Inspection of
Environment, Safety,
and Health Management
at the

Oak Ridge National Laboratory

July 2004

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

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Abbreviations Used in This Report

ACE	Assess, Correct, Educate (an ORNL-developed observation program)
ACGIH	American Conference of Governmental Industrial Hygienists
AHA	Activity Hazards Analysis
ALARA	As Low As Reasonably Achievable
ANSI	American National Standards Institute
AOP	Abnormal Operating Procedure
ASE	Accelerator Safety Envelope
ASME	American Society of Mechanical Engineers
ATS	Assessment Tracking System
CA	Contamination Area
CAIRS	Computerized Accident/Incident Reporting System
CFR	Code of Federal Regulations
CNS	Center for Neutron Scattering
CO	Carbon Monoxide
CSD	Chemical Sciences Division
CY	Calendar Year
D&D	Decontamination and Decommissioning
DOE	U.S. Department of Energy
DRCO	Division Radiological Control Officer
DSA	Documented Safety Analysis
EH	DOE Office of Environment, Safety and Health
EM	DOE Office of Environmental Management
EOP	Emergency Operating Procedure
EPA	Environmental Protection Agency
ESF	Essential System Functionality
ES&H	Environment, Safety, and Health
ESH&Q	Environment, Safety, Health, and Quality
FFCA	Federal Facilities Compliance Agreement

(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) Oak Ridge National Laboratory (ORNL) during June and July 2004. The inspection was performed by the OA Office of Environment, Safety and Health Evaluations. OA reports to the Director of the Office of Security and Safety Performance Assurance, who reports directly to the Secretary of Energy.

Aerial View of ORNL

The DOE Headquarters Office of Science (SC) has line management responsibility for ORNL. SC provides programmatic direction and funding for most research and development (R&D), facility infrastructure activities, and ES&H program implementation at ORNL. The Office of Nuclear Energy, Science and Technology (NE) provides programmatic direction for certain ORNL facilities and has responsibilities for certain aspects of operations at ORNL nuclear facilities, such as the High Flux Isotope Reactor (HFIR), in accordance with a memorandum of agreement with SC. At the site level, the Oak Ridge National Laboratory Site Office (OSO), within the Oak Ridge Operations Office (ORO), has line management responsibility for ORNL activities. ORO provides specialized technical support to OSO in ES&H-related areas when requested by OSO. Under contract to DOE, ORNL is managed and operated by University of Tennessee–Battelle Memorial Institute, LLC (UT-Battelle).

The ORNL's primary mission is basic and applied R&D in support of the DOE mission. The Laboratory's six major scientific competencies include neutron science, energy, high-performance computing, complex biological systems, advanced materials, and national security. As a multiprogram laboratory, ORNL receives funding for specific projects from most DOE program offices, several other DOE sites, various other government agencies, and various commercial organizations.

ORNL activities involve a variety of potential hazards that need to be effectively controlled. Radiation hazards include ionizing radiation and/or contamination from nuclear reactors, accelerators, and various radioactive materials. Chemical hazards are present in numerous ORNL facilities and laboratories, which use a wide variety of chemicals. Potential physical hazards include machine operations, noise, high-voltage electrical equipment, excavation, pressurized systems, and construction. Various areas within the ORNL site have a number of legacy hazards, such as radioactive contamination, lead paint, beryllium, polychlorinated biphenyls (PCBs), and various other hazardous materials, as well as hazards associated with aging facilities and infrastructure.

The purpose of the ES&H inspection was to assess the effectiveness of selected aspects of ES&H management at ORNL as implemented by UT-Battelle under the direction of OSO. Using a selective sampling approach, the OA inspection evaluated selected aspects of the integrated safety management (ISM) program:

- ORNL implementation of the core functions of safety management for selected activities, including R&D performed by the Chemical Sciences Division (CSD), R&D and operations performed by the Physics Division, operations and experiments at hot cell facilities, and selected construction activities.

- OSO and UT-Battelle feedback and continuous improvement systems.

- OSO and UT-Battelle management effectiveness in managing selected aspects of the ES&H program that have been identified by OA as focus areas warranting increased management attention; specific focus areas included management of legacy hazards, safety during excavations and blind penetrations, selected aspects of safety in protective force training, and the unreviewed safety question process.

- Improvement initiatives and essential safety system functionality of the primary coolant system and spent fuel pool and related systems at the HFIR, which is a research reactor operated by the ORNL Reactor Research Division (RRD) under the programmatic direction of NE.

Section 2 provides an overall discussion of the results of the review of the ORNL ES&H programs, including positive aspects and weaknesses. Section 3 provides OA's conclusions regarding the overall effectiveness of OSO and UT-Battelle 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 provides the results of the review of the application of the core functions of ISM for the ORNL work activities. Appendix D presents the results of the review of the OSO and contractor feedback and continuous improvement processes. Appendix E presents the results of the review of the selected focus areas. The results of the review of the HFIR improvement initiatives and essential safety system functionality are discussed in Appendix F.

For each of these areas reviewed, OA identified opportunities for improvement for consideration by DOE and contractor management. The opportunities for improvement are listed at the end of each Appendix so that they can be considered in context of the status of the areas reviewed.

2.0 Results

2.1 Positive Attributes

Several positive attributes were identified in ISM implementation at ORNL. Many work activities were performed with a high regard for safety, and significant progress is being made in establishing structured work control processes.

ORO and OSO have made significant progress in establishing and implementing a systematic line management oversight approach. ORO has established a systematic approach to line management oversight through Laboratory Management System Descriptions, which provide an appropriate top-down mechanism for assessing and evaluating performance of line management organizations and contractors. The fiscal year 2004 Integrated Assessment Schedule identifies a number of assessments of ORNL programs that are appropriately focused on site hazards and performance issues. Clear direction has also been provided for use of a single tracking system to resolve the recurring integration problem among tracking databases used across ORO organizations. OSO has made good progress in improving its assessments and operational awareness program, including development of an adequate procedure and initiating structured processes for regularly reviewing facility conditions and work activities. ORO and OSO have performed a number of assessments that have led to improvements in ORNL ES&H programs.

UT-Battelle management has demonstrated a commitment to continuous improvement in safety performance through the assignment of committed managers, organizational realignments, targeted safety initiatives, improved communications, and the use of innovative feedback and improvement tools. UT-Battelle has made progress in the use of feedback and improvement processes to drive continuous improvement since the 2001 OA inspection, and specifically in the last year. Line and support organization managers are being held accountable for safety performance. Initiatives such as strengthening the critique process, the ACE observation program, and the Operational Awareness Program are improving assessment and issues management performance. Behavior-based observation programs conducted by Facilities and Operations managers are effectively encouraging meaningful supervisory oversight of work activities, communicating management safety expectations and Standards Based Management System (SBMS) requirements to workers, and identifying and correcting unsafe behaviors and conditions.

During the past two years, ORNL has implemented a number of improvements to the research work control process that have improved the identification and control of research-related hazards. The Research Hazard Analysis and Control System is now used to establish and maintain research safety summaries (RSSs) addressing research activities. In addition, the Laboratory Space Manager concept, although still in the early stages of implementation, has been an effective mechanism for identifying and controlling hazards at the research laboratory level. CSD management has implemented the system and required that all RSSs be reviewed at least annually by a multidisciplined group. This process has identified several potential experimental hazards and controls that may have otherwise been missed, and has resulted in more robust RSSs. More recently, CSD initiated a process to ensure a formal ES&H evaluation of all proposed research projects, and has used this process effectively to reduce risks. The Physics Division uses a combination of processes to effectively identify and analyze hazards. The Physics Division establishes and maintains RSSs for each facility that bound operations, maintenance, and routine experiment performance. The division also reviews RSSs on an annual basis or when conditions change. The experiment safety review processes at each facility further analyze experiment proposals to determine whether the accelerator safety envelope (ASE) and the facility-level RSS bound the expected hazards. For new or unique hazards, an RSS specific to the experiment is developed as part of the experiment review process, and the review process results in a comprehensive analysis of the hazards.

UT-Battelle has made significant improvements in management of hot cell facility operations and enhancement of work planning and control tools. In response to systemic deficiencies identified in previous assessments, UT-Battelle established a new organization – the Nonreactor Nuclear Facilities Division (NNFD) – to manage the various hot cells and other nuclear facilities at ORNL (except HFIR). NNFD has taken various actions to improve consistency and uniformity of approach in such areas as safety basis analysis and documentation, drawing and procedure development, work planning and control, and work scheduling. There is also a clear commitment to disciplined operations, with processes and procedures consistent with DOE requirements in place for conduct of operations, maintenance, and work control. Support organizations, such as Radiological Support Services, have implemented several innovative electronic tools that simplify the development, implementation, and review of such radiological controls as radiation work permits (RWPs), radiological surveys, bioassays, and radiological area inventories. For example, a survey tool provides easy and immediate searchable access to relevant information, and the bioassay participant tool provides the ability to search for specific employees and retrieve data on bioassay participation history.

UT-Battelle management is actively engaged in the implementation of programs and processes that are being effectively used to address legacy hazards and environmental vulnerabilities. UT-Battelle proactively sought funding from various sources for removal of legacy materials and the disposition of aging facilities no longer having a mission requirement. A prioritized list of legacy issues has been developed using the institutional risk-ranking process. The Facilities Disposition Program was established to focus activities and has effectively identified, prioritized, and dispositioned excess facilities within the constraints of available funding. The Landlord-Tenant Model and Laboratory Space Management Program were established to help eliminate existing legacy materials and prevent the recurrence of legacy materials by controlling the accumulation of excess materials in laboratories. The Legacy Materials Disposition Initiative (LMDI) program is a noteworthy practice for identifying, characterizing, and removing legacy items and uses rigorous controls to ensure safety. The LMDI program has used available funds to disposition significant amounts of hazardous legacy materials from the site over the past three years, including approximately 32,400 cubic feet of low-level waste, 56 cubic yards of asbestos, 4,327 excess chemicals, over 1,100 gas cylinders, 8.25 tons of lead, and 1,915 pumps and motors that were potentially contaminated.

At HFIR, UT-Battelle has systematic approaches to address longstanding deficiencies and improve operations. The ORNL RRD Performance Management Plan has been effective in defining meaningful goals and critical outcomes as a mechanism to focus senior management attention. Furthermore, the plan provides a framework to drive self-assessment programs and prioritization processes to achieve continuous improvement. The HFIR Integrated Work Plan is a comprehensive planning and work management tool that addresses infrastructure needs (such as system modifications), program improvements (such as system engineering and maintenance program upgrades), mission needs, and routine operations and maintenance.

HFIR Complex

HFIR operations, maintenance, and design features contribute to safety. RRD has established an effective program for training operators and an effective set of procedures for operating HFIR. Operators understood the operations of HFIR components well and demonstrated the capability to safely operate HFIR during normal and emergency conditions. Preventive, predictive, and corrective maintenance programs are well defined and implemented. Various design features also enhance safety. Examples include a reactor pool-to-reactor check valve that requires no operator action or external power source to provide makeup water to the reactor for loss-of-coolant accidents; battery-powered reactor coolant pump pony motors that continuously run to provide cooling flow to the reactor core for loss-of-offsite-power events; and a reactor pool that surrounds the reactor vessel and provides inherent cooling for loss-of-normal-cooling events.

2.2 Weaknesses

Although some aspects of ISM at ORNL are effective, significant work remains to ensure that the ISM elements are effectively implemented.

Some hazards at CSD laboratories have not been adequately analyzed and controlled to ensure the safety of laboratory researchers. At the research experiment level, most of the research conducted within the CSD is dynamic and continually evolving. RSSs often do not provide a sufficient description of a specific experiment such that the worker hazards can be identified and the appropriate controls can be selected and linked to the hazard for which the control is intended. In some cases, exposure hazards from hazardous compressed gas cylinders, such as carbon monoxide and hydrogen, which are currently in use within CSD laboratories, have not been sufficiently analyzed. In several instances, hazardous chemicals that are synthesized or produced in ORNL laboratories were not sufficiently and consistently labeled such that the identity and hazards of the chemicals can be readily recognized. In addition, line management and the Radiological Support Services Group have not defined or implemented sufficient radiological controls (e.g., survey requirements and labeling) to prevent the inadvertent transfer of contamination from posted Contamination Areas (such as fume hoods) to non-radiological areas, as required by regulations. SBMS subject areas do not provide sufficient guidance to address this concern.

Operations at ORNL accelerator facilities are not governed by an adequate set of requirements and procedures. DOE Order 420.2A, *Safety of Accelerator Facilities*, is not included as a requirement in the Work Smart Standards (WSS) for the accelerators and no equivalent requirements (outside of contractor implementing documents in SBMS) have been specified. The WSS final report included unresolved minority reports that were not specifically addressed, and the OA team review of the WSS requirement set also indicates that the WSS requirement set is not adequate to ensure adequate ES&H protection. This situation has contributed to problems in several areas, including lack of appropriate written procedures; lack of periodic reviews by the Accelerator Safety Review Committee; and lack of DOE approval of ASE changes. In addition, the ORNL Physics Division's interpretation of activities requiring an approved procedure has resulted in a standard of operational discipline below that needed to ensure the safe operation of accelerator facilities. Operations such

Holifield Radioactive Ion Beam Facility

as startup, shutdown, sulfur hexafluoride gas transfers, and response to abnormal events are directed by approved guidelines or operational aids, rather than procedures. The guidelines do not require the same level of adherence as procedures, and allow individuals performing an activity to deviate from guidelines and operational aids based on their judgment. In a few cases, activities interfacing with experimental or operations activities were performed with unapproved documents. These cases involved changing targets inside accelerator beam lines, performing safety interlock checks, and handling pyrophoric cesium following uncontrolled, unapproved instructions. Also, some activities were performed without developing step-by-step procedures as required by an RSS.

Implementation of the NNFD and Radiological Support Services work planning processes has not been rigorous enough to ensure that hazards have been adequately analyzed and that proper controls have been implemented prior to authorizing work. Implementation of existing work planning tools and systems has resulted in incomplete or ineffective analysis of work-related hazards and poorly defined controls, resulting in the potential for adverse safety consequences. While existing work tools and NNFD procedures provide a unique automated capability to incorporate hazard controls into work execution steps, implementation of this capability was deficient. In addition, RWPs did not contain sufficient clarity, specificity, and detail about expected radiological conditions and required controls to adequately control all potential radiological hazards. A number of procedural requirements were not properly addressed in RWPs, resulting in incomplete and/or conflicting information on radiological controls. Deficiencies were identified in specification of radiological conditions, limiting conditions, expected changes to radiological conditions, bioassay requirements, and special instructions. Air sampling requirements were also not specifically defined, resulting in the potential for incorrect or insufficient air monitoring. The process for independent radiological reviews of RWPs and radiological work does not meet the level of rigor prescribed by DOE implementation guidance.

Workers have been allowed to work with several radioisotopes for which there are no approved methods to perform bioassay measurements or otherwise accurately assess potential internal doses, contrary to SBMS and regulatory requirements. The site is aware of and has been working to address these problems; however, no timeline or funding has been established to complete the effort. No other compensatory measures designed to meet internal dosimetry requirements have been formally established.

Some health hazards were not identified for construction activities. Review of material safety data sheets and involvement by individuals with industrial hygiene expertise were not sufficient in some cases to identify, analyze, and control such potential health hazards as noise and silica dust. Some required controls were not effectively communicated to construction workers through activity hazards analyses. Some requirements, including Occupational Safety and Health Administration training requirements, contractual requirements, and requirements in programs, such as hazard communication and respiratory protection programs, did not adequately flow down to subcontractors.

Although progress is being made, HFIR lacks a fully mature systems engineering program to fully address weaknesses in the HFIR configuration management program. These weaknesses include quality issues related to safety basis as-built drawings, a backlog of open modification requests, and lack of a well-defined and understood design basis. A number of key activities, such as detailed walkdowns of systems to document system status, development of system design descriptions, and establishment of system engineering files, are far from complete. RRD management recognizes that the lack of a fully implemented systems engineering program poses a threat to achieving success in meeting RRD's strategic goal (i.e., critical outcome) of outstanding nuclear facility operations.

Some analyses supporting the HFIR safety analysis report were incomplete or lacking rigor, and the RRD configuration management program has weaknesses that potentially impact maintenance of the HFIR design. While many design analyses for HFIR systems were effectively performed, some analyses of components were either incomplete or inadequate to fully demonstrate the safety-related capabilities of the structures, systems, and components (SSCs). Examples included the analyses for seismic interactions of non-seismically qualified SSCs with safety-related SSCs, the reactor/fuel pool dam lifting lugs, the reactor/fuel pools' heatup upon loss of normal cooling, the structural adequacy of the reactor/fuel pools and the adequacy of spent fuel

HFIR Pool

cooling for this event, and the structural adequacy of most of the in-pool fuel and equipment handling tools. Further, deficiencies were identified in three elements of the HFIR configuration management program: accuracy of the safety-related equipment list, adequacy of the unreviewed safety question procedure, and timely implementation of processes for analyzing potential inadequacies in the safety analysis.

UT-Battelle feedback and improvement processes are still not being fully and effectively implemented to consistently and proactively identify process and performance deficiencies and apply preventive actions and lessons learned to ORNL work processes and activities. Some SBMS documents do not fully delineate requirements and the processes to be used to implement management systems. Some assessments lack sufficient rigor, and areas chosen for assessment are not always selected based on risk or do not always effectively cover pertinent activities and processes. Issues are not always put into the Assessment Tracking System (ATS) when appropriate, and insufficient attention is directed at analyzing issues for adverse trends and developing effective preventive actions. Improvement is needed in instilling a questioning attitude, identifying the extent of conditions and root causes for events and deficiencies, evaluating and applying lessons learned, and ensuring that actions are directed at preventing recurrence.

ORO/OSO is not effectively implementing some elements of their line management responsibilities. Although an adequate framework has been established, some aspects of the ORO assessment program are not yet fully and effectively implemented. Independent assessments of line management at ORO are not being routinely conducted as required by ORO requirements. The OSO self-assessment program is not rigorous and comprehensive and has not resulted in sufficient formal assessments to ensure continuous improvement. OSO self-assessments have been limited in number and scope. OSO communication, trending, and follow-up of ORNL performance deficiencies identified by Facility Representatives are not sufficiently systematic and rigorous.

The lack of assigned responsibilities among DOE program offices for implementing disposition and transfer processes for excess facilities, the lack of agreement for funding to address legacy hazards and program weaknesses, and the lack of documented processes within some program elements have resulted in environmental and safety hazards that are not being addressed. SC, NE, the DOE Office of Environmental Management, and the National Nuclear Security Administration have not reached consensus on funding activities to address legacy hazards for some buildings at ORNL and ORNL-operated facilities at the Y-12 National Security Complex. Without this consensus, environmental and safety hazards are not being addressed because of undefined responsibilities for funding. In addition, there is a backlog of legacy hazards and excess facilities that is not being addressed because of funding limitations. While UT-Battelle has developed several strategic plans for specific legacy issues (e.g., Facilities Strategic Plan and Legacy Materials Strategic Plan), it has not developed a strategic plan that identifies funding requirements and provides an overall approach for ensuring that legacy hazards are addressed in a prioritized and integrated manner across the Laboratory. Processes used for the deactivation, surveillance, maintenance, and demolition of facilities have not been adequately documented or effectively implemented in some cases, resulting in some environmental vulnerabilities and accumulation of hazardous materials.

3.0 Conclusions

Research and Development

Work control processes have been established for R&D work in the SBMS Work Control subject area. The assignment of Laboratory Space Managers and implementation of a laboratory certification process have resulted in the laboratory work areas visited exhibiting good housekeeping, with engineering and safety controls being appropriately operated and maintained. In most cases, the RSS provides an adequate boundary for generic types of research, and when the RSS is supplemented by other mechanisms, such as safety basis documents or procedures, the hazards and the analyses and controls at the activity level were adequate. However, when the RSS is used without supplemental control mechanisms, the hazards and controls are not sufficiently defined for specific activities and phases of experiments. Inadequacies in the labeling of certain chemicals synthesized at the Laboratory were also identified. Training processes were rigorous for accelerators but in need of improvement for other research areas. Radiological controls for preventing the spread of contamination were not adequate. While activities were conducted safely, the use of procedures for accelerator operations and activities was not consistent with safety basis documents or DOE directives. Additionally, the WSS set did not specify adequate requirements for accelerator safety.

Hot Cell Operations

UT-Battelle has implemented a new management structure for hot cell facilities that reassigns responsibility for operation and maintenance of the facilities from multiple research organizations to the newly formed NNFD. NNFD's operation of ORNL's hot cell facilities has resulted in improvements in a number of areas, including safety basis analysis and documentation, drawing and procedure development, work planning and control, work scheduling, and legacy materials reduction. There is a visible commitment to disciplined operations, with processes and procedures consistent with DOE requirements in place for conduct of operations, maintenance, and work control. The application of work control and procedure development to R&D work is evolving but requires continued attention. Work scheduling and planning tools have been implemented that provide a unique automated capability to incorporate hazard controls into work execution steps. Implementation of this capability, however, needs improvement, as many work packages observed did not implement the capability as intended. Insufficient training for work planners and insufficient requirements for ES&H subject matter expert involvement contribute to the implementation deficiencies. Additional attention is also needed to address weaknesses in establishment of radiological controls, including implementation of the RWP process and conduct of independent radiological reviews.

