Inspection of
Environment, Safety,
and Health Management
at the

Pacific Northwest National Laboratory

December 2003

Office of Independent Oversight and Performance Assurance
Office of the Secretary of Energy

Table of Contents

Abbreviations Used in This Report

ALARA	As Low As Reasonably Achievable
AMT	RL Associate Manager for Science and Technology
ANSI	American National Standards Institute
BMI	Battelle Memorial Institute
CFR	Code of Federal Regulations
CPP	Chemical Process Permit
CRD	Contractor Requirements Document
CSM	Cognizant Space Manager
CY	Calendar Year
DOE	U.S. Department of Energy
dp	Differential Pressure
DSA	Documented Safety Analysis
ECR	Environmental Compliance Representative
EDP	Engineering Design Plan
EEWP	Energized Electrical Work Permit
EJTA	Employee Job Task Analysis
EM	DOE Office of Environmental Management
EMSL	Environmental Molecular Science Laboratory
EPR	Electronic Prep and Risk
ES&H	Environment, Safety, and Health
ESH&Q	Environment, Safety, Health, and Quality
ESR	Electronic Service Request

(Continued on inside back cover)

OVERSIGHT

1.0 Introduction

The Secretary of Energy's Office of Independent Oversight and Performance Assurance (OA) conducted an inspection of environment, safety, and health (ES&H) at the U.S. Department of Energy (DOE) Pacific Northwest National Laboratory (PNNL) during November and December 2003. The inspection was performed by the OA Office of Environment, Safety and Health Evaluations.

The DOE Office of Science (SC) is the cognizant secretarial office for PNNL and has overall Headquarters line management responsibility for programmatic direction and ES&H at PNNL. At the site level, the DOE Richland Operations Office (RL) reports to the DOE Office of Environmental Management (EM) and currently has line management responsibility for operations and ES&H at PNNL.

Aerial View of PNNL

Within RL, the Associate Manager for Science and Technology (AMT) performs most DOE line management functions involving PNNL. However, DOE line management responsibility for PNNL is currently in transition. On December 5, 2003, the Office of the Secretary of Energy approved establishing the Pacific Northwest Site Office (PNSO) as an SC Site Office to provide direction to and oversee PNNL. According to SC plans, which are currently under review by the Office of the Secretary of Energy, AMT and other RL individuals will transfer to the new PNSO on December 14, 2003, which will report directly to SC and will receive support primarily from SC support offices in accordance with the ongoing SC reorganization. The Head Contracting Authority and Chief Financial Officer are expected to be reassigned from RL to the SC Office of the Deputy Director for Operations (SC-3) and the Oak Ridge Operations Office, respectively, within the next couple of months.

PNNL is operated by Battelle Memorial Institute (BMI), under contract to DOE. A new laboratory director was selected on April 1, 2003. The new director has expressed a strong commitment to ensuring that safety is integrated into all work activities. The DOE/BMI contract includes provisions that address the approach to DOE line management oversight of PNNL. Specifically, the contract addresses the principles of contract management issued by the Under Secretary for Environment, Science, and Energy in 2002, such as requiring contractor accountability for ES&H performance. Contractor self-assessments and quantitative performance measures are also to be used as major elements of monitoring and evaluating performance.

PNNL is a multi-program national laboratory that delivers solutions to science and technology challenges across all four of the DOE missions. As a federally funded research and development (R&D) center, PNNL performs work for most of the DOE program offices and other Federal agencies. PNNL is also a consolidated laboratory with both private (BMI) and government facilities. One-third of the facilities are located in the 300 Area of the Hanford Site, near Richland, Washington. PNNL has one Category 2 nuclear facility—the Radiochemical Processing Laboratory (RPL)—and a number of radiological and industrial facilities comprising a total of 2.1 million square feet. The PNNL activities include R&D in a wide variety of areas, including fundamental science, computational science, energy, environment, health and safety, information technology, national security, and nuclear technology. PNNL also operates and maintains the research facilities and performs various support activities, such as facility maintenance and construction. PNNL activities involve a variety of potential hazards that need to be effectively controlled, including exposure to radiation, radiological contamination, chemicals, biological agents, hazardous materials, and various industrial hazards.

Throughout the evaluation of ES&H programs, OA reviewed the role of DOE organizations in providing direction to contractors and conducting line management oversight of contract activities. OA evaluations emphasized contractor self-assessments, including issues management, and DOE line management oversight in ensuring effective ES&H programs. In reviewing DOE line management oversight, OA focused on the effectiveness of RL and AMT in managing the PNNL contract, including such management functions as setting expectations, providing implementation guidance, monitoring and assessing contractor performance, and monitoring the quality of contractor self-assessments. Similarly, OA focused on the effectiveness of the contractor management system and self-assessment programs.

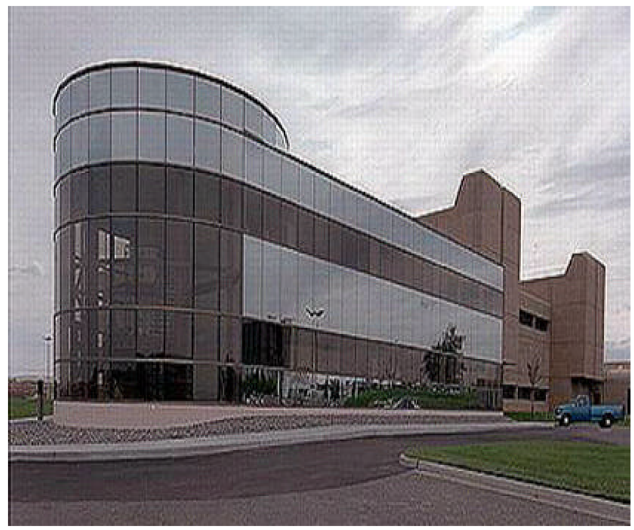
The purpose of the ES&H inspection was to assess the adequacy and effectiveness of selected aspects of ES&H management as implemented by PNNL under the direction of RL/AMT. The OA inspection team used a selective sampling approach to determine the effectiveness of RL/AMT and PNNL in implementing DOE ES&H performance expectations. The approach involved examining selected institutional programs that support the integrated safety management (ISM) program and implementation of requirements in selected PNNL organizations, facilities, and activities.

The ES&H inspection was organized to evaluate selected aspects of the ISM program:

- RL, AMT, and PNNL implementation of selected ISM guiding principles, including safety-related roles and responsibilities (ISM Guiding Principle #2) and identification of safety standards and requirements (ISM Guiding Principle #5). The processes for implementing suspect/counterfeit item (S/CI) requirements were a focus area.

- RL, AMT, and PNNL feedback and continuous improvement systems, including the use of selected performance measures.

- PNNL implementation of the core functions of safety management for selected facility support activities and R&D activities. Facility support activities that were reviewed included construction, maintenance, electrical work, welding, maintenance, waste management, and subcontractor activities. R&D activities reviewed included:
    - Hot cell work and laboratory activities at RPL performed by the Radiochemical Sciences and Engineering group, which is within the Process Science and Engineering Division of the Environmental Technology Directorate (ETD)
    - Chemical and biology experiments at the Environmental Molecular Science Laboratory performed by PNNL and external users
    - Biology experiments on molecular and cell processes involving chemical and physical agents, performed by the Fundamental Sciences Directorate and the ETD at Building 331.



Building 331

- Functionality of a selected essential system—the radioactive exhaust ventilation system (REVS) at the RPL— including the unreviewed safety question process.

During the review of these programs and activities, OA devoted particular attention to selected ES&H requirements, including work control processes, S/CI controls, subcontractor ES&H controls, radiological work planning and permits, radiological controls, assessment and control of hazardous chemicals, injury and illness record keeping, facility maintenance, electrical work, welding, and construction. In reviewing management systems, OA examined both the current operations and SC, RL, and AMT plans for transitioning to the PNSO office.

Section 2 provides an overall discussion of the review results for the PNNL ES&H programs, including positive aspects and weaknesses. Section 3 provides OA's conclusions regarding the overall effectiveness of RL/AMT and PNNL management of the ES&H programs. Section 4 presents the ratings assigned during this review. Appendix A provides supplemental information, including team composition. Appendix B identifies the specific findings that require corrective action and follow-up. Appendix C presents the results of the review of selected guiding principles of ISM. Appendix D presents the results of the review of the RL/AMT and contractor feedback and continuous improvement processes. Appendix E provides the results of the review of the application of the core functions of ISM for the PNNL R&D activities and facility support activities. The results of the review of essential system functionality are discussed in Appendix F.

2.0 Results

2.1 Positive Attributes

Several positive attributes were identified in the AMT and PNNL implementation of ISM. Work activities, particularly those involving higher hazards, were performed with a high regard for safety, and engineering controls and environmental programs were effective.

SC, EM, RL, and AMT are effectively coordinating their efforts to facilitate a smooth transition to the PNSO. AMT is performing most of the functions that will be performed by PNSO. SC, EM, and RL have identified the RL resources that will transfer to PNSO and the SC Service Center. Plans have been developed that provide for a phased transition. The OA inspection did not identify any DOE line management oversight functions that were not being performed while the transition is awaiting senior management approval. However, the transition has encountered significant delays and thus the intended benefits (e.g., clearer lines of responsibility and accountability) associated with the transition are not yet being realized.

Most work activities at PNNL were performed with a high regard for safety. Although some weaknesses in identification and implementation of controls were identified (see below), PNNL managers, staff, support personnel, and workers demonstrated a high regard for safety. Management was engaged and knowledgeable about hazards and safety in their areas of responsibility. The workforce was competent and experienced. Workers were involved in safety and indicated that PNNL management was supportive of safety. PNNL actively participates in the DOE voluntary protection program and has achieved Star status. The use of facility core teams, deployed staff, cognizant space managers, and the building management concept has helped ensure that safety is integrated into line management and that the activities of multiple organizations can be coordinated and controlled in PNNL laboratories. PNNL makes good use of electronic tools, such as the Standards Based Management System (SBMS), Integrated Operating System (IOPS), and Electronic Prep and Risk (EPR), to provide information to staff and facilitate development of hazards analysis and permits. For many activities, including higher hazard activities and most Facilities and Operations (F&O) activities, clear procedures are in place and effective controls have been identified and implemented. PNNL has developed effective processes for the flowdown of requirements to subcontractors and implementing S/CI requirements.

Institutional and facility-specific environmental protection and waste management programs are effectively implemented. The deployment of environmental compliance and field services representatives to the R&D and F&O organizations has ensured that sufficient environmental and waste management expertise is available in the PNNL facilities and programmatic activities. In addition, PNNL has been proactive in using International Standards Organization (ISO) 14001 as the basis for its environmental management system, and has been certified by an independent external organization. Further, the PNNL pollution prevention program has been effective, and PNNL has received several awards for its pollution prevention efforts. For example, PNNL received the White House "Closing the Circle Award" for being a good steward of natural resources for the Green Custodial Products Initiative.

2.2 Items for Management Attention

Although many aspects of ISM at PNNL are effective, PNNL hazards analysis and control processes for some lower-hazard activities are not sufficiently rigorous or documented and the REVS design has not been adequately verified. RL, AMT, and PNNL feedback and improvement programs are not always effective in ensuring that management expectations and ES&H requirements are effectively implemented, monitored, and improved.

RL, AMT, and PNNL feedback and improvement processes are not sufficiently

effective in identifying and correcting ES&H deficiencies. Although a significant number of inspections are performed, PNNL's self-assessment program is not sufficiently rigorous to consistently and effectively evaluate ES&H programs and measure performance. In addition, there are weaknesses in PNNL issues/corrective action management processes that hinder effective management evaluation of performance issues. As a result, some readily observable deficiencies are not being identified, and corrective actions for identified deficiencies have not always been implemented and verified to be sufficient to preclude recurrence. Further, PNNL is not always conducting sufficient investigations of injuries and illnesses to ensure that root causes are identified and appropriate corrective actions and recurrence controls are identified and implemented. RL and AMT have not always been effective in achieving correction of previously identified deficiencies in the PNNL self-assessment and corrective action management programs.

PNNL hazards analysis and control processes are not implemented with sufficient rigor at the activity level to ensure that some hazards are effectively addressed, particularly for lower risk activities. PNNL chemical use documentation and implementation of processes for identifying and controlling chemical hazards (i.e., IOPS, the Chemical Management System, and chemical use permits) do not always ensure sufficiently tailored hazard controls (i.e., specific personal protective equipment requirements and hazard communications) such that appropriate protection is provided to the workers as required by SBMS. Worker exposure assessments and ventilation surveys are not being performed as required by the Occupational Safety and Health Administration and DOE Order 440.1A to provide assurance that worker exposures are maintained below regulatory compliance levels. In most instances, controls were effectively identified and implemented in higher hazard facilities/activities, but hazards analysis and control processes for some lower hazard activities are not well defined and other controls were not implemented with sufficient rigor. As a result, needed controls were not in place for some PNNL R&D and F&O support activities.

RL and PNNL have not adequately demonstrated that the REVS at the RPL will perform its safety function for some credible accident scenarios. The amounts of radioactive material in the RPL are limited and the REVS design is generally robust. However, there are several fundamental design weaknesses in REVS that could prevent the system from performing its intended safety function under certain accident conditions that are not adequately reflected in the documented safety analysis. These include: (1) the design does not account for potential building pressurization and resultant unfiltered leakage during a design basis fire due to rapid loading of the REVS high efficiency particulate air (HEPA) filters; (2) the design does not include adequate criteria for maintaining negative building pressure that accounts for wind effects; and (3) the REVS HEPA filter isolation dampers alone do not provide adequate isolation to maintain the required system filtration efficiency when a filter bank is isolated. In addition, some REVS design requirements are not translated adequately and correctly into the system procedures (i.e., the REVS HEPA filter and backup air supply testing were inadequate to demonstrate operability). Further, PNNL did not develop sufficiently rigorous and formal analysis to support the REVS design and operating requirements and capabilities, resulting in some incorrect or non-conservative requirements and capabilities.

3.0 Conclusions

Overall, implementation of ISM at PNNL has improved noticeably since the 1998 DOE Headquarters independent oversight evaluation. This improvement is based on successful implementation of a number of initiatives and application of modern information management tools. RL, AMT, and PNNL management are supportive of safety and understand and accept their line management responsibility. SC, EM, RL, and AMT have coordinated their efforts to establish an appropriate plan for transitioning to PNSO. With a few exceptions, AMT and PNNL have adequately identified and communicated responsibilities for ES&H functions. PNNL has an effective process for identifying requirements and ensuring that they are clearly incorporated into working-level processes and procedures. PNNL has effectively integrated S/CI requirements into facility procedures. However, PNNL line management has not always ensured that management expectations for rigorous implementation of ES&H requirements are established and communicated.

The REVS at RPL is in good material condition, operators are well trained, and most operating procedures are well designed. Configuration management is effective, and SC, RL, and PNNL have taken appropriate actions to maintain and upgrade components in the aging system. However, REVS has several design elements that were not adequately analyzed in the safety analysis, and that could prevent the system from performing its design safety function. The REVS design and operating requirements and capabilities are not adequately supported by formal, rigorous analyses, resulting in some incorrect requirements and capabilities.

Most aspects of work that the OA team observed at PNNL were properly performed with a high regard for safety. With some exceptions, effective hazard controls were in place and effectively implemented, particularly for higher hazard activities, environmental protection/waste management activities, and certain facility support activities. Some aspects of PNNL implementation of ES&H requirements are particularly rigorous (e.g., engineering controls in most laboratories and F&O activities).

However, weaknesses were identified in the implementation of a number of hazard controls and procedures, and ES&H requirements were not always rigorously implemented for some activities, primarily lower hazard activities. Facility management, supervisors, and ES&H personnel did not always take sufficient action to ensure that requirements were being effectively implemented. For lower hazard activities, management expectations for the degree of rigor and documentation are not well defined, placing too much reliance on individual expertise and experience rather than clear thresholds and standards. Most PNNL personnel are experienced and competent, are familiar with the facilities and hazards, have experience with PNNL processes (e.g., SBMS, IOPS, and EPR), and often implement effective controls. However, performance varied among individuals and organizations, and documentation of decisions and controls was lacking in many cases. Improvements are needed in implementation of a number of PNNL processes, including worker exposure and ventilation assessments, interfaces between IOPS and EPR, chemical use documentation, and documentation of controls.

Radiochemical Processing Laboratory (RPL)

RL, AMT, and PNNL feedback improvement programs include numerous inspections and have contributed to improvements in ES&H programs. However, AMT and PNNL assessments and corrective actions have not been consistently effective in identifying and correcting deficiencies in facilities, processes, and work activities. The PNNL feedback and improvement program is not sufficiently rigorous or effective in identifying and correcting ES&H deficiencies. RL and AMT have not always been effective in achieving correction of previously identified deficiencies in the PNNL self-assessments and issues/corrective action management processes.

Overall, the ISM programs at PNNL are mature and well structured and effectively address many of the potential hazards. However, improvements are needed in important aspects of the RL, AMT, and PNNL implementation of ISM, including implementation of activity-level controls, REVS safety basis analysis and documentation, and RL, AMT, and PNNL feedback and improvement systems. While improvements are needed in some of the areas, PNNL has maintained a very good safety record.

4.0 Ratings

The ratings reflect the current status of the reviewed elements of the PNNL ISM program:

Safety Management System Ratings

Guiding Principle #2 – Clear Roles and Responsibilities .... EFFECTIVE PERFORMANCE
Guiding Principle #5 – Identification of Standards and Requirements ... EFFECTIVE PERFORMANCE

Feedback and Improvement

Core Function #5 – Feedback and Continuous Improvement .... NEEDS IMPROVEMENT

Implementation of Core Functions for Selected Work Activities

Core Function #1 – Define the Scope of Work.................................. EFFECTIVE PERFORMANCE
Core Function #2 – Analyze the Hazards .... EFFECTIVE PERFORMANCE
Core Function #3 – Develop and Implement Hazard Controls .... NEEDS IMPROVEMENT
Core Function #4 – Perform Work Within Controls .... EFFECTIVE PERFORMANCE

Essential System Functionality

Design and Configuration Management .... SIGNIFICANT WEAKNESS
Surveillance, Testing, and Maintenance .... EFFECTIVE PERFORMANCE
Operations .... EFFECTIVE PERFORMANCE

APPENDIX A
SUPPLEMENTAL INFORMATION

A.1 Dates of Review

Scoping Visit	September 9 - 12, 2003
Onsite Review Visit	November 10 - 21, 2003
Report Validation and Closeout	December 2 - 4, 2003

A.2 Review Team Composition

A.2.1 Management

Glenn S. Podonsky, Director, Office of Independent Oversight and Performance Assurance
Michael A. Kilpatrick, Deputy Director, Office of Independent Oversight and Performance Assurance
Patricia Worthington, Director, Office of Environment, Safety and Health Evaluations
Thomas Staker, Deputy Director, Office of Environment, Safety and Health Evaluations

A.2.2 Quality Review Board

Michael Kilpatrick
Dean Hickman
Patricia Worthington
Robert Nelson
Thomas Staker

A.2.3 Review Team

Patricia Worthington (Team Leader)
Bill Miller (Deputy Team Leader)

Ali Ghovanlou, Management Systems Lead
Phil Aiken
Robert Compton
Albert Gibson

Bill Miller, Essential Systems Functionality Lead
Michael Gilroy
Don Prevatte
Joe Panchison

Marvin Mielke, Core Functions Lead
Vic Crawford
Mark Good
Joe Lischinsky
Jim Lockridge
Edward Stafford
Mario Vigliani

A.2.4 Administrative Support

Sandra Pate
Tom Davis

APPENDIX B
SITE-SPECIFIC FINDINGS

Table B-1. Site-Specific Findings Requiring Corrective Action Plans

FINDING STATEMENTS
1. RL and AMT have not always been effective in correcting previously identified deficiencies in the PNNL self-assessment and corrective action management programs.
2. PNNL has not applied sufficient rigor to feedback and improvement processes to ensure that ES&H performance is consistently and effectively evaluated and that ES&H-related incidents and program and performance deficiencies are thoroughly and formally evaluated, resolved with effective recurrence controls, and analyzed for adverse trends.
3. PNNL line management has not sufficiently implemented SBMS requirements for chemical use documentation to ensure that specific activity-level hazard controls are identified for all chemical hazards.
4. Workplace exposure assessments and ventilation surveys are not being performed as required by OSHA and DOE Order 440.1A to provide assurance that worker exposures are maintained below regulatory compliance levels.
5. The PNNL RPL REVS design contains fundamental weaknesses that could prevent it from performing its design safety function and that are not adequately addressed in the DSA and associated TSRs.
6. PNNL has not adequately and correctly translated some REVS design requirements into system procedures, and REVS HEPA filter and backup air supply testing was not adequate to demonstrate operability.
7. PNNL has not ensured that the REVS design and operating requirements and capabilities are adequately supported by formal, rigorous analyses. The DSA and TSRs for the REVS were developed without sufficient formal technical analyses to support the design, operating parameters, or limits.
8. The safety evaluation process conducted by RL to support approval of the RPL DSA and TSRs for REVS did not provide an adequate basis for approval.

APPENDIX C
GUIDING PRINCIPLES OF SAFETY MANAGEMENT IMPLEMENTATION

C.1 Introduction

The U.S. Department of Energy (DOE) Office of Independent Oversight and Performance Assurance (OA) evaluation of safety management systems focused on selected guiding principles of integrated safety management (ISM) at the Pacific Northwest National Laboratory (PNNL). OA examined Guiding Principle #2 (Clear Roles and Responsibilities) and Guiding Principle #5 (Identification of Standards and Requirements). OA also reviewed the status of selected ongoing actions in areas of interest to the Defense Nuclear Facilities Safety Board, including implementation of suspect/counterfeit item (S/CI) requirements.

DOE Headquarters Office of Science (SC), Richland Operations Office (RL), PNNL, and subcontractor personnel were interviewed to determine their understanding of the ISM program and their responsibilities, as well as the status of ongoing initiatives and corrective actions. The OA team reviewed various documents and records, including ISM program documents; environment, safety, and health (ES&H) procedures; functions, responsibilities, and authorities manuals (FRAMs); ES&H manuals; contract provisions related to safety; subcontract provisions; selected aspects of staffing, training, and qualifications of technical personnel; and various plans and initiatives relating to PNNL and RL oversight. The evaluation of the guiding principles also considered the results of the concurrent OA review of the core functions.

The review of the guiding principles focused on institutional and facility-level programs and implementation of requirements at selected PNNL facilities, including the Radiochemical Processing Laboratory (RPL), the Environmental Molecular Science Laboratory (EMSL), and Building 331, as implemented by selected PNNL research and development (R&D) organizations, including the Radiochemical Sciences and Engineering group within the Process Science and Engineering Division, the Fundamental Sciences Directorate, the Environmental Technology Directorate, and the Facilities and Operations (F&O) organization. The review of DOE line management focused on the current line management responsibilities: SC as the cognizant secretarial office, the DOE Office of Environmental Management (EM) as the landlord for the Hanford Site, RL as the onsite organization responsible for PNNL, and the Associate Manager for Science and Technology (AMT), which is the organization within RL that is assigned responsibility for implementing most of RL's line management oversight responsibilities. In addition, OA reviewed the SC, RL, and AMT plans to transition to the SC Pacific Northwest Site Office (PNSO). On December 5, 2003, the Office of the Secretary of Energy approved establishing the PNSO as an SC site office to provide direction to and oversee PNNL. The Head Contracting Authority and Chief Financial Officer responsibilities are expected to be reassigned from RL to the SC Office of the Deputy Director for Operations (SC-3) and the Oak Ridge

Environmental Molecular Sciences Laboratory (EMSL)

Operations Office, respectively, within the next couple of months.

C.2 Results

C.2.1 Clear Roles and Responsibilities

Guiding Principle #2: Clear and unambiguous lines of authority and responsibility for ensuring safety shall be established and maintained at all organizational levels within the Department and its contractors.

SC, RL, and AMT

SC has developed a restructuring project that will realign the SC Headquarters and field structure in order to clarify and streamline roles, responsibilities, authority, and accountability (R2A2) for management of science laboratories. When this project is implemented, SC will have a site office manager at PNNL and each of its other science laboratories. The site office managers will have primary line management responsibility for operations and ES&H, and will report to the Chief Operating Officer, SC, thereby eliminating one layer of management. The SC site offices will be augmented by support centers, formed primarily from SC personnel at Headquarters and the current Chicago and Oak Ridge Operations Offices.

SC has developed a systematic three-phase plan for implementing the restructuring project across SC. The first phase includes defining the new organizational structure, appointing the new management team, and related activities (e.g., developing R2A2 documentation and memoranda of understanding with other affected organizations). However, the restructuring plan has encountered significant delays. Phase 1 was initially projected to be complete by the end of calendar year (CY) 2002, but senior DOE management has not yet approved the reorganization.

Similarly, SC, EM, and RL have effectively coordinated efforts to develop a plan to transfer AMT and a few other RL support positions to the new SC PNSO, but the approval of the transfer has encountered some delays. Although no schedule has been established, AMT anticipates the transition will be approved in the near future by senior DOE management. In anticipation of the formal approval of the new PNSO, AMT is currently performing most DOE line management functions as a semi-autonomous organizational element within RL. The RL Manager maintains appropriate awareness of operations and issues but has authorized AMT to make most of the decisions regarding the PNNL contract and operations.

The delay in the formal approval of the PNSO office has not had an adverse impact on ES&H at PNNL because the key DOE management functions are presently being implemented by AMT and RL. However, the benefits of the clear lines of responsibility and accountability are not yet being realized. Until the transition to PNSO is complete, RL and EM (as the site landlord and the organization that RL reports to) will continue to have line management responsibilities for PNNL.

