- NE Research G-133, Microfluidic System for Precipitation Experiments
- NE Research G-133, Hands-on Operation of Countercurrent Centrifugal Contactors
- NE Research G-117, Analytical Chemistry Laboratory General Analytical Operations
- NE G-131, Glovebox Waste bag out with pre-job brief and post job review
- NE Building 211 Pre-Shift Briefing
- NE Building 211, Big Foot Maintenance work and pre-job brief
- NE XRF Depleted Uranium Pouches pre-job brief

- Central Shop Safety Briefing
- Lockout/tagout installation/removal associated with maintenance of vertical milling machine.
- Central Shops metal working including; milling, drilling, band-saw cutting, shear cutting, welding, lathe and EDM machining operations.
- Maintenance evolutions associated with band-saw blade replacement
- Walkdown of Central Shops (including building 363, Satellite Shop locations and Carpenters Shop)
- Walkdowns of Divisional Machine Shops
- Lockout/tagout of equipment found deficient during walkdowns

ASO

- Facility Representative Activity at Building 363, Central Shops
- Facility Representative Activity at Materials Design Laboratory Construction (tower crane assembly) and plan of the day
- Facility Representative activity at Alpha Gamma Hot Cell, including plan of the day
- Facility Representative Activity at Argonne Tandem Linac Accelerator System, including Operations Meeting
- Facility Representative Activity at Materials Science Division, building 223, Experiment Review Meeting
- Facility Representative Activity at FMS Rapid Response Construction project, Building 203, Physics Building
- SME participation in ANL inspection of Satellite Accumulation Areas, Chemistry Building

Appendix C
Deficiencies

Deficiencies that do not meet the criteria for a finding are listed below, with the expectation from DOE Order 227.1A that site managers will apply their local issues management processes for resolution.

Work Planning and Control

- The work scope definition in three MSD and NE experimental WCDs was not sufficiently detailed to permit the identification and analysis of all hazards associated with the work, as required by LMS-PROC-200 and local implementing procedures.

- Experimental hazards in MSD or NE WCDs were not identified or adequately analyzed in two of the WCDs reviewed by EA. In NE, WCD preparers did not identify the ergonomic hazards associated with general glovebox work performed in various NE laboratories as required by LMS-PROC-200 and the local implementing procedure. Further, in two cases, in both MSD and NE the research staff did not ensure that IH surveys were performed as required by the WCD, resulting in unanalyzed magnetic and RF field hazards.

- ANL Industrial Hygiene has not provided sufficient "triggers" or criteria in division level WP&C process procedures or communicated such criteria to ESH coordinators and research managers to ensure that Industrial Hygiene is appropriately notified to conduct workplace exposure monitoring as required by Attachment 6 (Industrial Hygiene) of the ANL Worker Safety and Health Program.

- LMS-PROC-200 and the associated divisional WP&C implementing procedures in MSD, NE, and APS do not provide sufficient guidance to the research staff members on how standard operating procedures (SOPs) are to be prepared, reviewed, and approved to ensure that hazard controls within SOPs are not in conflict with control sets in the WCDs, as required by Section B.3 of ANL Procedure LMS-PROC-200 and DOE Order 422.1.

- Although the WAE tool that ensures that workers who authorized a WCD are current with training requirements, it does not validate the training status of ancillary workers assigned to support the WCD as required by LMS-PROC-200 and divisional WP&C procedures.

- In more than half the NE WCDs and in one of the six MSD WCDs that EA reviewed, MSD and NE did not use the WAE tool effectively to document work authorization and/or formal worker concurrence with each WCD, as required by LMS-PROC-200 and local implementing procedures.

- The EHCP generated by experimental users at the APS does not clearly define the boundaries of the work scope for users, as required by Section B.2 of LMS-PROC-200.

- At APS, there are no WP&C mechanisms to ensure that the hazards and controls documented in an EHCP are read and understood by all users prior to performing work. One of the requirements for local WP&C implementing procedures, according to Section B.5 of LMS-PROC-200, is to describe "how workers acknowledge their understanding of the work and its associated hazards and controls."

- APS has not sufficiently defined clear work scope boundaries and limitations for users granted access to APS chemistry and electronic laboratories, as required by Section B.2 of LMS-PROC-200. In addition, mechanisms have not been implemented at APS to ensure that users are informed and trained on the hazards and controls associated with their laboratory work activities, as required by

Section B.2 of LMS-PROC-200 and Section 2 of *ANL Integrated Safety Management System Description*

- Contrary to LMS-PROC-78, *Machine Guarding and Operation*, ANL has not ensured that all machine tool workers (e.g., machinists, machine shop custodians, and line management members) are aware of all machine guarding requirements, and ANL has not ensured that all equipment with insufficient or unevaluated machine guarding and/or equipment without appropriate equipment postings have been placed out of service.

Argonne Site Office

- ASO has not conducted trending analysis of oversight issues identified by ASO personnel and maintained in the ASO issue tracking system as required by SCMS *Quality Assurance and Oversight*, Procedure 2, *Analyzing, Charting, and Reviewing Performance Trends*; ASO Oversight Plan; and SOP-12, *Issues Management*.

- Closure validation and effectiveness reviews of ASO-identified issues were not adequately conducted or timely for FY15 and FY16, as required by DOE Order 226.1A, Section 4.b.(4) and d, and ASO SOP-12.