Construction and Excavations/Blind Penetrations

Appropriate processes have been established to capture safety requirements, analyze the hazards, and establish controls at both the project and activity level, and onsite safety representatives are improving safety for construction projects. However, while most physical hazards had been identified and controls had been specified, in some cases health hazards were not identified in the activity hazards analysis, resulting in observed deficiencies. Significant improvements in controls for excavations/blind penetrations have been recently implemented, and recent assessments have identified further improvements. However, protocols are not providing adequate information, and some exclusions lack a technical basis.

Feedback and Improvement

ORO/OSO and UT-Battelle have established and implemented many new feedback and improvement processes, and much progress has been made since the 2001 inspection, especially in the last year. Committed managers, organizational realignments, maturing management systems, ongoing safety initiatives, and some innovative tools are effectively improving safety performance. However, these feedback and improvement programs are still at various levels of maturity, and the effectiveness of implementation varies.

Legacy Hazards

DOE and UT-Battelle managers and staff are proactively addressing legacy and environmental vulnerabilities. Two key actions, the LMDI and the Facility Disposition Program, along with several other initiatives, are being effectively used by UT-Battelle to manage legacy hazards within available funding. However, the lack of assigned responsibilities for disposition and transfer of excess facilities, unclear

Legacy Materials in a Satellite Accumulation Area

funding responsibilities between DOE program offices, and limited funds have resulted in environmental and safety hazards not being addressed in a timely manner. In addition, several improvement areas were identified that would enhance the management of legacy hazards.

HFIR Essential Systems Functionality

Effective processes have been established and implemented to ensure that reactor operations personnel are appropriately trained and qualified and are provided with quality procedures in order to safely carry out normal and abnormal operations. Most of the primary coolant system and reactor/fuel pool systems and components reviewed are well designed and analyzed. Furthermore, most aspects of the maintenance program are well defined and implemented. However, several design analysis weaknesses have been identified in the areas of seismic effects on equipment, fuel pool dam lug and lifting tools, and fuel pool heatup. Also, inputs and assumptions about ventilation airflow rate and mixing to remove hydrogen in the pony motor battery rooms had not been verified to ensure adequate ventilation in the room. The safety-related equipment list contains errors and omissions that can adversely affect configuration management in such areas as procurement and testing, and evaluation of changes to the facilities or procedures. Furthermore, the ORNL sitewide and HFIR unreviewed safety question procedure is not fully consistent with certain aspects of the 10 CFR 830 nuclear safety rule to ensure that all changes to the facility or procedures are systematically evaluated for impact on the safety basis. Weaknesses were also identified with the timeliness of the processing of potential inadequacies in the safety analysis.

HFIR Improvement Initiatives

RRD has established key management system processes for ensuring that RRD mission scope and goals are linked to the ORNL strategic plan and for balancing priorities and work scope to achieve progress. RRD HFIR management has made significant progress in implementation of these tools by integration within the current HFIR management system processes and in addressing the previously identified issues in systems engineering, interfaces with R&D users/experimenters, work planning and control processes, and self-assessment. A variety of both internal and external assessments have been conducted on key areas of HFIR operations and are providing meaningful feedback to management on HFIR performance, particularly in areas of previous known weaknesses. However, HFIR management is not always consistently entering actions taken in response to self-assessments or management reviews and/or improvement initiatives into the ATS.

Overall, significant improvement was evident in all areas reviewed since the 2001 inspection, when ORO/OSO lacked structured oversight processes, ORNL lacked effective work control processes, the SBMS was not fully implemented, and there were deficiencies in operations of nuclear facilities. Since then, ORO/OSO and UT-Battelle have made significant progress. They have developed structured oversight and work control processes, implemented SBMS, and restructured their management of nuclear facilities. They have also made progress in changing the site culture from one of satisfaction with the status quo to that of continuously improving safety. The framework for integrating safety into work activities has been established, and further process refinements and improvements in implementation are underway to ensure that effective processes are established and sustained for the numerous types of work activities and hazards at ORNL.

While ORO/OSO and UT-Battelle have made considerable progress, further work is needed. There are some gaps in the ISM program at the activity level, and continued effort is needed to ensure effective implementation of the enhanced systems. However, ORO/OSO and UT-Battelle have a good understanding of the remaining weaknesses and in most cases have appropriate ongoing initiatives to address them. Sustained management attention and additional focus on implementation of the enhanced systems is needed to ensure that the ongoing initiatives address remaining deficiencies and are effectively implemented.

4.0 Ratings

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

Implementation of Core Functions for Selected Work Activities (See Appendix C, Section C.4, for a more detailed breakdown of the Core Function ratings.)

Core Functions #1-4 Implementation – Chemical Sciences Division R&D .... NEEDS IMPROVEMENT
Core Functions #1-4 Implementation – Physics Division R&D .... EFFECTIVE PERFORMANCE
Core Functions #1-4 Implementation – Hot Cell Operations .... NEEDS IMPROVEMENT
Core Functions #1-4 Implementation – Construction .... NEEDS IMPROVEMENT

Feedback and Improvement

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

HFIR Essential System Functionality

Engineering and Configuration Management .... NEEDS IMPROVEMENT
Surveillance, Testing, and Maintenance .... EFFECTIVE PERFORMANCE
Operations .... EFFECTIVE PERFORMANCE

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APPENDIX A
SUPPLEMENTAL INFORMATION

A.1 Dates of Review

Planning Visit	May 24-28, 2004
Scoping Visit	April 13-14, 2004
Onsite Inspection	June 7-17, 2004
Report Validation and Closeout	June 29-July 1, 2004

A.2 Review Team Composition

A.2.1 Management

Glenn S. Podonsky, Director, Office of Security and Safety Performance Assurance
Michael A. Kilpatrick, 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	Patricia Worthington
Dean Hickman	Robert Nelson

A.2.3 Review Team

Thomas Staker, Team Leader

Al Gibson	Joe Lischinsky	Jim Lockridge
Ed Stafford	Mario Vigliani	Ali Ghovanlou
Robert Compton	Bob Freeman	Jim O'Brien
Bill Miller	Don Prevatte	Joe Panchison
Vic Crawford	Bernie Kokenge	

A.2.4 Administrative Support

Sandy Pate
Tom Davis

A.3 Ratings

OA uses a three-level rating system to provide line management with a tool for determining where resources might be applied toward improving environment, safety, and health and emergency management. It is not intended to provide a relative rating between specific facilities or programs at different sites because of the many differences in missions, hazards, and facility life cycles, and the fact that these reviews use a sampling technique to evaluate management systems and programs. The three ratings and the associated management response are:

- Significant weakness, which indicates a need for immediate management attention, focus, and action
- Needs improvement, which indicates a need for significantly increased management attention
- Effective performance, which indicates that management should address any identified weakness.

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APPENDIX B

SITE-SPECIFIC FINDINGS

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

FINDING STATEMENTS	REFER TO PAGE
1. Hazardous chemicals that are synthesized or produced in ORNL laboratories are not sufficiently and consistently labeled such that the identity and hazards of the chemicals can be readily recognized, as required by 29 CFR 1910.1450 as invoked by the ORNL work smart standards.	23
2. Exposure hazards from hazardous compressed gas cylinders (e.g., carbon monoxide and hydrogen) that are currently in use within ORNL CSD laboratories have not been sufficiently analyzed.	23
3. At the research activity or experiment level, ORNL CSD research work activities, hazards, and hazard controls are not sufficiently defined, documented, and linked as required by DOE Policy 450.4.	25
4. ORNL management and the Radiological Support Services Group have not defined or implemented sufficient radiological controls, such as survey requirements and labeling, to prevent the inadvertent transfer of contamination from posted Contamination Areas (such as fume hoods) to non-radiological areas, as required by regulations.	26
5. OSO and SC have not performed functions, including developing guidance and approving safety basis revisions, consistent with the expectations of DOE Order 420.2A and have not provided sufficient guidance and oversight to ensure that the WSS process provided a set of standards and requirements that establish adequate and appropriate ES&H protection for all aspects of accelerator operations.	29
6. The ORNL Physics Division's implementation of requirements for approved written procedures does not ensure that all operations and activities are conducted in accordance with approved procedures.	30
7. ORNL's NNFD has not ensured that work plan developers implement the NNFD-004 work control process in a manner that ensures that appropriate hazard controls needed to perform work safely have been identified and clearly documented as part of the work instructions.	34
8. ORNL Radiological Support Services has not ensured that radiation work permits contain sufficient clarity, specificity, and detail about expected radiological conditions and required controls, as needed to adequately control all radiological hazards and meet institutional radiation protection requirements.	35
9. ORNL workers have been allowed to work with several radioisotopes for which there are no approved methods to perform bioassay measurements or otherwise accurately assess potential internal doses, contrary to SBMS and regulatory requirements.	35

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

FINDING STATEMENTS	REFER TO PAGE
10. UT-Battelle hazards analysis processes did not ensure that health hazards associated with exposures to noise and hazardous materials were adequately identified and analyzed by construction subcontractors.	40
11. UT-Battelle did not ensure effective communication of ES&H requirements to the construction workforce through programs and activity hazards analyses.	41
12. Independent assessments of line management at ORO are not being routinely conducted as required by ORO requirements.	52
13. Communication and follow-up of ORNL performance deficiencies identified by OSO FRs are not sufficiently systematic and rigorous.	54
14. The OSO self-assessment program is not rigorous and comprehensive and has not resulted in sufficient formal assessments and effective tracking and follow-up to ensure continuous improvement.	55
15. UT-Battelle assessment programs are not sufficiently proactive, rigorous, and consistent in evaluating the implementation of individual safety and health program elements and safety management processes.	58
16. UT-Battelle has not established and implemented a fully effective issues management process that consistently and rigorously categorizes, documents, and manages events and issues, evaluates causes, and establishes and implements effective corrective and preventive actions.	59
17. UT-Battelle has not been fully effective in consistently identifying, evaluating, and applying lessons learned from internal and external events and activities to prevent accidents and operational events from occurring at ORNL.	62
18. SC, EM, NE, and NNSA have not reached consensus on funding responsibilities for addressing legacy hazards, resulting in environmental and safety hazards that are not being addressed.	70
19. Weaknesses in the UT-Battelle excavation and penetration process reduce its effectiveness in protecting workers from energetic sources.	74
20. ORO and ORNL have not ensured that the ORNL USQ process, procedure, and implementation are adequate.	75
21. Several analyses supporting the ORNL HFIR USAR are missing or incomplete for the primary coolant system, the reactor/fuel pool, and the refueling equipment.	90

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

FINDING STATEMENTS	REFER TO PAGE
22. The ORNL HFIR USAR classification of equipment and components (as detailed in the safety-related equipment list) contains errors and omissions that can adversely affect configuration management in design, maintenance, procurement, testing, and other disciplines.	91
23. RRD did not invoke the current ORNL USQ/PISA process to address missing and incomplete design analyses.	91
24. ORNL's RRD has not identified and included all appropriate in-service testing in its ISI/ IST program.	92

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APPENDIX C
CORE FUNCTION IMPLEMENTATION (CORE FUNCTIONS #1-4)

C.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) for selected Oak Ridge National Laboratory (ORNL) activities. The OA review of the ISM core functions focused on environment, safety, and health (ES&H) programs as applied to:

- Chemical Sciences Division (CSD) research and development (R&D) activities (Section C.2.1)
- Physics Division operations and R&D activities (Section C.2.2)
- Hot cell operations and R&D activities (Section C.2.3)
- Construction (Section C.2.4).

For all four areas, OA reviewed procedures, observed ongoing operations, toured work areas, observed equipment operations, interviewed managers and technical staff, reviewed interfaces with ES&H staff, and reviewed ES&H documentation (e.g., permits and safety analyses). Specific processes in each area, OA team activities, and work observed in the four areas are discussed further in the respective results sections.

C.2 Results

C.2.1 Chemical Sciences Division – Research and Development

CSD conducts both fundamental and applied research using experimental, theoretical, and computational approaches. Specific areas of research include catalysis, surface science and interfacial chemistry; molecular transformations and fuel chemistry; heavy element chemistry and radioactive materials characterization; aqueous solution chemistry and geochemistry; mass spectrometry and laser spectroscopy; separations chemistry; materials chemistry, including synthesis and characterization of polymers and other soft materials; chemical biosciences; and neutron science. The CSD staff consists of over 200 personnel, approximately half of whom are University of Tennessee-Battelle (UT-Battelle) employees and half of whom are guests, including visiting researchers, post-doctoral students, graduate students, and undergraduate students on short-term internships, particularly in the summer months. CSD research is conducted in 163 ORNL laboratories in five major ORNL buildings.

Recoil Mass Spectrometer

OA's evaluation of implementation of the first four core functions of ISM for CSD research focused on evaluation of safety performance across 6 of the 14 CSD research groups. CSD research work observed by OA included synthesis and characterization of inorganic materials, testing of catalytic performance of advanced materials using a variety of techniques, solvent extraction and ion exchange using radiotracers, organic and inorganic synthesis operations, and the chemistry of aqueous solutions over wide ranges of temperature, pressure and composition. Experimental plans, research safety summaries (RSSs), CSD policies and procedures, laboratory spaces, and administrative and engineering controls were evaluated.

Core Function #1: Define the Scope of Work

At the institutional level, research work control processes have been broadly defined within the Standards Based Management System (SBMS) subject areas. For example, the SBMS Work Control subject area includes a procedure for "Implementing ISM in Research and Development."

At the research laboratory level, the CSD RSSs provide a sufficient overall description of the general type of research conducted within CSD laboratory spaces, such that the most significant hazards within a laboratory space level can be documented. The computer-based Research Hazard Analysis and Control System, which is used to generate RSSs, provides a useful mechanism to define a safety envelope or the "bounding conditions" for work conducted within a branch of chemistry research (e.g., organic synthesis). Current CSD research is described in 79 RSSs. In some cases, the RSS is dedicated to a specific experiment or research apparatus. In these cases, the RSS also provides a detailed description of the experiment.

However, in most cases, the application of the RSS within CSD is to bound a number of experiments conducted within a similar research discipline. Such RSSs provide only a general description of the type of research being conducted. For example, the RSS description *Basic Aqueous Chemistry at High Temperatures and Pressures* identifies the purpose of the basic research being conducted; the general type of measurements performed (e.g., molecular-level, thermodynamic, and chemical-equilibrium measurements over wide ranges of temperature, pressure, and composition); and the general techniques to be employed when conducting the measurements (e.g., flow calorimetry). However, the RSS does not provide the work scope details for any specific experiment bounded by this RSS.

For some CSD research, the work description in the RSS is supplemented by more detailed research descriptions in additional procedures, manuals, or instructions. This supplemental detail is typically provided for research involving quality assurance requirements, or requirements imposed by a client or external agencies, such as the Centers for Disease Control and Prevention. For example, although the research conducted by the CSD Radiochemical Analysis Group is broadly defined in one overall RSS, the details of any individual experiment are described in one or more of 30 standard analytical methods, which are developed to ensure consistency and quality control. For CSD research conducted at the Chem-Bio Facility, the scope of research is also generally described in one overall RSS, but additional details of the research are provided in standard operating procedures (SOPs), hazard surveys, and a chemical hygiene plan developed specifically for the Chem-Bio Facility. For CSD research conducted using radiological sources, the description of work in the RSS is also supplemented by descriptions of the work in radiation work permits (RWPs) and radiological procedures.

At the research experiment level, most of the research conducted within the CSD is dynamic and continually evolving. As a result, the research scope, hazards, and controls often vary from one research experiment to the next. For example, the type, quantity and use of chemicals in a research experiment will frequently change, resulting in different hazards and requiring new or modified hazard controls. To address this dynamic type of research the RSS description is typically broad and general. For example, the research description in RSS 542.1, *Surface Chemistry, Analytical Spectroscopies and Catalyst Studies,* does not provide the details of any specific experiment, but broadly describes the research as "a battery of analytical techniques." As a result, RSSs often do not provide a sufficient description of a specific experiment such that the worker hazards can be identified and the appropriate controls can be selected and linked to the hazard for which the control is intended. In some cases, a specific procedure will be attached to the RSS to provide details for a specific experiment. However, this is the exception for most CSD research projects.

In addition to the RSS, other mechanisms are available to describe these dynamic and evolving research experiments, such as the research proposal and laboratory notebooks. The research proposal, however, is often too broad to describe the details for a specific experiment or may have been developed years prior to the conduct of the experiment. In some cases, the research proposal no longer reflects the current research conditions, equipment, and setups.

Most CSD researchers maintain some record of an experiment in a laboratory notebook. However, there are no documented expectations for the minimum content of a laboratory notebook, or that the laboratory notebook should provide a description of the experiment. The content of a laboratory notebook varies considerably among CSD researchers, and in some cases may only contain a record of experimental results, but no description of the experiment or setup. For instance, in one experiment observed by the OA team, the CSD Aqueous Chemistry and Geochemistry Group was studying the effects of an aqueous solution using a high temperature hydrogen electrode concentration cell. Although RSS 557.1, *Basic Aqueous Chemistry at High Temperatures and Pressures*, bounds portions of this experiment, the RSS does not discuss any of the series of research work steps associated with preparation of the aqueous solutions, reacting the media in a temperature-controlled heat cell, extracting and processing the reactant, analysis of the materials, and eventual disposal of the waste products. Furthermore, the experiment is not described in any procedures attached to the RSS, or the researcher's laboratory notebook. The initial research proposal was prepared over three years ago, and has not been maintained current with changing laboratory setups and research conditions. In many CSD experiments, the RSS, laboratory notebook, and experiment proposal have not provided a sufficient mechanism for describing a research experiment such that hazards can be identified and the appropriate controls can be selected and linked to the hazard (see Finding #3).

Summary. In most cases, the RSS defines the boundaries for categories of research such that the most significant hazards for a laboratory can be identified. In some cases, the description of research work in the RSS and accompanying procedures is also adequate to define the work scope at the experiment level (e.g., radiochemistry analysis and Bio-Chem research). However, for dynamic and evolving chemical research, which is the majority of research conducted in CSD, the RSS alone does not sufficiently describe the details of a specific experiment. Although other mechanisms are available for documenting experiment work scopes, guidance is lacking within SBMS or CSD policies and procedures concerning the use and expectations for defining the scope of an experiment in other related research documents, such as research proposals, laboratory notebooks, and procedures.

Core Function #2: Analyze the Hazards

The formal hazard identification and control process for research activities within the CSD focuses primarily on the Research Hazard Analysis and Control System (which is used to generate the RSS), the annual group review of an RSS, and the proposal screening process for new candidate research projects. The informal hazard identification and analysis process is the daily interchange of ideas and discussion of hazards among researchers, their group lead, the affected Laboratory Space Managers (LSMs), and CSD ES&H subject matter experts (SMEs). Although some of the informal hazard identification process may be documented in interoffice memos, most often the hazard identification and analysis process resides with those researchers directly involved in the experiment, and the conclusions of the hazard analysis for an experiment may or may not be documented.

The majority of UT-Battelle researchers within CSD are knowledgeable of the hazards associated with their research, and have years of experience and expertise in identifying and controlling hazards within their areas of research. However, the level of knowledge of hazards decreases when a researcher assists in other research areas, for which they may have limited expertise. Likewise, guest researchers may be unfamiliar with the hazards of the ORNL laboratories or may be unaccustomed to implementing safety practices with the degree of rigor expected at a DOE site. Students, who may be least knowledgeable of the hazards that could be encountered when conducting chemical research with the CSD laboratories, are monitored by the senior research staff.

Within some CSD groups the hazard identification and analysis process is robust, because the expectations for hazard identification, analysis, and documentation of hazards are rigorously controlled by ORNL and external agencies. For example, a rigorous hazard identification and analysis process is required for research conducted at the CSD Chem-Bio Facility, particularly due to the potential risk associated with the small quantities of highly toxic chemicals and biological agents used in research experiments. Hazards and potential hazards at this Biological Safety Level-2 facility are documented in an RSS, a Chemical Hygiene Plan, a hazard assessment, and operating procedures. Requirements for conducting and documenting hazards analyses are well defined by ORNL, DOE, the U.S. Department of Defense, and the Centers for Disease Control and Prevention.

As noted under Core Function #1, the RSS is a useful and effective tool for defining and bounding most significant hazards for a laboratory or a category of research. However, the RSS has been least effective in documenting hazards at the individual experiment level, particularly for research that is dynamic, evolving, and continually introducing new or changing levels of hazards. For example, for organic and inorganic synthesis work, only the most hazardous or toxic chemicals (i.e., typically the "top five hazards") are identified in the RSS. However, numerous other chemicals, including carcinogens or toxic chemicals, are not identified or discussed in the RSS, or elsewhere.