Although the current management structure does not reflect the planned streamlining and clarification of line management responsibility, the current R2A2s for DOE's management of PNNL are adequately defined, documented, and communicated. The SC FRAM and a signed management agreement (between SC, EM, and the RL Manager) clearly describe the relationships and flowdown of SC R2A2s to the RL Manager. The RL FRAM describes the flowdown of R2A2s from multiple Program Secretarial Officers (including SC) through 14 RL Management System Owners, and down to implementing documents. The RL FRAM provides an Applicability Matrix that "crosswalks" the requirements to RL implementing documents. As indicated by the AMT transition plan, AMT anticipates developing a lower-tier FRAM document for PNSO (when the office is formally established) in accordance with DOE Manual 411.1-1B.

AMT has adequate implementing documents that describe AMT line management and oversight processes. AMT uses many of the RL implementing documents to perform line management and oversight responsibilities at PNNL. There are a few administrative discrepancies in the AMT implementing documents because AMT uses different oversight processes than the rest of RL due to the provisions of the DOE/Battelle Memorial Institute (BMI) contract. Two processes used by AMT differ slightly from the RL processes (i.e., the performance assurance procedure and the proposal and work authorization approval procedure) and the AMT-specific processes are not listed in the RL FRAM Applicability Matrix. In addition, the AMT Facility Representatives (FRs) report to AMT rather than to the RL organization specified in the RL FR Process Description. The two FRs and four other RL positions were reassigned to AMT in July as part of the preparation for establishing the PNSO. However, the corresponding AMT processes meet the intent of the RL processes and requirements.

R2A2s for AMT, including those for FRs and subject matter experts (SMEs), are well documented, and are understood by the AMT staff (however, see Appendix D for discussion of weaknesses in implementation of line oversight responsibilities). The RL Manager recently (November 10, 2003) approved a new document, *AMT Roles, Responsibilities, Accountabilities, and Authorities*, that provides details on the identification and flowdown of AMT R2A2. The position-specific R2A2s are used to meet the top-level SC R2A2s. Additional details on individual/ position-specific R2A2s are provided in individual performance plans, supervisory performance appraisal forms, the AMT management system description, the management system assignment matrix, and AMT-specific procedures. AMT personnel had a clear understanding of their respective roles, responsibilities, and authorities. Administration of the individual performance plan process at AMT provides the framework for an effective accountability process.

PNNL

Institutional R2A2s. Many institutional ISM R2A2s for PNNL staff and managers are adequately described in the integrated ES&H program description document, facility use agreements (FUAs), the work control procedure (ADM-16), a number of Standards Based Management System (SBMS) management systems and subject area descriptions, and the SBMS R2A2 document. (SBMS is a web-based electronic delivery system that also describes a set of 20 PNNL management systems.) At PNNL, two institutional organizations—the Environment, Safety, Health, and Quality (ESH&Q) and F&O Directorates—are assigned important support functions for PNNL R&D line management in developing, implementing, and maintaining systems that enable PNNL researchers to conduct their work safely.

ESH&Q provides SMEs and field-deployed staff to support line organizations. In addition, ESH&Q is responsible for setting institutional policies, maintaining SBMS, and providing ES&H performance feedback to the upper management. ESH&Q is the process owner for several important SBMS management systems, such as worker safety and health and integrated ESH&Q. SBMS management system owners and SMEs assigned to various subject areas have a clear understanding of management expectations and their roles and responsibilities. PNNL actively participates in the DOE voluntary protection program and has achieved Star status.

However, with some exceptions (e.g., environmental compliance representatives and waste management field service representatives), detailed management expectations and institutional R2A2s for field-deployed ESH&Q personnel have not yet been fully defined by the ESH&Q organization. Currently, the operation managers of the "host" organizations develop the expectations for the support roles of ESH&Q staff, with the concurrence of the ESH&Q organization manager. The lack of well-publicized and documented institutional expectations for safety and health (S&H) representatives, as part of the SBMS process for worker safety and health, has, in some instances, reduced the effectiveness of deployed ESH&Q staff in their interactions with R&D staff and managers. In addition, the SBMS worker safety and health management system description does not address the relationship of this process with the Integrated Operations System (IOPS) and Electronic Prep and Risk (EPR) processes.

The F&O Directorate functions as the landlord for most facilities and buildings and has assigned building managers, engineers, and core team staff to provide direct facility support to the R&D line organizations. R2A2s for these individuals are generally well defined and implemented in PNNL documents. For example, the building management role includes ownership of the FUA and implementation of the work control process for maintenance and constructions. FUAs define the operating boundaries/requirements for each facility, including R2A2s for building mangers and occupants. Building managers lead an F&O "core team" that, depending on the size and other requirements of the building, includes a building engineer, facility project managers, work control specialists (planners), and safety engineers. Implementation of roles and responsibilities within the core team is comprehensive, and the interface between the support staff and the researchers (through the building manager, building engineer, and cognizant space manager [CSM] position) has been well established and maintained.

The implementation of roles and responsibilities for PNNL support functions is generally well defined and supported by such modern information management tools as the electronic service request (ESR). These tools allow electronic distribution of documents (e.g., the permit and/or forms) to those who need to review and approve them, or others who could benefit from the information. For example, the ESR system, a mechanism used to obtain service and maintenance support from F&O, is linked to the IOPS database and automatically displays hazards for the space where the

New LAN Installation

work is to be performed. In addition, the ESR is automatically sent to the responsible CSM for early notification of pending work in his/her space or facility. In another example, the EPR automatically sends email notifications to SMEs and CSMs, alerting them to the hazards of new or proposed R&D projects.

Roles and Responsibilities for Authorizing and Conducting Work. R&D work at various PNNL facilities, including Building 331, EMSL, and RPL, are based on two related processes. In each building, the IOPS process is designed to allow performance of R&D work at various "spaces" within a building where the hazards/controls for the intended type of work have been evaluated with respect to the IOPS requirements in the laboratories and are bounded by the FUA/ documented safety analysis (DSA). The second process, the EPR, is intended to identify and communicate the risk and ES&H hazards of a new or a modified project for the IOPS space where the work is to be performed. With some exceptions, the EPR and IOPS processes are used for most R&D activities.

The overall responsibility for safety in the workplace has been appropriately assigned to line management. The line management chain flows from the PNNL Director, to associate laboratory directors, division directors, and technical group managers. For spaces within their jurisdictions, the technical group managers have authorized CSMs. The CSMs, who typically perform R&D work within these spaces, implement a process to assure that only work allowed by the safety requirements for the space is performed. CSMs are assisted by support organizations for their divisions and/or facilities. These organizations provide administrative and technical services associated with IOPS, support staff, ESH&Q, and F&O. R2A2s for identifying, bounding, and communicating risks/hazards of new R&D projects are assigned through the EPR process to product line managers (PLMs) and project managers.

The IOPS is an effective process for conducting small R&D projects (most PNNL activities fall into this category). The IOPS process and the associated R2A2s at the facilities inspected are appropriately defined and, in most instances, were effectively implemented. For example, most R2A2s for identifying and documenting IOPS hazards for laboratory spaces used to conduct research in such fields as chemistry and molecular biology have been appropriately defined. Furthermore, CSMs were knowledgeable of their duties and responsibilities, including building and facility access control, self-assessment, and changes to hazards.

The CSMs' R2A2s have also been clearly communicated and supported by all levels of PNNL management, including the PNNL Director. CSMs have recently received a written delegation of authority from line management, emphasizing their R2A2s, and confirming their authority for IOPS laboratory spaces. The CSMs indicated that they believed they had the appropriate level of authority to perform their duties.

For RPL activities, additional measures have been taken to ensure that R2A2s are clearly defined and understood. RPL's DSA clearly describes operational and programmatic (R&D) functions for performing work. Further, the RPL Manager's R2A2s for implementing the DSA are clearly defined. The roles and responsibilities of the Independent Review Committee, which supports the RPL Facility Manager in authorizing new programmatic work, are also clearly defined.

Although the R2A2s for many organizations and the IOPS and EPR processes have generally been appropriately defined, the OA team identified a number of programmatic weaknesses in the area of R2A2s:

- SBMS has not adequately established requirements or clear and detailed R2A2s for S&H representatives and for assessment, issues management, lessons learned, employee concerns, and injury and illness reporting.

- The span of control for some CSMs, who also perform research, is too great and detracts from CSM responsibilities. A number of the CSMs have to maintain continuous awareness of over ten other projects performed by other researchers in their IOPS space(s). These CSMs may not have sufficient time to effectively address oversight, new projects, or project modifications.

- The interface between the resource managers who own craft resources and the CSM who owns the space where crafts work is not clearly established.

In addition, a number of deficiencies are evident in the implementation of certain ES&H controls, as discussed in Appendices D, E, and F. For some of those deficiencies, PNNL management systems had assigned responsibilities, but PNNL personnel did not rigorously and effectively execute their responsibilities. These include:

- The hazard identification/mitigation feature of the F&O job planning software was not used by a work planner in the preparation of a job planning package (JPP) for electrical work. The JPP, however, had been signed, authorized by several members of the core team, and executed. F&O management immediately responded to this issue by conducting a management assessment of over 100 JPPs and found additional instances of the same problem.

- Several deficient EPRs were approved by PLMs/ project managers without the identified hazards being appropriately addressed as required by the risk mitigation permit.

- There were instances where PLMs, who are accountable for assessing the safety of their projects, failed to obtain appropriate ESH&Q SME and ESH&Q representatives' support to review their projects.

- There were instances where the responsible CSMs did not ensure that IOPS hazards analysis summaries reflected all hazards present in the IOPS spaces or where the specific requirements for IOPS permits were not met at the project/task level.

- There were several instances where the IOPS hazards were not included in the JPPs and dispatch work orders, although these documents had been signed and work had been performed.

When viewed collectively, the deficiencies above indicate that PNNL management has not always established sufficient expectations for rigorous performance of safety responsibilities. However, many of the weaknesses in R2A2 are most evident in small, stand-alone projects, most of which are categorized as low-hazard activities. Additional controls are often in place for larger projects and higher-hazard activities. For example, the EMSL user proposal process requires that all proposals be reviewed by the ESH&Q staff for verification of ES&H hazards before acceptance. After acceptance, a host familiar with EMSL processes is assigned to the outside user to establish access to the IOPS space where the project is to be performed.

Summary. Most aspects of RL, AMT, and PNNL R2A2s are well defined and communicated. SC, RL, and AMT have an appropriate transition plan for the PNSO, but the benefits of the planned reorganization are not yet being realized because of delays in approving and implementing the reorganization. Although not yet approved, SC, RL, and AMT have coordinated effectively to develop a clear plan for the transition to an SC PNSO office and have ensured that key DOE management functions are performed while the transition is pending. Many PNNL R2A2 systems are mature and well documented. However, there are weaknesses in some aspects of implementation of the systems that are contributing to deficiencies in identification and control of some hazards, mostly in lower hazard activities. Notwithstanding these weaknesses, SC, RL, AMT, and PNNL have a good framework of R2A2s in place. Additional communication of management expectations for rigorous implementation of existing systems would further improve safety management at PNNL.

C.2.2 Identification of Standards and Requirements

Guiding Principle #5: Before work is performed, the associated hazards shall be evaluated and an agreed-upon set of safety standards shall be established that, if properly implemented, will provide adequate assurance that the public, the workers and the environment are protected from adverse consequences.

DOE

RL has established ES&H requirements in the DOE/BMI contract consistent with current Departmental policy for managing these requirements. Recent Departmental policy encourages the reliance on Federal, state, and local laws and regulations and national and industry standards to establish contractor requirements and performance criteria, while minimizing the use of DOE orders and directives for placing administrative and operating requirements on the contractor. Consistent with this policy, Special Contract Requirement H-18 was included in the DOE/BMI contract to provide a mechanism for PNNL to propose procedures and standards as alternatives to DOE directives listed in the contract and to allow implementation of these alternatives once approved by the contracting officer.

AMT has worked effectively with PNNL, using a formal requirements integration and tailoring process, to identify a necessary and sufficient set of ES&H requirements for meeting DOE expectations. Redundant requirements that had been included in the previous contract were eliminated. Requirements that apply only to the PNNL RPL, the only nuclear facility at PNNL, were listed separately in the RPL authorization agreement, which is included as part of the new contract.

RL and AMT processes for administering the PNNL contract are in transition. The PNNL Contract Administration Plan has not been updated to reflect the transfer of contracting officer responsibilities from RL to AMT and does not yet address recent contract changes that encourage use of industry standards in lieu of DOE directives. For example, the plan does not specify if alternate requirements, which are adopted in lieu of DOE directives, are to be included in the contract. AMT currently relies on the Richland Integrated Management System and on technical support from RL SMEs for review of new and revised DOE directives and for development of records of decision regarding applicability of these directives, but this support is not expected to be available in the future. AMT understands the need to update processes for contract administration. A strategy has been developed and an update to the Contract Administration Plan is being prepared.

RL has not established clear expectations for including adopted industry standards in the contract, and no such standards are currently included. Managers interviewed did not have a clear or consistent understanding of DOE expectations in this area. An international standard, ANSI/ISO14001-1996, *Environmental Management System*, was adopted for environmental management in lieu of DOE Order 450.1, *Environmental Protection Program*, but the adopted standard was not included in the contract. In addition, some facility safety requirements specified in DOE Order 420.1, *Facility Safety*, which were in the previous contract, are not in the current contract. However, the Facility Safety requirements and integration tailoring process negotiated with PNNL, AMT, and RL identifies that the following documents, as applicable to PNNL and PNNL-managed facilities, will be used as best practice approaches to address the design and natural phenomena criteria for new facilities or modification to existing facilities: DOE Guide 420.1-1, *Nonreactor Nuclear Safety Design Criteria and Explosives Safety Criteria Guide for Use with DOE Order 420.1, Facility Safety*; and DOE Guide 420.1-2, *Guide for the Mitigation of Natural Phenomena Hazards for DOE Nuclear Facilities and Nonreactor Facilities*.

PNNL

The PNNL SBMS provides a systematic process for the flowdown of ES&H requirements. External requirements, including laws, regulations, and contract requirements, are conveyed to the PNNL workforce through a formal hierarchy of documents, including policies, standards (i.e., standards of conduct), management system descriptions, program descriptions, and subject area descriptions (e.g., laboratory-wide procedures), which are delivered to users through SBMS. Each external requirement is supported by a record of decision that identifies the organization responsible for implementation and provides a link to implementing documents. The SBMS electronic delivery system is mature (established in 1995) and well used by the PNNL staff.

An SBMS subject area, "Requirements Management," provides adequate procedures for identification and processing of new and revised DOE directives, laws, and regulations. New and revised DOE directives are identified by DOE and processed by PNNL in accordance with specific terms in the contract. New and revised laws and regulations are not normally identified by DOE and are applicable to PNNL whether listed in the contract or not. The procedure for identifying changes to laws and regulations assigns responsibility for identifying such changes to management system owners but does not specify a process or frequency for systematically performing this task. Nonetheless, the individuals performed their responsibilities effectively for the following examples reviewed by the OA team:

- Recent Occupational Safety and Health Administration requirements for reducing occupational injuries due to needle sticks and other sharps-related injuries were effectively managed by PNNL. Federal regulation 29 CFR 1910.1030, *Bloodborne Pathogens*, was revised about two years ago to implement the Needle Stick Safety and Prevention Act of November 6, 2000. A record of decision was prepared and appropriate requirements were included in the applicable subject area.

- A March 2003 change to Federal transportation requirements for hazardous materials has been identified and implemented by PNNL. Regulation 49 CFR 172.800 requires shippers of hazardous materials to develop security plans for such shipments by September 25, 2003. The PNNL SME for transportation was well aware of this requirement and had developed a record of decision and the required security plan.

External ES&H requirements are adequately addressed in SBMS and lower-tier documents. To evaluate the effectiveness of SBMS, the OA team traced several external requirements through implementing documents in the SBMS to determine whether the PNNL workforce was provided the information necessary for safety and compliance. In general, external requirements, including contract clauses and applicable Federal regulations and DOE directives, were adequately addressed in SBMS and lower-tier documents. For example:

- The guiding principles and core functions of ISM, as specified in Contract Clause I-87, are addressed in SBMS through a program description and subject area procedures. In general, SBMS includes adequate procedures for addressing roles, responsibilities, and authorities pursuant to Guiding Principle #2 and for the identification of safety standards pursuant to Guiding Principle #5. The PNNL IOPS and the F&O procedure set provides a means of ensuring that work is planned and accomplished in accordance with the core functions of ISM. The procedures for this system, which are included as subject areas in SBMS, provide mechanisms for staff members to identify hazards associated with proposed work and for CSMs to evaluate these hazards and define the ES&H requirements that the staff members must meet.

- The requirements in Federal regulation 10 CFR 835, *Occupational Radiation Protection*, are satisfactorily addressed in the radiation protection program description in SBMS and in the PNNL Radiation Protection Manual, MA-266. These requirements flow down to the workforce through implementing procedures and radiation work permits.

- Fire protection requirements include a requirement in DOE Order 420.1A to comply with National Fire Protection Association standards. This requirement is included in the fire protection program description in SBMS. The requirement in National Fire Protection Association-80, *Standard for Fire Doors and Fire Windows*, for the annual testing of rolling fire doors is included in preventive maintenance procedure PM 44574 for testing of EMSL fire doors. This procedure does not require full documentation of test results, and some positive results of the most recent test were not recorded.

- The interface between PNNL and the Hanford Reservation occupational medical provider, Hanford Environmental Health Foundation (HEHF), is effective and fulfills the contractor requirements in DOE Order 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees*, Chapter 19, Occupational Medicine. PNNL and HEHF professional staff interact regularly to address worker protection health issues and have developed several specific medical surveillance formats to better identify health concerns while working with high-intensity magnetic fields and biohazard environments. The primary medical surveillance tool managed by HEHF, the employee job task analysis (EJTA), provides a comprehensive set of questions to identify a workers potential exposure to hazards. A proposed operations improvement initiative to better integrate the flow of data between PNNL and HEHF automated systems originally approved in fiscal year (FY) 2001, but not yet funded, would improve communication, improve accuracy, and reduce duplication of effort in the EJTA process.

In one instance reviewed by the OA team, flowdown of RPL maintenance requirements from DOE Order 433.1, *Maintenance Management Program for DOE Nuclear Facilities*, was incomplete. The contractor requirements document (CRD) for this order was included in the contract as a requirement applicable to RPL. The CRD requires PNNL to establish a DOE-approved maintenance implementation plan, and a record of decision in SBMS assigned development of this plan to the F&O

organization. This plan was being prepared but was not yet approved for implementation. Although implementation of this order was not yet completed, the safety significance was low because PNNL procedures met DOE Order 4330.4B, *Maintenance Management Program*, which was required by the previous contract and contained most of the same requirements.

The PNNL Requirements Management System has not been fully applied for the identification and processing of applicable industry standards. Industry standards may be voluntarily adopted by PNNL or may be adopted as alternatives to DOE directives in support of commitments made to DOE. In either case, the standards should be clearly identified as requirements in the contractor's Requirements Management System to ensure systematic flowdown through implementing procedures. The PNNL Requirements Management System includes steps for identification, receipt, and processing of external requirement documents but, in the past, industry standards were not generally regarded as external requirement documents and thus were not identified or processed in the Requirements Management System. In the area of ES&H, many of these standards are indirectly included because they are referenced by DOE directives that are listed in the contract as requirements.

An SBMS subject area, "Requirements Integration and Tailoring," provides a process for proposing a set of ES&H requirements and industry standards applicable to each PNNL management system. This process was instrumental in developing the set of adequate DOE directives that is included in the current contract and for establishing a list of agreed-upon industry standards. The "Requirements Integration and Tailoring" subject area specifies that the process is continuous and used on an ongoing basis but does not specify a minimum frequency or other criteria for reevaluating and updating existing requirements. The process was recently revised to require records of decision for applicable industry standards, but these records have not yet been generated, and few industry standards have been identified as requirements in SBMS. For example, records of decision have not been prepared for agreed-upon standards that were identified during development of the current contract.

However, PNNL established an environmental management system pursuant to ISO 14001 as an applicable external requirement in a record of decision and established an environmental management system within SBMS based on this international standard. PNNL was determined to be in conformance with ISO 14001 in November 2002 and was verified to be in continuing conformance in October 2003.

PNNL understands the need to prepare records of decision for applicable industry standards. Preparation of these records is expected to begin early in CY 2004 but has not yet been scheduled.

Formal processes are in place to assure that applicable ES&H requirements flow down to subcontractors. The Acquisition Management System assigns project managers the responsibility for specifying appropriate safety requirements, and the "Purchasing Goods and Services" subject area procedure includes procedures for identifying hazards and including applicable ES&H requirements in subcontracts. The subcontracting process includes appropriate provisions for involvement of ESH&Q SMEs in the planning and oversight of subcontracted activities. Involvement includes review of safety expectations in requests for proposal, evaluation of bidders' past safety performance, participation in pre-construction meetings and job walkdowns, and oversight of work activities. Subcontractors are given the option of using their own health and safety plan or adopting the Battelle Contractor Safety Guide. All subcontracted work is controlled by JPPs and by IOPS when the work is performed in a space where IOPS is applied.

Building 331

Flowdown of ES&H requirements to subcontractors has been effective. Subcontracts for the renovation of the first and third floors of Building 331 and for upgrade of the Building 331 liquid monitoring system were reviewed. Both contracts contained appropriate ES&H requirements. Both included workplace exposure assessments, JPPs, and radiation work permits. The contract for upgrading the liquid monitoring system included the Battelle Contractor Safety Guide; however, the contract for renovation of the first and third floors did not include this guide or a requirement for a subcontractor's health and safety plan, but the guide was adopted after the contract was awarded. This contract identified radioactive materials, asbestos, and mercury as potential hazards and specified appropriate controls for each.

Oversight of subcontractor activities is generally consistent with contractual requirements. Clause I-80 of the DOE/BMI contract states that PNNL is responsible for compliance with ES&H requirements regardless of who performs the work and requires that ES&H requirements flow down to any tier to the extent necessary to ensure compliance. This responsibility is reiterated in the integrated ES&H program description and was understood by PNNL managers contacted during this evaluation. PNNL ES&H personnel frequently inspect construction subcontractor work activities.

DOE requirements for control of S/CIs are adequately addressed in SBMS program descriptions and procedures. DOE requirements in DOE Order 440.1A, CRD Section 22, for identification and control of S/CIs have been integrated into the PNNL quality assurance program and into an S/CI program description. Requirements for implementing this program are adequately addressed in two subject area procedures and lower-tier implementing procedures, which provide requirements for procurement, inspection, control, and reporting of S/CI. The program descriptions and subject area procedures are available to users through SBMS.

In the area of procurement, SBMS includes adequate restrictions and guidance to reduce the probability of purchasing S/CI using purchase cards (P-Cards). A formal inspection process for all purchased items includes steps for identifying S/CI. Inspection criteria direct special attention to items purchased for use in a nuclear facility and include provisions for independent inspections by Quality Engineering when appropriate. The procedures are supported with guidelines describing S/CI identified at DOE facilities.

Adequate processes are in place for identifying and dispositioning S/CI. Procedures direct staff members who identify potential S/CI to contact an S/CI single point of contact (POC) for assistance in identification, reporting, and disposition of these items. Adequate procedures have been established for tagging, segregating, and reporting items that are identified as either suspect or counterfeit. The S/CI POC maintains awareness of S/CI issues identified at other sites by monitoring the DOE Lessons Learned List Server and by participating in periodic S/CI teleconferences sponsored by DOE's Office of Environment, Safety and Health. An Occurrence Reporting and Processing System coordinator in the F&O Directorate reviews occurrence reports and lessons-learned reports from other DOE sites and notifies the S/CI POC of those related to S/CI. The PNNL S/CI POC interfaces with a DOE POC in AMT.

Deficiencies in the implementation of the S/CI program were recently identified through self-assessments and were corrected. A self-assessment of the S/CI program performed by the S/CI POC in September 2002 identified that some individuals receiving purchased items were not familiar with S/CI inspection requirements. A follow-up management self-assessment performed in January 2003 determined that most staff members performing inspections of items having high potential for being S/CI did not inspect for S/CI characteristics. These findings have been adequately addressed through a retraining program.

Summary. AMT and PNNL have worked effectively together to identify an adequate set of ES&H requirements for meeting DOE expectations. Redundant requirements that had been included in the previous contract were eliminated, requirements that apply only to RPL were listed separately in the contract, and increased reliance was placed on industry standards consistent with DOE policy. The SBMS electronic distribution system provides an effective infrastructure for conveying the requirements to the PNNL workforce, including subcontractors. ES&H requirements, including recent changes to these requirements, have been adequately addressed in SBMS subject areas and in lower-tier implementing procedures. The effectiveness of these processes was particularly evident in the procedures for the identification and control of S/CIs, which provide adequate direction to the workforce for identification and control of S/CIs. Processes for management of adopted industry standards do not ensure requirements are incorporated into contracts and procedures. AMT has not clearly conveyed expectations regarding incorporation of standards into the contract and identification of applicable standards in SBMS is incomplete. However, these areas are being addressed by ongoing PNNL initiatives.

C.3 Conclusions

AMT and PNNL have established a comprehensive framework for the institutional ISM program and have implemented most requirements effectively. With some exceptions, clear roles and responsibilities have been established and communicated to responsible staff. The processes for establishing requirements and incorporating them into work instructions are effective. S/CI requirements are clearly established and communicated. However, line managers have not always ensured that management expectations are established, communicated, and met. These weaknesses contribute to deficiencies in implementation of some aspects of ES&H requirements and the quality of assessments and corrective actions. Although improvements are needed in communication of management expectations, most AMT and PNNL institutional management systems are well defined and are contributing to a safe work environment at PNNL.

C.4 Ratings

The ratings of the guiding principles reflect the status of the reviewed elements of the AMT and PNNL programs.

Guiding Principle #2 – Clear Roles and Responsibilities .... EFFECTIVE PERFORMANCE
Guiding Principle #5 – Identification of Standards and Requirements .... EFFECTIVE PERFORMANCE

C.5 Opportunities for Improvement

This OA inspection identified the following opportunities for improvement. These potential enhancements are not intended to be prescriptive or mandatory. Rather, they are offered to the site to be reviewed and evaluated by the responsible line management, and accepted, rejected, or modified as appropriate, in accordance with site-specific program objectives and priorities.

DOE Office of Science and DOE Office of Environmental Management

1. **Consider accelerating efforts to gain approval for the establishment of PNSO, transfer resources from RL to SC/PNSO, and implement the transition plan for shifting responsibilities to PNSO.**

RL Associate Manager for Science and Technology

1. **Ensure that appropriate national standards are included as requirements in the DOE/BMI contract.** Specific actions to consider include:

    - Establish screening criteria for determining which national standards are to be included in the contract.
    - Establish ongoing processes to periodically review national standards for changes and revise the contract as appropriate.

Pacific Northwest National laboratory

1. **Clarify expectations and enhance the rigor of implementation of R2A2s, particularly with the interfaces among SBMS, IOPS, and EPR.** Specific actions to consider include:

    - Establish and communicate clear senior management expectations for rigorous implementation of responsibilities at all levels of management.
    - For PLMs and project managers, include performance metrics related to hazard identification and implementation of hazard controls through PNNL processes, such as the EPR and IOPS processes.
    - Develop, document, and publicize the institutional expectations for S&H representatives as part of the SBMS process for worker safety and health.

- In the SBMS worker safety and health management system description document, address the relationship between this management system and the IOPS and EPR processes.

- Examine the span of control of CSMs to determine whether assigned ES&H responsibilities are commensurate with their workloads. Identify additional support requirements or alternative distributions of workloads as appropriate.

- Formalize expectations for PLMs and project managers to make timely notifications to CSMs about the risks and hazards of new/modified projects.

2. **Further strengthen the requirements management processes in the areas of management of national standards, implementation plans for contractual requirements, and review and approval of subcontract documents.** Specific actions to consider include:

   - Use the requirements and integration tailoring process to identify national standards that are applicable to PNNL. Enter applicable standards as requirements in SBMS.

   - Screen applicable national standards using criteria provided by AMT to develop an agreed-upon list of standards to be included in the contract.

   - Develop an implementation plan, including milestones and schedules, for implementation of CRD 433.1.

   - Review implementation of other ES&H contractual requirements and submit implementation plans for those that are not yet fully implemented.

3. **Continue to promote operational improvement initiatives that will improve the efficiency and accuracy of the HEHF EJTA tool**. Specific actions to consider include:

   - Improve the efficiency and accuracy of the data gathering process for the EJTA tool through the revised improvement initiative.

   - Ensure that the initiatives reduce duplication of effort by populating a single data system and better inform managers concerning worker medical surveillance and training requirements.

   - Ensure that the initiatives enhance communication of worker health information between PNNL and HEHF medical providers.

APPENDIX D
FEEDBACK AND CONTINUOUS IMPROVEMENT (CORE FUNCTION 5)

D.1 Introduction

The U.S. Department of Energy (DOE) Office of Independent Oversight and Performance Assurance (OA) evaluated feedback and improvement programs at the Pacific Northwest National Laboratory (PNNL). The organizations that were reviewed included the DOE Office of Science (SC), the Richland Office Operations Office (RL), and PNNL. Within RL, OA focused primarily on the Associate Manager for Science and Technology (AMT) organization, which performs most of the DOE line oversight functions on behalf of RL. The OA review focused on feedback and improvement programs as they are applied to environment, safety, and health (ES&H) programs at the facilities and activities selected for review on this inspection—the Radiochemical Processing Laboratory (RPL), Environmental Molecular Science Laboratory, Building 331, and Facilities and Operations (F&O) support activities—as implemented by selected PNNL research and development organizations, including the Radiochemical Sciences and Engineering group within the Process Science and Engineering Division, the Fundamental Sciences Directorate (FSD), the Environmental Technology Directorate (ETD), and the F&O organization.

The OA team examined the RL line management oversight of integrated safety management (ISM) processes and implementation of selected line management oversight functions, including the Facility Representative (FR) program, ES&H assessments, AMT oversight procedures, AMT self-assessments, the issues management process, the lessons-learned program, and the employee concerns program. The OA team reviewed PNNL processes for feedback and continuous improvement and implementation of those processes, including assessment processes, corrective action/issues management, lessons learned, injury and illness investigations, and employee concerns.

D.2 Results

D.2.1 SC, RL, and AMT Line Management Oversight

SC uses a variety of informal weekly and monthly phone calls, and an annual onsite meeting to communicate with RL and AMT and to stay informed about major ES&H issues. However, SC historically has not taken a proactive role in providing direction to or overseeing PNNL operations.

The SC reengineering effort is a significant step in changing SC's historical approach to line management oversight. In the planned organization, the Pacific Northwest Site Office (PNSO) will report directly to SC without an intermediate layer of management (i.e., RL). Therefore, SC will be more directly involved in decisions related to PNSO and PNNL activities.

SC has established expectations that guide line management oversight activities and that emphasize contractor self-assessments, encourage contractors to use external experts, and make extensive use of performance indicators to monitor and evaluate contractor performance. As discussed below and in Appendices C, E, and F, there are some deficiencies in PNNL ES&H programs and PNNL self-assessments and issues management, indicating that increased SC attention is needed to enhance PNSO line oversight.

The AMT line management program has the appropriate elements, including FR and ES&H assessment programs. The assessment and operational awareness processes are well documented and the operational oversight of the contractor is accomplished in accordance with the AMT performance assurance procedure. As discussed in Appendix C, on December 5, 2003, the Office of the Secretary of Energy approved establishing the PNSO as an SC site office to provide direction to and oversee PNNL. The Head Contracting Authority and Chief Financial Officer responsibilities are expected to be reassigned from RL to the SC Office of the Deputy Director for Operations (SC-3) and the Oak Ridge Operations Office, respectively, within the next couple of months.

AMT has been implementing a "partnering" paradigm with PNNL since 1995. This partnering approach reflects longstanding SC guidance. As part of this paradigm, AMT emphasizes a coordinated approach to planning and performing assessments and emphasizes performance measures as a tool for monitoring and evaluating performance. The new DOE/Battelle Memorial Institute (BMI) contract (awarded October 2002, signed August 2003, and extending through fiscal year [FY] 2007) reinforces the basis for the partnering approach. The new contract incorporates the six principles from the April 2002 memorandum from Under Secretary Robert Card entitled "Principles for Office of Science Laboratory Contract." In accordance with these principles, AMT management emphasized to its staff that PNNL management is fully responsible and accountable for PNNL activities and quality, including ES&H performance.

The 20 PNNL management systems defined in the Standards Based Management System (SBMS) are used by AMT and PNNL as a framework for line oversight activities. AMT has designated leads for each of the 20 systems, and these leads work with their PNNL counterparts to reach agreements on the assessment expectations, deliverables, and schedules for the year.

AMT's documentation of their contractor oversight activities varies considerably and does not demonstrate sufficient line oversight activities in some management systems. Recently, AMT began using Capture Tool (a desktop documentation application) to document its activities in each of the 20 areas. Partnership agreements for the integrated quality, environment, safety, and health and environmental management areas were reviewed, and documentation for these areas was adequate. However, OA identified that seven AMT primary leads for business management systems had no Capture Tool entries during the period sampled.

The AMT FR program is a well-documented program that meets or exceeds DOE requirements for coverage of PNNL nuclear facilities. Master oversight plans and master surveillance plans are complete and meet the requirements of the RL FR program source documents and procedures. However, AMT has only two qualified FRs, and there are a large number of PNNL facilities. Consequently, the degree of FR attention devoted to the many non-nuclear PNNL laboratories is limited.

Sixty-one FR surveillances were conducted and documented between October 2001 and October 2003. Generally, findings are tracked to closure in a tracking system known as ATS. However, observations are not formally tracked. Further, a number of FR observations were related to requirements and should have been identified as findings so they could be tracked to closure. For example, one surveillance listed an inadequate lockout/tagout as an observation. The practice of not formally tracking observations reduces the effectiveness of the FR program, since surveillance observations are not always verified to be corrected, and observations are not recorded so that they can be tracked and trended.

AMT has not updated guidance for AMT staff to reflect the new contract. The new contract was signed August 26, 2003. AMT has not yet developed a contract administration plan to provide guidance on AMT roles, responsibilities, and authorities relative to contract implementation and execution. The AMT contracting officer advised that the contract administration plan for the previous contract is being utilized until a new one is written and approved. In addition, AMT has not revised its internal performance evaluation and measurement plan (PEMP) procedure, which provides guidelines for the AMT staff in developing year-end evaluation reports, for the new contract. The PEMP, which would normally be approved prior to the start of the fiscal year, is still in draft form, but a final draft is expected to be sent to SC in late December 2003, although it is not clear that the PEMP will be approved before the end of the year.

Performing Facility Rounds

The new DOE/BMI contract provides the contracting officer with the authority to take significant actions if PNNL ES&H performance is not adequate. The contract specifies that the contractor must meet minimum standards for an ES&H program. ES&H minimum standards are to be developed by the contractor, and approved by DOE. The contract gives the DOE official (i.e., the operations office manager) the authority to reduce the award fee by up to the amount earned for failure to meet the approved ES&H minimum requirements or for catastrophic events (such as a fatality, or a serious workplace-related injury or illness to one or more Federal, contractor, or subcontractor employees or the general public, or significant damage to the environment).

The PEMP establishes four top-level performance objectives and metrics for AMT: program implementation, contract management, laboratory stewardship, and internal operations. Metrics and sub-metrics are defined under each of the top-level performance objectives. AMT staff members are assigned for each of the metrics. Data is gathered by these responsible AMT staff members, and is documented in the capture tool. The PEMP requires monthly exception reports, quarterly program review meetings, and an annual year-end self-assessment. Data collected in the capture tool is collected and collated to provide AMT management and staff information relative to performance for monthly program reviews.

The RL employee concerns program is consistent with the requirements specified in DOE Order 442.1A, *Department of Energy Employee Concerns Program*. RL implementing procedures adequately define Federal actions in administration of the program.

Corrective action tracking for Federal actions needs improvement. Currently, Federal corrective actions are being tracked manually by individual action officers within AMT. A new automated, computer-based capture tool (with corrective action capability) has been developed by AMT (accessed from the newly developed PNSO website) and is anticipated to be fully operational by the end of December.

AMT has the framework for a line oversight program that meets SC expectations and contractual provisions. However, many of the key features are in transition or in various stages of development (e.g., internal PEMP procedure, contract administration plan, and PEMP). Further, as discussed in Section D.2.2, AMT has not been effective in ensuring that PNNL establishes and maintains an effective program of self-assessments and corrective action management. AMT surveillances and reviews have identified repeat deficiencies with the PNNL corrective action program, but AMT has not ensured adequate enhancements. In addition, AMT has not required PNNL to formally respond to recent surveillance reports, and PNNL has not always taken adequate corrective actions. As discussed in Appendices E and F, many aspects of PNNL's safety management program are effective but a number of weaknesses are evident. AMT line oversight activities have not always been effective in identifying weaknesses and ensuring that PNNL addresses identified weaknesses. Some ES&H deficiencies (e.g., electrical safety deficiencies) were readily observable during facility tours, indicating that AMT has not performed effective reviews of operations in some areas.

Finding #1. RL and AMT have not always been effective in correcting previously identified deficiencies in the PNNL self-assessment and corrective action management programs.

D.2.2 PNNL Feedback and Improvement Systems

Assessments. PNNL performs a variety of assessments to evaluate the adequacy of ES&H programs and performance using processes that are defined in an SBMS management system entitled "Integrated Planning and Assessment." The associated SBMS documents apply to all types of business and operational programs and activities and address development of business plans by organizations and management system owners, preparation of Laboratory investment proposals, performance assessment plans, conducting assessments, evaluating performance, and implementing improvement actions. Each directorate and management system owner is required to develop and implement an annual comprehensive performance assessment plan, which is to include roles and responsibilities, detailed schedules for assessments, and administrative processes. These plans, which include ES&H programs and activities, vary from directorate to directorate in the level of detail, with some providing specific assessment schedules and others describing a higher-level description of how PEMP metrics will be addressed. In accordance with the independent oversight (IO) management system, PNNL schedules and conducts a variety of institutional-level assessments and special reviews requested by the line, as well as formal root cause analyses for events or significant issues. BMI also arranges for the conduct of an annual independent corporate assessment of PNNL environment, safety, health, and quality (ESH&Q) programs. Suggested guidelines for areas to consider for assessment and techniques and tools for conducting assessments are provided in SBMS attachments.

PNNL organizations perform a variety of types of assessments with varying degrees of rigor and formality. Documented ES&H-related self-assessments are performed by research and support directorates and include management and ES&H walkthrough inspections, cognizant space manager (CSM) Integrated Operations System (IOPS) space assessments, line and support functional area self-assessments, requested IO assessments, and contracted external assessments. F&O has established the most comprehensive and formal assessment program, employing a variety of mechanisms to evaluate performance. F&O and RPL have written internal implementing procedures describing their self-assessment processes. CSMs in research directorates and F&O conduct regular self-assessment inspections tailored to the hazards and activities present in their assigned spaces using formal checklists. These walkthrough inspections are typically conducted quarterly, but the frequency can be adjusted based on individual risks and activity levels. F&O has implemented a risk ranking process for job planning packages (JPPs) that flags high-risk jobs for management consideration for performing activity-based assessments. Some high-risk tasks are being selected for work observation assessments. PNNL management has indicated an expectation for and the importance of managers conducting regular walkthroughs of work areas. Many management walkthroughs are scheduled and conducted by research and F&O managers, often accompanied by ES&H staff. Matrixed ES&H representatives conduct informal inspections and walkthroughs during routine oversight and support of work activities. ES&H functional area subject matter experts (SMEs) conduct programmatic assessments required by regulations and periodic elective program reviews. Research and support organizations conduct a limited number of topic-specific self-assessments, many in reaction to events or identified performance issues.

Notwithstanding the number of assessment activities performed at PNNL, the OA team identified a lack of rigor in the planning and conduct of assessments that is limiting the effectiveness of these activities in evaluating ES&H programs and performance. Although numerous inspections of material conditions are performed, there is much less focus on performing formal, structured assessments, both of processes and performance, and of the results of inspection activities. SBMS documents, written to address top-level business processes, do not always provide clear and specific requirements that drive a consistent and fully effective ES&H self-assessment program. Specific expectations for management walkthroughs have not been established, including who must perform them, to what level of formality, and at what expected frequency. Although some records are being maintained to indicate the number of management walkthroughs conducted, with the exception of ETD, the other evaluated components had no processes to monitor and ensure that management walkthroughs are being conducted by all designated managers as frequently as expected. The conduct of planning and assessments by research and support directorates and management system owners is not always thorough and in compliance with the SBMS documents. Directorate assessment plans have not been issued in a timely manner, and issued plans are not consistent between directorates and do not contain all the elements specified in the SBMS documents. For example, the ESH&Q FY 2003 plan was not issued until June 2003, and the ESH&Q and ETD FY 2004 plans have not yet been issued. The ESH&Q plan for FY 2003 contained an assessment schedule for only two of the six ES&H groups, with the remainder submitting a performance metrics summary. The ETD FY 2003 self-assessment plan and schedule did not include a schedule of assessments. A 2003 schedule, managed by the ETD Operations Manager's Office, existed independent of the document that was reviewed. It does not appear that management is adequately reviewing the submitted plans to assure that effective assessment programs are being established or holding the directorates accountable for meeting SBMS requirements. Although some annual plans were issued late and did not contain assessment schedules, inspections and assessments were still being performed. Although SBMS requires directors and management system owners to perform a "performance evaluation" of assessment and other data to feed into the next year's assessment plan/schedule, no format for reporting the performance evaluation results is specified. ESH&Q has not documented any analysis or analyses for FY 2003 and FY 2004. Each ESH&Q organization and management system owner is expected to perform their own analysis and make adjustments to their individual inputs to the following year's assessment plan/schedule, but this expectation is not documented. Each of the organizations in the OA review scope submitted widely varying reports, many focused on high-level metrics and non-ESH&Q business performance, with little evaluation of self-assessment results or identification of areas for improvement, as specified in SBMS requirements and guidance.

The OA team identified weaknesses in the rigor and quality of self-assessment planning and execution. Although improvements have been made over the last few years, the line organizations still do not consistently perform appropriate elective assessments based on risk and site/facility-specific circumstances. The research directorates have not developed implementing procedures, desk instructions, or guidance on how assessments are selected, planned, and performed, or how findings are to be handled or tracked (e.g., issues management/corrective action management). FSD has no formal, written procedure for tracking issues resulting from self-assessments, and no training or guidance is available for line and support personnel to communicate effective assessment techniques or develop assessment skills.

Other than IO and mandatory ESH&Q functional area assessments, much of the self-assessment activity that was performed addressed inspection of physical conditions, rather than process and program adequacy or observation of work activities. FSD focused self-assessments are very limited in number (eight in FY 2003) and in scope. These included two assessments that were performed to address Occurrence Reporting and Processing System (ORPS) events and several ongoing inspection processes (chemical inventories, trend analysis of accident/injury rates, and environmental compliance summaries). Although at the beginning of this calendar year ETD (including RPL) required ESH&Q SMEs to perform documented activity-based assessments (e.g., watching work), there is no similar expectation for managers, except for RPL. Further, although the expectation was that the seven SMEs would each conduct three of these assessments each quarter, only seven were performed during the first six months of the year. Of the more than 600 deficiencies recorded since June 2002 in the ETD and RPL databases of self-assessment findings (e.g., management and ES&H walkthroughs, non-RPL activity-based assessments, and CSM IOPS inspections), none identified issues describing work observations or programmatic weaknesses. Some RPL activity-based assessments identified work observation performance deficiencies, but all were related to radiological control or waste issues. Although CSM assessments and management walkthroughs are evaluating physical conditions and hazards/controls and some limited individual activity-based assessments are being performed, it is not clear whether the overall work control processes are being comprehensively evaluated. Functional areas and programs, such as ORPS reporting, employee concerns, and injury and illness reporting, have not been assessed in recent years. Assessment of the lessons-learned program was limited to evaluation of usage. Some management system owners are not conducting regular self-assessments of the effectiveness of their processes as indicated in the management system maturity evaluation tool listed in SBMS and the FY 2003 instructions for developing management system business plans. Although there was an employee concern related to health concerns for working with lead, this topical area has not been included in PNNL self-assessments. (See Appendix E for further details on OA team concerns about controls and requirements related to lead exposure.)

Weaknesses were identified in the conduct of CSM space assessments. Few deficiencies were noted on the sample of IOPS checklists reviewed by the OA team. Some staff indicated that if deficiencies were fixed on the spot, they would not be recorded. In one case, a checklist item for laser interlock tests that are required by the SBMS subject area for lasers was checked as satisfactory, although there is no record of the tests being performed. There are no procedures or forms for documenting the completion of the required laser interlock surveillances. There were other indicators of weaknesses in self-assessment activities for hazard recognition and space inspections, including the material condition deficiencies and program weaknesses identified by the OA team (see discussion in Appendix E), the recent Occupational Safety and Health Administration (OSHA) inspection results, and the results of special studies performed by PNNL. For example, because of a high-voltage shock event this spring, extensive inspections were conducted in June and July for "high risk" installations (high voltage) and some unspecified number of lesser risk installations. Approximately 200 deficiencies were identified, including approximately 80 additional installations with exposed energized parts that would have imparted a shock on contact with exposed skin. The wide range of readily identifiable deficiencies indicated the failure of self-assessment programs to identify deficiencies. These deficiencies also indicate complacency, a lack of attention to safety deficiencies, or weaknesses in expectations for workers and supervisors who occupy the maintenance shops and laboratories on a daily basis.

Finding #2: PNNL has not applied sufficient rigor to feedback and improvement processes to ensure that ES&H performance is consistently and effectively evaluated and that ES&H-related incidents and program and performance deficiencies are thoroughly and formally evaluated, resolved with effective recurrence controls, and analyzed for adverse trends.

Issues Management. PNNL has defined a tiered corrective action management program description in SBMS. The program description outlines four tiered significance categorizations: accident investigations are Significance Level 1, Price-Anderson Amendments Act non-compliances and ORPS-reportable events are Level 2, radiological problem reports and quality problem reports are Level 3, and problems that are described as minor, easily fixed, and relatively low risk are Level 4. Problems in the first three categories are required to be tracked in the ATS. The resolutions of Level 4 problems do not require any documentation, and each directorate is given the flexibility to track these issues as deemed appropriate.

The ATS provides a generally adequate vehicle for documenting and tracking conditions and corrective actions, including identification of responsible owners, due dates, and closure dates. The process for formally tracking deficiencies or improvement opportunities in ATS is delineated in the "Assessment Closure" SBMS subject area. The subject area document states that this process applies to external assessments, IO assessments, internal audits (business), Price-Anderson Amendments Act non-compliances, and Type A or B accident investigations. This process document specifies that a closure package should be compiled, appropriate files should be attached to the ATS action, and a description of what was done to complete the action should be documented in ATS. Condition owners may designate that prior to closure they must review and accept closure evidence.

The F&O and ES&H organizations have chosen to use the ATS for tracking the resolution of deficiencies identified during self-assessments. ETD has developed an internal tracking system for self-assessment findings, including CSM self-assessment deficiencies. In the FSD, self-assessment findings are tracked by individual assessors or the assessed organizations. F&O formally tabulates and trends issues from both internal and external sources in over 50 topical areas in a defined "risk universe." These areas are ranked by importance, and such factors as the number of findings and time since prior self-assessments are computed to identify potential areas of weakness or programmatic concerns. Managers meet quarterly to discuss this trend report and determine if additional assessments are warranted. This process is detailed in an F&O procedure. FSD compiles all available assessment information (internal and external) into a database and rates each one on a red/yellow/green scale for significance of the findings in an attempt to identify future focus areas and to prioritize assessment resources.

As part of the performance evaluation and fee agreement (PEFA) process, PNNL performs monitoring and analysis of several agreed-upon quantitative ES&H performance indicators and measures that are communicated regularly to AMT. These metrics are used by PNNL and DOE to measure contract performance and to monitor performance trends. However, evaluations of assessment findings in other directorates and institutionally are much less formal. Issues and potential adverse trends are discussed at various staff and management meetings within directorates and among senior managers. However, with few exceptions, there is little evidence of formal data analysis, and management discussions and decisions are typically not documented.

Although many ES&H issues are documented and evaluated, with corrective actions developed, implemented, and tracked to closure, the multiple tracking methods, many of which are informal, and the lack of a structured process to collect and evaluate issue and action data hinder effective management of feedback information. While evaluations and corrective/preventive actions in reaction to significant events are generally rigorous and comprehensive, insufficient attention is directed at the identification of precursors that could be identified by structured evaluations of the many inspection and walkthrough findings. Procedural and performance deficiencies are limiting the effectiveness of corrective action management at PNNL. SBMS documents for corrective action management are not always consistent and do not include several elements of effective issues management programs. Examples of process weaknesses include the following:

- The threshold for entry of items into the formal tracking mechanism of the ATS, as defined in SBMS documents, is based on the source of the issues rather than the relative significance of the issues. Although the source in many cases does indicate significance (i.e., ORPS or Price-Anderson Amendments Act non-compliances) significant deficiencies can and should be identified during the performance of routine work activities and self-assessments, but they may not receive resources, management attention, and controls commensurate with their significance.

- With the exception of the defined threshold for the type of issues that must be tracked in ATS, the SBMS documents do not provide any individual risk or significance prioritization element.

- Although the program description document discusses the importance of determining and addressing the causes of deficiencies, the implementing assessment closure SBMS document does not address the need to evaluate deficiencies for extent of condition or conduct causal analysis, or specify that corrective actions (recurrence controls) must address causes. There is no field in the ATS for documenting identified causes. The SBMS document does not specify requirements for training and qualification, or processes for conducting causal analysis.

- The "Assessment Closure" subject area document does not identify it as applicable to several types of deficiencies identified in the corrective action management program description as requiring tracking in ATS (e.g., it does not identify it as applicable to ORPS or radiological problem reports).

- The PNNL staff and SBMS documents use inconsistent terminology to identify issues (i.e., problems, conditions, deficiencies, issues, opportunities for improvement, weaknesses, nonconformance, observations, and findings).

- The research directorates have not established any procedures detailing how issues are to be managed in the directorates.

- With the exception of F&O Radiation Control radiological problem reports, suspect/counterfeit item reports, and quality problem reports, there is no routine trend analysis of the deficiencies compiled in ATS or other tracking systems. Analysis metrics are limited to aging of actions and a few high-level dashboard quantitative metrics such as recordable injury rates, ES&H training, and ORPS.