In three of the five CSD experiments observed by the OA team, hazards were identified that were not addressed in the respective RSSs, which are intended to bound these experiments. In one case, the potential existed for inadvertently using a mercury-filled distillation trap for concentrated bromine gas, which could have resulted in an explosion within the fume hood. Although the hazard potential was well described in the researcher's laboratory notebook, there was no mention of the potential explosion hazard in the RSS, and no other established hazard analysis process had addressed the explosion potential. In another case, a researcher was synthesizing a class of catalytic compounds using a gold solution and titanium dioxide substrate. Again the potential for an explosion existed if the researcher would have used ammonia hydroxide to raise the pH of the gold solution, thereby producing gold fulminate (an extremely shock sensitive compound). Again, the researcher included a typed note in his laboratory notebook concerning the hazard potential; however, the potential hazard was not otherwise documented. In a third example, a researcher was developing nanoparticles using wet chemical synthesis techniques. Although the RSS for this experiment identified the "wet chemical synthesis of nanoparticles," neither the RSS nor the researcher's laboratory notebook identified the potential unknown respiratory hazards of inhaling nanoparticles and the precautions for handling such material. The researcher, however, was aware of the potential hazards and was diligent in ensuring that the nanoparticle material was kept wet or only used within a fume hood. Even in those CSD groups that rely to a greater extent on procedures or methods for conducting research (e.g., Radiochemical Analysis Group), only a few of the analytical methods clearly documented the hazards associated with the research. In general, neither the SBMS R&D Work Control subject area nor CSD procedures provides sufficient guidance on the mechanisms and rigor to which experimental research hazards are to be documented (see Finding #3).

Another concern observed in the CSD laboratories is the lack of adequate or consistent labeling for some hazardous chemicals within the CSD laboratories, which has resulted in the inability to readily identify the hazards for these chemicals. About 8,000 chemicals in over 31,000 containers are currently in use throughout the CSD laboratories. Most of the purchased stock chemicals in CSD laboratories have been adequately labeled by the manufacturer, and have also been bar coded by UT-Battelle for inclusion into the ORNL Hazardous Material Inventory System (HMIS), although this process has yet to be fully implemented in some CSD laboratories. However, secondary chemicals and chemicals that have been synthesized or produced within the CSD laboratories are not always sufficiently and/or consistently labeled. As a result, hazards for these chemicals are not clearly identified, analyzed, and/or documented, and may only be known to the researcher. A commercially prepared material safety data sheet (MSDS) often does not exist, and the development of an MSDS is not required by the Occupational Safety and Health Administration (OSHA) for this limited application. Typically, these synthesized chemicals exhibit properties and hazards that are comparable to the compounds from which they were produced. Labeling of these chemicals varies among CSD groups, and researchers. However, the origin and hazards of the chemicals are not readily apparent in some cases. In CSD laboratories, the OA team observed no identification labels on some chemicals, or a chemical formula that was not fully legible. In other CSD laboratories, some chemicals were labeled only as "Solvent 3" or "Hazardous Waste No. 32" or "SRN 1643d." In some cases, the researcher provided a chemical formula on the chemical container. In other cases the researcher devised a system wherein the label referred to a notation in his/her laboratory notebook. Guidance is lacking in the SBMS subject area on Chemical Safety and in the ORNL Chemical Hygiene Plan on documenting hazards for synthesized chemicals or chemicals produced at ORNL for which a commercial MSDS does not exist. On June 4, 2004, ORNL legacy materials disposition staff were cleaning out Room 17 in Building 5505 when a tray of chemicals was discovered including several small bottles with crystalline materials in or around the containers. Due to the appearance of the containers and the lack of documentation and chemical labeling, the materials had to be managed as potentially shock sensitive, until the chemicals could be identified and the hazards analyzed. The chemicals are currently located in an explosives magazine within the laboratory. As a result of this event and concerns identified by the OA team and the CSD Research Support Group, CSD management has begun to implement a more consistent process for labeling secondary and synthesized chemicals, although this process has yet to be documented and implemented throughout CSD.

Finding #1. Hazardous chemicals that are synthesized or produced in ORNL laboratories are not sufficiently and consistently labeled such that the identity and hazards of the chemicals can be readily recognized, as required by 29 CFR 1910.1450 as invoked by the ORNL work smart standards.

Another hazard in CSD laboratories is the presence and use of toxic and flammable compressed gases outside a fume hood or vented gas cabinet for which the potential exposure hazards resulting from an abnormal event have not been analyzed and/or sufficiently documented. For example, several large compressed gas cylinders containing hydrogen and 100 percent and 1 percent carbon monoxide (CO) gases were in use in CSD Laboratory F-17 (Building 4500 North). One CO cylinder was connected to an analytical instrument using nylon or Tygon® tubing. The tubing was also used to transport the CO exhaust for the discharge of the instrument across the laboratory to a fume hood. A commercially available CO detector had been purchased by the LSM and installed on a wall of the laboratory opposite the instrument. Assuming that the CO detector was functional, the detector would have alarmed prior to the CO concentration exceeding the OSHA permissible exposure limit. However, the LSM was unaware if the CO detector was required, because an analysis of the CO hazard potential had not been performed. As a result, there was no evaluation of the CO detector by the CSD Research Support Group, no established procedure for performing maintenance or calibration of the detector, and no assurance that the placement of the detector and alarm setpoint was adequate. The RSS for this research indicated only that "the CO detector in F-21 should be used and consulted"; however, there is no assurance that all occupants of the laboratory had read the RSS. The researcher conducting the experiment was not listed as a participant on the RSS, and was not aware of the presence of the detector. There were no postings on the laboratory door to alert occupants to the potential CO hazard. Although the CSD Research Support Group was aware of the presence of CO in the laboratory, they were unaware that the research staff had recently added the 100 percent CO cylinder, and had not previously conducted a hazards analysis. During the OA team evaluation, the CSD industrial hygienist calculated that a malfunction of the CO cylinder regulator could result in CO concentrations that were well above the Immediately Dangerous to Life and Health values for CO as established by the National Institute for Occupational Safety and Health. As a result, on June 15, 2004, the ORNL Assistant Laboratory Director for Physical Sciences initiated a stand-down of activities performed in this laboratory until the CO hazards and controls had been reviewed.

Of particular concern was that a regulator on a cylinder of ammonia gas located in a Physics Division building had recently failed (March 2004), resulting in a potential concentration of ammonia above the Immediately Dangerous to Life and Health level in the laboratory. Fortunately, there were no over exposures to ammonia, because the odor threshold for ammonia, unlike CO, is well below the regulatory exposure limits. As a result of this incident, an occurrence report was generated, a lessons-learned bulletin was issued, and an inventory of toxic cylinders in CSD laboratories was taken. CSD removed a number of gas cylinders containing CO and silane. However, the corrective actions from this incident failed to adequately identify and analyze the CO hazard in CSD Laboratory F-17, and perhaps other CSD laboratories.

Furthermore, the SBMS subject area for compressed gases does not provide guidance on the storage and use of such compressed gas cylinders when outside a fume hood or ventilated gas cabinet. The SBMS subject area does not identify the controls for permitting such storage, and there is no definition of what type of gas constitutes a "toxic gas."

Finding #2. Exposure hazards from hazardous compressed gas cylinders (e.g., carbon monoxide and hydrogen) that are currently in use within ORNL CSD laboratories have not been sufficiently analyzed.

Summary. CSD researchers are generally knowledgeable of the hazards that they encounter in their primary research. CSD has made significant progress in establishing a work control system and developing RSSs to identify facility hazards and controls. However, the level of documentation of hazards in an RSS is often insufficient to address the hazards for a specific research experiment. Furthermore, there is no other formal mechanism to identify and document research hazards at the experiment level. A number of chemicals that were synthesized or produced at CSD laboratories are inadequately labeled such that the hazards of the chemical cannot be easily identified. Similarly, the potential exposure hazards for toxic gases supplied by compressed gas cylinders outside fume hoods and vented gas cabinets have not been adequately analyzed. SBMS and CSD guidance for chemical labeling and compressed gases is lacking in these applications.

Core Function #3: Identify and Implement Controls

The ORNL SBMS Work Control subject area identifies the Research Hazard Analysis and Control System as the mechanism for selecting the appropriate hazard controls. The product of this process is the RSS, which contains the identified hazard controls, known as the Safety Envelope, and the limits within which the research activities are authorized and conducted. As discussed in Core Functions #1 and #2, the RSS may also be accompanied by research proposals, procedures, analytical methods, and experimental plans that also address to a varying extent the identification and application of hazard controls. A robust development and implementation of hazard controls is particularly evident in the Chem-Bio laboratory within CSD.

At the laboratory level, engineering and safety systems installed within CSD laboratories have been effective in controlling research hazards. Safety equipment observed in CSD laboratories was either in good working condition or tagged out appropriately. Chemical fume hoods were routinely inspected and operated with sashes at the appropriate levels, and the collection or storage of materials in fume hoods was minimized. Most CSD research activities involving hazardous materials are conducted within a fume hood. Safety showers, eyewashes, and fire extinguishers were appropriately located and maintained. Room ventilation was adequate to provide sufficient air exchange. CSD laboratory spaces were neat, orderly, and clean. Housekeeping was excellent in several laboratories visited, such as Laboratories C/D 263 and D259. Storage of glassware and hazardous chemicals was in accordance with laboratory requirements and good practices. Overall, the condition of most laboratory spaces within CSD was good, and in some cases housekeeping was exceptional.

However, the CSD laboratories are aging, and maintenance of these spaces has become a challenge. In a number of cases the laboratories lack the inherent safety features and hazard controls of more modern chemical research laboratories, such as programmable door interlocks, automatic sash and ventilation controls on fume hoods, and centralized and ventilated enclosures for compressed gas cylinders, which could have eliminated the potential CO hazard discussed in the previous section. CSD has requested additional funding to address the storage needs for compressed gases.

In addition to engineering controls, CSD is also in the process of implementing several administrative control initiatives to improve the control of hazards within CSD research laboratories. For example, since the inception of the RSS process two years ago, CSD management has required that all new or revised RSSs be reviewed by a multidisciplined group that includes LSMs, ES&H SMEs, CSD division management, and appropriate line managers. Although this process is not yet formalized through written procedures or instructions, the process has identified potential experimental hazards and controls that may have otherwise been missed. More recently, during the last quarter of 2003, CSD initiated a “Proposal Review Screening Sheet” process. All new research projects are now screened by CSD line management and the CSD Research Support Group for ES&H concerns using the screening sheet. Although the screening process has yet to be formalized in a procedure or instruction, the application of the screening process has identified some projects for which the identification of hazards and controls was less than adequate. During the past year, CSD also implemented a program for inventorying, labeling, and periodically reviewing time-sensitive chemicals to ensure that unstable conditions, such as the production of peroxides, are not developing. To ensure environmental compliance, an environmental protection officer has been integrated into the CSD staff. UT-Battelle relies on environmental compliance representatives and environmental protection officers to provide direct support to line organizations to help ensure that regulatory requirements are met. These representatives/officers provide direct support and serve as an environmental protection and waste management point of contact for other CSD SMEs and line managers.

At the research activity or experiment level, the broad capacity of the RSS to bound a group of experiments, both in description of the research activities and identification of the most significant hazards, has inherently limited the RSS in documenting the hazard controls for a specific experiment and in linking those hazard controls to specific experimental hazards. Neither the SBMS Work Control subject area nor CSD procedures provides sufficient guidance on the mechanisms and rigor to which experimental hazard controls, at the activity or experiment level, are to be documented and linked to the hazards for which the control is intended. For example, CSD researchers have established specific personal protective equipment

(PPE) expectations, such as chemical protective gloves and eye wear for some experiments. However, these controls are not documented in the RSS, laboratory notebooks, or elsewhere. For example, requirements for the use of face shields when handling aqueous solutions above 100 degrees centigrade, for the use of thick vinyl gloves, or to perform work involving lead or nickel powders in a fume hood were not identified in RSS 557.1, although these controls are understood and expected by the researchers conducting the experiment. Often, when specific hazard controls are identified in an RSS (e.g., fume hoods or protective eye wear), it is not clear for which experiment or which stage of the experiment the hazard control was intended, because the RSS is applicable to many experiments. In most cases, the RSS only points to an SBMS subject area, such as Chemical Safety or Fetal Protection, and relies upon the researcher to define the appropriate control. However, once the researcher identifies a hazard control, neither the control nor the basis for its selection is typically documented in an RSS, laboratory notebook, or elsewhere.

Based on discussions with CSD researchers, some hazard controls implemented during research at the experiment level are presumed to be inherent in a researcher's education, training, and experience and are therefore not documented in the RSS or elsewhere (e.g., working with liquid nitrogen). However, the SBMS R&D Work Control subject area does not define a category of "researcher skill of the craft," and the SBMS does not provide guidance or limitations for conducting research only by skill of the craft.

Furthermore, neither the SBMS R&D Work Control subject area nor CSD procedures provides sufficient guidance on the mechanisms and rigor to which training requirements, at the activity level, are to be documented in an RSS and linked to the hazards for which the training is intended. Within CSD, a researcher's training requirements (including visiting researchers and students) are established by the Group Leader upon initial assignment to the Group. Typically, the identification of training requirements for a researcher is conducted in consultation with the CSD Research Support Group in which the CSD ES&H SMEs reside. Although this approach is effective in identifying training requirements for research work that affects most researchers, such as general employee training, radiation worker training, and hazardous waste training, some training requirements that are specific to the researchers' activities may be missed. For example, some researchers who routinely work with lead bricks have not received lead awareness training as defined in SBMS.

The mechanism for documenting training requirements that are unique to a researcher's experiment is unclear in SBMS. For example, some researchers may work with hazardous chemicals that have OSHA-mandated training requirements that are applicable regardless of the level of exposure, such as cadmium. However, there are no specific requirements for how such training is to be documented. Some research equipment may require electrical safety training as a result of the operating voltage of the instrument being greater than 50 volts or 600 volts, for which SBMS requires specific training.

In some cases, researchers who are less experienced (such as students) may require more formal training in such areas as compressed gases, pressurized systems, cryogenics, and chemical toxicity that exceeds the level of instruction provided in the CSD orientation class and is more consistent and robust than the guidance provided by their mentor or host. Similarly for LSMs, there is no SBMS guidance concerning their safety training requirements for hazards within their workspace for which they are not directly involved. For example, there is no SBMS requirement that if a laboratory has a Class 4 laser, that the LSM receive laser safety training if the LSM is not an operator of the laser. Because the LSM has responsibility for safe operation of the laser within his/her laboratory, CSD typically requires such training.

At the research experiment or activity level, such hazard controls as PPE and training for a number of experiments conducted within CSD laboratories are not sufficiently defined.

Finding #3. At the research activity or experiment level, ORNL CSD research work activities, hazards, and hazard controls are not sufficiently defined, documented, and linked as required by DOE Policy 450.4.

A number of laboratories within CSD use radioactive materials. In most cases, radioactive material use is confined to laboratory hoods or glove boxes located within a space in which non-radiological work is also conducted. To simplify access and egress, the laboratory space in which radioactive material is used or stored is posted as a Radiological Buffer Area (RBA), and the hood or glove box in which radioactive material work is performed is posted as a Contamination Area (CA). Radiological requirements associated with RBAs and CAs are listed in SBMS. The OA team observed that movement of material in and out of the CA hoods and exiting of personnel out of RBAs are not supported by sufficient radiological surveys or controls that verify contamination is not being inadvertently spread to non-radiological areas, including RBAs. RBAs are not recognized by DOE regulations and are therefore considered nonradiological areas under 10 CFR 835. Under 10 CFR 835.1102 and 835.703, controls designed to prevent the inadvertent transfer of removable contamination to locations outside of radiological areas must be maintained, verified, and documented.

For example, in CSD radiological laboratories D-263 and C-263 (Building 4500 South), contamination surveys are not being performed or documented when items are removed from fume hoods designated as CAs for placement elsewhere in the laboratory. Such items include stock solutions used to create aliquots, radiological tracers, and other materials such as beakers, glassware and other items removed from the CA hood during the course of the work. Typically radiation control technicians (RCTs) do not provide coverage during this equipment removal activity, although the RWP requires initial RCT coverage. According to SBMS, initial coverage means at a minimum consultation with an RCT at the beginning of each shift concerning work to be performed under the RWP. Upon exiting laboratory spaces posted as RBAs, such as Laboratories C/D-263, the research staff are only required to conduct a hand and foot frisk. However, SBMS requires a whole body frisk when exiting a CA. Although working in a CA hood does not involve the entire body, SBMS does not differentiate, and it is possible that researchers could have contaminated portions of their body other than just the hands or feet when working in front of a contaminated fume hood. Typically, whole body frisks are not performed when exiting CAs or RBAs within CSD laboratories. Some LSMs and researchers have taken the initiative to perform and/or require their users to conduct more detailed surveys and body frisks. However, such actions are at the subjective discretion of the individuals and are not consistently applied through SBMS.

In a related radiological and contamination control concern, uranium and thorium standard solutions without requisite radioactive material labels were identified in several laboratories operated by both CSD and the Nuclear Science and Technology Division (NSTD). The use of these solutions, containing uranium and/or thorium at concentrations up to 10,000 µg/ml, has not been covered under the auspice of specific RWPs and has not been confined to posted radiological CAs within laboratory spaces. While uranium and thorium activity in these solutions is low, there is sufficient radioactivity to result in internal exposure risks from an inadvertent intake as well as detectable contamination above CA posting limits in the event of a spill.

Finding #4. ORNL management and the Radiological Support Services Group have not defined or implemented sufficient radiological controls, such as survey requirements and labeling, to prevent the inadvertent transfer of contamination from posted Contamination Areas (such as fume hoods) to non-radiological areas, as required by regulations.

Summary. Engineered hazard controls at the laboratory level, such as fume hoods, emergency eye wash stations, and room ventilation systems, are appropriately located and are being operated and maintained as required. In addition to engineering controls, CSD is also in the process of implementing several administrative control initiatives to improve the control of hazards within CSD research laboratories, such as the new CSD proposal screening process. At the research experiment or activity level, hazard controls, such as PPE and training for a number of experiments conducted within CSD laboratories, are not sufficiently defined in either the RSS or a chemical analytical method, procedure, proposal, or laboratory notebook. In addition, radiological controls for work in laboratory spaces may not be rigorous enough to prevent the inadvertent spread of contamination.

Core Function #4: Perform Work Within Controls

Research activities observed by the OA team in CSD laboratories were conducted safely, using the appropriate engineering and administrative controls and PPE. However, because a number of the observed controls were not documented within the RSS as previously discussed in Core Function #3, the appropriateness of the hazard controls is subjective and not based on clear standards. Historically, CSD has maintained a safe research environment as evidenced by a low incidence of injuries and illness. CSD has not experienced a first aid case since calendar year (CY) 2002 and has had no recordable injuries or illnesses since CY 2000. CSD's record of recordable injuries and illnesses is well below the DOE average for comparable research facilities. Furthermore, CSD has not had a reportable environmental occurrence or environmental noncompliance in the last eight years.

During this review, Satellite Accumulation Areas (SAAs) for current operations and cleaning out legacy areas were being effectively managed in accordance with external and internal requirements. Waste containers were kept closed, were being moved to disposal, and were clearly labeled. Generators were aware of regulatory requirements and knew their points of contact in the waste services. SAAs were clearly posted and registered with ORNL Environmental Compliance Services.

Summary. Research work conducted within CSD laboratories has a longstanding record of being performed safely, as evidenced by historically low rates of recordable injuries and illnesses. A similar conclusion can be drawn regarding environmental compliance activities within CSD. However, in the absence of well-defined controls, safety relies on the experience and expertise of the research staff rather than well-defined standards as intended by ISM.

C.2.2 ORNL Physics Division – Accelerator Operations and Research and Development

OA's evaluation of implementation of the first four core functions of ISM for Physics Division activities focused on evaluation of safety performance of operations and experiments in three facilities. The Holifield Radioactive Ion Beam Facility (HRIBF) is currently the largest operating accelerator at ORNL, producing heavy ion particles for nuclear research. Principal hazards at HRIBF include equipment that can deliver estimated radiation dose rates of 95,000 rem per hour and large quantities of sulfur hexafluoride (a heavy gas that is an asphyxiant). The Oak Ridge Electron Linear Accelerator (ORELA) facility uses an electron accelerator to produce bursts of neutrons for various experiments. Principal hazards at the ORELA facility include radiation from the electron accelerator and intense neutron fields. In addition, some ORELA equipment beam lines have large enough vacuum spaces to become extremely hazardous in the event of an accident. The Multicharged Ion Research Facility (MIRF) consists of one existing ion source particle accelerator, which is used for atomic and molecular particle interaction research, and a similar accelerator currently being installed as part of a facility upgrade. The MIRF accelerators are small and have substantial installed shielding, and thus do not create a radiation area, and the facility has no other hazards unique to accelerator operations. All three facilities present electrical hazards because of the numerous power supplies and high-voltage equipment needed for operations and experiments.