In addition, deficiencies in the implementation of the PNNL corrective action tracking processes were also identified. Examples include the following:

- In many cases, evaluations, corrective actions, causal analysis, recurrence controls, closure evidence files, and references were not well established or documented as required by the SBMS documents. Evaluations are not always rigorously performed such that corrective actions fully address the issues and provide appropriate recurrence controls. Corrective actions that are applicable at an institutional level are sometimes limited to divisions or directorates, and some corrective actions do not adequately address recurrence controls. For example, the issue of excessive delays in reporting of accidents and injuries, a recurring problem at PNNL, was addressed by a one-time presentation to staff rather than more formal actions, such as strengthening employee training or written SBMS expectations. In response to a July 2003 IO analysis of Laboratory events, senior management made commitments and set expectations for management assessments of their facilities in two limited-distribution memoranda without formally directing the implementation of those expectations or establishing any formal mechanisms to ensure that those commitments and expectations were implemented. The records that are available on management walkthroughs indicate that some managers are not performing or documenting assessments as specified in these memoranda. Corrective actions to an employee concern in 2000 related to hazard controls on working with lead were not effective in preventing ongoing concerns. (See Appendix E for further discussion.) A recent self-assessment of ATS identified some of these weaknesses, and corrective actions are being developed.

- Because ATS is an assessment tracking system rather than an issue tracking system, and its required use is limited in scope, some important ES&H issues may not be entered into ATS or entered in a timely manner.

- The management conclusions on the trend analysis of F&O deficiencies are not documented on the trend report (as required by their procedure) or in meeting minutes. Adverse trends are not entered directly into ATS, but are used to target future self-assessments.

- The routine CSM IOPS space assessment reports document adverse conditions but rarely identify the dispositions, and with the exception of the ETD, there is no system to record or track the completion of corrective actions.

Various internal and external assessments, including the BMI corporate assessment, IO assessments, and AMT surveillances, have identified concerns with the effectiveness of the issues management program, but effective corrective actions have not been taken by the Laboratory. For example, an October 1998 DOE Headquarters independent oversight evaluation and a 2001 DOE surveillance identified findings and observations citing undesirable variations in the scope, methods, context, and rigor of PNNL self-assessments, and inadequate self-assessment guidance in SBMS. The 1998 Headquarters evaluation, a 2000 BMI corporate assessment, and a 2000 IO assessment all identified deficiencies in the corrective action program, the failure of existing processes to provide causal analysis, and insufficient tracking data. The conditions reported in these various assessments continue to exist (see Finding #2).

Lessons Learned. PNNL has established and implemented a process for identifying, evaluating, and applying lessons learned. PNNL has developed an innovative and aggressive program to identify positive lessons/best practices. A number of comprehensive and well-written lessons are posted to the website. The institutional procedure provides for screening of externally generated lessons learned by self-assessment points of contact (POCs) and SMEs to establish applicability and any needed actions. Internal lessons learned are being generated, and external lessons learned are being disseminated to department managers/supervisors and to SMEs. Lessons learned and best practices are posted to an institutional database on the PNNL intranet. The website contains 86 lessons learned/best practices in 16 ES&H functional areas, and provides links to numerous external sources for lessons learned. The intranet websites for the electrical safety functional area and for the ES&H organization also include lessons-learned postings. Various documents reflect that lessons learned are being communicated to managers and workers. A tracking feature recording people accessing the online database indicates steadily increasing use.

Although many lessons learned are being reviewed, generated, and disseminated, consistent and effective evaluation and application of externally generated lessons learned cannot be demonstrated due to weaknesses in the established process and implementation. With the exception of an informal program description in F&O, there are no procedures describing the implementation of the lessons-learned program at the institutional or directorate/division level. Although the SBMS subject area provides high-level expectations for self-assessment POCs and unspecified SMEs to search and review information sources for lessons, it does not provide the level of detail needed to clearly identify who is to review what information, and the specific information sources. It specifies no requirements for documentation or feedback on the review or results of lessons learned. Forty-one people are identified as lessons-learned or self-assessment contacts at PNNL, but the list on the intranet has not been kept up to date (e.g., the person several interviewees referred to as reviewing the DOE list server and ORPS for applicability to PNNL is not listed as a lessons-learned or self-assessment POC). Further, the scope of some functional area responsibilities is not clearly delineated (i.e., the topical areas for which the "field work" POC is responsible are not defined). The SBMS subject area document also does not provide for adequate documentation or formal feedback to provide assurance that the program is being effectively implemented.

Implementation of the lessons-learned process is sometimes inconsistent and incomplete. Externally identified lessons learned are not being consistently and rigorously reviewed for all functional areas. Several of the listed POCs interviewed by OA stated that they did not subscribe to or routinely access major sources of lessons learned applicable to DOE activities, such as the list server or the Society for Effective Lessons Learned Sharing (SELLS) database. Further, the criteria for when a lesson learned is to be posted to the intranet lessons-learned/best practices database are not clearly defined in SBMS, and the POCs are not consistently submitting them for inclusion in the intranet database even when the lessons learned are disseminated to multiple Laboratory organizations.

Documentation related to lessons learned is insufficient to demonstrate that lessons learned are being consistently and rigorously evaluated and acted upon. There are no formal collective records of the evaluation of external lessons learned (e.g., which lessons are reviewed, applicability evaluations and results, or actions needed or taken). When additional

Installation of 16-ton Superconducting Magnet at EMSL

reviews are requested by a POC or SME or when lessons learned are disseminated, the only record is electronic mail on the sender's computer, and the electronic mail is typically not maintained in a separate file or as a record. Lessons learned and safety alerts posted on the institutional and electrical safety websites do not describe specific actions taken or to be taken. With the exception of the few best practices and some special lessons learned posted to the PNNL institutional website, actions are not tailored to PNNL.

Some external lessons learned with apparent applicability to PNNL have not been identified and communicated to workers. For example, no evidence could be provided that several recent ORPS-related lessons from the DOE list server had been evaluated by POCs. There are no lessons learned posted to any of the PNNL websites (electrical safety, ES&H, or institutional) related to the unintended penetration of hidden energy sources (i.e., hitting energized piping or electric lines in excavation or wall penetration work). However, hidden energy sources are a recurring event throughout the DOE complex and were the subject of a special lessons-learned report by the DOE Headquarters Office of Environment, Safety and Health. Further, lessons learned from complex-wide blind wall penetration events have not been well integrated into site implementing procedures. The SBMS subject area addresses some blind wall requirements, but lower-tier implementing procedures needed to effectively apply these controls have not been developed. In addition, several other functional areas do not appear to have been kept up to date (i.e., the last health bulletin posted to the ES&H website was in 1999, and the latest nuclear facilities lesson posted on the institutional website was in 2001).

Employee Concerns Program. PNNL has established and implemented an employee concerns program that generally conforms to the expectations in DOE Order 442.1 and associated guidance and provides an effective avenue for workers to voice and obtain objective evaluation and resolution of ES&H concerns. This program is advertised through posters, brochures handed out to new hires, and an intranet website. PNNL staff members are encouraged to report and seek resolution of safety concerns through their supervisors, but workers can also report concerns to the employee concerns staff. Few ES&H-related concerns are reported using the formal employee concerns process (only 13 ES&H-related employee concerns were reported in the last two years, and many were minor). The evaluations and dispositions for ES&H-related concerns reviewed by the OA team were appropriate.

However, several aspects of the employee concerns program could be strengthened. There are no procedures detailing how the employee concerns program is to be implemented. The SBMS subject area documents only provide "suggested guidelines" for how staff should report concerns and for how managers, supervisors, or designated representatives should address employee concerns. The SBMS does not describe how the Concerns Program Office is to receive, advertise, document, investigate, refer, communicate, or resolve concerns. The opportunities to report concerns with anonymity or confidentiality are not discussed in the guidelines on reporting (but are discussed on the website and in the new-hire brochure). The documentation and investigation files could be more rigorously maintained. The files lacked a chronological log and verbatim documentation of the employees' concerns, and no attempt was made to get formal feedback from the concerned individuals on the final resolution. Investigation notes were often cryptic and not well organized. Supporting evidence, such as reports/evaluations by support organizations or ATS entries, was not on file. However, overall documentation on file adequately supported the final resolution of the concerns.

Injury and Illness Investigations. Injury and illness statistics for PNNL reflect that recordable and lost workday case rates are low when compared to their DOE peers and have been improving for several years. Facts related to cases of OSHA-recordable injuries and first aid cases, including evaluations of the conditions and causes and specification of corrective and preventive actions, are documented on forms that are consistent with DOE and OSHA requirements. PNNL has developed a detailed computerized investigation reporting process (designated as the Safety and Health Information Management System, or SHIMS) that is used by immediate supervisors and ES&H investigators. A Safety and Health Department procedure describes how investigators conduct reviews and administer the program. Although injuries and illnesses are logged, categorized, and reported as required by OSHA and DOE requirements, PNNL procedures are inadequate, and the requirements of several SBMS subject area documents and the safety and health (S&H) internal procedure are not being implemented as required.

The SBMS documents do not align with the S&H procedure or the actual process (e.g., SBMS specifies that a worker's immediate manager interviews staff and submits a written report, but makes no mention of the S&H representative investigators who actually do the evaluation and designation of corrective/preventive actions.) Other weaknesses in the SBMS document and the S&H procedure include:

- There are no specific steps/requirements to actually identify or implement corrective or preventive actions.

- There are no references to tracking identified preventive/corrective actions in either SBMS or the S&H procedure.

- The SBMS document does not clearly specify what constitutes an injury or require/encourage conservative reporting. For example, it specifies that medical attention should be obtained for "significant" injuries or illnesses and states only as a "suggested guideline" that staff members should report any situation that could result in potential injury or illness or could have caused injury or illness. In another section, the SBMS specifies that staff who are potentially exposed to a chemical, radiological, biological, or physical hazard (shock, laser, noise) "must be provided the opportunity to be evaluated by medical personnel," rather than a clear expectation or requirement that potential exposures are to be reported and evaluated by medical and S&H personnel.

Although many investigations were effectively performed and packages were complete, there were numerous deficiencies in the evaluation and documentation of injuries and illnesses:

- The investigation reports by ES&H or supervisors are often untimely or not performed. Injury and illness records indicate there are about 60 case files that remained open without investigation reports for accidents/illnesses reported three or more months after the incidents, including 10 in calendar year (CY) 2001, 17 in CY 2002, 28 in CY 2003, and several from 1997 and 1998.

- Many evaluations of the causes and corrective actions for many injury cases were either not conducted or were conducted with insufficient rigor to demonstrate that the causes of injuries were being adequately identified or that appropriate recurrence controls were being implemented.

- Not all fields on the SHIMS electronic form are filled in when appropriate (i.e., the personal protective equipment worn).

- Conditions and event descriptions are often inadequate (i.e., details of what work was being done or the work conditions are not specified or the description is simply the statement from the injured party reported to the clinic, rather than a supervisor's description of conditions and events).

- Some causal analyses and corrective actions are not appropriate or complete, and in some cases, corrective actions did not address the identified causes. For example, the root cause specified when a worker was cut when a pipette broke was "defective part," and in another case the specified corrective action was to hold a lessons-learned meeting with the injured party to determine whether something needed to be done. These causes and actions are usually developed by ES&H representatives; however, SHIMS does not provide signature/prepared-by blocks for indicating who provided what information, even though this is part of the form that the SBMS specifies is to be completed by the direct supervisor.

- In some cases, actions were closed in ATS without notation of what or whether action was taken or the attachment of closure evidence as required by the SBMS "Assessment Closure" subject area document. The actions were closed by the ES&H staff, rather than the line action owners as specified in the SBMS document. Additionally, the ES&H staff did not verify that closure packages were compiled and filed as specified in SBMS before closure of the conditions (cases) in ATS (see Finding #2).

Other Feedback Mechanisms. In addition to the assessment program, other feedback mechanisms have been established to provide continuous improvement. The Voluntary Protection Program and IOPS provide effective vehicles to involve workers in inspections and safety feedback. Union safety committee meetings and frequent senior management and directorate-level staff meetings also provide feedback and continuous improvement information to contractor management, including the current status of safety performance and improvement initiatives, and discussions of recent incidents and lessons learned.

Cross-cutting or high-cost projects, identified as operations improvement initiatives, including ES&H projects, are proposed by line and support organizations and evaluated annually for funding. If funded as improvement initiatives, milestones and incentives are established and included in the contract performance evaluation and award fee process. Examples of past and ongoing initiatives include IOPS, the Electronic Prep and Risk process, and waste management process improvements.

Formal, documented post-job reviews by workers and supervisors specified in F&O procedures provide feedback to work package planners and management after completion of maintenance and modification work. The F&O work control process requires post-job reviews and provides fields for comments and feedback in JPPs. However, documented feedback on reviewed dispatch work orders and JPPs was minimal. Dispatch work orders do not contain a field for worker comments or feedback.

D.3 Conclusions

AMT has the framework for a line oversight program that meets SC expectations and contractual provisions. The FR program is mature and well documented. However, many of the key features are in transition or in various stages of development. Further, AMT has not been effective in ensuring that PNNL maintains an effective self-assessment and corrective action management program, and AMT line oversight activities have not always been effective in identifying weaknesses and ensuring that they are corrected by PNNL.

PNNL conducts many feedback and improvement processes and has made many improvements in the safe conduct of work at the Laboratory. SBMS documents describe programs for conducting independent and line self-assessments, documenting deficiencies and tracking corrective actions, addressing employee concerns, and identifying and communicating lessons learned. Several PNNL organizations have processes for annually reviewing assessment results and determining areas where additional improvements are needed. However, requirements for some aspects of safety assurance processes have not been clearly delineated in SBMS or rigorously implemented by research and support organizations, and have not been fully effective in identifying and addressing performance deficiencies. Results of inspection and assessments are not being analyzed for adverse trends or recurrence. The documentation, tracking, evaluation, and resolution of deficiencies to prevent recurrence and the inclusion of evidence to support closure actions in ATS need management attention. Many injury and illness investigations have not been performed, and there are many documentation deficiencies regarding condition descriptions and corrective actions. The adequacy of evaluation and implementation of lessons learned cannot be demonstrated because of insufficient rigor in documentation for this program.

D.4 Rating

Core Function #5 – Feedback and Continuous Improvement .... NEEDS IMPROVEMENT

D.5 Opportunities For Improvement

This OA inspection identified the following opportunities for improvement. These potential enhancements are not intended to be prescriptive or mandatory. Rather, they are offered to the site to be reviewed and evaluated by the responsible line management, and accepted, rejected, or modified as appropriate, in accordance with site-specific program objectives and priorities.

RL Associate Manager for Science and Technology

1. **Improve systematic mechanisms within AMT to strengthen line oversight of the contractor.** Specific actions to consider include:

   - Increase the frequency of FR and SME surveillances of the PNNL self-assessment program.
   - Increase the DOE FR oversight of research and F&O shop work activities.
   - Strengthen management review of FR surveillance findings and observations.
   - Establish a formal mechanism for tracking FR surveillance observations to closure.
   - Encourage AMT "partnering agreements" to emphasize SME participation in field activities and PNNL self-assessments.
   - Target training for AMT SMEs on conduct of observations/assessment of ES&H requirements in facilities.
   - Develop a metric within the PEMP for SME involvement in field activities and assessments.
   - Strengthen the metric within the PEMP for use of the Capture Tool, beyond counting entries, to one that measures quality/substance of the input.

Pacific Northwest National Laboratory

1. **Strengthen self-assessment performance and hold line management accountable for effective implementation.** Specific actions to consider include:

   - Establish more specific requirements for assessment plans, performance evaluations, and self-assessment in SBMS documents, increasing the focus on observation of work, process/program evaluations, and analysis of assessment results.
   - Line organizations should develop formal instructions to delineate the local processes and requirements for implementing SBMS requirements for assessments.
   - Provide training materials or courses on effective self-assessment techniques, and establish a mentoring resource to improve the rigor and effectiveness of self-assessments.
   - Establish an independent SME assessment review function on an interim basis to provide feedback to line and support organizations, with a focus on strengthening the depth and rigor of management assessment criteria and evaluations. Establish a method to measure improvement or attainment of acceptable performance.
   - Require and establish mechanisms to ensure that required management walkthroughs are being performed as required.

2. **Establish a more rigorous issues management system that promptly documents issues in a tracking system, assures management rigor is applied based on issue significance rather than the source of the issue, includes the graded documentation of the causes of deficiencies in programs and performance in the tracking system, provides effective recurrence controls, and provides accessible data for effective trend analysis.** Specific actions to consider include:

- Revise and strengthen SBMS requirements for documenting, categorizing (risk-ranking), evaluating, resolving, and tracking issues, regardless of how they are identified. Provide for documenting all identified issues in the appropriate issues management system in a more timely manner.

- Line organizations should develop formal instructions to delineate the local processes and requirements for implementing SBMS requirements for issues management and corrective action.

- Develop and implement processes to rigorously analyze inspection and assessment results at all levels in the organization to identify adverse trends (precursors) and to identify repetitive issues that require recurrence controls.

- Revise the ATS to document root or probable causes to promote the development of actions that will prevent recurrence. Strengthen the rigor of root cause analyses to ensure that root and contributing causes are more consistently and clearly defined.

- Ensure that SBMS requirements for documenting closure actions and evidence files are met before actions and conditions in ATS are closed. Consider establishing a formal, routine monitoring mechanism until consistent compliance is achieved.

- Strengthen the rigor and formality of issue evaluations and dispositions documented in employee concerns and illness and injury programs.

3. **Improve the rigor and formality in implementing the lessons-learned program.** Specific actions to consider include:

   - Better define the responsible persons and their roles and responsibilities for performing screening and evaluation of externally generated lessons learned in SBMS documents.

   - Establish requirements and processes to document the screening of external lessons learned and the results of applicability reviews by POCs/SMEs and provide feedback to the institutional lessons-learned office.

   - Ensure that applicability reviews evaluate and document that existing processes and hazard controls are sufficient to prevent the occurrence of reported external events at PNNL.

   - Tailor recommended actions to PNNL organizations, programs, and systems. Ensure that actions deemed necessary are not categorized as "recommended." Designate specific responsible parties to take directed actions.

   - Establish procedural requirements that line and support organizations provide formal feedback to SMEs and the institutional lessons-learned office detailing the actions taken and the results.

   - Conduct a rigorous self-assessment of the implementation of the lessons-learned program.

4. **Improve the rigor of documentation of the investigation of employee concerns.** Specific actions to consider are:

   - Strengthen SBMS documents to include the roles and responsibilities of the employee concerns office and processes for that office to resolve employee concerns. Include a description of the opportunity for and qualifications regarding maintaining confidentiality and anonymity.

   - Employ a written concerns record form, and encourage concerned individuals to sign the form. This would ensure consistent documentation of basic information and assure common understanding of the concern. Regardless of the method used, obtain verbatim documentation of the employee's concern and get agreement from the concerned individual. Consider using the form to record final disposition/resolution and closure.

   - Establish a chronological log in the investigation file to provide a concise history and status of all activities related to resolution of the concern.

- Use the most formal communication method possible to notify the concerned individual of the final disposition of their concerns and options for escalating their concerns if they are not satisfied. Include a request for feedback indicating acceptance, disagreement, or comments. Document in the records any feedback from the concerned individual.

- Provide concise summaries of investigation notes from meetings and interactions with the concerned individual and investigators. Include in the investigation package supporting documentation or such evidence as reports/evaluations by support organizations or ATS entries for identified issues and corrective actions.

- Ensure that any required corrective actions have been placed into formal tracking systems and are completed satisfactorily before formal closure of the case file.

5. **Improve the process and performance for investigating and documenting preventive actions for injuries and illnesses.** Specific actions to consider are:

- Ensure that line supervisors and management take ownership of injury and illness incidents and that ES&H provides a supporting role. Require the closure of actions to be performed by the owners and not the ES&H injury and illness staff.

- Include mechanisms in SHIMS to identify who supplied what information and analysis.

- Ensure that all pertinent fields in investigation reports are consistently completed (i.e., personal protective equipment worn).

- Resolve the backlog of missing investigation reports, and institute controls to monitor and ensure timely completion of the investigations and associated actions to prevent recurrence.

- Establish/strengthen a review process to ensure that investigations are rigorously performed and documented and that identified causes and corrective and preventive actions are appropriate.

APPENDIX E
CORE FUNCTION IMPLEMENTATION (CORE FUNCTIONS 1-4)

E.1 Introduction

The U.S. Department of Energy (DOE) Office of Independent Oversight and Performance Assurance (OA) evaluated work planning and control and implementation of the first four core functions of integrated safety management (ISM) at selected Pacific Northwest National Laboratory (PNNL) facilities and activities. The OA review of the ISM core functions focused on environment, safety, and health (ES&H) programs as applied to the two major types of activities performed at PNNL:

1. Research and development (R&D) activities (discussed in Section E.2.1)

2. Facility support activities (discussed in Section E.2.2).

OA's review of R&D activities focused on selected facilities, organizations, and activities:

- **Radiochemical Processing Laboratory (RPL)**. The Radiochemical Sciences and Engineering (RS&EG) group is the primary R&D organization in RPL. The RS&EG group provides capabilities in nuclear process engineering, radiomaterials characterization, and radiochemical separations and processing. The High Level Radiochemistry Facility, the Shielded Analytical Laboratory hot cell complexes, and the stand-alone mini-cells are used to conduct work with highly radioactive materials. RPL also serves as the radioactive material receipt and distribution center for approximately 70 percent of the radioactive materials utilized in the numerous research laboratories.

- **Environmental Molecular Science Laboratory (EMSL)**. EMSL is a DOE-funded facility that promotes fundamental research in physical, chemical, and biological sciences. The facility is equipped with over 100 major instrument systems and is classified as a low-hazard facility. The facility and equipment are managed by the Fundamental Sciences Directorate (FSD) and made available to PNNL and external (e.g., university researchers) users. Currently, EMSL has over 550 active projects and supports over 800 distinct users throughout the facility.

- **Building 331.** PNNL Building 331 Life Sciences Laboratory houses research activities conducted by the PNNL FSD, and to a lesser extent research being conducted by the Environmental Technology Directorate (ETD). The FSD's Biological Sciences Division conducts experimental studies to understand molecular and cellular processes resulting from insult by physical and chemical agents. Basic and applied research concerning microorganisms and/or their processes in various environments is conducted within the facility. ETD currently has three technical resource groups conducting work in the 331 Building. ETD works with external clients to develop environmental monitoring programs and scientific and technological solutions for long-term stewardship of waste sites. In general, the research conducted within Building 331 presents a variety of potential hazards to researchers, including physical, chemical, biological, and radiological hazards. Biosafety Levels 1 and 2 are permitted in this facility.

At all three R&D facilities, OA examined waste management and environmental compliance activities, reviewed procedures, observed ongoing experiments, toured facilities and laboratories, observed equipment operations, interviewed managers and research staff, reviewed interfaces with Environment, Safety, Health, and Quality (ESH&Q) staff, and reviewed safety documentation (e.g., permits and safety analyses). At RPL, most of the ongoing work during the assessment occurred in the hot cells and associated support areas. Work observed in these areas included a decontamination and inspection project involving control rod drive mechanism housings removed from retired commercial reactor vessel heads, a project involving radiochemical separation of uranium-232 decay products for commercial medical isotope use, and general hot cell activities, such as sample transfers. At Building 331, research observed included work that involved biological, chemical, and radiological hazards, typically with small quantities of chemical and biological materials for which the exposure hazard was generally low risk. FSD Product Line research projects were observed principally in Laboratories 169, 170, 317, and 350. ETD Product Line research projects were observed principally in Laboratories 108 and 110.

OA's review of facility support activities focused on the Facilities and Operations (F&O) Directorate. F&O provides strategic planning, management systems, safeguards and security services, facility operations, craft resources, and facility projects and engineering services for PNNL government, private, and leased facilities. F&O provides a dedicated core team that includes the building manager, building engineer, facility project managers (construction managers), and maintenance supervision and support craft. The F&O core team is an integral part of each research facility and provides direct support to the research mission. Craft resources and central shops support both the facility infrastructure systems and equipment, but also provide requested support and manufacturing for research-related tasks.

F&O work activities are governed by a comprehensive procedural set, and a single administrative procedure ADM-16, *Facility Operations Maintenance Work Control*, that governs F&O work in all facilities. The work control procedure and supporting procedures govern maintenance, fabrication, and construction, including subcontracted work activities. More complex jobs are performed under job planning packages (JPPs) and most routine craft work is performed under "dispatch" work orders. Subcontracted activities are performed under contracts, but work is implemented by JPPs prepared by PNNL that contain elements required of a planned maintenance job package.

For F&O activities, OA reviewed work control systems and work performance for fabrication activities, preventive and corrective maintenance, and construction for the RPL, Building 331, and EMSL facilities. The review also included the Building 350 central fabrication shops and associated work activities.

E.2 Results

E.2.1 R&D Activities

E.2.1.1 Core Function #1 – Define the Scope of Work

Missions are translated into work, expectations are set, tasks are identified and prioritized, and resources are allocated.

RPL. Research work at RPL is generally well defined. Each R&D project has a formal scope of work that is provided through the proposal contract or a formal scope of work statement. The research proposals describe the apparatus, needed materials, and the overall approach in sufficient detail to permit effective hazard identification and analysis. The Electronic Prep and Risk (EPR) process provides documentation of the overall scope of work for R&D projects and also defines project-level risks associated with the scope of work. Product line managers approve the submission of proposals and again approve the final scope of work and risk profile presented in the EPR for a funded project. At the activity level, the scope of work is further defined by technical work documents and work practices used to control specific activities.

Although work scopes were generally well defined, information provided on the EPR documents for RPL projects often did not provide enough details to determine environmental risks. One document involving development of sensors to detect radioactive contamination in soil in the section on waste management indicated "no comment" on the EPR. Therefore, the environmental compliance representative (ECR) had to contact the researcher to determine how much radioactive waste would be generated so that arrangements could be made for proper management.

EMSL. Research work at EMSL is generally well defined through the use of the proposal process. Each R&D project requires the submission of a formal proposal that includes a work statement and scope of work. The proposals describe the overall experimental approach in sufficient detail to permit effective hazard identification and analysis that allows activities to be assigned to appropriate laboratory spaces. Additionally, the safety and health representative is involved with all phases of the proposal review and approval process.