Activities observed by OA included user access training, accelerator operations, end station operations, and facility modification activities. Procedures, guidelines, and policies were evaluated, and the ORNL Research Hazard Analysis and Control System components were examined.

Core Function #1: Define the Scope of Work

Overall, the scopes of work for Physics Division activities are well defined. The scope of operational activities at the accelerators is adequately described in facility safety and operations documentation. The HRIBF and ORELA facility-level activities are described in the facilities' safety assessment documents (SADs) and accelerator safety envelope (ASE). These documents are also used as the definition for further analysis in the ORNL Research Hazard Analysis and Control System, as further discussed in the next section. Specific operations are further described in facility procedures, guidelines, and operational aids. The details provided in these documents are sufficient to permit effective hazard identification and analysis of operational activities. For experimental activities, each experiment begins with an experiment proposal that includes a description of the scope of work. The proposals describe the experimental apparatus, needed materials, and interface with the accelerators in sufficient detail to permit effective hazard identification and analysis. In addition, scheduling at the accelerators is effective in ensuring that the appropriate hazards analysis can occur prior to performing experiments.

Summary. The scope of work and schedule for Physics Division operations and experiments is well defined through facility descriptions, documents, and proposals.

Core Function #2: Analyze the Hazards

Most hazards associated with Physics Division accelerators are well understood and have been analyzed as part of various safety reviews over the years. Facility-level hazards analyses for the accelerators are currently adequately documented in SADs. Longstanding hazards assessments accurately address hazards associated with accelerator operations and anticipated hazards associated with performance of experiments.

For other facility and activity-level hazards analysis, the Physics Division uses a combination of processes to effectively identify hazards. The Research Hazard Analysis and Control System is used to establish and maintain RSSs for each facility, which bound operations, maintenance, and routine experiment performance. For example, an annual review meeting for the ORELA operations RSS was comprehensive. The facility assembled all required reviewers and reviewed the existing RSS line by line, with numerous discussions related to various safety topics. The ES&H officer facilitated the review using a real-time projection system of the computerized RSS system. The team approach was an effective hazard review and analysis method and ensured comprehensive coverage of ORELA operation, maintenance, and generic experiment (experiments with unique hazards have their own RSS) hazard and control analysis and review. In another example, the RSS for the MIRF adequately analyzed the hazards associated with construction and assembly activities of the facility upgrade to add a new ion source. The experiment safety review processes at each accelerator further analyze each experiment proposal to determine whether the ASE and the facility-level RSS bound the expected hazards.

For proposed experiments with new or unique hazards, an RSS specific to that experiment is developed as part of the experiment review process, and the review process results in a comprehensive analysis of the hazards. For example, the experiment review process and the associated RSS for experiments involving the unique hazards of hydrogen gas targets was comprehensive and addressed all potential consequences introduced by the hazard. Similarly, the division performed extensive hazards analyses prior to the use of beryllium beams and targets in research activities.

Summary. Hazards associated with Physics Division activities are effectively analyzed. Facility-level hazards analyses are documented in facility-level safety documents, and hazards associated with new or unique hazards are effectively analyzed using a combination of the Research Hazard Analysis and Control System and the experiment review system. The OA team found no unanalyzed hazards during the review.

Core Function #3: Identify and Implement Controls

The combination of engineering and administrative controls results in effective prevention and/or mitigation of hazards associated with Physics Division operations and experiments in most cases. Engineering controls are prevalent in the facilities and include comprehensive safety interlocks to disable power supplies and effectively eliminate high radiation, high voltage, and/or flammable/explosive gas hazards to personnel. Facility-level administrative controls include the ASEs and RSSs, which provide effective controls to ensure that interlocks and other necessary engineering controls are appropriately tested and maintained operable. The ASEs and RSSs also provide some assurance that administrative controls for safe operation of the facility are maintained. At the activity level, the primary administrative controls for operations, maintenance, and experiments are summarized in the applicable RSS and further tailored to specific activities when warranted. Specific administrative controls for unique experiment hazards may be specified as part of the experiment review process, in an RWP, or in other permits as directed by ORNL SBMS requirements. Operations and maintenance controls are generally specified in associated RSSs, procedures, guidelines, checklists, or work packages. For example, beam end stations in MIRF have emergency shutdown guidelines posted. These guidelines include diagrams and pictures and enhance the safety of the facility by providing instructions for shutdown during an abnormal event when the principal investigator may not be present. Radiation protection administrative controls are also adequately implemented. For example, a radiation area surrounding an activated cooling water system was appropriately barricaded and posted with the appropriate signs and the current RWP needed for entry. Although some specific implementation deficiencies exist (discussed later in this section), the overall process usually produces an adequate set of hazard controls.

The Physics Division uses LSMs effectively to control hazards in laboratory spaces. For example, LSMs in MIRF and HRIBF Astrophysics areas were knowledgeable of the hazards, controls, and operations within their assigned areas. Postings were current and accurately reflected the hazards in the space.

Training programs at the accelerators are extensive and are appropriately used to communicate hazards and control access to the facilities. The accelerators are user facilities and host outside experimenters on a routine basis. The prerequisite training for unescorted access to the facilities is comprehensive and addresses facility hazards and associated controls. Most of the training is computer-based, making it easy for users to complete training prior to arrival at the site. The computer-based training courses are technically accurate, effective, and efficient. The electrical safety module is particularly comprehensive due to the large amount of electrical equipment and associated hazards used in the accelerator facilities. In addition to the computer-based training, Physics Division supervisors provide site-specific hazard communication training to all experimenters and workers. This training is tailored to the trainees' specific jobs. For example, the Group Leader for the Astrophysics Group trains experimenters on the hydrogen target in addition to other hazards specific to the target station and associated data collection equipment. The Astrophysics Group Leader uses a map of the area and pictures of specific equipment with the site-specific training to provide a comprehensive review of the activity-level hazards.

Although most hazard controls are adequately addressed, the OA team observed some fundamental weaknesses in implementation of facility-level requirements as further described below.

DOE Order 420.2A, *Safety of Accelerator Facilities*, is not included as a requirement in the WSS for the accelerators, and no equivalent requirements (outside of contractor implementing documents in SBMS) have been specified. The only additional requirement document listed is some unspecified portions of ANSI Standard N43.1, *Radiological Safety in the Design and Operation of Particle Accelerators*, a standard that was issued in 1978 and has since been withdrawn by ANSI. According to the WSS identification team final report, an implementation assumption is that the principles of DOE Order 420.2A are considered as a best management practice for the accelerators; however, no WSS guidelines or contract requirements define expectations for using implementation assumptions or best management practices. Further, the WSS final report included three unresolved minority reports from the identification team (representing one third of the voting members) that were not specifically addressed by the confirmation team approval documentation. Of particular concern is that the WSS set was approved by senior contractor and Oak Ridge National Laboratory (OSO) management with one unresolved minority opinion that stated, "the team's recommendation does not provide adequate ES&H protection…" In this case, senior contractor and OSO management took no action to resolve the described ES&H concerns. The OA team review of the WSS requirement set also indicates that the requirement set is not sufficient to ensure adequate ES&H protection.

OA also determined that the current accelerator WSS set does not meet the intent of several of the requirements in the order. For example, the approved accelerator WSS set does not include equivalent requirements for SADs, ASEs, written procedures, periodic safety reviews, and other DOE expectations listed in the order, and listing the order as a best management practice has not been effective in meeting the intent. This situation has contributed to problems in several areas discussed elsewhere in this report, including lack of appropriate written procedures for operation startup, normal operation, emergency conditions, and conduct of experiments; lack of periodic reviews by the Accelerator Safety Review Committee; and lack of DOE approval of ASE changes. For example, the contractor recently approved a major revision to an ASE; however, OSO did not participate in or approve the changes as would be required by the order. In addition, OSO has not ensured that other requirements of the order have been implemented by ORNL. The omission of the order requirements in the WSS may be partly attributable to the lack of current guidance from the DOE Office of Science (SC). DOE Order 420.2A requires the Cognizant Secretarial Office (i.e., SC) to provide written guidance to line organizations for implementing the requirements of the order; however, no such guidance for this order has been developed. The last guidance was published in September 1993, is not available online, and is not applicable to the current order. The ORNL SBMS subject area addressing accelerator safety has a "related information" section that contains an August 2001 draft DOE guidance document for DOE Order 420.2A; however, this document is unapproved and unavailable online from a DOE website.

Finding #5. OSO and SC have not performed functions, including developing guidance and approving safety basis revisions, consistent with the expectations of DOE Order 420.2A and have not provided sufficient guidance and oversight to ensure that the WSS process provided a set of standards and requirements that establish adequate and appropriate ES&H protection for all aspects of accelerator operations.

The HRIBF ASE and DOE Order 420.2A (adopted as a best management practice in the WSSs) require facility operations in accordance with approved procedures. In addition, DOE Order 420.2A lists minimum operational activities that must be addressed by approved procedures at DOE accelerators. The HRIBF safety documents also establish a strict requirement for procedure compliance. The Physics Division has taken a narrow interpretation of the requirements for approved procedures and only develops approved procedures for safety requirements directly mentioned in the safety basis documents. Consequently, most of the actual instructions for operations such as startup, shutdown, sulfur hexafluoride gas transfers, and response to abnormal events are contained in approved guidelines or operational aids. Although the guidelines and operational aids are generally technically well written, accurate, and reviewed and approved with the same rigor as procedures, they do not require the same level of adherence as procedures. The HRIBF SAD and administrative procedure on operation documents state that the individual performing an activity may deviate from guidelines and operational aids if, in their judgment, the deviation will clearly result in more effective operation. System pressure limits, instrumentation operability requirements, and other limitations are listed in a procedure and thus subject to strict adherence. However, other potentially hazardous operations, such as transfer of large quantities of sulfur hexafluoride gas (an asphyxiant specifically addressed in the safety basis documents) are addressed in transfer system guidelines. Because such operations are covered by guidelines, individuals are allowed to deviate from the set of instructions if the individual performing the activity deems it more effective to perform a gas transfer a different way (the procedures do not clarify what is meant by more effective). An operational philosophy that allows deviation from operational instructions for any reason other than safety is not in accordance with the operational discipline principles of ISM.

In some cases, experimental activities are not addressed by approved procedures, contrary to requirements in the RSS, ASE, and the best management practices adopted from DOE Order 420.2.A. The HRIBF ASE states, "Approved written procedures shall be followed in the conduct of experiments at the Holifield facility." In most cases, experiments are performed in accordance with approved guidelines, and thus the same concerns previously discussed are applicable. In a few cases, activities interfacing with accelerator operations were performed with unapproved documents. In one example, an HRIBF target change-out was performed in accordance with an uncontrolled, handwritten set of instructions taped to the equipment, and no approved procedure exists that specifically addresses conduct of target change-outs by experimenters. While the evolution was relatively simple, the inappropriate performance or performance of steps out of sequence could admit air to the accelerator vacuum envelope or damage and spread contamination from the target. In another example, the experiment review process and the RSS for the hydrogen target identified the need for the step-by-step procedure to test hydrogen gas isolation interlocks. A requirement to test the interlocks was listed in an operational guideline developed for the apparatus, but a step-by-step procedure for testing the interlocks was never developed. In a third example, the RSS for the Material Test Stand in HRIBF addresses the small quantities of pyrophoric cesium used in the activity and states that a guideline for handling cesium applies. The referenced guideline provides needed controls for handling this hazardous substance, but is questionable in its application because it is unapproved, unmarked as to the revision, and not formally controlled. In addition, a 2003 self-assessment found that some workers handling cesium during the work activity were unaware of the existence of the guideline.

Finding #6. The ORNL Physics Division's implementation of requirements for approved written procedures does not ensure that all operations and activities are conducted in accordance with approved procedures.

Summary. In most cases, the Physics Division effectively uses a combination of engineering and administrative controls to ensure prevention and/or mitigation of hazards associated with operations and experiments. However, some fundamental problems in implementation of controls exist within SC, ORO, and ORNL. DOE has not effectively ensured implementation of DOE policy and expectations delineated in DOE Order 420.2A, and the Physics Division has not fully implemented a standard of operational discipline for procedure development and use that reflects commonly accepted standards and DOE expectations. Increased line management attention is needed at all levels to ensure that minimum DOE expectations for accelerator safety are fully implemented at ORNL.

Core Function #4: Perform Work Within Controls

The accelerators effectively verify readiness for operations and experiments by using experiment approvals, weekly scheduling meetings, and real-time verifications by operations personnel. For example, the Accelerator Operations meeting was an effective forum for discussing upcoming schedules, issues, impacts to the schedule, ES&H concerns, and other topics. The meeting covered HRIBF, ORELA, and MIRF, and served the same functions as plan-of-the-week meetings at other sites.

Operations and experimental work observed by the OA team was generally conducted safely and in accordance with the established controls. For example, HRBIF shift turnover was performed efficiently and in accordance with good operating practices. Operators appropriately covered facility status, previous shift evolutions, and operating parameters. The Accelerator Systems Technical Manager was present and reviewed the previous shift's log entries. In another example, in preparation for an upcoming experiment, a pipefitter removed a flange from a beam line in accordance with established controls. The worker contacted an RCT in accordance with the room posting, and the RCT performed appropriate surveys and swipes before, during, and after removal of the flange.

Accelerator operators and experimenters are knowledgeable and have considerable experience within their areas of expertise. Operators were familiar with accelerator operations and were efficient in safely tuning the beam to provide the required beam to the end station. Experimenters were familiar with the operation of the end stations, including operation and setpoints of applicable safety interlocks on such parameters as radiation levels, vacuum, and hydrogen concentration.

Summary. Overall, Physics Division personnel effectively verify readiness and perform work in accordance with established controls. The personnel are experienced and knowledgeable of accelerator equipment and interlocks. However, as discussed under Core Functions #2 and #3, the requirements and procedures used to perform work need to be enhanced to ensure that controls are comprehensive and mandatory.

C.2.3 Nonreactor Nuclear Facilities Division – Hot Cell Facilities

ORNL hot cell facilities are currently managed and operated under a UT-Battelle Landlord-Tenant Model by the Nonreactor Nuclear Facilities Division (NNFD) of the Facilities and Operations Directorate. NNFD was established at the end of 2002, and assumed control of ten nuclear facilities that are diverse in their discipline of operation, physical condition, mission, and design. This OA review focused on NNFD operations and maintenance activities but also included review of tenant activities conducted by other organizations within NNFD facilities. Work was observed in several NNFD facilities, including 2026, 3025E, 3019A, 3047, 3525, and 7920. Work observations included such hot cell activities as cell transfers, material movement, and routine cell entries, as well as such maintenance evolutions as cell window repair, high efficiency particulate air (HEPA) filter testing, and decontamination evolutions. Selected research activities conducted by CSD and NSTD within 2026 and 7920 were also reviewed.

Core Function #1: Define the Scope of Work

The scope of work for most operations and maintenance-related hot cell work was generally well defined. At the facility level, each NNFD nuclear facility has an approved Safety Analysis Report (SAR) or Basis for Interim Operations that provides a detailed description of authorized building activities. At the activity level, NNFD work instructions and procedures provided adequate work scope definition such that hazards and controls associated with NNFD work could be identified. However, as discussed in the CSD section of this report, individual scopes of work for research activities conducted within NNFD space by other organizations, such as CSD, are not always clearly delineated in RSSs or other work documents such that activity-level hazards and controls can be easily identified.

Summary. Work control processes have been established for NNFD hot cell operations and maintenance activities, and working documents sufficiently describe the work plan, scope, schedule, and requirements. However, work scopes for some research activities are not described in sufficient detail to effectively analyze and control hazards.

Core Function #2: Analyze the Hazards

The primary mechanism used to document hazards associated with NNFD work is the job hazard evaluation (JHE) tool contained in the ORNL Work Plan System. This tool provides a suitable mechanism for identifying and analyzing activity-level hazards associated with maintenance and operations work in NNFD facilities. The JHE tool and associated planning aid entitled *Typical Hazards to be Considered in a Job Hazard Evaluation* provide an appropriate framework for identifying hazards applicable to a specific work scope and also provide linkages to additional resources, including SBMS subject areas for further information on typical controls that may be needed to mitigate each hazard.

While adequate systems for scope definition and hazards analysis were in place, ineffective implementation of these systems has, at times, resulted in incomplete or ineffective hazards analysis. Specifically, some hazards associated with work evolutions within NNFD were not identified on the JHE or sufficiently analyzed through the JHE and NNFD-004 work planning process. For example, the hazards associated with use of chemical solvents, organic-based paints, and an electric heat gun were not addressed by the JHE or work instructions in the 3025E cell 1 window replacement work package. While there is evidence of informal evaluation of some of these hazards by the industrial hygiene group, the information is incomplete and was not integrated into the work plan system as required. At 7920, the hazards associated with heat sealing equipment used in laboratory 209 and "sharps" (e.g., razor blades) within a CA hood were not identified in the JHE or work instructions for the iodine-131 sample preparation in the Radiochemical Engineering Development Center (REDC) 7920 laboratory 210 hood.

Similarly, the work package for a recent ORNL event (i.e., the 7930 hoist removal work that resulted in a dropped load) did not have sufficient information in the JHE or work instructions to adequately analyze the potential hazards associated with the work. For example, the rationale used to determine why the work did not require a critical lift plan was not documented and there is no evidence of any technical basis, such as quantitative or engineering assessment of the load bearing needs or capability of the securing instructions for movement of the hoist.

In a related concern, neither the SBMS nor NNFD work control processes have formal requirements for SME involvement in hazards analysis and work package approval. While encouraged in NNFD-004, SME approval of work instructions and JHEs is not required, with the exception of approval of any needed permits, such as RWPs or hot work permits. Involvement of SMEs in review and approval of JHEs and work instructions is therefore based on subjective interpretations of the work planner, with a potential for inadequate review and poorly defined accountability for the quality of the hazards analysis (see Finding #7).

In the radiological area, SBMS drives a graded approach to the level of independent review of RWPs and radiological hazards based on a set of predefined radiological criteria. All radiological work must be characterized as level 1 through level 6 based on collective and individual doses and other conditions specified on the Radiological Work Review Checklist. Level 1 work requires only review by a Radiological Support Services representative and responsible line manager, while Level 6 work requires review by various levels of management, including the ORNL Director. Several deficiencies exist with the current process as described in the following paragraphs.

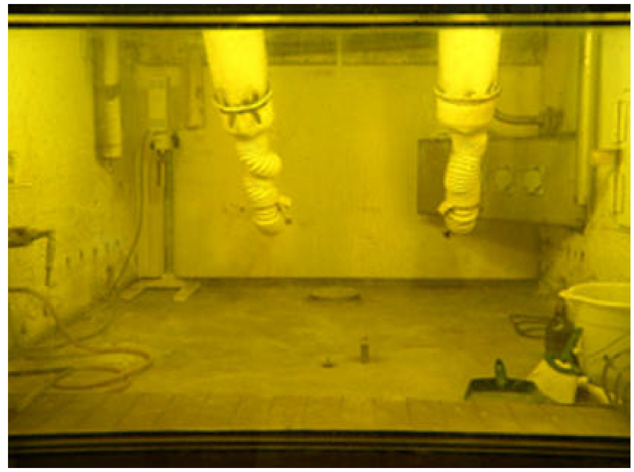
First, there are no instructions for properly categorizing work into the various levels requiring review. The dose-based criteria do not indicate whether they are actual or projected doses, and RCTs interviewed did not calculate projected doses based on the expected time in the area when determining the hazard category. Instead, RCTs who were interviewed used the contamination thresholds even when dose rates and anticipated times to complete the work were high enough to warrant a higher hazard category. Further, there is no requirement to document the basis used to determine why a particular hazard category was chosen. Another concern is that thresholds that would require involvement by professional health physicists are so high that they are rarely invoked. Most work performed at ORNL falls under Category 1 or 2 (out of 6), which at the highest level requires review only by a Radiological Support Services field supervisor. The 2026 cell pan cleanout job involved contamination levels of several million dpm alpha and beta-gamma as well as general area dose rates up to 500 mR/hr gamma and 7 rad/hr beta. However the hazard category for the job was only classified as level 2, requiring Radiological Support Services technical lead concurrence with the RWP but no other formal as-low-as-reasonably-achievable (ALARA) or radiological review by a senior-level health physics professional.

Some work is categorized as Level 3, which requires additional review by the Division Radiological Control Officer (DRCO). However, there are many individuals across ORNL who serve as DRCOs, and most DRCOs are not professional health physicists or radiological engineers. While all DRCOs receive ORNL-specific DRCO training, both the level of health physics education and the professional qualifications of DRCOs vary considerably. At ORNL, some DRCOs have health physics degrees or are certified health physicists; others have degrees in related scientific disciplines, and some have operational experience in health physics. The qualification requirements for DRCOs do not include any level of formal health physics or related scientific higher education. This inconsistent level of formal education requirements for DRCOs may result in considerable variability in the quality and consistency of independent radiological reviews.

Lastly, while the process does require an independent radiological review for some hazard

Before

After



Building 2026 Hot Cell Cleanout

categories, there is no requirement to formally document the scope or results of the review other than the signature of the reviewer, indicating that a review was performed. This conflicts with specific implementation guidance on formal radiological reviews provided in the DOE Radiological Control Standard (DOE-STD-1098-99). The current ORNL process does not define a systematic approach to the reviews or demonstrate how the radiological criteria set forth in the Radiological Control Standard have been evaluated and incorporated into work plans and procedures (see Finding #8).

Summary. A formal mechanism exists for identifying and analyzing hazards associated with NNFD work activities. This process provides a suitable mechanism for identifying and analyzing activity-level hazards associated with maintenance and operations work in NNFD facilities. The automated tools provide linkage to such institutional resources as SBMS subject areas for reference, including identification of typical controls that may be needed to mitigate each hazard. However, insufficient rigor and SME involvement have been applied to implementation of some of these processes, resulting in hazards that have not been properly identified, analyzed, or documented. In addition, the required independent radiological reviews for work at ORNL are not conducted as rigorously as defined in DOE implementation guidance.

Core Function #3: Identify and Implement Hazard Controls

NNFD facilities rely on extensive use of engineered controls, which serve as the primary mechanism to control many activity-level hazards. Engineered controls include such items as hot cells, glove boxes, hoods, temporary enclosures, and ventilation systems specific to the work. Engineered controls are complemented by a variety of administrative controls, including RWPs, SOPs, and work instructions prepared to control a particular activity.

ORNL has established some innovative electronic mechanisms for certain radiological hazard controls. For example, Radiological Support Services has several tools that simplify the development, implementation, and review of radiological controls, such as RWPs, radiological surveys, bioassays, and radiological area inventories. For example, the RSS Web survey tool provides easy and immediate searchable access to sitewide RWPs, radiological surveys, and air sampling data. The data is easily retrievable from any remote location with intranet access. The radiological area inventory tool provides the current posting status for radiological areas around the site. Another example is the bioassay participant tool, which provides the ability to search for specific employees and retrieve data on bioassay participation history.

To control operations and maintenance work, NNFD has established internal protocols and procedures consistent with SBMS requirements. These procedures include NNFD-001, which defines the process and requirements pertaining to development of technical and administrative procedures, and NNFD-004, which defines the methods for implementation of ORNL work control processes for all operations and maintenance activities conducted within NNFD facilities. A formal system of change control is included with both of these requirements. NNFD has made a concerted effort to enhance procedure quality, use, and adherence at hot cell facilities as part of an effort to address weaknesses identified in the 2001 OA inspection (e.g., inadequate policies for development and use of procedures, varying levels of effectiveness across divisions, and insufficient identification and communication of hazards).

The combination of engineering and administrative controls can result in effective mitigative and preventive controls. However, deficiencies in implementation of work planning and radiological requirements in NNFD facilities have resulted in inadequate or poorly defined controls during some work evolutions, resulting in the potential for adverse safety consequences and/or unnecessary or uncharacterized exposures. These deficiencies are discussed in the following paragraphs.

NNFD-004 sets forth expectations for work control of operations, maintenance, and service work in NNFD-operated facilities. The procedure requires use of the ORNL Work Plan System and JHE tools to identify activity-level hazards and associated controls. A unique aspect of the system is that its format is such that all hazards and controls are expected to be identified on the JHE and again at the appropriate location within the work instructions where the hazard is introduced. While a few work packages reviewed met this expectation, many packages failed to incorporate hazards and controls in the JHE and applicable work steps, and some packages had inadequate or incomplete controls. A possible contributing factor to these deficiencies is insufficient training or qualification requirements for work plan authors. Examples of work packages that did not include hazards and controls in the applicable work steps include: 7930 Hoist #1 Cell A, 7920 iodine-131 glove box ampoule prep, package and transfer Pu-238 to Building 3525, 3025E HEPA test, and 3025E cell 1 window repair.

In addition, intent changes to work scope resulting in new hazards and controls have not been managed in accordance with the NNFD-004 change control process, including required updates to the work package. For example, the work instructions and JHE for the 3025E cell 1 window repair were not updated to include information on chemical hazards and the need for organic cartridges and special gloves for new chemicals that were introduced to the work as a result of paint stripping and re-painting. Evaluation of the controls for these new hazards was handled through informal communications with the industrial hygiene SME rather than formal change to the JHE and work instructions, as required by the procedure.

Institutional training requirements and qualifications needed to perform certain work covered by work instructions have not always properly flowed down to work packages. For example, the work package for the 2026 cell pan cleanup identified temperature extremes and indicated the use of ice vests as a control. However, heat-stress training was not identified as a control, and workers were not required to receive the ORNL institutional heat-stress training module. Workers recall Operational Safety Services Division (OSSD) support personnel providing some informal review of heat-stress topics, but this information is not indicated in the work package, and the workers were not updated to reflect heat-stress qualifications.

Some work packages reviewed did not contain sufficient controls to mitigate potential hazards. The work package for the iodine-131 ampoule work in 7920 resulted in a small fire in the glove box during iodine-131 handling activities. This event resulted in a declaration of significance Category 1 notification to DOE Headquarters – because it met the criteria for an unplanned fire or explosion within confinement/ containment boundaries of a nuclear facility. In this work, no hot work permit was requested because of an exclusion in the 7920 facility hazards analysis (FHA) for the micro-torch in the glove box in Laboratory 209. However, this exclusion does not meet the requirements for exclusion under the current SBMS subject area for *Welding, Burning, and Hot Work* (issued after the FHA for 7920 was issued). In addition, no controls to prevent the possibility for combustion of flammable materials in the glove box were established. Similarly, the work package for the 7930 hoist removal work did not include appropriate controls to prevent the hoist from falling, resulting in a near miss and reportable occurrence.

Finding #7. ORNL's NNFD has not ensured that work plan developers implement the NNFD-004 work control process in a manner that ensures that appropriate hazard controls needed to perform work safely have been identified and clearly documented as part of the work instructions.

Radiological controls for most NNFD work are identified and implemented as part of the RWP process. Most aspects of RWPs are adequately implemented at the hot cells.

However, a number of concerns associated with RWPs and specification of radiological controls were identified during the inspection. Requirements for RWPs, as defined in RSS SOP 02-320-01, were not properly implemented for RWPs approved to control work. First, the SOP requires that, for initial conditions, the preparer enter the current radiological conditions from a pre-job survey or other estimating techniques if a pre-job survey cannot be obtained. Contrary to this requirement, initial conditions on several RWPs did not provide a summary of the radiological conditions from the survey but provided only a description of the posting status for the area, such as "Radiation Area." Second, the SOP requires expected changes to include a description of the expected radiological conditions anticipated during conduct of the work. However, on several RWPs, expected changes did not include this information but stated terms such as "dose rates will change" or "dose rates will go up" without any estimate of the magnitude of the departure from the initial conditions. Third, limiting conditions are required to stipulate those radiological conditions under which the RWP should no longer be valid. However, several RWPs did not specify any limiting conditions, possibly resulting in authorization to work in an unsafe condition without appropriate radiological controls. Fourth, isotopic information for key radionuclides was not always entered correctly, resulting in RWPs that did not require bioassay controls consistent with SBMS requirements. Fifth, special instructions are required to convey information that does not fit elsewhere on the form, such as extremity dosimetry thresholds and placement. For example, the SOP requires the RWP to provide specific details on body location for extremity dosimeters and when they are required. None of the RWPs reviewed contained the level of detail specified in the SOP. For instance, in several cases the special instructions for extremity dosimetry indicated that they will be issued at the discretion of the RCT "in accordance with SBMS requirements."

In another concern, RWPs specify whether air sampling is required; however, no information as to the expectations for the type or placement of air samplers is included. The 2026 cell pan cleanout work had a high potential for airborne radioactivity because of the very high contamination levels. Air sampling was required by the RWP and was being conducted; however, the air sampler in use was a portable unit placed near the entrance to the cell and not a lapel sampler or tube fed sampler representative of the worker breathing zone. As such, the adequacy of the protection factor for the respirator could not be verified because an accurate assessment of the breathing zone concentration of radioactive material was not assessed. Another example of where air sampler placement was not representative of the worker breathing zone was the iodine-131 ampoule work in REDC.

Finding #8. ORNL Radiological Support Services has not ensured that radiation work permits contain sufficient clarity, specificity, and detail about expected radiological conditions and required controls, as needed to adequately control all radiological hazards and meet institutional radiation protection requirements.

Several rare isotopes are occasionally used at ORNL. At the time of the OA inspection, there were no approved analytical methods available for bioassay monitoring of berkelium, einsteinium, and fermium, and therefore SBMS and internal dosimetry bioassay requirements could not be implemented for routine monitoring or in response to potential intakes. Workers in REDC and 5505 occasionally perform work using these isotopes. An RWP for use of berkelium at 7920 indicates "under development" in the bioassay field. Such a condition represents a potential regulatory and legal issue for ORNL and DOE. The ORNL Dosimetry Service Group is close to finalizing a technique for performing urinalysis bioassay for berkelium but still has no documented capability for einsteinium and fermium. The site is aware of and has been working to address these problems; however, no timeline or funding has been established to complete the effort. Nevertheless, work has been allowed to proceed with these isotopes in the absence of an approved bioassay capability or establishment of other compensatory controls designed to meet internal dosimetry regulations. For example, under some conditions a more rigorous and comprehensive area and personal air sampling program designed to provide continuous representative air monitoring of personnel using these materials may be sufficient to demonstrate compliance with internal dose limits. No such compensatory measures have been addressed by the internal dosimetry program or RWP process.

Finding #9. ORNL workers have been allowed to work with several radioisotopes for which there are no approved methods to perform bioassay measurements or otherwise accurately assess potential internal doses, contrary to SBMS and regulatory requirements.

In another bioassay-related problem, some workers involved with iodine-131 isotope work have not been subject to the appropriate level of bioassay monitoring stipulated in SBMS because of a flaw in the bioassay data management system database used to schedule workers for bioassay appointments. The required frequency for routine sampling for iodine-131 is bi-monthly to achieve sufficient sensitivity for detection. All other isotopes can be evaluated using an annual frequency. However, the system, which is linked to RWP entries, did not update the whole body bioassay monitoring frequency to bi-monthly for iodine-131 if a worker was already entered into the system for an annual whole body count for another isotope. An annual bioassay frequency for iodine-131 could result in significant intakes going undetected because of the short half life of iodine-131. However, because this work is performed relatively frequently in 7920, there is a good likelihood that the annual bioassay for involved workers would have occurred at a time that would have detected any unusual iodine activity. The site initiated actions to correct this deficiency as soon as the problem was verified.

As discussed earlier, much progress has been made in enhancing procedure quality and use at the hot cell facilities. Some important activities, such as TSR implementation, alarm response, and operation of safety class ventilation systems, have been updated at facilities such as REDC. However, significant work remains to be accomplished to achieve a fully effective system of procedures for nuclear activities in NNFD facilities. Many of the old procedures have not yet been revised to meet the current requirements. A schedule for review and revision of these older procedures has been established. With respect to research activities conducted in REDC, progress in developing compliant procedures has been limited, in part because of a perception that NNFD-001 is too restrictive for use in a research environment. Currently at REDC, some procedures for research activities have been developed under an administrative procedure for research (i.e., AP-1). However, AP-1 is undergoing revisions to achieve a greater level of rigor needed for work in a Category 2 nuclear facility. As a result, research activities in need of procedure revision or too complex to be controlled through the RSS process must await procedure development under the new process. In the interim, some ORNL research activities have been converted to work packages similar to NNFD-004 in lieu of a research-specific procedure bounded by an enhanced RSS. However, this practice circumvents the rigorous review requirements for technical procedures as required by the new process.

Summary. Formal work control processes have been developed by NNFD to set forth management expectations for identifying and controlling workplace hazards. Engineering controls are in place for many hazards and are effectively implemented. The combination of engineering and administrative controls resulted in effective mitigative and preventive controls in most cases. However, deficiencies in some aspects of implementation of work planning and radiological requirements in NNFD facilities have resulted in some inadequate or poorly defined controls, resulting in the potential for adverse safety consequences and/or unnecessary or uncharacterized exposures. Additional attention is needed to address deficiencies in the clarity and effectiveness of controls defined in RWPs used to control radiological work, including independent radiological reviews. The lack of formal requirements for SME involvement and approval of work packages as well as lack of consistent training requirements for all work plan authors may exacerbate safety vulnerabilities. Lastly, the site has not addressed or compensated for the internal dosimetry shortfalls for several rare radioisotopes in use at ORNL.

Core Function #4: Perform Work Within Controls

NNFD facilities effectively use the Facility Management Scheduling System in conjunction with formal plan-of-the-day (POD) meetings to define daily work evolutions. All NNFD facilities publish a daily POD defining the activities that may occur during the work shift. At REDC, a daily pre-shift meeting with key facility staff is held, followed by a formal POD meeting. Facility status and conditions are reviewed, and line items from the POD scheduling tool are discussed and authorized at the POD meeting. These mechanisms provide adequate assurance of readiness to perform work within the facility.

However, some work activities, primarily in the operations section of the POD, appearing on the NNFD POD scheduling tool are not actually ready to be worked, thereby limiting the utility of the POD as a work authorization mechanism. Some work evolutions appearing on the POD have not been ready to work because the work package is not yet completed, required signatures have not been obtained, comments have not been resolved, and/or resources were not assigned to support the work. As a result, many items remain listed on the POD for long periods of time without specific knowledge of the specific date or time they are actually authorized and ready to be worked.

As discussed in Core Function #3, weaknesses associated with establishment and implementation of controls were observed. However, in cases where controls were adequately defined, workers who were observed generally followed requirements and performed their work in a safe manner. In addition, workers and line management appeared knowledgeable of their facilities and had considerable experience within their areas of responsibility. The HEPA testing on the roof of 3025E was an example of a work evolution that followed all required controls, including appropriate fall protection within 6 feet of the building roof. The repackaging of plutonium material in the 3525 glove maintenance airlock was performed by procedure and included the appropriate PPE and radiological controls. Similarly, a routine cell entry to load materials in a 2026 hot cell was performed safely and followed all applicable requirements.

In a few isolated cases, work was not performed in accordance with established controls. In 3025E, workers opened and entered the cell 1 area to work the window repair package despite a "Grave Danger, Very High Radiation Area" posting on the door. Evidence suggests a number of prior entries to this area with the same posting. In some cases, workers did not always follow proper radiological control practices. For example, RCTs did not always take radiological or contamination measurements to evaluate RWP limiting conditions or to verify the lack of potential for impacts on individuals without respiratory protection from contamination spread or re-suspension during work. In addition, initial RCT coverage requirements were not always followed or understood, and frisking speeds were too rapid during some observed self-frisk activities.

Summary. Formal conduct of operations within NNFD nuclear facilities, including POD meetings, published schedules, and pre-job briefings, provide adequate assurance of readiness to perform work. However, in some cases, items not completely ready to work could be authorized on the published POD. Several work evolutions with well-defined controls were performed in accordance with expectations, although a few instances of procedural nonconformance indicate a need for increased attention to detail with regard to postings and other radiological controls.

C.2.4 Construction

Significant construction was underway at ORNL as part of an initiative to modernize ORNL facilities. Existing facilities were being renovated, old unneeded facilities were being removed, and new facilities were being constructed to reduce operating expense and enhance research capabilities. Procedures for implementation of DOE Policy 450.4, *Safety Management System Policy,* for ORNL construction were contained in ORNL-ENG-051, *ORNL Construction ES&H Requirements Identification and Oversight,* and in SOPs referenced by ORNL-ENG-051. Most of the work was being performed by four construction subcontractors under UT-Battelle fixed price contracts.

The OA team evaluated work performed by the four subcontractors, including construction of the Research Support Center (RSC) Building, construction of Building 7625, addition of new greenhouse facilities at Building 1506, and decontamination and decommissioning (D&D) of Building 7010. The team also reviewed ORNL procedures for ensuring safety, and observed work at job sites to assess implementation of the ISM core functions.

Core Function #1: Define the Scope of Work

ORNL procedures assigned appropriate responsibilities and provided adequate instructions for setting ES&H expectations for planned construction projects. Procedures required early involvement of the UT-Battelle construction safety staff in setting these expectations. This involvement included development of ES&H requirements to be included in bid solicitations and contracts, meetings with subcontractors, and review and approval of activity hazards analyses (AHAs) before the start of site work. Contracts required construction subcontractors to identify and document specific tasks to be performed during construction on an AHA for each project and to submit these AHAs to UT-Battelle for approval before site work began. Contracts also required submittal of AHA changes for approval before the changes were implemented.

UT-Battelle processes ensured that the tasks were defined and that safety expectations were communicated to construction subcontractors. The scope of work, which was broadly defined in construction subcontracts, was broken down into discrete tasks in an AHA for each construction project reviewed by the OA team. As start dates approached, changes were made to better describe planned tasks, and these changes were reviewed and approved by UT-Battelle prior to implementation in accordance with established procedures. This process ensured that UT-Battelle remained aware of planned construction activities and that tasks were adequately defined in AHAs. After contracts were awarded, UT-Battelle met with subcontractors before the start of field activities to discuss safety expectations. Subcontractors were informed that their safety performance would be evaluated at project completion and that the results of this evaluation would be considered in awarding future

ORNL construction contracts. The UT-Battelle construction manager also meets with construction subcontractor management monthly during construction to review past safety performance and to convey ES&H expectations.

The breakdown of project work into specific tasks was generally adequate to support the identification of hazards and controls for each task. Construction subcontractors identified tasks based upon their past experience performing similar work, discussions with their sub-tier subcontractors, communications with UT-Battelle, and site visits. Planned work tasks were identified in the AHA for each construction project reviewed by the OA team. In general, the work tasks identified in these AHAs were adequate to support identification of task-specific hazards and controls in AHAs. However, insufficient work task descriptions were a contributing factor to some of the deficiencies in hazard identification discussed under Core Function #2. For example, the identification of respiratory and skin hazards associated with mortar mixing at RSC would have been more likely if these work tasks had been described in the project AHA. While most tasks were described with sufficient specificity to support identification of unique hazards or controls, a few exceptions were noted. One such exception was the listing of power tools as a general task in the RSC AHA. Different power tools present unique hazards that could have been more effectively addressed under more specific task descriptions. For example, use of jack hammers was not listed as a task at RSC and, as discussed under Core Function #2, noise hazards associated with jack hammering were not adequately identified.

Summary. UT-Battelle conveyed appropriate safety expectations to construction subcontractors. Contracts and ORNL procedures included adequate requirements for the breakdown of planned construction work into specific tasks to support development of task-specific AHAs. Although a few tasks were not described with sufficient specificity to effectively support identification of task-specific hazards and controls, most tasks were adequately described in AHAs.

Core Function #2: Analyze the Hazards

UT-Battelle established appropriate programmatic controls to ensure hazard identification and analysis. UT-Battelle procedures ensured that ES&H personnel were involved in identifying legacy or environmental hazards associated with construction work. The UT-Battelle construction safety staff worked with the procurement staff early in the procurement process to ensure that these hazards were identified in requests for proposals and in construction subcontracts. Subcontractors were required by their contracts to inform workers of hazards in the workplace by identifying them on an AHA for each construction project and to obtain approval of the AHA before starting work. Each subcontractor was required to update its AHA to reflect changes in planned work, hazards, and controls and to ensure that all persons entering the construction site review and sign the AHA. For the projects reviewed by the OA team, AHAs were approved by UT-Battelle before work began and were maintained current as conditions changed, and the requirement to review AHAs prior to site access was strictly enforced.

Chemical hazards were also identified at ORNL construction sites in MSDSs pursuant to OSHA requirements. UT-Battelle is contractually required to comply with OSHA standards for maintaining MSDSs, and UT-Battelle has imposed this requirement on its construction subcontractors. Each construction subcontractor evaluated by the OA team maintained a file of MSDSs; these files were up to date and used effectively for most construction projects.

Identification and analysis of occupational safety and environmental hazards met established requirements in most cases. With a few exceptions, hazards associated with physical safety, such as falls, falling objects, fire, electrical shock, machine guarding, compressed gas bottle storage, and eye injuries, were consistently identified and documented in AHAs. Potential environmental hazards associated with asbestos, chemicals, lead paint, and radioactivity were adequately analyzed and identified in an AHA prior to demolition of Building 7010.

Although appropriate requirements were imposed on construction subcontractors and most hazards were adequately identified and analyzed, some requirements were not effectively implemented, as discussed in the following paragraphs.

Identification and analysis of health hazards did not consistently meet requirements and were not fully effective. In particular, hazards associated with potential exposures to airborne hazardous material at RSC, and noise hazards at both RSC and Building 1506, were not adequately identified or analyzed.