The EPR also documents the project-level scope of work for R&D projects and defines the general risks associated with the proposed project. Product line managers approve the submission of proposals and again approve the final scope of work and risk profile defined in EPR for a funded project. At the activity level, the scope of work is further defined by technical work documents and project-specific information requested by the cognizant space manager (CSM) that will be used to identify hazards and control specific activities.

Building 331. The research work scope within the FSD is typically defined in the research proposal and the EPR. Occasionally, a project plan is also prepared for larger research projects with multiple organizational or resource interfaces. Work scope details are most often defined through communications among the research staff and the CSMs, although these communications are often informal and seldom documented. In general, the level of detail provided in research proposals and EPR mitigation permits is sufficient to communicate the scientific nature of the work in order to obtain funding, identify the level of resources, and initiate the EPR process. However, the research proposal and EPR, which, other than research notes, may be the only written record of the research scope of work, are often not developed with sufficient detail for an independent party, such as the ECR or FSD safety and health representative, to be able to evaluate the work activity and identify the hazards associated with the work. Figure 3.2, R&D Planning Control, in the PNNL integrated ES&H program description indicates that a function of the EPR is to define work scope. Based on a review of several R&D projects in Building 331, the statement of work in the EPR is insufficient to describe specific risks of the work to be performed. To compensate for a limited definition of work, some organizations, such as the PNNL Radiation Control organization, for example, require project managers who plan to use radiological material to prepare a more explicit statement of work so that the radiological hazards and controls can be identified. In addition, for radiological work, the radiation work permit (RWP) enhances the definition of work scope.

As a work scope document, the level of detail in an EPR risk mitigation permit varies among projects within the same directorate. For example, some projects are conducted in multiple laboratories within Building 331. Informally, project managers will negotiate for bench space in laboratories that have the required equipment and controls, and this will guide the work locations. However, the EPR does not clearly link research activities to laboratories. The ECRs, when reviewing the EPR, use their knowledge of the research and the building laboratories to forecast and link research activities with laboratories. In most cases, the ECR will also discuss the research project with the researcher. Again, the results of these discussions are seldom documented. As a result, the bases for the environmental waste accumulation, storage, and control requirements, which are imposed for a research project, are not well documented in the EPR or elsewhere.

Summary. The scope of most R&D work activities is sufficiently described and defined to specify what work is to be performed, and to allow subsequent identification of the associated hazards. Research activities have formal processes to define the scope of work for various R&D work activities. For major tasks with higher risks, the scope of work was generally appropriately documented. However, in some cases, the details of the scope of work are not well documented for smaller projects and lower-risk work.

E.2.1.2 Core Function #2 – Analyze the Hazards

Hazards associated with the work are identified, analyzed, and categorized.

RPL. A combination of established processes is used to identify hazards associated with research work at RPL. The EPR process establishes the risk profile and general hazard mitigation methods for the initial project safety review process. The Integrated Operations System (IOPS) and the technical work document development process further define the principal hazards specific to the proposed activity. The Independent Review Committee provides a final verification of hazards analysis and control development for all projects and technical procedures through a formal review process. At times, additional planning is required before allowing work to begin. Although some specific deficiencies exist, particularly for the smaller and more routine R&D laboratory work (see below), the overall process provides for a systematic approach to safety reviews.

Most work at RPL involves actual or potential radiological hazards, and RPL has a well-defined and mature process in place to ensure that radiological work receives appropriate hazard review by ES&H radiological professionals. Through Standards Based Management System (SBMS) requirements, users of radioactive materials are required to complete an electronic RWP request form for any new or revised work involving use of radioactive materials. This form is forwarded to a dedicated facility radiological work planner who is responsible for reviewing the hazards and preparing an RWP for the proposed work. The work planner also coordinates other reviews depending on the complexity of the work and predefined review triggers. For example, an internal dosimetrist is called upon to evaluate bioassay requirements that are incorporated into the RWP, and additional reviews are performed by radiological engineering staff and/or as-low-as-reasonably-achievable (ALARA) committees based on the complexity and involved hazards.

While adequate systems for scope definition and hazards analysis were in place, ineffective integration of these systems has at times resulted in incomplete or ineffective hazards analysis. Specifically, mechanisms for communicating the specific scope of work for research projects do not ensure that all relevant details of the work are communicated to those individuals responsible for analyzing and controlling hazards. For example, the AlphaMed medical isotope work involved radiochemical separation and purification of different radioisotopes from the uranium decay chain. However, the RWP request form only listed "uranium-232 isotope work" as the scope of work and hazards, and did not define the presence of concentrated radium or thorium being handled, nor did it identify the potential for pre-existing tritium hazards in the hot cells that were used with this project. As such, corresponding controls were not sufficiently defined or developed. While the EPR did identify some of these hazards, the EPR is not reviewed or accessible to radiological work planners.

In some cases, IOPS hazard awareness summaries did not reflect certain hazards present in IOPS spaces as required by SBMS. For example, the hazard awareness summary for Room 58 did not include references to any chemicals; however, both chemical and lead hazards were present in the room. Similarly, the one for Laboratory 603 did not reflect the presence of dry ice (carbon dioxide) hazards being used in support of control rod drive mechanism work. Several laboratories had lifting hazards that were not reflected in the posted hazard awareness summaries.

EMSL. A combination of processes is established to effectively identify most hazards associated with research work. The EPR and proposal processes establish general project-level requirements and hazard categories for the initial proposal safety review process, and the IOPS process tailors the hazards analysis to the laboratory spaces where a proposed activity takes place. Safety representatives, peer researchers, and subject matter experts (SMEs) regularly review and analyze proposals and hazards related to projects and laboratory-specific activities. For example, a fire protection engineer reviewed a proposed catalyst research project involving hydrogen to ensure that any flammability concerns were adequately addressed. Overall, the process is appropriate for a systematic approach to safety reviews.

In some cases, however, researchers are not rigorously applying the process, resulting in some activity hazards associated with use of chemicals not being appropriately identified. Some chemical process permits (CPPs) address the chemical quantities and uses specific to the research work, but do not address the handling and transfer of much larger quantities of the chemicals obtained from vendor containers. For example, a CPP for Laboratory 1410 addresses 50 milliliter quantities of acids and bases used in research activities, but the activity of dispensing those quantities from vendor containers within the Laboratory is not addressed. Consequently, hazards and associated controls such as personal protective equipment (PPE) for handling the significantly larger (multi-liter) quantities of the bulk chemicals are not addressed.

In addition, some routine laboratory hazards, such as handling sharp objects (syringes) and potential ergonomic concerns (moving heavy objects), are not analyzed or identified in standard IOPS documentation, and the SBMS subject areas do not address some common hazards encountered in the laboratory environment (see Appendix C).

Building 331. The Building 331 scientific, operations, and ES&H staff is knowledgeable of the hazards associated with the research projects conducted within the facility. Researchers, project managers, and CSMs are typically the individuals with primary responsibility for identifying, recognizing, and controlling hazards within their laboratories and are also the individuals with the greatest knowledge of the potential hazards associated with their research. On a number of occasions, CSMs in Building 331 have identified potential research hazards and have taken action to control those hazards. For example, in calendar year (CY) 2002, the CSM for Laboratory 350 identified non-resident researchers attempting to store infectious biological samples in a laboratory that had not been approved for storage of such samples. Since the research was to be conducted as a non-funded collaborative research project, the EPR process had not been invoked. However, the quick recognition of the hazard by the CSM avoided a potential mishap. (Note: This gap in the EPR process for non-funded research work has subsequently been addressed and rectified). In addition to the research staff, the ES&H SMEs (e.g., industrial hygiene, radiation protection, and environmental protection/waste management) and operations and building management have also been effective in identifying, analyzing, and controlling research-related hazards.

Changes to the EPR process in April 2003 have resulted in an improved capability of this tool to identify bounding-level hazards for individual research projects and ensure that projects can be accommodated in Building 331 laboratory spaces. The EPR identifies categories of hazards associated with a research activity (e.g., chemicals, non-ionizing radiation, and lasers) such that those hazards can be compared against the facility safety envelope (e.g., Building 331 facility use agreement) and laboratory space controls (e.g., permits, training, engineering controls) to ensure that the hazards can be appropriately controlled and mitigated.

The hazard awareness summary is another useful tool for communicating general classes of workspace hazards to Building 331 laboratory occupants. All Building 331 laboratories were posted with current hazard awareness summaries, which described the types of hazards that could be possible, based on the active research being conducted in the laboratory.

Although the EPR and IOPS processes (training, permits, hazard awareness summaries) have provided a system for the identification and analysis of those hazards with the most significant risk, some aspects of these processes could be further improved to provide for more consistent and effective identification and analysis of hazards.

For example, some EPR risk mitigation permits, which are generated from implementing the EPR process and revised on an annual basis, contain inaccurate or dated information concerning the hazards of the research project. For some Building 331 research activities, the EPR risk mitigation permit identifies hazards that are not relevant to the research project. One EPR risk mitigation permit, for example, identifies there are large quantities of chemicals and a high-powered laser involved in the research, although neither statement is accurate. In some cases, the EPR has not remained current with changing hazards. For example, the recently revised EPR risk mitigation permit for Project 27197 (Deinococcus Radiodurans for Bioremediation) continues to identify uranium as a hazard, although uranium has not been used for this research project for some time.

In a few cases, some laboratory hazards have not been sufficiently analyzed and/or documented to ensure that the hazard control is appropriate. For example, routine radiochemical work performed in Laboratory 152 involves the use of low-activity radioactive samples. A portion of Laboratory 152 has been established as a radioactive materials area. In this area, radiochemical sample analysis by inductively coupled plasma (ICP) chromatography is conducted to analyze trace quantities of plutonium, uranium, and thorium, as well as other metals. Since the samples are assumed to be low in radioactivity, an RWP request form was not generated and a radiological hazards analysis was not conducted to determine the appropriate level of radiological controls, as would be required by procedure for all new projects involving use of radioactive materials. Most samples processed in this area typically contain only a few picoCuries (pCi) of activity and have not given rise to a detectable level of contamination. However, for samples that contain less than 10 milliliters of dilute nitric acid, each sample could contain as much as 30 pCi. Because up to twenty samples at this concentration could be in process or available for dispersion (i.e., spill) at any one time, contamination of process equipment and areas is possible. However, this aggregate hazard has not been analyzed or documented as required by PNNL procedures to ensure that the existing controls are appropriate.

For a number of routine laboratory research hazards, such as working with sharp instruments (e.g., syringes), lead shielding, and ergonomics, the hazards are not sufficiently addressed in SBMS or mapped into IOPS such that hazards can be recognized and documented at the research activity level to ensure that the appropriate controls are identified and implemented. In general, expectations have not been established for the identification, analysis, documentation, and control for routine, low-risk hazards typically encountered when performing research. It is not clear whether these hazards are to be considered as “skill of the researcher,” which is not defined, or should be addressed by some other mechanism within IOPS. For example, the use of sharp instruments is a common hazard within the Building 331 laboratories, but the hazards associated with the use of sharp instruments are not addressed within the SBMS subject areas, unless there is a potential bloodborne pathogen concern. In another example, the “Working with Chemicals” SBMS subject area identified a number of “safe practices” for preventing explosive reactions when working with laboratory heating equipment (ovens, burners, etc.), glass apparatus containing gases or vapors under pressure, etc., and other common laboratory work practices. However, there is no clear expectation or process for identifying, documenting, and communicating such routine hazards (such as a standard laboratory practices instruction) for a research project and ensuring that the appropriate administrative controls (training, permits, hazard awareness summary) have been identified and implemented through IOPS.

Many of these low-risk hazards are considered to be routine and are commonly encountered when performing research. However, failure to recognize, identify, and control these hazards can also result in the potential for injuries and illnesses. For example, in February 2003, a culture bottle over-pressurized in Laboratory 108. A methane-producing bacterium was introduced into a bottle that was not vented, and the ensuing buildup of gases shattered the bottle. The use of such bottles and culture medium (which contained no hazardous chemicals) is commonplace in the laboratory. There is no mechanism within EPR or IOPS for targeting and documenting this type of hazard.

Summary. The hazards for most work observed had been properly identified and analyzed through PNNL review and planning processes. Several positive practices and initiatives were identified that minimized or eliminated hazards, provided for communication of hazards, and contributed to risk mitigation and safer work. The use of an Independent Review Committee at RPL and the IOPS database linked to EPRs improved the review of R&D operations and communication of hazards to workers, respectively. The use of hazard awareness summaries that are posted at laboratories aided hazard communications for workers in laboratories. However, some weaknesses were identified in the identification and analyses of hazards that in some cases decreased the effectiveness of work planning and/or resulted in inappropriate or incomplete hazard controls being applied. Although the process and procedures are in place and are effective for identifying and analyzing hazards, some implementation deficiencies need to be corrected to provide for a more robust program.

E.2.1.3 Core Function #3 – Develop and Implement Hazard Controls

Safety standards and requirements are identified and agreed upon, controls to prevent/ mitigate hazards are identified, the safety envelope is established, and controls are implemented.

RPL. At RPL extensive use of engineered controls serve as the primary mechanism to control many activity-level hazards. Engineered controls include items such as hot cells, gloveboxes, hoods, temporary enclosures, and ventilation systems specific to the work. Engineered controls are complemented by a variety of administrative controls, including radiation work and chemical use permits, standard operating procedures, facility research practices, and in some cases specific technical work documents prepared to control a particular activity. Although some specific deficiencies exist (see below), the overall process produces a generally adequate set of hazard controls.

PNNL has established some innovative electronic mechanisms for certain radiological hazard controls. For example, the radioactive materials management tool allows a user to identify the applicable SBMS and facility-specific radioactive materials management procedures based on the users selection of the facility, the type of radioactive material, and the nature of the activities. In addition, the radiological control technician (RCT) scheduling tool allows users to determine availability of RCTs and schedule the necessary RCT resources to cover work.

Controls for waste management/environmental compliance for RPL are provided by documented work practices and deployed ECRs and Waste Management field services representatives (FSRs) who are matrixed to the operations manager and are available to R&D personnel as a resource for meeting compliance objectives and proper waste management functions. Researchers who generate waste are required to follow the waste accumulation and disposal practice. This practice provides an easy-to-use method for meeting regulatory requirements and ensuring proper management of hazardous, mixed, and radioactive waste.

While the combination of engineering and administrative controls results in effective mitigative and preventive controls for research work in most cases, deficiencies in implementation of some institutional systems governing chemical use and management have resulted in ambiguous or undefined hazards and controls during some work evolutions, including improper selection of PPE. These deficiencies are discussed in the following paragraphs.

SBMS requires documentation of the specific PPE for each unique chemical hazard present in a work activity. At RPL, the use of generic chemical use permits does not fully comply with SBMS requirements for chemical use documentation. While the SBMS allows similar chemicals with similar controls to be grouped together in chemical use documentation, it requires a separate listing for each group of chemicals that have unique hazards and controls. Contrary to these requirements, RPL lists similar chemicals with differing PPE requirements in the same permits and does not provide the unique PPE requirements for the specific chemicals. For example, specific glove types for differing acids are not provided. These ambiguities have resulted in workers performing activities with inadequate PPE. For example, a worker was observed using concentrated nitric acid using latex gloves, which are ineffective protection for that chemical. In another example, a worker was observed using a decontamination chemical listed as being a severe eye irritant without using any eye protection. In a third example, large quantities of dry ice (500-pound storage) were introduced into the control rod drive mechanism decontamination project. This chemical was procured using a Laboratory purchasing card (P-Card) without required SBMS training on P-Card chemical purchases. As a result, the dry ice did not get listed on the CMS chemical management inventory, and it was never listed as an IOPS hazard in the space in which it is used. While most controls for users were incorporated into the operating procedure, IOPS permits were not revised, chemical inventories were not updated to reflect this chemical, exposure limits were not documented, potential work-level concentrations were not formally analyzed, actual work-level concentrations were not measured, and all personnel with access to the space were not made aware of the new hazard through the hazard awareness summary (see Finding #3 in Section D.3.3).

In addition, chemicals covered by static inventory requirements are being stored in locations that are not accurately reflected on CMS inventory listings, resulting in inaccurate chemical location listings. For example, a significant number of combustible materials are permanently stored in RPL Room 58; however, the chemical inventory listing for Room 58 shows no chemical inventory. Another example included the presence of cleaning solutions and the recently added dry ice listing in shielded facility operations (SFO) spaces that do not appear under the chemical inventory in their location of actual storage. Under SBMS and RPL IOPS practice, movement of a chemical location for more than one working day requires an update to the CMS inventory listing to reflect the actual location of storage.

Each laboratory in RPL has a hard-copy laboratory handbook containing a variety of information for researchers, including RPL practices, permits, and related information. However, the information presented in these handbooks is not always tailored to or applicable to the space, and in some cases is not complete. For example, the laboratory handbook for Room 58 contains research practices, permits, and other information that do not apply to F&O operations. The laboratory handbook for RPL 701 contained an outdated RWP, and a number of other handbooks did not include copies of any RWPs.

Some radiological controls specified in RWPs or other documents were not properly implemented or defined. The RWP for the AlphaMed medical isotope production specified the wrong type of air sampling using a continuous air monitor rather than a high-volume air sampler as an indicator of exposure in lieu of bioassay monitoring. Work involving removal of the control rod drive mechanism from the shipping container subjected a worker to a higher dose potential to the lower legs and feet, whereas only finger ring dosimetry was required to monitor extremity dose. The job required contamination measurements when opening the shipping container and decontamination "as necessary"; however, the specific levels requiring decontamination and limitations on performing decontamination without respiratory protection were not specified.

Although most laboratory operator aids were appropriate and controlled in accordance with RPL requirements, laboratory operator aids were improperly implemented in two cases. One approved operator aid addressing exhaust fans for a temporary glovebox conflicted with the governing procedure, and another operator aid providing an overhead crane pre-start checklist was not approved and controlled in accordance with procedure.

EMSL. In most cases, the combination of engineering and administrative controls results in effective prevention and/or mitigation of hazards associated with research work. Engineering controls are prevalent in this relatively new facility and include state-of-the-art controls, such as computer-assisted "auto balance" ventilation design and control for fume hoods and laboratory space. In another example, delivery systems for bulk hazardous gasses are located in external chase with vented stacks. Administrative controls include IOPS-generated activity permits (CPPs, laser use permits, etc.), such EMSL work practices as the EMSL practice for chemical waste disposal, and the EMSL chemical management system. In addition, an ECR and FSR have been matrixed from the PNNL Environmental Management Services Division to EMSL to provide direct support for control of waste operations. EMSL also uses IOPS-generated hazard awareness summaries as an administrative control for communicating general classes of workspace hazards to occupants. EMSL rooms and laboratories were posted with current hazard awareness summaries describing the types of hazards in the space. In another example of strong administrative controls, EMSL researchers working with strong magnetic fields developed, in conjunction with the medical department, a magnetic field worker screening permit to determine whether metal or other materials in workers' bodies (particles or surgical implants) could be affected by the magnetic field. In a combination of engineering and administrative controls, the facility uses a proximity card access system for the EMSL hallway and individual laboratory spaces that is controlled by CSMs, who have final authority to authorize access and use of associated equipment. Although some specific deficiencies exist (see below), the overall process produces a comprehensive set of hazard controls.

The EMSL IOPS-generated training process for user access to laboratory areas sufficiently covers the identified hazards and controls within the laboratory spaces. The CSM establishes the training and review requirements for access to specific laboratory spaces, and access is controlled through the proximity card system. The OA team conducted a performance test of the CSM's application of the access control system training requirements by proposing a hypothetical environmental chamber activity to the CSM in the Environmental Spectroscopy Laboratory. The CSM established the appropriate training and review requirements for the postulated job. The IOPS effectively integrated these requirements with the training department's computer-based training courses, and the system mandated the appropriate required reading of the laboratory hazards summary as well as task-specific permits. The system tracks module completion and does not allow access until all specified training is complete.

EMSL uses a teaming concept between chemical purchasing and environmental management that provides a "cradle to grave" approach for controlling chemical management. This close working relationship between the chemical material manager and the ECR/FSR allows these types of controls to be implemented, since all three services are performed as a team concept, allowing application of pollution prevention to be applied when purchasing new materials.

Although processes for developing hazard controls were appropriate and most controls were adequately implemented, ineffective or incomplete implementation of some processes have resulted in incomplete controls. Some EMSL CPPs do not sufficiently tailor PPE to specific activities to ensure that the appropriate protection is provided to the workers. SBMS requires that appropriate PPE be listed for specific chemical hazards. While the SBMS allows similar chemicals with similar controls to be grouped together in chemical use permits, it requires a separate listing for each group of chemicals that have unique hazards and controls. Contrary to these requirements, some EMSL CPPs list similar chemicals with differing PPE requirements in the same permits and do not always provide the appropriate PPE requirements for the specific chemicals. For example, specific glove types for differing acids are not provided in some cases. In another example, some CPPs addressing the handling of corrosive chemicals that may splash only require chemical safety goggles, closed-toe shoes, long pants, and a long-sleeved shirt. However, the material safety data sheets (MSDSs) for many corrosive chemicals require chemical-resistant aprons for adequate protection. Although all the PPE requirements in a typical MSDS may not be required for a specific application, the current method of CPP implementation at EMSL does not ensure that the appropriate PPE is selected, documented, and linked to the hazard. In some cases where small bench-top quantities are involved, the lesser controls may be appropriate; however, the differing activity hazards are not delineated in the permits (see Finding #3).

Building 331. Overall hazard controls within Building 331 laboratory spaces are well designed and effectively implemented. Engineering controls, such as fume hoods and room and local ventilation systems, are adequately maintained and are being operated as designed. PPE consisting primarily of chemical gloves, shields, and aprons are available to the research staff. Administrative controls, such as training and permits, were generally adequate for the hazards identified in the laboratories. Training requirements and records are maintained through IOPS. Researchers were generally current with respect to their training requirements. Furthermore, since the health risks resulting from exposure to most chemicals or biological materials used in Building 331 are low, researchers in the conduct of their research utilize few formal procedures or technical work documents.

Building emergency planning and radiological control planning are comprehensive. The Building 331 emergency plan is kept current with changing facility conditions, and emergency responders from the Hanford Fire Department are knowledgeable of the potential hazards within the building, and are well trained and experienced in addressing the diversity of potential hazards, including biological hazards. Radiological control planning for research activities involving radiological materials is also comprehensive. A review of the radiological planning conducted in support of the introduction of cesium-137 to an existing experiment at Building 331 indicated that the health physics staff conducted a rigorous review of the proposed activity.

PNNL has instituted an aggressive pollution prevention program that has been implemented by inclusion of pollution prevention/recycling activities in work practices and in review of EPR mitigation permits. For example, as part of the EPR process for one research project conducted in Building 331, the ECR recommended use of a less hazardous material in order to reduce the generation of hazardous waste as part of the PNNL Pollution Prevention Program. A key component of this program is the pollution prevention opportunity assessments. Because guidance for conducting these assessments for DOE laboratories was not available, PNNL has prepared a book for use by laboratories across the DOE complex, building on the successes and lessons learned at PNNL. As a result of this action, along with other aggressive pollution prevention activities, PNNL has received numerous awards for preventing pollution, including the EPA's National Waste Champion Award.

Although the EPR and IOPS processes have been effective in identifying and implementing most hazard controls, the processes could be further improved in a number of areas.

In some cases, the appropriate chemical protective glove could not be identified for one or more chemicals listed in a CPP. For a number of chemicals listed in CPPs, researchers are directed to the chemical glove list posted in Laboratory 170, Bay 4, for glove selection guidance. However, this list does not include a number of chemicals identified in the CPPs, and therefore the appropriate chemical glove could not be identified. In other cases, the chemical glove required by the chemical glove charts was not in use or readily available in the laboratory (e.g., butyl gloves). For some research work involving chemicals (Laboratories 170 and 350), it was not clear to the researchers who were interviewed which CPPs were applicable to their research work, if any (see Finding #3).

Although procedures are not routinely used within Building 331, a number of safe operating procedures are used for radiochemical work performed in Laboratory 152. These safe operating procedures are not adequately integrated into IOPS, and in some cases do not address all aspects of the operation. In some cases, the training requirements mapped in IOPS are incorrect with respect to safe operating procedures. For example, the IOPS training matrix for individuals working in Laboratory 152 and the IOPS requirements mapped to EPR mitigation permits for the same space failed to identify the two primary safe operating procedures routinely used by researchers working in this lab. The RWP issued for Laboratory 152 includes a reference to these procedures; however, given the omissions in IOPS, there is no alternative mechanism for CSMs or radiation control personnel to ensure that individuals are trained to these procedures. In another example, the safe operating procedure developed for radiochemical work performed in Laboratory 152 does not address the use of ICP chromatography, which is one of the primary tools used by researchers in the laboratory. The operations protocol (Procedure No. 331-AF-001) omitted the use, hazards, and controls associated with the ICP, although other less significant equipment is addressed in detail. The ICP is routinely utilized to analyze trace quantities of plutonium, uranium, and thorium, as well as other metals. In addition, the CPPs related to the operation of the ICP did not identify the actinide metals and associated hazards (i.e., uranium is a known kidney toxin).

In one case observed, the laboratory hazard awareness postings were not conspicuously posted. The radiological surveys for Laboratories 110 and 112 were not posted at the normal entrance to the radiologically posted area. The normal entrance path for researchers working in the radiologically controlled portions of Laboratories 110/112 is through a contiguous laboratory (i.e., Laboratory 108); however, radiological surveys for Laboratory 110 are posted only at a door that is infrequently used. Furthermore, the radiological boundary transition point (where hand and foot monitoring and radiological surveys occur) between the buffer area and the "clean area" is in an aisleway within Laboratory 108. No survey information is available at this location, where such information would be most useful to researchers entering the lab.

The EPR mitigation permit provides a means for informing SMEs of potential new hazards, such that the SMEs can be involved in the planning of hazard controls. In some cases this notification to SMEs has not occurred or has not been effective. For example, for Project 48357 conducted in Laboratory 350, a high-powered laser and large quantities of chemicals were identified in the EPR mitigation permit. However, the EPR mitigation permit was approved by the product line manager without the PNNL facility safety task group leader or the PNNL laser safety officer being notified of the large quantity of chemicals or the potential use of a high-powered laser, respectively. The PNNL safety task group leader is responsible for ensuring the accuracy of the technical basis for the Building 331 facility use agreement that could be impacted by large quantities of chemicals. The laser safety officer, in conjunction with the FSD safety and health representative, are responsible for ensuring that laser controls (e.g., permits and PPE) are adequately specified and in place in the laboratory. The lack of notification of SMEs in this example has been attributed to the use of an earlier version of the EPR process, which did not incorporate this capability. Regardless, the product line manager did not ensure that the appropriate SMEs had the opportunity to review the EPR prior to its approval.

One section of each EPR mitigation permit provides a summary of "IOPS requirements for the location identified." For most EPR permits that were reviewed, the summary of IOPS requirements for the location could not be linked to the specific hazard controls for the research project. In some cases, required permits were not listed in this section of the EPR mitigation permit. For example, a lead CPP was prepared for Project 27197, "Deinococcus Radiodurans for Bioremediation," for use with cesium-137 sources in Laboratory 110 because the project manager failed to identify chemical hazards in that IOPS space. The CPP, however, was not listed in the EPR mitigation permit for Laboratory 110. In another case, the EPR mitigation permit associated with intercellular signaling research being conducted in Laboratories 149E, 320, and 350 did not identify any permit, training, or work practice documents in these three laboratories, although there are a number of IOPS requirements (e.g., chemical permits and training) for working in these areas. Furthermore, the EPR risk mitigation permit is misleading by implying that all of the permits, training, and work practice controls listed are requirements, when only some of the listed controls are required by the hazards presented by the research activity. For example, a number of EPR risk mitigation permits require respiratory protection training, although no research hazards are identified in these EPR risk mitigation permits that require the use of a respirator. Another concern with the EPR risk mitigation permit is that the radiological work planning process is not linked with either the EPR or IOPS processes.

Summary. PNNL uses extensive engineering controls for many R&D activities, such as hot cells, fume hoods, room and local ventilation, and filtration control. Newer facilities, such as EMSL, use state-of-the-art, automatically balanced ventilation and external delivery chases for bulk gas delivery. Renovation of Building 331 laboratories will improve research space and modernize fume hoods and local ventilation. The engineering controls are supplemented by a variety of formal administrative controls that are generally well established across PNNL. A variety of tools and permits are in place and being used to adapt controls to specific R&D activities. However, weaknesses in implementation of SBMS requirements, procedural controls, and the application of chemical controls were identified at all facilities reviewed. Chemical permits, though viewed as a positive tool, were not consistently implemented, resulting in ineffective identification and analysis of hazards, which resulted in incomplete definition of controls or selection of incorrect controls by researchers. Weaknesses in the implementation of EPR and/or IOPS were also identified where requirements (permits, training and work practices) were incorrect or could not be linked to the specific research activity, and controls were not consistent with the identified hazards. Overall, PNNL has a generally mature process for establishing proper hazard controls, but improvements are needed to resolve several weaknesses in implementation.

Finding #3: PNNL line management has not sufficiently implemented SBMS requirements for chemical use documentation to ensure that specific activity-level hazard controls are identified for all chemical hazards.

E.2.1.4 Core Function #4 – Perform Work Within Controls

Readiness is confirmed and work is performed safely.

RPL. Most of the work the OA team observed in RPL was conducted safely and in accordance with established controls. RPL workers and line management are knowledgeable of the RPL facility and have considerable experience within their areas of expertise.

For SFO work, pre-job briefs for both hot cell sample prep and control rod drive mechanism transfer work were performed efficiently and in accordance with the pre-job checklist as required by procedure. Precautions were covered, and hazards and associated controls were discussed. During the work evolutions, radiological coverage and work practices by staff and RCTs were conducted in accordance with established work practices and procedures. RCT presence on reviewed jobs was clearly evident, and coverage was sufficient to limit exposures and the potential for spread of contamination. RCTs took numerous job coverage surveys, including radiation and contamination measurements during work and were observed assisting and counseling workers regarding proper ALARA practices. Technicians effectively performed a control rod drive mechanism housing move and hot cell transfers in accordance with controls established in the operating procedures. The technicians demonstrated an effective awareness of the radiation hazards and safe work practices needed to mitigate the hazards.

Only limited amounts of benchtop and fume hood radiological work were being conducted during the time of the assessment. A recent DOE surveillance of fume hood and benchtop radiological work identified numerous radiological conduct of operations deficiencies for these types of activities in RPL. As a result, site management held a work stand-down and counseling session with all RPL radiological workers in late October as an initial corrective action. While formal root cause analysis and corrective actions are not yet due for completion, the stand-down occurred only a short time before this OA inspection and may have contributed to better awareness of requirements and improvement in compliance with required radiological work practices (based on the observed radiological performance during the limited fume hood and benchtop laboratory work observed). In these activities, researchers practiced positive contamination control methods, including frequent glove changes as well as alpha and beta surveys of gloved hands each time they were removed from the hood, as called for in radiological work practices. Workers transferring waste materials from a hood had the proper RCT coverage and followed all required radiological practices and procedures, and RCT survey documentation was complete, legible, and accurate.

Waste management activities related to ongoing work in RPL were in accordance with state and DOE requirements. This included satellite accumulation areas (SAAs), where waste containers were kept closed except when waste was being added, hazardous waste labels were visible, and liquids were stored inside secondary containment. Monthly inspections were being performed, logs of waste added to containers were being completed, and SAA operator aids were posted on doors into the laboratories. Management of the less-than-90-day storage area was also effective, including properly labeled containers and a storage location with secondary containment features. Keys to the area were controlled by the FSR, and evidence that weekly inspections were being performed was available.

Permitted waste treatment, storage, and disposal facilities are also operated within RPL and in Building 305B. These areas were also effectively operated in accordance with regulatory requirements. Radioactive waste in RPL is being managed in accordance with the requirements of DOE Order 435.1. Work areas were well maintained, controls for access were being followed, and inspections were performed as required. Containers and bags of low-level waste were stored in designed areas that ensure the containers would not deteriorate. Legacy low-level waste areas had been cleaned out except for a few remaining items as part of a PNNL effort to eliminate legacy waste.

In a few cases, workers failed to follow established work practices and/or requirements contained in the procedures or safety review documents.

- In some instances, items in hoods were located less than the 6-inch requirement from the contamination area boundary and/or where hoods were overloaded to the point that could result in degradation of airflow.

- Two workers performing required hand and foot self-monitoring at the radiation boundary area exit did not allow sufficient time for instruments to respond to potential contamination prior to moving the probe away from the area, in conflict with the provisions of the applicable work practice.

- The RWP for the AlphaMed medical isotope work included tritium contamination suspension limits; however, no analysis of the wipe sample for tritium was conducted.

- Chemical use permits require workers to contact the safety and health professional for determination of specific PPE requirements (glove types). However, in most cases, workers make their own determination, resulting in some inadequate implementation of controls.

- Researchers were using the mezzanine catwalk in Room 510 for storage of miscellaneous supplies. However, such items as metal piping of assorted lengths were being stored unsecured in such a way that they might have accidentally fallen or been pushed through the railing onto an active laboratory bench below.

- A monthly inspection of SAAs had not been completed as required by PNNL. The monthly inspections are performed to help ensure proper operation of the SAAs. However, for one month the newly hired FSR was unable to access the laboratory, and no monthly inspection was performed.

- One SAA, intended only for accountability of waste for ongoing operations, has been used to store mixed waste for over a year. The waste containers had been sealed by researchers, but arrangements for disposal of the waste had not been made.

EMSL. Although limited activities were observed during the inspection, most work observed by the OA team was conducted in accordance with established controls. EMSL researchers and technicians performed research work safely within CPPs and EMSL practices. CSMs were knowledgeable of the hazards and have considerable experience within their areas of expertise. In addition, several higher hazard projects had specific procedures generated to assure that specific controls were followed.

EMSL workers are managing SAAs and the less-than-90-day storage area in accordance with State of Washington regulations and PNNL administrative requirements. Researchers and technicians kept waste containers closed except when waste was being added, hazardous waste labels were visible, and liquids were stored inside secondary containment. Required weekly inspections were being performed, logs of waste added to containers were being recorded, and SAA operator aids were posted on each cabinet containing a waste storage area. In the less-than-90-day area, containers were properly labeled, no containers had been in storage over 90 days, and weekly inspections of the area were being performed. Required signs were on the door, and the doors were under key controls to prevent unauthorized entry.

Although most work was performed safely, in some cases EMSL workers were not performing waste management activities in accordance with specified controls. For example, two hazardous waste labels on two containers in the 90-day area did not have the regulatory-required start date. In addition, the FSR did not identify the deficient labels during performance of two weekly inspections after these containers were placed in 90-day storage. In another example, a four-liter unlabeled container was found in the flammable cabinet in a service corridor. EMSL chemical management requirements specify that all containers must be labeled. In a third example, lecture-size cylinders of hazardous waste are stored in the compressed gas room at EMSL in an SAA instead of the more appropriate 90-day area because the 90-day storage area is not approved for compressed gases. Since these cylinders are not being accumulated, regulations would require they be managed under more restrictive 90-day requirements.

Building 331. Waste storage areas within Building 331 were being operated in accordance with PNNL and Washington State environmental requirements. At the facility level, an FSR is deployed to Building 331 to ensure that generators maintain compliance with Resource Conservation and Recovery Act requirements as well as radioactive waste limitations at the facility. Waste management is effectively conducted through a partnering methodology between the generator (researcher) and the FSR. Researchers have also been effective in maintaining SAAs in accordance with PNNL requirements.

Overall, few weaknesses were identified in the authorization or performance of work in Building 331. Most activities were performed according to established controls. However, improvements in a few areas could further enhance worker safety.

In some cases, EPR risk mitigation permits have been approved by the project managers and product line managers without the hazards or risks being mitigated as indicated by the required permit. For one research activity in Laboratory 350, both the project manager and the product line manager approved the EPR risk mitigation permit with clear warnings in the permit that the proposed chemical and laser activities were not allowed in the laboratories selected for this work.

In other cases, hazard controls identified in permits have not been followed. For example, some requirements in the CPP for work performed in Laboratory 350 were not followed (e.g., laboratory coats were not worn, and latex gloves were used in lieu of the nitrile gloves specified in the CPP). In another example, researchers in Laboratory 170 were not utilizing the appropriate PPE when working with some hazardous chemicals. Furthermore, when questioned, several researchers were unsure of which specific PPE (primarily glove type) applied to which chemicals. Some work was being conducted without any chemical gloves being worn, contrary to the requirements stated in the

CPP, and in some cases the glove being used was not the glove required by the CPP. Activities in Laboratory 152 included working with dilute nitric acids (2%) containing plutonium, uranium, and thorium and were conducted without any PPE other than safety glasses, which was contradictory to the CPP.

Summary. A variety of safe work activities by R&D organizations were observed in the three facilities reviewed. Workers were generally knowledgeable in their technical areas and familiar with the facilities, systems, and equipment being worked on. Readiness to perform work, including ensuring appropriate training, qualification, and authorization prior to performing work, was well implemented. In most cases, work is being performed with a high regard for safety at PNNL by research organizations. Although most work observed was safely performed, some weaknesses and specific deficiencies were identified where SBMS, ES&H, IOPS, or other requirements were not properly implemented. These types of deficiencies could impact safety and/or result in regulatory vulnerabilities.

E.2.2 Facility Support Activities

E.2.2.1 Core Function #1 – Define the Scope of Work

Missions are translated into work, expectations are set, tasks are identified and prioritized, and resources are allocated.

There are several common elements in F&O that resulted in good definition for planned work and most dispatch work across the facilities reviewed. The use of JPPs for higher-risk work, with input from craft, supervisors, ES&H, and work planners, improves work definition during the initial planning stage. Work instructions further define elements of the job and provide limits to ensure that work outside the scope is not performed. On more complex activities, further task breakdown is accomplished by the use of a master work order and subordinate work orders linked to the master work order that further define specific elements of the overall task.

Construction work is well defined through contract provisions and JPPs that define individual tasks under each contract. Facility project managers, responsible for in-progress construction activities in various facilities, participate in plan-of-the-day (POD) meetings to ensure that work for the day is clearly understood, listed on the POD, and appropriately coordinated with facility and R&D operations.

The F&O work control system provides for prioritization based on risk and mission needs. The prioritization for reviewed work activities was appropriately based on the risk of the work activity and the importance of the system and equipment. Work is further prioritized through interaction of building managers, building engineers, facility project managers, supervisors, and customers during formal POD meetings. The prioritization includes both planned work packages (JPPs) and "dispatch work" (skill-of-the-craft). Managers and supervisors allocate craft resources based on the priority, safety, and mission needs. Defining the work during POD meetings and on the approved POD facilitates notification of the environmental compliance and field service representatives about the scope of potential chemical usage and environmental impact on the facilities or surroundings.

Although work was generally well defined, the definition of work on some dispatch work orders was limited and did not fully address the scope and limitations of intended tasks. Many dispatch jobs are relatively simple, within the skill of the craft, and are self-explanatory, requiring minimal definition. However, because dispatch work does not typically include work instructions, a more complete scope of work is necessary for some dispatch work to ensure that personnel clearly understand the scope of work and the limitations. For some dispatch work orders, the system has evolved toward listing a limited scope and then verbally modifying or amplifying the scope before and during the job. One RPL job, with a description to line three survey caves with ¼-inch lead sheet and paint exposed lead with epoxy paint, actually involved the transfer of three 500-pound caves out of a radiological controlled area; surveys and release by an RCT; hoisting and rigging; handling, shearing, and filing of lead; modification of the caves and fabrication of stainless steel doors; attaching the lead; and returning the caves to the radiological controlled area. The work request did not define and address numerous elements of this task.

Summary. The scope of most work activities is sufficiently described and defined to specify what work is to be performed, and to allow subsequent identification of the associated hazards. F&O activities have formal processes to define the scope of work for various facility and R&D work activities. Construction and subcontracted work activities were well defined through contract provision and JPPs. However, F&O dispatch work orders do not always fully describe or limit the allowable work scope.

E.2.2.2 Core Function #2 – Analyze the Hazards

Hazards associated with the work are identified, analyzed, and categorized.

The review of work activities and associated documentation indicated that hazards associated with the work were properly identified and understood by workers. With few exceptions, work documents included both the hazards of the tasks and hazards in the workplace and surroundings. Dominant hazards were also addressed during pre-job briefings.

PNNL has implemented a sitewide IOPS database to capture hazards related to facility spaces. The system was linked to the Electronic Service Request (ESR) system on October 20, 2003, to automatically print hazards associated with spaces where work is being performed on individual work orders. Integration of the IOPS hazard database into planned and dispatch work orders is a significant improvement that formalizes and documents communication of space-related hazards to workers performing work in IOPS spaces. The system will also improve compliance with DOE Order 440.1A and Occupational Safety and Health Administration (OSHA) requirements for communicating hazards in the workspaces to employees. F&O also improved a JPP electronic tool to automatically trigger flags to management of jobs with higher-risk profiles. Management can then use that information to weigh which activities to assess.

PNNL and F&O have received several awards associated with "going green" initiatives by switching to less-hazardous chemicals, solvents, and lubricants, thereby minimizing hazards and the potential environmental impact of chemical use. PNNL received the White House Closing the Circle Award for the Green Custodial Products Initiative. A Certificate of Partnership was awarded from DOE for green power emission reductions associated with power generation. Several other facility management, energy management, and energy and water conservation initiatives also garnered awards and contributed to safety by removing the hazards associated with increased preventive and corrective maintenance. Water and power conservation reduces waste streams associated with the generation of power and excessive use of water.

F&O has proactively managed the potential for beryllium exposure to workers. PNNL devoted considerable effort to identifying potential areas for beryllium sampling, evaluating aluminum welding for the presence of beryllium in the welding fumes; performing sampling in the central fabrication shops and grinders throughout the Laboratory; identifying older fluorescent tubes containing trace amounts of beryllium; identifying the potential for beryllium in electrical bus bars, contacts, and breakers; and identifying and eliminating beryllium-containing tools. These efforts have reduced the potential for worker exposure to beryllium across PNNL.

While most hazards were adequately identified and documented, some weaknesses were identified. Walkdowns of the RPL, Building 331, and EMSL mechanical equipment rooms indicated that most confined spaces, high noise areas, and other area hazards were properly identified with appropriate signage. However, a number of EMSL ventilation plenums were not identified as confined spaces and had not been evaluated and documented by Safety and Health. Twenty-five maintenance access hatches for ventilation plenums (five in each wing) had apparently been overlooked, as other spaces in the mechanical equipment rooms were properly marked. Many of those spaces, upon evaluation, may qualify for "non-permitted" confined spaces, provided that no hazards (solvents, cleaners) are introduced into the space during maintenance. At Building 331, confined spaces in the mechanical equipment rooms and outside were marked as confined spaces with one deficiency. Two wood-covered pipe trenches were marked by only one sign near the end of one of the trenches. OSHA 1910.146 (c)(2) requires that spaces be marked by danger signs or other equally effective means to inform employees. Marking each space separately would provide more effective employee notification.

The implementation of the IOPS hazard database provides ready access to space hazard information and is an effective tool in most respects. However, the recently implemented system has some software problems that caused several dispatch work orders to be issued with annotations of "No IOPS Hazards." For several of the work requests, the work was performed in IOPS spaces that had numerous hazards (see Section E.2.2.3, Core Function #3).

Summary. The hazards for most F&O work observed had been properly identified and analyzed through the PNNL review and planning processes. Several positive practices and initiatives were identified that minimized or eliminated hazards, provided for communication of hazards, and contributed to less risk and safer work. For example, the F&O "green" initiatives have reduced the chemical hazards profile, and special hazards, such as beryllium, have been proactively managed to minimize exposure to workers. However, weaknesses were identified in the identification and analyses of hazards that in some cases resulted in inappropriate hazard controls being applied. Overall, the process and procedures are in place and are generally effective to identify and analyze hazards such that appropriate controls can be implemented, although correcting implementation deficiencies could result in a more robust program.

E.2.2.3 Core Function #3 – Develop and Implement Hazard Controls

Safety standards and requirements are identified and agreed upon, controls to prevent/ mitigate hazards are identified, the safety envelope is established, and controls are implemented.

Implementation of integrated core teams with dedicated maintenance management and maintenance staff assigned to designated facilities is a significant improvement promoting integration of F&O building management, engineering, and maintenance personnel into the "science" team. The dedicated building managers and engineering and maintenance personnel are more familiar with the facility, laboratories, and systems, and are more knowledgeable of research missions, equipment, and interfaces between R&D and the facility. Dedicated building engineers are readily available to support facility and maintenance engineering and R&D activities. During observation of work activities and walkdowns, the consistency of core teams from facility to facility was evident. Building managers, building engineers, and facility project managers are well engaged in F&O and research work, and day-to-day operations in their respective facilities. Close interactions during walkdowns and observation of work activities indicated that they were experienced and knowledgeable of systems and equipment.

PNNL facility use agreements are well written, detailed, and identify the boundary interfaces and division of responsibilities between F&O and user organizations. The facility use agreements contain the hazardous material listings and quantity limits for dominant chemicals and hazardous material in the facilities. For the evaluated facilities, the facility use agreements were current and in place and serve as the "authorization basis" documents for the non-nuclear facilities. The agreements also supplement the documented safety analysis for RPL.

PNNL subcontracts and F&O work procedures require that subcontractors work to the equivalent of a planned job package for all work. F&O requires subcontractors to perform work in accordance with a JPP prepared by PNNL construction personnel, based on the requirements in the F&O work control procedure (ADM-16). Requiring all subcontractors to work to PNNL-prepared JPPs adds to the formality, safety, and consistency of subcontracted work activities. To provide better visibility and identification of subcontractor work activities, F&O requires the use of a clearly visible and posted subcontractor "job box" that names the subcontractor, the work activity, and the site point of contact. Subcontractor job boxes allow for easy access to the subcontractors job package and information. Job boxes were evident for the outfall construction and the first and third floor construction renovations in Building 331.

A variety of preventive and corrective maintenance jobs were observed. F&O procedures for preventive maintenance were current and detailed, and work instructions for planned job packages were detailed. Many work instruction and preventive maintenance procedures were in a step-by-step or checklist format, with check boxes for each work step. In general, signature blocks were used to certify that work was complete and that post-maintenance testing was satisfactory.

The F&O administrative work control procedure appropriately addressed management of waste streams from work activities. The procedure provides an effective tool for ensuring that waste is managed in accordance with DOE and regulatory requirements. In addition, this procedure contains guidance on recycling materials in order to reduce disposal costs and protect the environment. Steps in the procedure link the craft personnel to the FSR as a control to ensure that waste management expertise is involved in deciding proper disposal paths for waste generated by F&O activities. For example, for management of empty containers, craft must verify, with the FSR, that the container meets the criteria for proper disposal.

The OA team identified that a few modifications are being performed without using the modification process or permit required by site procedures. In Building 331, a structural modification was being performed on the building supply fans without a modification permit. Matrix-type filters were being removed from each supply fan, and the roll filters were being relocated to the intake side of the coils. The modification required decontamination and decommissioning of the existing matrix filters, the removal of roll filters from the downstream side of the intake coils to the upstream side, and fabrication of mounting plates, guards, and other miscellaneous parts for the installation. As discussed previously, a door to the high-voltage switchgear room had been permanently removed, constituting a minor facility modification. Administrative procedure ADM-58 requires that a modification permit be completed for facility modifications to ensure that all elements of configuration management are appropriately considered. After this concern was identified, the chief engineer indicated that a modification permit would be processed for the supply ventilation roll filter job.

Adequate controls are not implemented to ensure that dispatch work requests receive a final documented review by supervisors to verify that the scope of work is clear and that hazards appropriate for the location of the work activity are listed. As a result, some dispatch work requests for work in IOPS space were issued to the field with the hazard block marked as "no IOPS hazards." Although the cause was software interface problems between the ESR and the IOPS database, a reasonable supervisory review would have identified that the work orders incorrectly listed no space hazards. Readiness to perform work was not assured before these work orders were released to the craft for work. Supervisors and craft should be accountable to perform a careful review of work orders prior to starting work.

Most craft work is performed using dispatch (skill-of-the-craft) work orders. The dispatch work criteria include many effective elements that ensure that planned packages are used for higher-risk work, and triage managers effectively use the criteria to screen and upgrade many jobs to planned work packages. However, the criteria for such work does not address any criteria based on the complexity of the work, number of craft or multiple trades involved, coordination between organizations (Operations, Radiological Control, ES&H, F&O, and R&D), or using several dispatch work orders in lieu of a JPP. Additionally, the present criterion does not fully address some non-permitted work that may require special planning, such as asbestos or lead work. The RPL lead cave job, as discussed in Section E.2.2.1, contains several elements that may be more appropriately addressed by a JPP rather than a dispatch work order.

PNNL does not have sitewide institutional controls in place to consistently control work activities involving lead. Lessons learned from numerous events across the DOE complex had indicated weaknesses in control of work activities associated with lead. There have been exposures from handling seemingly small quantities of lead. At PNNL, workers and researchers use lead (e.g., solder, shielding bricks, weights, and lead sheeting) in numerous facilities, sometimes without formal controls. Improper practices with lead were observed in RPL shops (cutting and stamping on bare lead), and oxidized bare lead was being used for manipulator weights in Room 58. A recent work activity included shearing, filing, and gluing lead to other surfaces without controls specified in the work order. Controls for lead may be inconsistently implemented across the site. One facility used a CPP (because there was no other vehicle), and another facility performed shearing and filing of lead on a dispatch work order. The only documented guidance on lead at PNNL is a lessons-learned bulletin that is labeled with a course number and called "site training"; however, it is a "read and sign" process that was put in place by the supervisor rather than being driven by the formal work control process.

The review of the energized electrical work permit (EEWP) raised several concerns about sitewide program implementation of the EEWP program. Numerous completed R&D and F&O EEWPs were reviewed that identified several program and implementation weaknesses. For example, the author and reviewer for most of the EEWPs was the same, thereby reducing the value of the intended multi-level review of the permits. Standing permits are issued for one year, and the only approval required for each energized electrical job is by a "person in charge," with no management review. Building and upper management may be unaware of the true extent of energized electrical work being performed across the Laboratory. The standing permits were not fully tailored to each particular job, so one cannot determine the specific controls and PPE that were used for a particular job. Standing permits listed the full range of PPE and control options, and individual controls or PPE were not circled or checked to indicate the particular controls that were used for the job. The compelling reason for performing energized work was not filled in on many of the standing EEWPs reviewed. The format of the permit was such that reviewers could not determine whether each energized job used a second person or attendant. The specific work assignment for each worker assigned to the job was not listed. Energized electrical work requires clear delineation of assigned tasks for each worker involved.