Processes for identifying airborne hazardous material did not identify crystalline silica as a hazard in the RSC AHA, and potential exposures to respirable airborne silica were not adequately evaluated. As a

Building 7010 Demolition

result, respiratory protection may not have been adequate, and unnecessary exposures could have occurred. The potential for exposure existed during brick cutting, mortar mixing, and spraying fire resistant materials at the RSC construction site. MSDSs indicate crystalline silica may have been present in each of these three materials. Observed conditions were as follows:

- A worker was sawing bricks without respiratory protection. Water was being used during cutting to control brick dust, but dust or mist was visible in the air and on the worker's face shield. The construction subcontractor's health and safety program notes that silica dust may be present in operations such as brick cutting and requires use of MSDSs to determine silica content. The MSDS for the bricks states that the bricks may contain silica, but the MSDS was not on site at the time cutting began and was not used to identify the hazard. The AHA requires use of water and fans to control dust during block/brick sawing. Water was used but fans were not. The constructor's health and safety program stated that air tests or historical data were required to confirm that the controls in place were working and whether PPE was or was not required. Neither air tests nor historical data was used. The AHA does not identify silica as a hazard but requires that half-face respirators be worn if controls do not bring dust below the threshold limiting value. Half-face respirators were not used until after respiratory protection was questioned by the OA team.

- A second worker, wearing a dust mask, was dumping dry mortar into a cement mixer. The AHA did not identify cement mixing or the handling of dry mortar as a work task. Mortar dust was visible in the worker's breathing zone. The MSDS states that the mortar may contain crystalline silica but the MSDS was not on site at the time of the observation and had not been used to identify the hazard. The subcontractor's health and safety program required air tests or historical data to determine whether PPE was required when there was a potential for silica exposure. Because the hazard was not identified, air tests were not performed, historical data were not used, and respiratory protection required by the health and safety program was not worn.

- Workers wearing dust masks sprayed a fire proofing material, which contains crystalline silica, onto steel beams in overhead spaces in the RSC. Crystalline silica was listed on the MSDS but was not identified as a hazard in the AHA. Overspray material settled on workers' faces. The AHA does not identify silica as a hazard but requires use of dust masks when there is a potential for inhaling dust. The workers wore dust masks but the health and safety program required half-face respirators for silica protection and air tests or historical data to confirm whether PPE was or was not required. Neither air tests nor historical data was used.

Noise hazards associated with work at Building 1506 and RSC construction sites were not adequately analyzed. Observed conditions were as follows:

- A sustained high noise level was present inside Building 1506 because of the operation of a gasoline-powered welding machine and generator in an adjacent outside area and operation of power tools inside the building. The area was not posted to require hearing protection and some workers in the area were not wearing protection. At the request of an OA team member, the noise level was measured and determined to be in the range of 87 to 92 decibels (dB). Posting and hearing protection were required by the AHA at a noise level of 85 dB. Following the resurvey, the area was posted and hearing protection was required. A noise hazard was not identified at the Building 1506 construction site because noise levels had not been reassessed when conditions changed. Noise levels of 81 dB, caused primarily by the gasoline-powered welder, had been measured the previous day. The addition of a portable generator and operation of several power tools caused the noise increase, but there was no noise monitoring instrument available at the construction site to measure noise levels when conditions changed.

- A high noise level in the vicinity of concrete chipping at the RSC facility had not been monitored and there was no noise monitoring instrument available at the construction site. The AHA did not address this concrete chipping operation and did not include a general provision for noise hazards. A general AHA for use of power tools did not address hearing protection. An electrician operating the jack hammer was wearing ear plugs, but a second electrician nearby was not wearing hearing protection. The electricians had not received hearing protection training. In addition, hazards associated with dust from the chipping operation had not been evaluated.

The RSC construction subcontractor did not provide sufficient monitoring or control to ensure compliance with silica requirements in the construction subcontractor's health and safety program. The construction subcontractor's health and safety program required sub-tier subcontractors to use MSDSs to determine whether products contain silica. The construction subcontractor provided copies of this subcontractor's health and safety program to sub-tier subcontractors but did not follow up to ensure compliance. MSDSs indicating that bricks, mortar, and a fire proofing material may have contained silica were not used, and the silica hazard was not identified. The construction subcontractor did not independently identify this hazard and did not list silica in the AHA as a hazard associated with use of these products. The subcontractor's health and safety program contains appropriate procedures for controlling exposures to silica but, because the hazard was not identified, the procedures were not implemented.

Finding #10. UT-Battelle hazards analysis processes did not ensure that health hazards associated with exposures to noise and hazardous materials were adequately identified and analyzed by construction subcontractors.

Summary. UT-Battelle established adequate measures for assuring hazard identification and analysis by construction subcontractors, and implementation of these measures was generally effective for identification and analysis of occupational safety hazards. However, implementation was not consistently effective for a few health hazards. In particular, health hazards described in MSDSs for the RSC project were not identified in the UT-Battelle-approved AHA for that project, and noise hazards were not adequately analyzed.

Core Function #3: Identify and Implement Hazard Controls

Construction subcontracts required that AHAs include "a list of actions or precautions to minimize the risk of hazards," and ORNL procedures required the UT-Battelle construction safety staff to review and approve AHAs. While both requirements are appropriate control mechanisms, requirements for development of AHAs lacked detailed requirements or guidance about information to be included in the AHA controls. For example, neither the contract nor the procedures specified whether controls should include OSHA training requirements, MSDS protective measures, subcontractor health and safety program requirements, or ES&H requirements from Division 1 of the subcontract.

Another mechanism used for controlling construction hazards was the issuance of safety work permits, including hot work and confined space permits developed by subcontractors to meet OSHA and National Fire Protection Association requirements, and the excavation/penetration permits described in SBMS. Controls established in safety work permits were generally adequate for identified hazards. Appropriate requirements were established in hot work permits for welding, cutting, and grinding. The permits were posted, and fire extinguishers were available at all job sites reviewed. As discussed in Appendix F, excavation/penetration permits were used effectively to assure marking of underground utilities prior to excavation.

Confined space permit program requirements are consistent with OSHA requirements, but program implementation was not fully effective in some cases. RSC confined space permits were incomplete, and required information was not recorded on several forms (e.g., description of the work to be performed, times and initials for finished work, and entry supervisor's signature). In addition, there was no record of calibration of an oxygen analyzer that was used to monitor a confined space.

Appropriate controls were described on AHAs for most physical occupational safety and environmental hazards. For example, appropriate requirements were established for fall protection, electrical safety, equipment condition, and for PPE such as hard hats and safety glasses, and no deficiencies were identified in training for fall protection, fire watch, scaffold erection, or equipment operation. Environmental controls were also appropriate. For example, to control the spread of asbestos to the environment during demolition of Building 7010, roofing materials were sprayed with water during removal to control the spread of asbestos, storm drains were covered with filter cloth and bails of hay to prevent asbestos entry, and rubble was wrapped in double polyethylene before being sent off site for burial as asbestos waste.

Onsite safety subcontractor representatives were effective in improving safety. UT-Battelle required construction subcontractors to have a designated qualified safety representative on site at all times during work activities. For the projects reviewed, the safety representatives were familiar with the work in progress, had good communications with workers, and intervened when appropriate to improve safety. However, some did not have expertise in the area of industrial hygiene, an area where deficiencies in hazard identification and control were identified by the OA team.

WSSs did not include sufficient industrial hygiene requirements to ensure consistent identification and control of health hazards. The contract references OSHA standards and American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit values, but does not include DOE expectations for industrial hygiene programmatic controls, which are specified in DOE Order 440.1A, *Worker Safety*, Attachment 2, Section 18, and some of those expectations were not met. For example, the qualitative, undocumented exposure assessment for brick cutting at RSC did not meet the expectations in paragraph 18.d for a documented analysis using an accredited industrial hygiene laboratory, and the lack of involvement by industrial hygienists did not meet the expectation in paragraph 18.k for involvement of professionally and technically qualified industrial hygienists. As discussed under Core Function #2, potential health hazards were not identified, and as discussed in the following paragraphs, required controls were not established to ensure protection of worker health.

Required controls were not specified on AHAs for some identified hazards. Although the controls specified in AHAs for construction-related hazards were adequate for most construction projects, UT-Battelle had not ensured that some of the ES&H requirements in construction subcontracts were included in the subcontractor's health and safety programs and AHAs. For example, neither the subcontractor's health and safety programs nor the AHA adequately addressed requirements from Division 1 Technical Specifications as indicated by the following omissions:

- Training requirements were not typically listed on the AHA for the RSC project. For example, the AHA did not specify training required for silica exposure during concrete chipping, hearing protection during use of power tools, or respirator use during masonry work. Training deficiencies were identified in most of these areas.

- Construction subcontracts require use of threshold limit values published by the ACGIH as exposure limits for chemical and physical agents. This requirement was not included in AHAs or the subcontractor's health and safety programs for RSC, Building 7625, or Building 1506 construction projects.

- RSC workers handling wet, unhardened cement were not wearing long sleeves to prevent dermatitis as required by the construction subcontract. Long sleeves were not required by the AHA or the subcontractor's health and safety program.

An RSC sub-tier subcontractor did not establish a required respiratory protection program. Masonry workers on the RSC construction project were required to wear dust masks for several jobs and a half-face respirator on one job, but the masonry sub-tier subcontractor had not established a respiratory protection program that met the requirements of OSHA 1926.103 or the construction subcontractor's health and safety program. Specifically, requirements were not established for medical exams, fit testing, training, or record keeping.

The above examples indicate a need to strengthen contracts and procedures to ensure flowdown of appropriate controls to the construction workforce. Industrial hygiene requirements included in WSSs were not sufficient, and some potential health hazards were not adequately evaluated or controlled. Contracts and procedures did not clearly convey expectations regarding the controls to be included in AHAs, and some required controls were not included. Reviews of health and safety programs and AHAs by UT-Battelle were not effective in identifying these deficiencies.

Finding #11. UT-Battelle did not ensure effective communication of ES&H requirements to the construction workforce through programs and activity hazards analyses.

Summary. Controls were specified on AHAs for most identified occupational safety hazards. Construction safety practices for some projects were generally effective. Some deficiencies were evident at one project – RSC – in areas where the construction subcontractor had not verified the adequacy of sub-tier subcontractor programs and training. The deficiencies indicate a need to strengthen processes for ensuring that required controls are effectively flowed down to the construction workforce, and the nature of these deficiencies indicate a need to focus attention in the area of industrial hygiene to assure that controls necessary for protecting worker health are in place.

Core Function #4: Perform Work Within Controls

Most work was performed within the controls specified in AHAs. PPE specified in AHAs was worn for most observed construction activities. Safety glasses and hard hats were worn when required at all sites visited. All workers within an asbestos control boundary during D&D of Building 7010 were wearing appropriate protective clothing, full-face respirators, and asbestos air samplers. Strict compliance with fall protection requirements was observed at all sites. For example, all workers on scaffolds and boom lifts were wearing appropriate fall restraint devices, workers on scaffolds and lifts were protected by guardrails or wearing appropriate fall restraint devices, and fall protection for roof work was adequate. Safety equipment at all construction sites was in good condition. Tools and most heavy equipment were inspected daily and removed from the site if defective. Ground fault circuit interrupter receptacles were in place for all extension cords and powered all tools. With a few exceptions, extension cords were properly grounded, had the appropriate gauge, and were properly suspended above the floor. Metal-sided ladders were prohibited at construction sites as an electrical safety measure. No deficiencies were identified in completion of training for fall protection, fire watch, scaffold erection, or equipment operation.

Some controls listed in documents other than AHAs were not implemented. The requirements on most hot work permits were met, but an exception was noted at RSC where a requirement to move combustible materials at least 35 feet from a metal saw was not met and sparks were falling into a cardboard box. OSO had recently documented a similar observation at the same facility. In another example, masonry workers at RSC were not trained on chemical hazards in the workplace as required by the sub-tier subcontractor's hazard communication program. As discussed earlier, hazards included potential exposures to crystalline silica.

The AHA and daily pre-work briefings were not always effective in reinforcing expectations for implementing hazard controls. Workers were briefed on AHA contents when they initially arrived at the site and were briefed on changes that affected their work. However, the reviews were sometimes infrequent, and workers were likely to become less familiar with the detailed AHA controls as time passed. Daily pre-work briefings, during which the hazards and controls associated with activities planned for the day are discussed, can compensate for this infrequent review and are required by UT-Battelle in construction subcontracts. However, the requirement for discussing hazards and controls at pre-work meetings was not always met. For example, at RSC, hazards and controls were not always discussed at pre-work meetings. Conversely, daily pre-work briefings at Building 7625 were systematically performed by craft foremen using a Safety Task Assessment checklist to remind workers of hazards and controls and to seek their input for changes before work began each day.

Summary. With a few exceptions, hazard controls at the activity level were effectively implemented, particularly for the controls specified in AHAs. However, the degree of rigor of implementation of some processes, such as pre-work briefings on hazards and controls, varied among the site subcontractors. Some health hazards were evident at the workplace because the hazards had not been identified, analyzed, and controlled (see other core functions).

C.3 Conclusions

The four areas reviewed (CSD R&D, Physics Division R&D, hot cell operations, and construction) typically have different applications of the site work control processes, and different ORNL organizations have line management responsibility. As discussed below, effectiveness in implementing the core functions of ISM varies across the four activities.

CSD research activities are diverse and involve dynamic and continually changing hazards. CSD researchers are generally knowledgeable of these diverse hazards and the appropriate controls, as evidenced by a low incidence of injuries and illnesses. Engineering controls in the CSD laboratories, such as fume hoods, are well maintained and are used effectively. Overall, at the laboratory level, the most significant hazards are identified and controlled though one or more RSSs. In some CSD groups, work scope, hazards, and controls are well defined for all research activities, such as the CSD Bio-Chem Laboratory. However, for other CSD groups, the RSS does not sufficiently describe the scope of a specific experiment, define the experimental hazards and controls, and provide a clear linkage between hazards and controls. In the absence of well-defined controls, safety relies on the experience and expertise of the research staff rather than well-defined standards as intended by ISM. In addition, chemicals that are synthesized or produced within the CSD laboratories are not adequately labeled such that the hazards can be readily identified. The storage and use of toxic or flammable compressed gas, and the potential for the spread of radiological contamination from some fume hoods, has resulted in unanalyzed or inadequately controlled hazards in some laboratories.

Physics Division operations and research activities are characterized by generally strong mechanisms for implementation of the core functions. Work scopes are adequately defined, implementation of the Research Hazard Analysis and Control System in conjunction with the experiment review process is working effectively to address hazard identification, analysis, and development of effective controls in most cases, and observed work was performed in accordance with the established controls. However, some problems exist in DOE oversight of accelerator safety (including establishment of applicable requirements) and the level of operational discipline demonstrated by the Physics Division with regards to development and application of approved procedures.

NNFD's operation of ORNL's hot cell facilities has resulted in a number of improvements since the 2001 DOE Headquarters ISM verification review. There is better consistency and uniformity of approach in such areas as safety basis analysis and documentation, drawing and procedure development, work planning and control, and work scheduling. There is a clear commitment to disciplined operations, with processes and procedures consistent with DOE requirements in place for conduct of operations, maintenance, and work control. The application of work control and procedure development to R&D work is evolving in positive ways but requires continued attention. Work scheduling and planning tools have been implemented that provide a unique automated capability to incorporate hazard controls into work execution steps. Implementation of this capability, however, needs improvement, as many work packages observed did not implement the capability as intended. Additional attention is also needed to address weaknesses in bioassays and establishment of radiological controls, including implementation of the RWP process and conduct of independent radiological reviews.

For construction activities, procedures and processes were in place for effective implementation of the core functions of ISM. Tasks necessary for completing construction projects were defined in AHAs with sufficient specificity to support identification of foreseeable hazards and appropriate controls. Work was performed within established controls at construction job sites. Occupational safety hazards were adequately identified and documented in AHAs, but some health hazards were not identified. More comprehensive review of MSDSs and increased involvement by individuals with industrial hygiene expertise are needed to improve performance in the construction area. Some required controls were not effectively communicated to construction workers through AHAs. More rigorous review of requirements, including OSHA training requirements, contractual requirements, and requirements in programs, such as hazard communication and respiratory protection programs, is needed to ensure effective flowdown of required controls to the construction workforce.

Overall, OSO and UT-Battelle have made progress in establishing processes and procedures. However, a number of processes and implementation weaknesses persist. Management attention is needed to ensure that these problems are effectively addressed.

C.4 Ratings

ORNL ACTIVITY	CORE FUNCTION RATING			
	Core Function #1 – Define the Scope of Work	**Core Function #2 – Analyze the Hazards**	**Core Function #3 – Identify and Implement Controls**	**Core Function #4 – Perform Work Within Controls**
Chemical Sciences R&D	Needs Improvement	Needs Improvement	Needs Improvement	Effective Performance
Physics R&D	Effective Performance	Effective Performance	Needs Improvement	Effective Performance
Hot Cell Operations	Effective Performance	Needs Improvement	Needs Improvement	Effective Performance
Construction	Effective Performance	Needs Improvement	Needs Improvement	Effective Performance

C.5 Opportunities for Improvement

This OA review 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 SC and ORO

1. **Strengthen DOE oversight of ORNL accelerator safety by implementing the DOE responsibilities specified in DOE Order 420.2A.** Specific actions to consider include:

   - Complete development of and issue the 2001 draft DOE Order 420.2A guidance document. During development, consider adding clarifying guidance on topics of interest to accelerator facilities, such as the definition of an accelerator facility, and acceptability of use of permanent shielding to reduce radiation levels or the use of other techniques to meet the exemptions listed in the order.

   - Ensure that DOE policy and expectations regarding accelerator safety that are delineated in DOE Order 420.2A are implemented in contract requirements. Convene a WSS committee to ensure that ES&H requirements for accelerator facilities listed in the order are incorporated into the UT-Battelle contract either by incorporation of the order or incorporation of equivalent requirements.

   - Consider performing an independent DOE review of recently revised ASEs to ensure that original assumptions in accelerator SADs remain valid.

UT-Battelle – Chemical Sciences Division

1. **Establish a process within CSD that enables and requires the documentation of research at the experiment level such that an experiment's scope, hazards, and hazard controls can be readily identified.** Specific actions to consider include:

   - Ensure that other researchers, guests, students, and ES&H SMEs can independently understand the basic nature of the experiment, identify the hazards, and recognize the prescribed controls, including unique training requirements.

   - Develop a process for documenting training requirements at the experiment level.

   - Establish criteria for determining when an experiment is best documented in an RSS, or when an RSS should be supplemented by an experimental plan, and how such a plan should be documented.

- For CSD groups that perform research by procedures or similar methods, evaluate the existing procedures or methods to ensure that the work scope, hazards, and hazard controls are well defined.

- In developing a process for documenting research at the experiment level, consider the use of electronic media such that documented experiments and associated hazards and hazard controls can be readily accessed by other CSD researchers, LSMs, line managers, and ES&H SMEs.

- Determine and document expectations, criteria, and controls for activities that are treated as within the "skill of the craft" of personnel performing experiments or other potentially hazardous activities.

- Evaluate the extent of condition and applicability of the weaknesses and opportunities for improvement in experiment-level hazards analysis and controls, as identified at CSD, to other ORNL divisions.

2. **Establish and implement within all CSD laboratories a chemical labeling system for secondary chemical containers, chemicals that are produced or synthesized in the CSD laboratories, or chemicals and chemical samples that are introduced into the CSD laboratories by outside researchers.** Specific actions to consider include:

   - Develop a consistent labeling system for chemicals that may fall outside the scope of the HMIS process, such that the identity and hazards of these chemicals can be easily determined by anyone in the CSD laboratories.

   - Document the hazards and recommended hazard controls for chemicals produced or synthesized within the CSD laboratories.

   - Prepare a CSD procedure or instruction that describes the labeling program.

   - Communicate the requirements of this program to the current research staff though training or required reading, and incorporate the requirements in the CSD New Employee Orientation.

   - Evaluate the extent of condition and applicability of the weaknesses and opportunities for improvement in chemical storage and labeling, as identified at CSD, to other ORNL divisions.

3. **Evaluate the hazard potential of hazardous compressed gases stored within the CSD laboratories.** Specific actions to consider include:

   - Perform an inventory of all compressed gas cylinders stored outside a fume hood or gas cabinet.

   - Identify those cylinders that could expose workers to hazardous concentrations of gases, or explosive levels of gases, in the event of a plausible accident scenario.

   - For these gas cylinders, calculate the concentration of gases that could be present in the room, assuming ventilation systems are operational.

   - For those laboratories with potential hazardous concentration of gases, identify both interim and long-term corrective actions, such as removing or containing the cylinders.

   - Identify and implement hazard controls, such as gas detectors, and administrative controls in the event that assumptions in the calculations are not met (e.g. hood ventilation or room ventilation is not functioning).

   - Provide appropriate warning postings on the laboratory doors, revise the impacted RSSs, and inform the laboratory occupants of the potential hazard.

   - Provide additional guidance in the SBMS subject area on compressed gases to define a "toxic gas" and requirements for storing and using gas cylinders outside gas cabinets and fume hoods.

   - Evaluate the extent of condition and applicability of the weaknesses and opportunities for improvement in hazards analysis and controls for compressed gases, as identified at CSD, to other ORNL divisions.