Workplace exposure assessments and hazards assessments are required by OSHA regulations and DOE Order 440.1A. OSHA 1910.132 requires employers to assess the workplace to determine whether hazards are present, or are likely to be present, that necessitate the use of PPE. It further requires written certification that the required workplace hazard assessment has been performed. DOE Order 440.1A requires implementation of a comprehensive and effective industrial hygiene program to reduce the risk of work-related disease or illness. The order requires initial or baseline surveys of all work areas or operations to identify and evaluate potential worker health risks. It further requires periodic resurveys and/or exposure monitoring as appropriate. PNNL workplace exposure assessments have a number of weaknesses:

- The Building 350 painting booth was being operated well above the maximum filter differential pressure (dp). The increased pressure would result in a substantial decrease in airflow needed to exhaust paint fumes from the booth. The paint booth was operating at 0.86 inches of water dp with a maximum limit of 0.50 inches of water dp. It is likely that the condition had existed for some time while the booth was used for painting. Discussions with one painter indicated that smaller painting jobs were performed in the booth without respiratory protection. The only workplace exposure assessments for the painting booth had been performed in 1993, and there was no evidence of periodic evaluation or re-surveys based on potential changes in painting materials over the past 10 years. The workplace exposure assessments were qualitative. If the potential to exceed the threshold limiting value (TLV) is low, a qualitative exposure evaluation without air sampling is normally adequate. However, one workplace exposure assessment indicated that potential exposure would be above action levels and that a respirator and monitoring were needed. There was no evidence that air sampling was performed or documented or that ventilation surveys had been performed.

- The Building 350 and EMSL designated welding area ventilation trunks did not have inspection tags indicating that face-flow velocities had been initially or routinely verified to ensure adequate airflow to exhaust welding fumes and potential ozone generated from arc welding. Discussions with F&O and Industrial Hygiene indicated that ventilation flow for both the welding booth roof exhausters and power ventilation trunks are not routinely verified and may not have a baseline assessment. Several workplace exposure assessments had been performed for the Building 350 welding booth, all in 1993. No workplace exposure assessments were located for the welding booth in EMSL. The workplace exposure assessments assumed adequate ventilation flow to ensure that action levels were not exceeded; however, there was no ventilation or air sampling data to verify that airborne concentrations of contaminants were below the TLVs.

- The Building 350 carpentry shop's dust collector ventilation exhaust trunks for various power tools did not have initial or periodic surveys to ensure that flow was sufficient to prevent worker exposures. Similar to the case for the paint booth and welding booths, several workplace exposure assessments had been performed in 1993. However, the exposure assessments lacked air sampling or ventilation measurements, and failed to justify the basis for not conducting these measurements. The workplace exposure assessments assumed that local ventilation was sufficient to keep particulates away from the breathing zone of employees. Two of the workplace exposure assessments, one for sanding and routing of woods and plastics, and one for bonding woods and plastics using glues and adhesives, stated that potential exposures were likely to be above action levels and recommended exposure monitoring to ensure that action levels were not exceeded. There was no evidence that follow-up monitoring had been performed. For the sanding and routing of wood, the workplace exposure assessment did not indicate that the most limiting materials were used for the assessment. Some pressure-treated wood contains arsenic, and certain types of bonded laminates contain formaldehyde and would be more limiting than wood or most plastics. One assessment for radial arm saw operation recommended that noise monitoring and personal dosimetry be performed because the saw had an estimated noise level of 95 to 100 decibels.

Finding #4: Workplace exposure assessments and ventilation surveys are not being performed as required by OSHA and DOE Order 440.1A to provide assurance that worker exposures are maintained below regulatory compliance levels.

Summary. PNNL appropriately uses engineering controls for maintenance and subcontracted work activities. F&O work activity controls are comprehensive and formal. The F&O core team and R&D function is well integrated, with seamless support by effective building management teams. Workers in all buildings, including subcontractors, are subject to the same consistent controls from building to building. A variety of effective electronic tools and permits are in place and being used to adapt controls to specific F&O work. However, several weaknesses were identified for F&O support operations in such areas as workplace exposure assessments, EEWPs, controls for lead, and dispatch work orders that could adversely affect safety. Overall, PNNL has a generally mature process for establishing proper hazard controls, but improvements are needed to resolve several weaknesses in implementation.

E.2.2.4 Core Function #4 – Perform Work Within Controls

Readiness is confirmed and work is performed safely.

The OA team observed a variety of F&O work activities, including construction, preventive and corrective maintenance, fabrication, and welding in the Building 350 shops, RPL, Building 331, and EMSL. All work observed was being performed safely and within work package and procedural controls. Work documents and procedures were present at the job locations, appropriate PPE was worn where required, and the workers were knowledgeable of the hazards involved. Construction areas were well marked with construction barricades and posted signs for EMSL and Building 331 outfall work and laboratory renovation construction areas.

Readiness to perform work was assured through formal POD meetings held each morning prior to the start of work and approved written PODs for each facility. The POD meetings at all facilities are driven by formal F&O procedures and were consistently performed in RPL, Building 331, and EMSL. PODs were well attended by the building manager, building engineer, facility project managers, maintenance supervisors, and support personnel, such as RCTs and ES&H representatives. An approved POD resulted in formal work authorization for all planned and some dispatch work in the facility. Minor dispatch work, not listed on the POD, was discussed at the POD and individually authorized by the building manager, building engineer, or facility project manager. Emergent work was formally added to the POD by a signed addition form appended to the approved POD.

Workers were experienced in their trades and knowledgeable of the facilities and equipment related to their work activities. The workers exhibited a good regard for safety and procedural adherence while performing work activities. The numerous lockout/tagouts (LO/TOs) and safe energy checks observed were performed safely and within procedural controls. One positive aspect of building configuration and system control is that system alignments for maintenance and LO/TOs are placed by Building Management/Operations personnel, and then craft over lock and verify the LO/TO. This ensures an additional level of facility authorization (in addition to the POD) on jobs involving LO/TO. When two craft were involved in a work activity, both craft over locked the tagout even if only one was doing the hands-on work.

Hoisting and rigging operations in EMSL and RPL were safely conducted. Hoisting and rigging equipment was properly marked with current inspection tags and was stored to prevent degradation and damage. A variety of hoisting and rigging equipment was inspected both in shops and in use during work activities. All inspections were current, and equipment was in good repair. In two Building 350 shop areas, deficient slings had been marked and set aside for evaluation or disposal. Several recent improvements in hoisting and rigging included magnetic lifting devices for improved water jet material handling; a counter-balanced boom crane to allow closer access to loads (no protruding legs); racks and stairs for trucks/vans to ease loading, entry, and exit; use of compressed gas carts to facilitate moving bottles; and a below-the-hook lifting device for forklifts to avoid smaller portable cranes.

With one exception, storage of flammables in all facilities was adequate. Flammable material was properly stored in flammable lockers and was neatly arranged within the lockers. No instances of incompatible storage were identified, and the lockers contained no standing oil or excessive combustibles. However, the Building 331 high-voltage switchgear room had a flammable locker stored directly against the building main feeder power panel and within a few feet of emergency standby feeder for building power. Additionally, one half of a double door that isolates the switchgear room from the mechanical equipment room had been permanently removed. The building manager indicated that the door had been gone for years and did not know when or why it was removed. Generally, building design features isolate high-voltage switchgear rooms from adjacent working spaces to reduce hazards from electrical fires or malfunctions. The door removal may have been an unapproved facility modification.

Notwithstanding the many strengths and positive aspects of the F&O work control program, weaknesses were identified that had potential to affect worker safety. Weaknesses were identified in the worker exposure program, in implementing procedural requirements that resulted in numerous facility deficiencies, and deficiencies in implementing the EEWP process.

While most work was performed safely, some work was being performed in workplaces (painting booth, welding booths, and the carpenter shop) that did not have current workplace exposure assessments. For the Building 350 painting booth, painting operations were being performed when the filter differential pressure was significantly above the maximum allowed for painting booth operation (see Finding #3).

Failures to follow PNNL and F&O procedural requirements resulted in numerous readily observable safety deficiencies and OSHA violations in the Building 350 central shops, and to a lesser extent at RPL, Building 331, and EMSL. The number of deficiencies across several facilities indicated weaknesses in establishing clear management expectations for rigorous self-assessment programs and day-to-day walkthroughs by supervisors and craft. The deficiencies included (see Findings #1 and #2 in Appendix D):

- There were several cases where machine disconnects and power panels were partially obscured by improper storage of material and equipment, and one fire extinguisher was blocked.

- Numerous heavy clamps in a welding booth were stored by hanging them on oxygen and acetylene piping and had slightly bent a copper elbow on an oxygen line, which could cause oxygen and acetylene leaks.

- Welding areas at Building 350 and EMSL had combustibles within 35 feet, contrary to site requirements, and welding curtains did not go down all the way to the floor, as required by site procedures. A microwave oven at EMSL and a refrigerator at Building 350 were located in designated welding areas.

- Numerous bench grinders in all facilities had evidence of minor grinding on aluminum, and several grinders had improperly adjusted tool guards.

- A gas cylinder bottle at Building 350 and one in a Building 331 research laboratory were not properly secured.

- There was poor housekeeping in several areas, including the central shops, paint shop, EMSL machine shop, and the Building 331 mechanical equipment rooms. One lathe was identified in a Building 331 mechanical room that had a number of safety deficiencies.

- Electrical safety deficiencies included a portable cooling fan with a blade guard that did not meet OSHA requirements in Building 350; extension cords were daisy-chained in two areas of Building 331 in violation of site electrical requirements; and a drill with a defective power switch (always on) was being used in a Building 331 research laboratory space.

- A planer in the central shops was modified to improve the emergency shutoff by adding a large knee plate that contacted the shutoff switch. However, misalignment of the plate could have prevented the machine from being stopped. After the modification, several people had reviewed the issue, which was then prematurely closed in the assessment tracking system.

- A construction barricade (plastic fence) around an excavation at the Building 331 outfall did not provide adequate fall protection for the excavation. The barricade was located at the edge of the excavation and was not sufficiently strong to prevent a fall of about 10 feet into the excavation. (This deficiency was corrected immediately by the construction safety inspector.)

Most of the safety deficiencies discussed above were promptly corrected during the course of the inspection. Extension cord deficiencies, blocked power panels and disconnects, and the blocked fire extinguisher were corrected soon after they were identified, and several machine grinders were removed from service. The paint booth and welding booths were placed out of service pending evaluation, and clamps were removed from the oxygen and acetylene piping. F&O also initiated actions to review other facilities and areas for the same type of deficiencies.

Summary. Most work by F&O at PNNL is being performed with a high regard for safety. Workers were generally familiar with the facilities, systems, and equipment being worked on. Readiness to perform work, including ensuring appropriate training, qualification, and authorization prior to performing work, was well implemented. Formal, well-documented POD meetings and schedules ensured appropriate coordination between the facility core team and R&D organizations. Subcontracted construction activities at Building 331 were being performed safely within and adjacent to active R&D spaces. Although most work observed was safely performed, some weaknesses requiring management attention were identified. These include deficiencies in the worker exposure program, weaknesses in following procedural requirements that resulted in numerous facility deficiencies, and deficiencies in implementing the EEWP process. These deficiencies are symptoms of weaknesses in feedback and improvement processes, as discussed in Findings #1 and #2 in Appendix D.

E.3 Conclusions

Most work activities reviewed by the OA team were performed with appropriate controls and a high regard for safety for R&D and F&O activities. Further, PNNL has achieved a good safety record. For example, FSD injury and illness rates indicate a safe operating history. The FSD fiscal year 2003 first aid case rate of 1.43 is below comparable rates for most other PNNL divisions for the same period of time. Furthermore, the FSD recordable case rate of 0.82 and the days-away restricted case rate of 0.20 are well below the CY 2002 DOE research contractor average rates of 2.20 and 0.90, respectively.

Although some deficiencies were identified with lower-hazard activities, the scope of work is adequately defined, the processes for identifying and analyzing hazards were generally adequate, and most work was performed in accordance with identified controls for R&D and F&O activities. However, for both R&D and F&O, processes for developing and implementing hazard controls were not always effective. Although some aspects of controls were particularly effective, including the use of engineering controls and environmental controls, other aspects of hazard controls were not rigorously implemented or well documented for some lower-hazard activities. Improvements are needed in a number of areas, including exposure assessments, interfaces between IOPS and EPR, lead controls, EEWPs, and documentation of controls.

E.4 Ratings

The ratings of the first four core functions reflect the status of the reviewed elements of ISM program elements at PNNL facilities. The ratings apply to both R&D and facility support activities.

Core Function #1 – Define the Scope of Work..EFFECTIVE PERFORMANCE
Core Function #2 – Analyze the Hazards ....EFFECTIVE PERFORMANCE
Core Function #3 – Develop and Implement Hazard Controls .... NEEDS IMPROVEMENT
Core Function #4 – Perform Work Within Controls ....EFFECTIVE PERFORMANCE

E.5 Opportunities For Improvement

This OA inspection identified the following opportunities for improvement. These potential enhancements are not intended to be prescriptive or mandatory. Rather, they are offered to the site to be reviewed and evaluated by the responsible line management, and accepted, rejected, or modified as appropriate, in accordance with site-specific program objectives and priorities.

Pacific Northwest National Laboratory

1. **Conduct a review to determine the causes and corrective actions for failures to properly identify and control all relevant radiological**

hazards associated with AlphaMed work in RPL and in ICP analysis in Building 331. Review radiological control requirements for a larger sample of current projects using radioactive materials to determine whether these examples represent anomalies or a more systemic concern.

2. **Consider establishing a mechanism to integrate radiological work planning outcomes with hazard awareness summaries and IOPS**. Consider linking radiological work planning with the EPR and IOPS processes to integrate controls identified in RWPs (e.g., training and protective clothing) into the research work control process.

3. **Enhance the EPR process and interfaces.** Specific actions to consider include:

   - Provide a more complete description of the work activity in the EPR. Write the work description such that individuals who are responsible for but not directly involved in the research (facility operations, ECR, ES&H, emergency management) can sufficiently understand the research work scope in order to identify workplace hazards or challenges to the building safety envelope. Include references to other proposal and technical work documents that may also describe the research work.

   - Hold product and project managers fully accountable for the accuracy of EPRs to ensure that hazards are consistent with the research project, and that EPRs are maintained current with changing hazards.

   - Increase the involvement of the Safety and Health representative in the review of EPRs.

   - Consider tailoring the IOPS requirements section of the EPR to include only those permits, work practices, and training that are required based on the hazards identified in the EPR. For example, exclude requirements, such as respiratory protection training, if the research project has no hazards requiring the use of a respirator.

4. **Conduct a survey and evaluation of routine laboratory work activities to identify common research hazards that may not be adequately captured through application of the present EPR and/or IOPS processes**. Specific actions to consider include:

   - Define a "skill of the craft" activity category for research work for which some routine hazards and their controls (e.g. use of syringes) may not need to be documented in either an EPR and/or through IOPS.

   - Establish training and/or qualification requirements for "skill of the craft" activities to ensure that all researchers, including those with less laboratory work experience or training (e.g. visiting students), perform routine work with the same level of hazard awareness and hazard controls.

5. **Strengthen the sitewide implementation of the EEWP program such that specific controls are tailored to each use of a permit and documented on the EEWP.** Specific actions to consider include:

   - Consider reformatting the EEWP form to allow the exact job scope to be entered or checked off and the specific controls used for each job listed or circled on the form.

   - Reestablish the multi-level review (prepared by, reviewed by, approved by signatures) as intended by program requirements.

   - Ensure that job-specific, compelling reasons for energized work are documented on the EEWP and receive some level of management review.

   - Establish periodic and more rigorous assessments of the energized electrical work.

6. **Improve the quality of the periodic self-assessments and day-to-day observation and walkdowns of work activities and spaces.** Specific actions to consider include:

   - Consider further customizing the CSM self-assessment checklists for such spaces as the

Building 350 shops (paint booth, welding booths, etc.) and mechanical equipment rooms to ensure that checklist attributes are clearly written and would reasonably identify safety deficiencies.

- Include supervisors and crafts as a normal part of self-assessment functions to raise and reinforce management expectations for maintaining workspaces free of ES&H deficiencies.

- Review recent management and self-assessments to determine why assessments have not been fully effective in identifying readily-observable deficiencies.

7. **Consider establishing sitewide institutional work controls for the use, cutting, machining, and handling of lead and lead products.** Specific actions to consider include:

   - Determine the quantities, locations, and uses of lead across PNNL by R&D and F&O, and verify the adequacy of existing controls.

   - Review DOE complex-wide lessons learned regarding improper control for lead and worker exposures.

   - Determine whether implementing work controls and/or procedures are in place to ensure that SBMS requirements will be consistently implemented across the site to protect workers.

8. **Establish formal work practice instructions for some shop operations, such as the paint booth and carpentry shops.** Specific actions to consider include:

   - Define operations and controls based on the most limiting materials to be used (epoxy paints, bonding adhesives, arsenic-containing wood, etc.).

   - Verify the controls by baseline and periodic workplace exposure assessments that include quantitative ventilation measurements and worker monitoring.

9. **Consider implementing changes to RPL practices to ensure compliance with chemical use documentation requirements of SBMS such that all individual chemical hazards associated with various processes are appropriately and uniquely identified and controls are tailored to the specific hazards.** Specific actions to consider include:

   - At RPL, use the SBMS permit authoring tool as a mechanism to better facilitate compliance with SBMS and OSHA requirements for documenting hazards and controls associated with chemical use.

   - Ensure that the appropriate PPE for each hazardous chemical is either clearly identified in a CPP, or some other document, such as a manufacturer's glove chart.

   - Conduct periodic training for CSMs to increase awareness of the need to continually review chemical inventories against existing permits and IOPS hazard awareness summaries to ensure accurate and complete hazard identification.

   - When using the "static inventory" location field of CMS for bulk chemicals, ensure that the storage location of individual containers is accurately reflected in CMS unless the product will be used and returned to the bulk chemical storage location each day of use.

   - Consider revising the CPP authoring tool to include maximum quantities of bulk chemicals in laboratories and associated PPE for handling bulk chemicals.

10. **Improve systematic mechanisms within IOPS or other means to ensure that personnel with radiological work planning responsibilities have access to all available details concerning scope of work such that hazards can be appropriately analyzed and controlled** Specific actions to consider include:

   - Establish a requirement to include EPR documentation along with RWP request forms.

- Establish an RWP request form writers guide to ensure that researchers and project managers include all relevant details of work scope and isotopes to be encountered during work.

11. **Increase emphasis on tailoring controls to specific hazards within IOPS spaces and in the development of RWPs.** Specific actions to consider include:

    - Ensure that hard-copy laboratory handbooks at RPL contain only the information that uniquely applies to the IOPS space for which it is intended and that CSMs keep the information current.
    - Improve the rigor of laboratory self-assessments to include periodic evaluations of CPPs to verify that the appropriate chemical PPE is identified and is being followed by researchers.
    - For higher-hazard radiological work at RPL, conduct and document time motion evaluations of actual work evolutions to ensure that prescribed controls are optimized (i.e., location of extremity dosimetry) and to document accuracy of pre-job dose estimates.
    - Ensure that appropriate controls for the work, such as the need for respiratory protection or appropriate suspension limits, are clearly specified in RWPs that allow such generic activities as "perform decontamination."

12. **Consider enhancements to further improve waste management activities**. Specific actions to consider include:

    - Ensure that inspections of waste management areas are performed on schedule and with sufficient rigor to identify non-compliance with requirements.
    - Ensure that all containers used for holding hazardous chemicals are labeled as either hazardous materials or hazardous waste to assist in proper management of waste.
    - Improve management of SAAs so that full containers or containers from activities that have ended are transferred to compliant storage in a timely manner and not stored in the accumulation areas.
    - Consider creating a less-than-90-day storage area in the EMSL compressed gas room for lecture-size compressed hazardous waste gas cylinders.

APPENDIX F
ESSENTIAL SYSTEM FUNCTIONALITY

F.1 Introduction

The U.S. Department of Energy (DOE) Office of Independent Oversight and Performance Assurance (OA) evaluated essential system functionality at the Pacific Northwest National Laboratory (PNNL). The purpose of an essential system functionality review is to evaluate the functionality and operability of a facility's system(s) and subsystem(s) essential to safe operation. The review criteria are similar to the criteria for the Defense Nuclear Facilities Safety Board Recommendation 2000-2 implementation plan reviews; however, OA reviews also include an evaluation of selected portions of system design and operation.

The OA team selected the Radiochemical Processing Laboratory (RPL) radioactive exhaust ventilation system (REVS) for evaluation. This system starts at the exhaust plenum in the RPL basement, includes the attached ductwork to the Filter Building Annex, the final high efficiency particulate air (HEPA) filters, housings, dampers, and exhaust fans, and ends at the top of the stack. The system is designated as "safety significant" in the documented safety analysis (DSA) and is intended to ensure safe confinement of radioactive materials under normal conditions and during certain accident conditions, including a fire or explosion in a laboratory room.

The OA team's review of this system focused on elements of system design, configuration control, surveillance and testing, maintenance, and operations that are important to ensuring that the system can perform its safety function. The OA team performed a detailed analysis of the safety basis of the system, including a critical review of parameters and assumptions made in the DSA.

F.2 Results

F.2.1 Design and Configuration Control

Design. The RPL was designed and constructed in the 1950s and was subsequently modified and upgraded to meet changing mission needs and safety requirements in accordance with applicable design and safety standards. The safety-significant REVS was part of the original facility design and was designed to prevent the release of radioactive materials from the facility by establishing airflow from potentially less contaminated areas to potentially more contaminated areas and ultimately to the environment through HEPA filters. This OA inspection focused on the design of this system, its ability to accomplish the requirements in the DSA and the technical safety requirements (TSRs), and the translation of this design into procedures and practices associated with the system. It also addressed design and configuration management processes associated with the RPL, including the unreviewed safety question (USQ) program. The inspection results were based on the RPL facility, the REVS, and the RPL DSA and TSRs as they were found at the time of the assessment.

The Richland Operations Office (RL) and PNNL engineering and technical personnel and the managers contacted were technically knowledgeable of the facility and the REVS, were highly motivated, and possessed a very strong sense of "ownership" of RPL safety systems. However, the degree of rigor and formality of the engineering documentation was not sufficient to adequately support the safety basis for a Category 2 nuclear facility. There was an absence of formal, detailed technical analyses to support the REVS design and its normal and accident operating parameters and limits.

In general, REVS has a robust design. However, weaknesses were identified in the system's DSA/TSR requirements, in its physical design, and in its design, operational, and testing parameters. As discussed in the following paragraphs, these weaknesses could prevent the system from fully performing its intended safety function for some design basis conditions.

The REVS design does not account for potential building pressurization during a design basis fire due to rapid loading of the REVS HEPA filters. The RPL heating, ventilation, and air conditioning (HVAC) system normally operates with three non-safety main supply fans and three REVS exhaust fans running. Under both normal and accident conditions, the exhaust fans must operate at a higher flow rate than the supply fans to maintain the building at a slightly negative pressure, with building inleakage making up the fan flows mismatch. However, for a design basis fire in one of the laboratories, the REVS HEPA filters would rapidly become loaded with combustion products, which could rapidly increase the REVS filter differential pressure and the overall system resistance. The system resistance increase could cause the exhaust fans to operate at a lower flow rate, potentially less than the supply fans, which could cause the building to become pressurized, and building inleakage would be changed to outleakage, bypassing the REVS HEPA filters. Initial research by the OA team indicated that additional filter loading as low as 1¼-inch water column (w.c.) differential pressure (dp) above normal would reduce the building negative pressure to zero (the filters' normal operating range is 1 inch to 2 inches w.c., and they are intended to be capable of accepting fire loading up to 10 inches w.c.). This previously unidentified system interaction could have been addressed with a design feature to automatically trip the supply fans when building negative pressure lower limits are approached. The exhaust fans normally operate near the high static pressure end of the fan curve data provided by the vendor. However, the additional system resistance from a fire would cause the fans to operate well outside the range of the vendor-supplied data.

The REVS design does not include criteria for building negative pressure that adequately accounts for wind effects. For an HVAC system, such as REVS, to provide confinement in an accident, it must accomplish two functions: (1) it must establish a controlled HVAC exhaust flow from the building through a filtered pathway that will remove sufficient radioactive material to prevent exceeding acceptable offsite and onsite exposures, and (2) it must establish building negative pressure with respect to the outside environment that is sufficiently low to prevent building leakage through unfiltered pathways for wind conditions that can produce localized negative pressures on the building outer surfaces. The current DSA and associated TSRs do not designate a minimum building negative pressure to maintain, and thus do not adequately address the second function. Specifically, the DSA/TSRs do not specify a minimum building negative dp requirement that will ensure no building leakage for wind velocities of concern nor, alternatively, does the DSA accident analyses for offsite and onsite exposures account for a credible percentage of unfiltered leakage that might occur in the absence of control of minimum building negative pressure. Therefore, these safety documents are insufficient to provide positive assurance that a critical design safety function of the REVS can be accomplished. Although existing operator rounds sheets require a building negative pressure, their minimum allowable dp of only minus 0.01 inch w.c. corresponds to wind velocities up to only 5 miles per hour (mph). The accident exposure calculations were performed for a 22-mph wind velocity, which could generate localized outside building skin pressures as low as minus 0.17 inch w.c. Facilities such as the RPL are typically maintained at about minus 0.25 inch w.c. to provide margin above the analyzed wind velocity. Based on observations during system walkdowns, OA concluded that the REVS system might not be maintaining all areas of the facility at a negative pressure.

The REVS filter isolation dampers' design is inadequate to accomplish their DSA-stated isolation function. The DSA, in Section 8.2.1.4 and other locations, states that the design basis function of these dampers is isolation of the filter banks, which is desirable in some situations (e.g., instances where a bank may be found to be outside its TSR-required efficiency). However, the design of these dampers (shutter-type, without seals) is inappropriate to achieve the level of isolation necessary to maintain overall system filtration efficiency within the 99.95 percent TSR limits. Although this deficiency can be overcome through compensatory system procedure changes (some of which were accomplished during this OA inspection), the DSA should also be revised to remove any ambiguity regarding the dampers' isolation capability.