4. **Increase the rigor associated with implementation of radiological controls in laboratory spaces to prevent inadvertent transfer of contamination from radiological areas (i.e., CAs) to non-radiological areas (i.e., RBAs).** Specific actions to consider include:

- Establish appropriate SBMS requirements to address the use of localized CAs, such as hoods and benchtop CAs, including appropriate personnel frisking requirements for exiting these areas.
- Provide additional guidance to researchers concerning appropriate contamination control requirements for management of radioactive materials and movement of items (i.e., laboratory ware, solutions, hands and forearms) in and out of localized CAs (e.g., hoods and glove boxes).
- Consider use of additional RCT coverage or contamination monitor coverage for locations where increased radiological support is required for control of contamination or radioactive materials that are present.
- Ensure that all materials removed from localized CAs are subject to appropriate documented and verifiable radiological surveys that demonstrate the lack of potential for contamination spread.
- Consider extending certification to researchers (once trained) for self-survey and limited release of materials (i.e., items from within localized CAs, hoods).
- Evaluate current researcher training to determine whether it is adequate to ensure that researchers have the knowledge and skills necessary to consistently implement workplace radiological survey and contamination control requirements.
- Ensure that all radioactive materials brought on site, including low-level uranium and thorium solutions, are properly labeled and controlled. Assess why these materials have not been previously subject to all applicable radiological controls.

UT-Battelle – Physics Division

1. **Reinforce senior management operational discipline expectations for implementation of procedure use and compliance in Physics Division activities.** Specific actions to consider include:

- Establish appropriate goals for the Physics Division to become best in class in operational discipline as well as research. Encourage Physics Division facilities to become an operational discipline model for incoming students.
- Reinforce the need to include instructions for normal and abnormal operational activities in approved procedures instead of guidelines and operational aids.
- For existing guidelines and operational aids that address system or component operating instructions, develop an implementation plan to convert them to approved procedures as part of the next required periodic review.
- Solicit assistance from conduct of operations experts in other divisions to ensure that the necessary operational flexibility for research is built in to new or revised procedures.

UT-Battelle – Hot Cell Facilities

1. **Initiate interim compensatory measures to mitigate potential dose uncertainties and regulatory risk associated with work conducted with radioisotopes that do not have approved bioassay methodologies**. Specific actions to consider include:

- Establish user authorization quantities for maximum working concentrations for each isotope. These quantities should be set at a level where worst-case doses resulting from any single event will not exceed 5 rem committed effective dose equivalent.

- For work that may involve inhalation exposures, define and implement a rigorous personal air sampling program designed to be representative of workers' breathing zones, and update internal dosimetry technical basis documents to reflect air monitoring as the primary means of internal dose assignment for these conditions.

- Determine how to address 10 CFR 835 requirements until a suitable, approved, analytical method is available for bioassay monitoring of each given isotope.

- Suspend activities that could result in potential intakes of berkelium, einsteinium, or fermium until a suitable, approved, analytical method is available for bioassay monitoring of these isotopes.

2. **Conduct a rigorous review of current RWPs to ensure that requirements and expectations outlined in SBMS and the Radiological Support Services RWP SOP are sufficiently applied at the working level**. Specific actions to consider include:

   - Identify and document a list of deficiencies and inconsistencies between current RWPs and SOP requirements. Consider having groups of RWP writers review and self-identify deficiencies.

   - Conduct a root cause analysis to determine the causes of the deficiencies in RWPs.

   - Provide additional training and guidance to RWP writers to ensure that expectations are met.

   - Expand RWP SOP and/or guidance documents to address information that is lacking, such as clear expectations as to the type and placement of air samplers for conditions when air sampling is specified on an RWP.

3. **Enhance work plan developer awareness and training**. Specific actions to consider include:

   - Provide additional training for task leaders, supervisors, and other workers who may serve as work plan developers to reinforce understanding and recognition of NNFD-004 hazards analysis and control expectations.

   - Identify and document a list of deficiencies and inconsistencies between current work plans and NNFD and ORNL Work Plan System expectations. Consider having groups of work plan authors review and self-identify deficiencies.

   - Conduct a root cause analysis to determine the causes of the deficiencies in work plans.

   - Provide enhancements to work plan writers training and guidance to ensure that expectations are met.

   - Periodically assess the effectiveness of improvement actions.

4. **Formalize requirements for SME(s) involvement in JHE and work plan development**. Specific actions to consider include:

   - Establish a baseline set of tasks and/or hazards that automatically require specific SME review and approval.

   - Establish formal thresholds and guidance for SME review and approval of synergistic hazards or coordination of controls for multiple hazards, such as when industrial hygiene and radiological controls may differ.

   - Clarify expectations as to when task leads may serve as an SME for work package review or when concurrence by a second technically qualified individual is required.

5. **Increase efforts to ensure that independent radiological reviews are meaningful, are conducted at the appropriate risk level, and incorporate appropriate controls.** Specific actions to consider include:

   - Establish a formal requirement to document the results of formal radiological reviews consistent with the guidance specified in the DOE Radiological Control Standard.

- Provide specific instructions for RCTs responsible for categorizing radiological work into the various hazard levels.

- Consider establishing a radiological engineer position, with appropriate health physics professional qualifications within the work planning framework and responsibility for conducting radiological reviews. Alternatively, establish minimum higher educational health physics qualifications for persons serving as DRCOs, and lower the threshold for DRCO review to Category 2, consistent with the DOE Radiological Control Standard.

- Procure and review a sampling of documented ALARA and radiological reviews from other DOE sites in an effort to locate areas for improvement.

- Establish and utilize such documentation as an ALARA review checklist for inclusion in work packages or attachments, to document results of radiological reviews and augment RWPs. Ensure that a narrative description of proposed ALARA actions is incorporated into work instructions.

6. **Increase the rigor associated with evaluation and implementation of radiological air monitoring controls to ensure that representative sampling is conducted for jobs that involve respiratory protection and/or potential for airborne releases.** Specific actions to consider include:

   - Evaluate current RCT training and frequency to determine whether it is adequate to ensure that RCTs have the knowledge and skills necessary to consistently evaluate and implement workplace air sampling requirements.

   - Provide additional guidance to RCTs concerning implementation of job-specific air sampling in order to obtain samples representative of a worker's breathing zone.

   - Consider using a personal air sampler for those jobs where decreased sensitivity is required or protection factors for respirators may be low when compared to potential airborne or surface contamination present.

UT-Battelle – Construction

1. **Strengthen processes for ensuring that subcontractor personnel are adequately trained and qualified and are aware of the hazards and controls.** Specific actions to consider include:

   - Require, in Division 1 Technical Specifications, that construction subcontractors confirm that mployees of lower-tier subcontractors have received required training. Consider expanding the use of the confirmation approach at Building 7625, where no training deficiencies were identified, to other projects.

   - Require construction workers to attend daily pre-work meetings where the hazards and controls for tasks planned that day are discussed. Consider expanding the use of the Building 7625 approach to other projects (i.e., discussing the hazards and controls on the AHA for planned tasks or by use of a safety assessment and training check list).

2. **Increase the rigor of the review of health and safety plans and AHAs.** Specific actions to consider include:

   - Review safety and health plans against Division 1 Technical Specifications in construction subcontracts to assure consistency. Include this review as part of the required review and approval of health and safety programs.

   - Clarify UT-Battelle expectations for subcontractor compliance with the provisions of their health and safety programs.

   - Ensure that hazards and controls listed in MSDSs are included in subcontractor AHAs and that controls required by subcontracts are included.

   - Confirm that AHA controls include OSHA-required training and requirements in programs such as respiratory protection and hazard communication programs.

3. **Strengthen UT-Battelle monitoring and assessment of construction activities.** Specific actions to consider include:

- Establish more definitive criteria for setting inspection frequencies.
- Attend pre-work meetings to assess discussions of hazards and controls.
- Review effectiveness of subcontractor respiratory protection and hazard communication programs.
- Establish clear expectations for oversight in procedures, including expectations for time to be spent at job sites observing work.
- Require deficient conditions to be promptly documented and communicated to subcontractors and UT-Battelle management.
- Devote additional attention to health/industrial hygiene (e.g., respiratory protection, skin irritants, noise) aspects of construction safety in assessments and program reviews.

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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 Oak Ridge National Laboratory (ORNL). The organizations that were reviewed included the DOE Office of Science (SC), the Oak Ridge Operations Office (ORO), the ORNL Site Office (OSO), and University of Tennessee – Battelle Memorial Institute, LLC (UT-Battelle).

The OA review focused on feedback and improvement programs as they are applied to environment, safety, and health (ES&H) programs at research and development (R&D), hot cell operations, construction, and High Flux Isotope Reactor (HFIR) essential system activities selected for review on this inspection. The OA team examined ORO and OSO line management oversight of integrated safety management (ISM) processes and implementation of selected line management oversight functions, including ES&H assessments, operational awareness activities, self-assessments, and the employee concerns program. The OA team reviewed UT-Battelle processes for feedback and continuous improvement and implementation of those processes, including assessment processes, corrective action/issues management, injury and illness investigations, lessons learned, and employee concerns.

D.2 Results

D.2.1 DOE Line Management Oversight

DOE Headquarters, ORO, and OSO have responsibilities for line management oversight of ORNL. Within Headquarters, SC has responsibilities as the site landlord. Through a memorandum of agreement, SC has delegated oversight responsibilities for nuclear safety at HFIR and several non-reactor nuclear facilities to the DOE Office of Nuclear Energy, Science and Technology (NE). ORO establishes the overall structure and expectations for the line management oversight program for ORNL and other ORO sites. ORO also performs assessments of OSO and manages the lessons-learned program and employee concerns program. OSO performs operational awareness activities and assessments of the ORNL contractor activities.

DOE Headquarters

SC personnel who were interviewed were generally knowledgeable about site ES&H issues. SC has been proactive in setting challenging ES&H expectations and clearly communicating expectations to its field offices and sites/laboratories. For example, in the area of injury and illness statistics, SC developed very specific annual targets for its sites/laboratories, including ORNL, to improve performance to levels achieved by the best in class science organizations. SC management is actively monitoring progress toward these goals. However, as discussed in Appendix E, increased SC management attention and coordination with other DOE program offices (NE and the National Nuclear Security Administration, or NNSA) is needed to address responsibility for addressing legacy hazards. In addition, as discussed in Appendix C, SC has not implemented some of its responsibilities for providing guidance on accelerator operations and ensuring an adequate requirements set.

NE's day-to-day nuclear safety oversight at HFIR is implemented through the Facility Representative (FR) program. FRs assigned to HFIR are funded by NE and administratively report to OSO. NE has assigned one of its Headquarters staff to maintain operational awareness of NE program activities at ORNL. This individual receives and reviews FR monthly reports and is responsible for coordination between NE and SC organizations. In addition to the day-to-day involvement, NE has been proactive in supporting ORNL in resolving deficiencies that had led to several reportable events at HFIR. Specifically, NE sponsored a recent management assessment of HFIR by a number of experts from other DOE sites, which led to a number of recent improvements at HFIR.

An area requiring attention by DOE Headquarters managers is the implementation of safety system oversight requirements at ORNL. As presently structured and described in the draft manual on Federal staff/training, assignment of system engineers to nuclear facilities that are not categorized as defense nuclear facilities is optional. Considering the risk associated with the Category I nuclear facility (HFIR) and ORNL hot cells, DOE Headquarters should re-evaluate the current policy and base the need for system engineers on the facility risks and hazards, rather than whether the facility is a defense nuclear facility or a science facility. This step is essential for facilities, such as HFIR, where a number of deficiencies observed during this inspection are related to weaknesses in design and configuration management.

ORO

Since 2001, ORO has appropriately defined a top-down approach for its assessments of ORO organizations and contractors. This approach is adequately described in the ORO Management System Description and ORO Order 220 and the accompanying ORO Assessment Manual. These documents establish requirements for a formal and robust assessment program for ORO organizations. For example, ORO has developed an Integrated Assessment Schedule that identifies assessments to be conducted of line management and contractor programs.

ORO senior management is regularly monitoring ES&H performance and is providing feedback on the status of ES&H across all ORO organizations, ORNL, and other ORO sites. For example, ORO holds monthly management meetings to review and discuss Occurrence Reporting and Processing System (ORPS) events, injury and illness performance metrics (i.e., total recordable case rate and lost workday case rate), assessments and corrective actions status, and Price-Anderson Amendments Act (PAAA) commitments.

ORO/OSO management has initiated several activities that have been instrumental in identifying and addressing deficiencies at ORO line management organizations and facilities. For example, ORO directed a “For Cause” review of electrical safety. The review was completed in May 2003 and identified a number of deficiencies, best practices, and lessons learned for penetration and excavation activities, and for work performed on or near energized electrical systems. UT-Battelle issued a corrective action plan for the electrical safety review in June 2003 and has completed most of the identified actions.

ORO has performed some self-assessment activities. For example, the October 2003 ISM re-verification covered all ORO organizations and identified a number of ORO-wide weaknesses (e.g., lack of formality and documentation of FR assessment activities) and OSO-specific weaknesses (lack of independence in OSO oversight of ORNL self-assessment process, and lack of structured documentation for self-assessment). ORO also performed self-assessments in preparation for the ISM re-verification, which identified a number of corrective actions. ORO has completed or initiated numerous corrective actions based on these self-assessment activities. ORO established a project team to review ISM and safety basis corrective actions to ensure that resolution of corrective actions will lead to effective ORO ISM implementation.

Although an adequate framework has been established, some aspects of the ORO assessment program are not yet fully and effectively implemented. Specifically, independent ES&H assessments of ORO line management organizations, including OSO, to ensure compliance with requirements of the assessment procedure is assigned to the Assistant Manager for Environment, Safety, Health, and Emergency Management. However, this organization did not complete an independent line management assessment of OSO in fiscal year (FY) 2003. Further, ORO has identified five assessments of OSO (or including OSO) to be conducted in FY 2004 that address important topics (e.g., OSO oversight at HFIR, implementation of 10 CFR 830 Subpart B, and the implementation of the radiological program) but none of these assessments have been completed or scheduled.

Finding #12. Independent assessments of line management at ORO are not being routinely conducted as required by ORO requirements.

ORO has implemented a lessons-learned program but does not currently have a formal procedure to institutionalize the program. ORO has assigned a lessons-learned program manager within its ES&H-Quality Assurance organization. This individual is regularly monitoring lessons-learned databases, such as SELLS and the NNSA database. The lessons-learned managers disseminate information to lessons-learned coordinators at OSO and other ORO offices. ORO recently provided expectations for the lessons-learned program in a memorandum. Based on this guidance, ORO is currently in the process of developing a lessons-learned procedure.

The employee concerns program requirements of DOE Order 442.1A and DOE Guide 442.1-1 are appropriately established through an ORO order and a comprehensive Employee Concerns Management

System Manual. The Manual provides a timetable for handling employee concerns and samples of relevant documents. The Manual requires quarterly and annual reports to document and trend receipt and disposition of employee concerns, which are distributed to a number of ORO organizations. ORO has an effective tracking system for the employee concerns program. The system documents relevant information, facilitates trending, and is updated daily. ORO has established appropriate measures to maintain confidentiality and securely store records. ORO performed a self-assessment of the employee concerns program in calendar year (CY) 2000, and the program manager is planning to perform a self-assessment by the end of CY 2004.

ORO has an adequate employee concerns program in place and the program is available to all ORO, OSO and ORNL employees. However, the ORO employee concerns program is rarely used by OSO or ORNL personnel for ES&H issues. A search of the tracking system did not return any ES&H-related employee concerns for CY 2003 or 2004 for OSO or ORNL personnel.

OSO

OSO has adequately delineated requirements for OSO-specific processes for performing self-assessments and assessing contractor performance in its OSO Laboratory Management System Description. It describes an adequate program that includes contractual performance evaluations, FRs, subject matter expert (SME) ES&H assessments and operational awareness of ORNL, and self-assessments of OSO activities.

As discussed in Appendix C, OSO has not implemented some of its responsibilities for establishing and approving requirements for accelerator operations. OSO self-assessments have not identified issues with requirements management at ORNL accelerators.

Performance Evaluation Plan. The Performance Evaluation Plan (PEP) process is appropriately structured and implemented. The performance criteria in the FY 2004 OSO PEP provide an adequate mechanism for evaluating the contractor's performance for awards fee determination, and include ES&H criteria. The PEP emphasizes the use of the contractor's self-assessment program to determine whether agreed-to performance measures and indicators are accomplished. One of the performance objectives in this area requires participation of OSO in assessing the effectiveness of the overall performance assessment programs at ORNL by reviewing nine selected line management feedback and improvement programs at ORNL.

FR Program. Some aspects of the FR program are adequately implemented. Current OSO FR procedures provide an adequate framework for most aspects of program implementation. Performance indicators for FR staffing are being reported to ORO consistent with the DOE FR standard. The current FR program at OSO consists of an FR Team Leader and three FRs. Two FRs are assigned to HFIR and the third is assigned to the 3019 facility and several hot cell facilities. A number of hot cells are covered by FRs only on an "as needed" basis.

The FR team assigned to HFIR has recently been restructured. FRs perform regular reviews and frequently interact with UT-Battelle HFIR management to discuss ES&H performance. For example, FRs conduct monthly one-on-one meetings with the HFIR Director. OSO now formally concurs on HFIR restart following outages, where deemed necessary; FRs review significant issues and actions taken by HFIR/ORNL management prior to restarting reactor operations. OSO FRs and HFIR management indicated that informal communications have improved, in part because of the OSO decision to relocate the FRs to offices near the HFIR. FR presence in key management activities and operations at HFIR is also evident. For example, FRs regularly participate in weekly HFIR/ORNL senior management meetings, plan-of-the-day meetings, event reviews, critiques, and HFIR weekly management walkthroughs on facility inspections. Review of one of the FR's monthly, biweekly, and log notes demonstrates that he reviews event follow-ups, monitors plant conditions and follow-up actions by HFIR management, and reviews unreviewed safety questions, selected maintenance work packages for major jobs, and significant assessments conducted by internal and external organizations.

Although progress has been made to improve the FR program at ORNL, a number of weaknesses limit the effectiveness of implementation of the program. As indicated in a recent, independently conducted OSO staffing analysis, FR activities do not sufficiently cover nuclear facilities (other than the HFIR). In addition, several FRs have only interim qualifications for their assigned facilities. Further, revisions to FR procedures and guidance have not yet been formally issued.

The effectiveness of the FR program is also hindered by various organizational factors. Other than the FR procedure, line management feedback and direction to FRs on key focus areas have been limited. In addition, OSO SMEs and FRs activities are not well coordinated and are not sufficiently mutually supportive. For example, SMEs do not normally analyze FR observations and perform follow-up analysis/ assessments of technical issues (e.g., problems in an ES&H discipline such as industrial hygiene, for which an FR may have limited expertise) or programmatic effectiveness (e.g., effectiveness of the work control process as a result of FR observations on a specific procedural problem). Further, OSO support for FRs in assessing technical issues is limited (e.g., OSO has minimal staff with systems engineering expertise).

The FR program has not been fully effective in rigorously following up on identified issues. FRs are sometimes successful in resolving findings and observations during monthly meetings with the ORNL managers. However, these meetings are typically informal and undocumented, and do not provide appropriate structure for formally closing important findings and concern.

The formal quarterly reporting process has not always been effective in documenting and resolving issues. The quarterly reports reviewed by OA do not provide a balanced assessment of ES&H performance. The known programmatic weaknesses are rarely addressed in quarterly reports to the contractor. In addition, the OSO FR procedures do not specify a mechanism for capturing and reporting positive observations on performance (or improving performance trends). Quarterly reports are not consistently compiled and transmitted to ORNL. No FR quarterly reports were developed for the second, third, and fourth quarters of 2003, and therefore the resolutions of some deficiencies (e.g., deficiencies identified in an October 2003 inspection/review) are not documented. An assessment scheduled for fourth quarter of FY 2003 on maintenance and hoisting and rigging was first rescheduled and later dropped from the schedule. According to OSO procedures, deficiencies identified by FRs are to be entered into and tracked to closure through the Assessment Tracking System (ATS). However, the FR quarterly report for August 2002 was the last quarterly report entered into the ATS.

Finding #13. Communication and follow-up of ORNL performance deficiencies identified by OSO FRs are not sufficiently systematic and rigorous.

SME Program. Since 2001, OSO has made good progress in establishing a program for operational awareness and assessment of ORNL activities by SMEs. OSO SMEs have established a working relationship with their ORNL counterparts and typically meet monthly to discuss responses to recent events, near misses, the status of their program areas, and PEP performance indicators. Several OSO SMEs are members of various ORNL safety committees.

OSO has developed an adequate Operational Awareness Program procedure to cover SME activities. For the most part, the procedure is effectively implemented by SMEs and is contributing to improving ES&H programs. In coordination with ORNL staff, OSO SMEs conduct weekly walkdowns that usually focus on facility conditions for a collection of facilities owned by one of the ORNL divisions. OSO SMEs and ORNL staff have also begun to jointly observe work activities, typically in the facilities where walkdowns are being performed. The results of the walkdowns and work observations are documented by ORNL in summary reports, which are reviewed by OSO. Although limited in scope, the walkdown process provides an effective means to monitor facility conditions. The recent addition of work observations to the process is a significant improvement that has the potential to identify and correct activity-level performance deficiencies.