Finding #5: The PNNL RPL REVS design contains fundamental weaknesses that could prevent it from performing its design safety function and that are not adequately addressed in the DSA and associated TSRs.

The REVS HEPA filter efficiency testing procedure is non-conservative. The RPL TSRs require REVS final HEPA filter efficiencies greater than 99.95 percent. The system contains four parallel filter banks, and the surveillance test procedure tests each bank separately by isolating three banks and performing a smoke penetration test on the remaining in-service bank. The test is performed by introducing smoke upstream of the banks and sampling the smoke concentration upstream and downstream of the filter banks and comparing the concentrations. However, the test method and sample configuration do not meet industry standards and could cause non-conservative results because the sample point is in the *common* outlet header for the four filter banks rather than the downstream flow from the specific filter being tested. This discrepancy is significant because of the potential leakage of the isolation dampers. Any such leakage from the three "isolated" banks would mix with the outlet flow from the bank being tested and could affect the test results. Calculations indicate that the dilution flow could be as much as 33 percent of the total flow with the current incorrect damper test acceptance criteria (discussed later). (Note: Even if an unacceptable individual filter bank is not detected as a result of this procedure weakness, the overall system filtration efficiency will remain within the TSR requirement, as long as the system is operated with all four filter banks on line. Although allowed by the DSA, there was no indication that the system had ever been operated with less than four banks on line except during facility outages.)

Functional testing of the REVS backup air supply is not adequate. The safety-significant compressed air system is a supporting system for REVS. Its safety function is to provide operating air to the REVS damper actuators upon loss of the normal air supply to ensure that the dampers remain in the correct position for all design safety basis conditions. Being a safety-significant system, it must be tested periodically to assure that it can perform its safety function. Although it is currently tested to verify that the backup air compressor will automatically start when the normal air supply is lost, no testing is performed to show that the system leakage, including back-leakage through the check valve, which separates the backup air supply from the normal air supply, is less than the backup air compressor's capacity. Such leakage would not necessarily be detected during normal operation, since the larger normal air supply capacity may be capable of maintaining system pressure in spite of the leaks, whereas the backup air compressor may not.

Finding #6: PNNL has not adequately and correctly translated some REVS design requirements into system procedures, and REVS HEPA filter and backup air supply testing was not adequate to demonstrate operability.

Calculations are normally only performed to support a new or unique modification or plant condition. These calculations are usually filed with the project documentation and do not become a part of the facility design basis documents. When a facility change is made, the acceptance of the plant change is based on its performance relative to the previous configuration (reverse engineering). However, analyses of its performance relative to the original design basis are not generally performed because no calculations for the original plant configuration are maintained or are readily available. There is effectively no analytical basis for the DSA descriptions or the TSR surveillance test acceptance criteria for the REVS. Two examples of design conditions that do not have adequate analytical bases are as follows:

- **The REVS filter accident loading analysis is incomplete and incorrect.** The RPL fire hazards analysis (FHA) contains a table of individual laboratory combustible/flammable materials loading limits. These are intended to ensure that, in the event of a laboratory fire, the particulate loading on the REVS final filters would not exceed that which could cause their structural failure because of high dp. However, the values in the FHA table contain technical deficiencies with respect to operational constraints of REVS. For example, the values in the FHA table were based on 156 HEPA filters or four filter banks in service, even though it is permitted to be operational with 117 HEPA filters or three filter banks in service. An analysis was conducted on PNNL's source for the FHA table values. Experimental results were taken from a 1995 American Society of Fire Protection Engineers conference paper about HEPA filter failure due to fire particulate loading. The paper evaluated a HEPA filter similar to the REVS system final filters and calculated the masses of various combustible/flammable materials required to cause failure. Although the paper may be valid, its calculated combustible/flammable materials limits were used incorrectly in the FHA; no adjustments were made to account for differences between the worst case REVS operating limits and the paper's evaluated conditions. Also, the FHA did not arrive at a conclusion whether or not controls are adequate or necessary for the RPL and whether or not a fire involving actual combustible materials contained in the RPL may cause final HEPA filter plugging. (Actual laboratory combustible loadings were observed to be well below the probable correct FHA limits.) As a result of this discovery, PNNL declared a potential inadequacy in the safety analysis (PISA), and an unreviewed safety question determination (USQD) was initiated. Compensatory measures were initiated, which included cessation of all planned fire alarm, detection, or suppression system outages, a fire protection program compliance field walkdown was conducted, with no deficiencies identified, and doubling of operator tours through the RPL to every two hours until the USQD evaluation is completed.

- **The REVS HEPA filter isolation damper surveillance test procedure does not demonstrate their isolation capability.** Section 8.2.1.4 of the final safety analysis report states that the safety-significant final filter bank isolation dampers are required to be capable of isolating a defective final stage filter "to meet the REVS [99.95% filter efficiency] requirements." Therefore, this capability should be verified by surveillance testing. Although a statement in the current test procedure and the procedure's precise quantitative acceptance criterion imply that it provides this verification, it does not for the following reason. The acceptance criterion considers the dampers to be operable if the filter bank dp with the dampers closed is less than 0.2-inch w.c. No valid analytical basis could be provided for this value, and the OA team calculated that this value would allow damper leakage bank as high as 11 percent of the total system flow, which would potentially reduce overall system efficiency to, at best, 89 percent.

> **Finding #7:** PNNL has not ensured that the REVS design and operating requirements and capabilities are adequately supported by formal, rigorous analyses. The DSA and TSRs for the REVS were developed without sufficient formal technical analyses to support the design, operating parameters, or limits.

> **Finding #8:** The safety evaluation process conducted by RL to support approval of the RPL DSA and TSRs for REVS did not provide an adequate basis for approval.

Configuration Management. Configuration management is important for maintaining the accuracy and validity of the safety basis and technical documents, such as the DSA, the TSRs, and drawings, procedures, and other technical documents used in day-to-day facility operations. PNNL has established the basic elements of an effective configuration management program, including the USQ process, drawing controls, calculation controls, procedure revision protocols and controls, and a design change process to assure that facility modifications are properly evaluated, documented, reviewed, and verified to be within the bounds of the DSA, the TSRs, and applicable codes, standards, and DOE orders.

The DSA and the TSRs, in most instances, adequately document the safety functions, roles, and performance requirements in detecting, preventing, and mitigating analyzed events. The descriptions of normal and accident conditions for the REVS, in most cases, were clear, adequately documented, and contained appropriate inputs, assumptions, and levels of detail. However, as previously discussed, significant aspects of the DSA had not been adequately considered.

Based on a review of the Administrative Procedure Facility Design Manual, the essential elements of configuration management and control were adequately addressed. Three design changes were reviewed, and the change package documentation generally complied with the requirements of the administrative procedure. The modification process establishes an engineering design plan (EDP), identifies the technical baseline documents affected by the modification, identifies essential drawings and other related documents that are required to be as-built, and provides for multi-discipline review and comment. Comments are solicited from all disciplines during development of a change, and a multi-discipline Facility Review Board conducts final modification review. Installation instructions and post-modification testing instructions were appropriately specified.

Drawings affected by facility modifications are appropriately identified and revised. Drawings that are deemed as defining the facility are designated as key drawings and are maintained and controlled. Drawings that are affected by facility modifications are identified from the key drawing list. Affected drawings are identified on the modification EDP consistent with the administrative procedure.

PNNL's USQ procedure and practices at the RPL were effective, with only a few refinements needed. The procedure is very straightforward and easy to use, with precise, correct reflections of the regulatory requirements of 10 CFR 830. Training and qualification requirements for USQ screeners and evaluators are appropriate and are clearly and correctly stated in facility personnel qualification documentation. Formal records are maintained of qualified personnel. A review sample of 12 USQ screenings and 4 USQ determinations identified only two cases where the procedure was not precisely followed.

Although PNNL has a generally effective USQ program, a few specific discrepancies were observed in the procedure or its implementation:

- **Missing final USQ criterion.** Although the procedure and the attendant forms contained the correct approach and the correct specific evaluation questions for the USQD, there was no specific statement in either the procedure or the forms that any "yes" answer to the form questions would constitute a USQ. (From discussions and samples reviewed, it was clear that this criterion was well understood in spite of its not being documented.)

- **Incorrect categorical exclusion example.** The procedure, in addressing categorical exclusions to performing a USQD, incorrectly cited maintenance procedure changes as an example.

- **Missing link to USQ training/qualification requirements.** The USQ procedure does not identify the specific procedures and forms that provide the requirements and documentation for the qualifications of USQ screeners and evaluator.

- **Incorrect modification screening.** USQ screening RPL-2003-134S of a modification to add a motor to a hot cell "lazy susan" incorrectly determined that a USQD was not required based on an incorrect "no" answer to the screening question, "Is this a temporary or permanent change to the facility as described in the documented safety analysis?"

- **Incorrect procedure screening.** USQ screening RPL-2003-205S addressed a new procedure to replace one of the 156 REVS final filter elements. As a new procedural activity for equipment described in the DSA, this new procedure constituted a change to a procedure as described in the DSA. However, the screening question regarding if this was a change to a procedure as described in the DSA was incorrectly answered "no."

Summary. The facility and RL engineering staff was knowledgeable, conscientious, and highly motivated. The RPL's REVS is a generally robust design. However, it contained three significant design deficiencies that could prevent it from fully performing its design safety function: (1) the design contained no features to prevent building pressurization and resultant unfiltered leakage due to REVS HEPA filter loading during a design basis fire, (2) the design did not contain adequate criteria for maintaining negative building pressure that accounts for wind effects on the building, and (3) the REVS HEPA filter isolation dampers alone did not provide adequate isolation to maintain the required system filtration efficiency when a filter bank was isolated. Further, the DSA was developed without sufficient technical analysis, and design requirements were not effectively translated into system procedures and TSRs. Configuration management processes and procedures, including the USQ program, are consistent with applicable standards and regulations and are governed by an appropriate set of procedures. However, PNNL did not have detailed, rigorous design basis analyses for the REVS, and design requirements are not clearly identified.

F.2.2 Surveillance, Testing, and Maintenance

Surveillance and testing of the REVS is governed by the TSRs. The TSRs establish appropriate requirements for functional testing of critical systems and components at a frequency to ensure their operability. The TSR surveillance and test acceptance criteria were appropriately based on the DSA (except as noted in the previous section).

Based on a walkdown of the REVS, the system is in good material condition. In support of the REVS designation as "safety significant," all maintenance tasks were classified as Category 1 work, the highest classification, which has directly contributed to a low maintenance backlog.

The REVS system engineer is knowledgeable of the REVS configuration, operation, and maintenance requirements, and maintains a close working relationship with the maintenance personnel who are dedicated to RPL. The dedicated maintenance staff was thoroughly familiar with the performance of maintenance on the REVS components and systems.

The completion of preventive maintenance tasks and surveillances for REVS are effectively tracked and trended. The process for dispositioning overdue tasks has been formalized. Authorization and approval from the building manager and the chief facility engineer are required to defer Category 1 preventive maintenance tasks past the due date and to enter into the 25 percent overdue grace period.

RPL does not adequately maintain vendor manuals for safety equipment. The RPL engineering staff was unable to locate vendor manuals for many of the safety-significant REVS components. This was largely attributed to the age of much of the equipment. Without these manuals, PNNL does not have ready access to some of the information needed to implement a proper preventive maintenance and surveillance testing program that will ensure that all manufacturers' recommended work is performed. Such programs are basic elements of ensuring optimum equipment reliability and equipment life.

The computerized maintenance management system, Maximo, used by RPL for developing its maintenance and surveillance work packages does not include a data field that would isolate the safety-significant equipment at RPL. Without this data field, RPL staff cannot readily re-create maintenance histories for this equipment. It is essential that accurate machine history tracking can be periodically performed on safety-significant equipment so that the proper frequency for surveillances and preventive maintenance is assured.

The maintenance work packages that were reviewed were clear and concise. Appropriate task planning was performed, and hazards were adequately identified. In accordance with the graded approach, more complex work packages included all necessary work instructions and information, including up-to-date drawings where necessary to properly perform the work. A review of several completed work packages identified no significant deficiencies, and included the supporting sign-off sheets and other documentation. Discussion with maintenance personnel indicated that they would not hesitate to stop work and contact a system or building engineer when inconsistencies were discovered in a work package.

RPL managers have taken the appropriate action to address the aging of critical facility components. In 2001, RPL developed the "Life Cycle Costs for Maintaining Systems in the RPL" report to address the facility's aging components. The engineering staff reviewed some of the historical data on the cost of maintaining REVS, the supply ventilation system, the supporting electrical system, and other major RPL systems. The systems were subdivided into component parts, and each part was reviewed for expected life. DOE Standard System Design Life Tables provided the primary reference for life cycle predictions. The systems were then analyzed for the risk of failure of each piece of equipment and the resulting facility impacts. The equipment in each system with the highest failure risk and the most significant facility impact was reviewed for life cycle and installation date. The older the equipment is, the higher the risk of failure, resulting in increased facility operation risk. The replacement costs of the equipment were researched and integrated into the cost analysis for the time of the completion of the equipment's life cycle. The equipment presently at the highest risk of failure and with the greatest negative impact to the facility were REVS components, including the exhaust fans, final HEPA filters, dampers, switchgear, and non-REVS components, including the supply fans and HVAC controls. Of those components listed, the switchgear was replaced in 2002 and the HVAC exhaust controls were replaced in 2001. Current plans are in place to replace the final HEPA filters in 2003 and the exhaust and supply fans in 2003 and 2004, respectively. In the interim, the system engineer has implemented a predictive maintenance approach to track and trend vibration analyses on bearings in all significant rotating machinery. An example of the success of this program was trending of vibration data of fan and motor bearing components, which resulted in the identification of one exhaust fan bearing's imminent failure conditions; this early detection allowed for timely replacement prior to its failure. A similar predictive maintenance approach has been applied to the primary HEPA filters located downstream of the hoods and gloveboxes in the individual laboratory rooms.

Because of radiological waste disposal requirements to characterize the waste stream in the primary HEPA filters prior to allowing disposal, maintenance instituted a plan to measure the dp across the primary HEPA filters on a quarterly basis. The results are tracked, and when the dp reaches a pre-set point, the researchers in the affected laboratories are requested to begin waste characterization so that delays for hood shutdowns are reduced.

The team reviewed the suspect/counterfeit item (S/CI) process at RPL. The RPL maintenance staff was assigned the responsibility to recognize and identify S/CIs when performing work. Discussions with the different craft and craft supervisors found that they were well aware of their S/CI responsibilities. In the past few years, some suspect/counterfeit bolts have been discovered and properly dispositioned at RPL. In addition, REVS was thoroughly reviewed for any S/CIs, and none were found.

Summary. The REVS is in good physical condition, and appropriate corrective and preventive maintenance is scheduled and performed to ensure continued capabilities. RPL has implemented an effective plan to address aging components, and the current replacement equipment or component tasks are on schedule. REVS work packages are appropriately prioritized, well written, and properly completed. The REVS maintenance backlog is maintained at a low level.

F.2.3 Operations

The OA team evaluated operating procedures and operator training to determine how well operators are prepared to take appropriate actions in case of an event (e.g., loss of power) that affects REVS. The OA team also evaluated normal operations as they pertained to ensuring that REVS is in the proper operating configuration.

There were several examples where RPL had implemented good conduct of operations principles with regard to operating REVS. The areas noted during the review included procedures, labeling, training and qualification, and shift turnover.

RPL has established a good set of REVS operating procedures. In general, they are current, technically accurate, controlled, sufficiently detailed, and clearly written. The set of REVS operating procedures addresses normal, abnormal, remote, and emergency conditions. The 325 round sheet parameters procedure is an example of one of the key procedures related to the REVS operation. It is a controlled procedure, and the correct procedure revision was available to the operators. The procedure contained sufficient detail, in that it identified each parameter (e.g., building dp); the associated normal, minimum, and maximum readings; alarms associated with the parameter; and the action the operator is directed to take if the parameter is out of specification.

The labeling of components in RPL is effective. Electrical breakers, fans, valves, and dampers associated with REVS are uniquely labeled with clearly visible and readable tags. These identification labels are rigorously used to identify components in the operating procedures. The labeling of REVS components matched the associated facility drawings.

The training and qualification process for the power operators is adequate and has resulted in knowledgeable operators. The qualification requirements for an RPL operator are clearly defined in the power operators training program procedure and are supplemented by the power operators qualification card. The qualification card provides a detailed list of required training courses, knowledge requirements, including a separate section on building ventilation, and a list of specific performance tasks and procedures. The building engineer verifies completion of each section of the qualification card. The RPL operators are current on their power operator qualifications. A review of a sample set of training lesson plans associated with the REVS revealed that the plans were adequate. Interviews and walkthroughs with the power operators demonstrated that they had a good understanding of the operating requirements for REVS and were, in general, proficient with performing operating tasks associated with the REVS.

For the most part, RPL personnel understand and effectively implement conduct of operation principles. However, during the review, a few deficiencies were noted in conduct of operations in a few areas, including operator proficiency when performing non-routine procedures, round sheet log taking, and operating procedures.

- Two operators did not fully understand the loss of power alarm for the REVS exhaust fans on panel HVC-070-CP, and one operator had problems performing SOP-325-ELEC-2, "Loss of Power," when given a simulated loss of power with loss of REVS. The performance problem related to SOP-325-ELEC-2 was the operator's inattention to reading the entire component identification label referenced in the procedure and matching it to the proper component in the field. In addition, the active alarms are not recorded as required in the narrative log on a daily shift basis.

- A few deficiencies were identified with the operating procedures. For example, in SOP-325-HVAC-2, "Manually Closing Vortex Dampers on the Main Building Exhaust Fan," the work instruction does not identify the non-running fan. In procedure SOP-325-HVAC-003, the references to some of the menu selections for METASYS do not match between the procedure and the METASYS selection screen. Procedure SOP-325-ELEC-2, step 7.3.6, is incorrect. The step should have the operator open breaker F3X12 rather than close it. The operators were aware of this procedure problem but had not initiated a temporary pen and ink change.

Summary. RPL has implemented several sound practices regarding REVS operation, including specific risk-based analyses of aging safety-significant systems. Specific positive attributes include knowledgeable operators and supervisors, well-written operating procedures, appropriate component labeling, up-to-date system drawings, and a thorough training and qualification process. A few deficiencies were evident in operator proficiency with performing non-routine procedures, but the overall approach to conduct of operations at PNNL is sound.

F.3 Conclusions

The RPL's REVS is generally a robust design. However, the system contains three fundamental design weaknesses that could prevent the system from performing the design safety function specified in the DSA: (1) the design does not account for potential building pressurization and resultant unfiltered leakage during a design basis fire due to rapid loading of the REVS HEPA filters, (2) the design does not contain adequate criteria for maintaining negative building pressure that accounts for wind effects, and (3) the REVS HEPA filter isolation dampers alone do not provide adequate isolation to maintain the required system filtration efficiency when a filter bank is isolated.

The REVS design is not adequately supported by formal, rigorous analyses, and design requirements are not effectively translated into system procedures and TSRs.

Configuration management processes and procedures, including the USQ program, are generally in accordance with applicable standards and regulations and are carried out in accordance with these procedures. In addition, facility engineers are knowledgeable, conscientious, and highly motivated.

The REVS is generally in good material condition, and appropriate corrective and preventive maintenance is scheduled and performed to ensure continued capabilities. RPL has been implementing an effective plan to address aging components, and the current replacement equipment or component tasks are on schedule.

RPL has implemented several sound practices regarding REVS operation. Specific positive attributes include knowledgeable operators and supervisors, well-written operating procedures, appropriate component labeling, up-to-date system drawings, and a thorough training and qualification process. Some attention is needed to improving operator proficiency with performing non-routine procedures.

F.4 Ratings

Design and Configuration Management	SIGNIFICANT WEAKNESS
Surveillance, Testing, and Maintenance	EFFECTIVE PERFORMANCE
Operations	EFFECTIVE PERFORMANCE

F.5 Opportunities for Improvement

This OA inspection identified the following opportunities for improvement. These potential enhancements are not intended to be prescriptive or mandatory. Rather, they are offered to the site to be reviewed and evaluated by the responsible line management, and accepted, rejected, or modified as appropriate, in accordance with site-specific program objectives and priorities.

Pacific Northwest National Laboratory

1. **Update the REVS design, the DSA, and the TSRs to address identified weaknesses.** Specific actions to consider include:

   - Provide an automatic trip for main building supply fans whenever building negative pressure approaches its lower limit to address the concern that building pressurization and resultant unfiltered leakage may result from rapid REVS HEPA filter loading during a design basis fire. Update the DSA and TSRs accordingly. Evaluate the ability of the exhaust fans to operate outside the vendor-provided operating range for the design basis fire.

   - Establish the intended approach to remedy the concern that the system provides insufficient building negative pressure in an accident to prevent unfiltered releases due to wind effects. Update the DSA and TSRs accordingly.

- Establish the intended approach to achieve positive isolation with the REVS final filter isolation dampers, and revise the DSA to remove ambiguities regarding their capabilities.

- Locate or generate detailed calculations or other rigorous bases, such as testing that simulates design basis accident conditions, to support all safety capabilities, parameters, values, etc., for the REVS as described in the DSA, the TSRs, and the TSR bases.

2. **In both the PNNL and RL organizations, review the processes for reviewing the REVS design, the DSA, and the TSRs and their bases to determine what in those processes would allow the above-described design and analysis inadequacies to not be detected.** Make the appropriate changes to correct the apparent process weaknesses.

3. **Perform an extent-of-condition review of the DSAs/TSRs or other RL facilities that have been subject to the same RL review process.** Make appropriate corrections to these documents and/or the facilities based on the results of the extent-of-condition reviews.

4. **Revise the REVS HEPA filter efficiency testing methodology and procedure to address the concern with the incorrect downstream sampling point.** Consider revising the test method to test all four filters together or moving the sampling point to a location where it will be sampling only the flow exiting the filter being tested.

5. **Establish a procedure to ensure the integrity of the safety-significant air supply to the REVS dampers.** This procedure should demonstrate that system leakage, including back leakage through the isolation check valve that separates the system from the normal air supply, is less than the backup air compressor's capacity.

6. **Perform a rigorous design analysis to establish the maximum allowable combustible/ flammable material loading of the RPL laboratories to prevent failure of the REVS final HEPA filters due to plugging with particulates from a design basis fire.** Ensure that the analysis accounts for the worst design basis conditions for such a fire. Update the FHA accordingly.

7. **Refine the USQ procedure**. Specific actions to consider include:

   - Add statements in the procedure body and the USQ evaluation form that the proposed change is a USQ if any of the evaluation's seven questions is answered "yes."

   - Remove from the procedure the incorrect categorical exclusion example (i.e., maintenance procedure change).

   - Insert into the USQ procedure specific document references to the training and qualification requirements for USQ screeners and evaluators.

   - Extract the valid areas of guidance in the current DOE USQ guide and insert them into the procedure.

8. **Populate the Maximo database with existing maintenance history records for individual safety-significant components.** Trending of component maintenance repair history is a valuable asset that is not available in the current system configuration.

9. **Enhance the power operators' proficiency in performing non-routine procedures.** Specific actions to consider include:

   - Develop a schedule for periodic operator walkthroughs, and simulate the performance of non-routine procedures.

   - Review the current non-routine procedures to determine if any improvements can be made to equipment labeling to reduce the potential for operator error.

   - Correct any procedures identified as needing improvement.

This page intentionally left blank.

Abbreviations Used in This Report (continued)

ETD	Environmental Technology Directorate
FHA	Fire Hazards Analysis
F&O	Facilities and Operations
FSD	Fundamental Sciences Directorate
FSR	Field Services Representative
FR	Facility Representative
FRAM	Functions, Responsibilities, and Authorities Manual
FUA	Facility Use Agreement
FY	Fiscal Year
HEHF	Hanford Environmental Health Foundation
HEPA	High Efficiency Particulate Air
HVAC	Heating, Ventilation, and Air Conditioning
ICP	Inductively Coupled Plasma
IO	PNNL Independent Oversight office
IOPS	Integrated Operations System
ISM	Integrated Safety Management
ISO	International Standards Organization
JPP	Job Planning Package
LO/TO	Lockout/Tagout
MSDS	Material Safety Data Sheet
OA	Office of Independent Oversight and Performance Assurance
ORPS	Occurrence Reporting and Processing System
OSHA	Occupational Safety and Health Administration
PEMP	Performance Evaluation and Measurement Plan
PLM	Product Line Manager
POC	Point of Contact
POD	Plan of the Day
PNNL	Pacific Northwest National Laboratory
PNSO	Pacific Northwest Site Office
PPE	Personal Protective Equipment
R&D	Research and Development
R2A2	Roles, Responsibilities, Authority, and Accountability
RCT	Radiation Control Technician
REVS	Radioactive Exhaust Ventilation System
RL	Richland Operations Office
RPL	Radiochemical Processing Laboratory
RS&EG	Radiochemical Sciences and Engineering Group
RWP	Radiation Work Permit
SAA	Satellite Accumulation Area
SC	DOE Office of Science
S/CI	Suspect/Counterfeit Item
S&H	Safety and Health
SBMS	Standards Based Management System
SFO	Shielded Facility Operations
SHIMS	Safety and Health Information Management System
SME	Subject Matter Expert
TLV	Threshold Limiting Value
TSR	Technical Safety Requirement
USQ	Unreviewed Safety Question
USQD	Unreviewed Safety Question Determination
w.c.	Water Column