SMEs are proactive in supporting the OSO program/project managers in their line management roles**.** SMEs perform "at request" and independent scheduled and unscheduled walkdowns in support of OSO program/project managers. For example, the SMEs in the environmental, construction safety, and industrial hygiene areas performed walkdowns of construction sites and provided their observations to the OSO construction project managers. SMEs also perform unscheduled walkdowns to observe ORNL performance in their respective technical disciplines (e.g., radiation protection or construction safety). Deficiencies noted in this process are communicated to the SME's ORNL counterpart, and subsequently communicated to responsible managers for resolution. However, closer coordination with FRs is needed as discussed earlier.

OSO recently implemented a process in which SMEs perform independent assessments of the ORNL programs. These assessments are included on the FY 2004 Integrated Assessment Schedule. Although the independent assessments are a new process, several assessments have been conducted, including a comprehensive review of the ORNL permitting process (e.g., confined space, hot work permit, excavation/ penetration, lockout/tagout), a review of criticality safety, and a review of selected ORNL corrective actions (focusing on the effectiveness of recent ORNL actions to improve work/project planning and control, performance-based management, and HFIR work planning). Reports from these recently completed assessments have been issued or drafted, and ORNL is developing corrective actions for the reports that have been issued. Several additional assessments are planned and scheduled for the remainder of FY 2004. These independent SME assessments constitute an enhancement in the OSO line management oversight approach. Continued attention is needed to ensure that the program matures and is institutionalized in a formal procedure; a draft procedure, which provides a generally appropriate basis for this program, has been developed and is undergoing internal review.

OSO also performs readiness assessments as part of its line management responsibilities. In FY 2004, OSO performed a readiness assessment for the 7930 (Radiochemical Engineering Development Center) Cell F and identified a number of pre-start deficiencies, including inadequate implementation of hazard controls in the procedures, and weaknesses in configuration control. These deficiencies were appropriately tracked and closed in ATS before the OSO Site Manager authorized operations to proceed.

OSO Self-Assessment Program. OSO has a process (OSOP 452) that establishes a site office self-assessment program. OSO has performed a few activities under this process, such as a FY 2003 review of procedures and a FY 2004 review of OSO FR staffing. In addition, as allowed by the procedure, OSO indicated that the FY 2003 activities in preparation for the ISM verification met the requirements for an annual self-assessment for 2003. According to the Annual Integrated Assessment Schedule for FY 2004, a self-assessment of OSO operational processes is scheduled for September 2004. According to the OSO Operations Division Manager, the scope of this assessment will satisfy the requirements of the FY 2004 annual self-assessment.

Although some progress has been made, OSO self-assessments have been limited in number and scope. The self-assessments conducted to date have focused on procedures and staffing, with minimal assessment of performance. Other than the planned review of operational processes, the Annual Integrated Assessment Schedule for FY 2004 has no further scheduled self-assessments. According to the OSO self-assessment procedure, all actions identified in the corrective action plan are to be tracked in the OSO Corrective Action Tracking System (OSOCATS). OA's review of OSOCATS indicates that the system does not have appropriate capabilities to be used as a self-assessment corrective action tracking system. In the future, OSO formal self-assessments will be entered into and tracked in the ORION II, as required by the new assessment order.

Finding #14. The OSO self-assessment program is not rigorous and comprehensive and has not resulted in sufficient formal assessments and effective tracking and follow-up to ensure continuous improvement.

D.2.2 UT-Battelle Feedback and Improvement

UT-Battelle has established many feedback and improvement processes at ORNL and has made much progress since the 2001 OA inspection, especially in the last year. These feedback systems, in combination with committed managers, organizational realignments, maturing management systems, ongoing safety initiatives, and some innovative tools, are having a positive impact on safety performance.

Assessments. UT-Battelle conducts a variety of assessment and inspection activities that evaluate ES&H processes and their implementation, and facility physical conditions. These assessment and inspection activities are identifying process, work environment, and performance deficiencies and are resulting in improvements in ES&H performance.

The Standards Based Management System (SBMS) documents for the Performance Based Management System (PBMS) describe adequate processes to assess safety processes and performance and address identified deficiencies. The PBMS documents include procedures and guidance for identifying/selecting, planning/scheduling, and performing self-assessments of safety performance. PBMS is one part of a broad integrated assessment process that is intended to capture all elements of business functions for ORNL organizations and management systems (business/financial, staff and leadership, customer focus, organizational effectiveness, and compliance). Assessment plans are required to be developed by directorate and division managers and management system owners. About half of the 25 designated ORNL management systems are directly related to safety (e.g., radiological protection and worker safety and health) or include some safety elements (e.g., training and qualification and engineering). The PBMS procedures address the development of assessment plans and schedules, the conduct of assessments, responding to assessments (managing results/findings-issues management), and analysis of assessment results (trending and consideration during development of subsequent assessment planning). Much of the performance assessment process is focused on addressing the objectives and performance measures delineated in the annual contract PEP, which typically includes some high-level ES&H objectives/measures.

Assessment schedules, individual assessments, and assessment findings are to be input to and managed (e.g., analysis, categorization, and identification and tracking of actions) using ATS. Performance results (including those from external and independent oversight assessments) are required to be analyzed and evaluated at least quarterly for systemic or programmatic conditions. Directorates are required to publish an annual performance evaluation report that, among other things, provides the input to the ORNL annual self-evaluation for the contract PEP. Divisions conduct annual ISM maturity reviews and management system owners conduct annual assessments.

The divisions reviewed by the OA team, including Physics, Chemical Sciences, Facilities Management, Facilities Development, Non-Reactor Facilities, Quality Services, and Operational Safety Services, established PEPs and schedules for FY 2004, with assessments identified in ATS. In general, the number and scope of scheduled safety assessments have increased for FY 2004. Most divisions included periodic physical condition inspections in their plans, some covering all areas quarterly. Many of the recent assessments reviewed by the OA team were comprehensive, rigorous reviews of important safety subjects, such as work control and ISM. The Facilities and Operations Directorate has established two effective mechanisms for conducting and documenting observation of work activities by supervisors and managers. A commercial, behavior-based safety observation program called STOP, which includes a series of training courses as well as a refresher course, has been employed for about 18 months. Standard observation card checklists are used to document work observations and actions taken. Records are kept to identify the individuals and organizations performing the observations. Over 13,000 STOP observations had been documented through May 2004 by approximately 150 Facilities and Operations supervisors and managers, with over 3,200 unsafe conditions or behaviors identified and corrected. An internally developed observation program called ACE (*Assess* work performed, *Correct* deficiencies, *Educate* staff) was initiated in February 2004 and specifically focuses on ISM elements, with a checklist of questions on work control, personal protective equipment (PPE), chemicals, and tools and equipment. As of June 2004, 108 ACE observations had been documented. For both of these programs the observers, their organizations, the percentage of unsafe behaviors, and the categories where deficiencies were observed are tabulated on the directorate website. Both programs result in direct communication of safety expectations to workers and encourage supervisors to conduct and document formal, routine, on-the-floor reviews of actual implementation of ISM.

The Oversight and Assessment Services group in the Audits and Assessments Directorate conducts several independent assessments related to safety processes annually as well as approximately 10 assessments of division and directorate implementation of the PBMS (assessment, corrective action, lessons learned). These assessments are performed jointly with OSO personnel and fulfill an objective of the contract PEP for determination of award fee. UT-Battelle management reviews are conducted semi-annually and include a summary analysis of management evaluations of overall ES&H performance.

The Operation Awareness inspection program provides routine evaluations of the physical conditions of workspaces in all areas of the facility, and involves managers, workers, ES&H SMEs, and OSO personnel. This assessment process is being strengthened by inclusion of an observation of work element. This process, now managed by the Quality Services Division, is being formalized as a self-assessment element within the PBMS. This program now includes a performance observation (e.g., watching work) element, with 12 hours of specific classroom and practical training for team members. Assessment reports have been strengthened with more analysis of findings and highlighting of more significant issues or weaknesses. Identified deficiencies are being maintained in a database that will support planned trend analysis and verification of corrective action completion, which is now being performed within a few months of the original assessment rather than during subsequent reviews.

One recent initiative that has improved safety feedback has been the strengthening of the critique process for identifying the details of operational events and injuries and illnesses. A management champion/mentor is assigned to improve the rigor and timeliness of completing and issuing critique reports. Critique minutes are posted to the ORNL internal website. ORNL established a goal of issuing critique minutes within 24 hours. Causal analysis and development of corrective and preventive actions is being performed as part of the critique process, with the goal of taking advantage of the synergy of the critique team and the current event information.

Routine safety inspections by construction safety staff members are an important element in the UT-Battelle construction safety oversight program. Three experienced safety specialists perform onsite reviews of construction subcontractor safety activities and provide feedback. This program is governed by procedures but, as discussed below, the procedural controls have not been fully effective. As discussed in Appendix C, UT-Battelle management provides feedback to construction subcontractors about safety expectations during monthly management meetings. Facility walkthrough reviews are conducted to assess construction progress and safety practices. UT-Battelle has established a formal oversight plan for each construction project in accordance with a standard operating procedure. The oversight plans assign responsibilities for construction safety and project management activities and specify minimum frequencies for documented oversight of safety performance. UT-Battelle is taking appropriate steps to improve its monitoring and assessment of construction safety, based on a comprehensive self-assessment of construction safety in February 2004.

Notwithstanding the recent initiatives and improvements in assessment activities at ORNL, some weaknesses remain in assessment processes and performance. Assessment planning and implementation is still at various levels of maturity, and effectiveness varies between directorates and divisions. In most cases management system assessments were not scheduled in ATS as required by SBMS. In many cases, scheduled assessments are simply a determination of whether a stated goal has been achieved (e.g., complete a report, or scan all material safety data sheets within 24 hours) or are limited in scope and rigor. For example, surveys completed by users were used instead of first-hand observations to evaluate compressed gas systems. A review of another division's self-assessment of hoisting and rigging was used instead of an independent self-assessment to evaluate the maturity of this program. Many divisions have not established internal procedures detailing how they implement PBMS. Most divisions have not identified the population of the topical areas or functions they are responsible for or determined assessment areas using any formal risk determination strategies to focus assessment resources. The expectations for self-assessment of the 25 identified ORNL management systems, which are described but not cross-referenced in both PBMS and SBMS, are not well understood by ORNL system owners. As a result, management system assessment plans have not been formally developed and input to ATS by many system owners as directed by PBMS procedures. Some of these weaknesses, including the need to better scope and prioritize self-assessments, were identified in a recently completed (report still in draft) Oversight and Assessment Services evaluation of the Environment, Safety, Health and Quality (ESH&Q) Performance Assessment Program.

The inspection of physical conditions is an effective assessment tool and ORNL devotes significant effort and resources to this process. However, the program is not as effective as it could be because insufficient effort is devoted to analyzing results and establishing preventive actions. Workplace inspections are conducted through the institutional Operational Awareness Program inspections, annual inspections by the new Laboratory Space Managers, and planned routine walkthroughs by the divisions, in some cases on a quarterly basis. However, little effort is expended on identifying causal factors, adverse frequencies and trends, and actions to prevent recurrence.

Although their work observation programs are effective in many ways, Facilities and Operations has not conducted sufficient analysis of observation data or established corrective actions for deficiencies identified in several program assessments. Facilities and Operations has only recently started an effort to trend observation data, and only included one quarter's data (rather than evaluate the 18 months of data already categorized from the elements of the observation card checklist). Quality Assurance assessments of STOP observation card quality, conducted in February and May 2004, identified a number of deficiencies in the quality of the cards and made numerous recommendations for improvement. However, no corrective actions were put into ATS. The STOP and ACE programs are similar and appear to be competing for management time; management's expectations for implementation of these two programs have not been defined. Further, requirements for implementation of elements of these programs, such as trending of results, have not been formally documented.

Independent assessment resources do not appear to be used in the most effective manner. More than half of independent assessments for FY 2004 are assessments of the self-assessment programs of individual divisions and directorates and almost half of FY 2002 and FY 2003 were individual self-assessment reviews (over 30 individual assessments). While it is appropriate to conduct periodic evaluations of self-assessment implementation, especially with the implementation of new processes, it is not clear that it is necessary to independently assess every division and directorate multiple times, over several years, to establish the adequacy of ORNL-wide implementation.

The Accelerator Safety Review Committee has not met its requirements for periodic review of the accelerators. DOE Order 420.2A and the SBMS accelerator safety subject area require the Accelerator Safety Review Committee to perform periodic reviews of accelerator safety, including review of accelerator procedures for adequacy and compliance status. The subject area does not state a periodicity, and a periodicity has not been established elsewhere. The last review was performed in April 1999. (See related concerns with accelerator requirements and procedures in Appendix C.)

Construction safety inspection frequency is not commensurate with safety performance expectations outlined in ORNL procedures. Although safety performance on the Building 7625 project is generally regarded by the construction safety staff as better than other projects, it receives much more frequent safety inspections than the other projects. In addition, expectations for documenting construction safety inspection results have not been clearly defined or enforced. The standard operating procedure for conducting site inspections contains requirements for documenting inspection findings, but these requirements are not being followed. For example, the form for recording inspection results is not consistently used, and information from these forms is not being entered into a database for reporting and trending purposes. Other procedural requirements are not sufficiently definitive. For example, an Engineering Division internal oversight procedure states that inspection "results will be documented via log books, e-mail or other project documents." Inspectors are using cameras to record observations, and some are entering data on observations of unsafe practices into a new sampling database, but expectations in these areas have not been defined in procedures. Observed unsafe acts are documented in an electronic database, but the database does not contain such information as detailed descriptions of observed conditions, references to applicable requirements, descriptions of corrective actions taken, or confirmation that appropriate subcontractor representatives were notified. Most inspections have focused on industrial safety during work activities rather than on application of industrial hygiene requirements and such ES&H program areas as training, industrial hygiene, and safety programs (see Appendix C).

Finding #15. UT-Battelle assessment programs are not sufficiently proactive, rigorous, and consistent in evaluating the implementation of individual safety and health program elements and safety management processes.

Issues Management. UT-Battelle has formal processes to: screen events, injuries, ES&H concerns and other identified ES&H-related issues; determine causal factors; establish corrective and preventive actions; and track actions to closure. Maturation and more rigorous implementation of the PBMS have improved safety issues management processes and performance at ORNL. The PBMS documents require that results of assessments, including assessments from external sources, be input to the ATS. Issues management includes assignment of condition owners, determination of causes and significance, development of a corrective action plan and action owners, performance of a Price-Anderson Amendments Act review, assignment of an independent reviewer for issues deemed significant, and tracking of completion of corrective actions and compilation of evidence packages. For most assessments reviewed by OA, the conditions and actions were appropriately entered into ATS and managed in accordance with the PBMS procedures. Another PBMS procedure requires managers and management system owners and others to perform periodic (quarterly minimum) analysis of performance measurement results for trends that indicate systemic deficiencies or ineffective corrective actions.

The tree format of ATS (i.e., assessment, conditions, and actions) provides a logical, visual presentation of the source, condition, and corrective actions. In most cases, source documents and materials that provide evidence of action completion are attached, with hot links in the ATS database. Although informally documented and tracked, corrective actions are implemented for many lower-level ES&H program and performance deficiencies, such as from the Operations Awareness Program inspection tours and the 2003 Occupational Safety and Health Administration (OSHA) inspection.

A formal critique process is being used extensively to promptly gather facts and initiate the analysis of incidents, injuries, and illnesses. This process has been recently revised and strengthened, with an institutional champion assigned to mentor users and monitor process application. Formal critique reports are now being completed in a timely manner and posted to the ORNL internal website. Critiques are linked to ATS entries for incidents and events.

Notwithstanding these improvements in the management of safety issues since the previous OA inspection, the processes and performance for issues management at ORNL are not yet fully mature and effectively implemented. Instances of inconsistent and inadequate implementation were identified by OA, including the following:

- The PBMS and associated guidance do not clearly establish a common framework of definitions of issues, which is needed to ensure consistency in application across the Laboratory. A variety of undefined or inadequately defined terms are used by individual organizations to describe deficient conditions and performance and opportunities for improvement. Noticeably absent are a requirement and guidance to effectively determine the extent of conditions (i.e., whether the issue possibly applies to similar activities or to other organizations or facilities) and ensure that corrective actions address the full extent of the issue. As an example, the negative results of Oversight and Assessment Services independent assessments are described and communicated in terms that imply that corrective actions are suggested, rather than required. The most negative findings, where the assessment criteria have not been met, are referred to as "recommendations."

- The PBMS procedures and guidance do not clearly define the threshold for issues that must be put into ATS. In general, directorates and divisions have not established formal processes (e.g., procedures) or systems to track issues not put into ATS.

- Some issues are not being input to ATS for documentation of evaluation and tracking of corrective actions.

- Some issues are not being rigorously evaluated for causes or addressed with sufficient actions to prevent recurrence.

- Some adverse conditions that met the criteria on the significance checklist were not classified as significant in ATS.

- Little formal trend analysis of safety issues is performed except for regulatory-driven data, such as radiation exposure and injury and illness rates. Although there is a stated requirement to perform trend analysis of assessment results, no procedures or guidance for how to conduct this analysis have been developed. The ATS does not support mining of issues from different organizations for trend analysis purposes or provide tools to efficiently categorize issues.

- Actions in ATS are not always closed in a timely manner. For example, actions to correct conditions noted in the January 2003 Oversight and Assessment Services assessment of the Physics Division's self-assessment program are not yet completed. Deficiencies from walkthroughs are not always being tracked to completion.

Other examples of issues management weaknesses are discussed in the following section on injury and illness investigations. Some of these weaknesses in ATS, causal analysis, and trend evaluations were self-identified in the recent Oversight and Assessment Services evaluation of the ESH&Q Performance Assessment Program.

Finding #16. UT-Battelle has not established and implemented a fully effective issues management process that consistently and rigorously categorizes, documents, and manages events and issues, evaluates causes, and establishes and implements effective corrective and preventive actions.

Injury and Illness Investigations and Reporting. ORNL has established and implemented an adequate program to evaluate and report occupational injuries and illnesses in accordance with the requirements and guidance of OSHA and the DOE Computerized Accident/Incident Reporting System (CAIRS). Injury and illness statistics for ORNL reflect that total recordable case rates have been higher than the DOE complex average for four of the last five quarters and higher than most other SC sites. Lost workday case rates have been about equal to the DOE complex average. Workers are directed to report all injuries and illnesses to supervisors and to report to the site medical clinic for evaluation and treatment. Supervisors are required to complete an incident report describing the incident and identifying causes and corrective actions. The critique process is used as an effective tool to accurately identify facts about injury and illness events, including first aid cases, and to conduct timely causal analysis and establish appropriate corrective actions. Subcontractors are required to report OSHA-recordable injuries and illnesses to UT-Battelle. ES&H personnel in the Operational Safety Services Division (OSSD) categorize each occupational injury and illness for reportability to OSHA and CAIRS.

OA reviewed a sample of UT-Battelle injury and illness case files and related documentation, such as critiques, ORPS reports, and CAIRS reports for injuries/illnesses classified as first aid cases and OSHA recordables from CYs 2003 and 2004. Recordability determinations, CAIRS reporting, and lost and restricted workdays were accurately documented and reported. Case files contained all pertinent medical information, including initial report and follow-up visit notes.

Although administrative aspects of injury and illness evaluations and reporting were generally adequately conducted, overall effectiveness of the program is impacted by weaknesses in investigating events and establishing preventive actions. In addition, deficiencies in procedures and documentation were identified. Many reported individual injury and exposure incidents involve routine activities at work and result in bumps, cuts, slips, strains, and ergonomic complications. Preventive actions can include hazard awareness training and elimination of hazards. However, a smaller set of incidents is more complicated and involves more complex work activities, and can be affected by work planning and control mechanisms that require a more rigorous evaluation. In some of these latter cases, the investigations did not address the core functions of ISM. Some injuries and exposures occurring during the past two years at ORNL were not consistently evaluated with sufficient rigor to clearly identify root and contributing causes and drive effective recurrence controls.

Although critiques were conducted for most injuries and illnesses, there were several cases in the sample reviewed by OA where the minutes and specified corrective and preventive actions had not been input to ATS, as required by PBMS procedures, or tracked formally by line management. For several cases, the critiques and, in at least one case, the DOE-approved ORPS report did not adequately address the causes or all pertinent elements of the event. For example, the fact that a chemical exposure was not reported promptly (i.e., a worker on a backshift did not report to supervisors or the Laboratory Shift Supervisor when an exposure occurred and did not report to the medical clinic until the next day) was not addressed by the critique or corrective actions. This case is an example of an SBMS procedure inadequacy (i.e., reporting actions for backshifts and weekend are not specified) discussed later in this section. Several other instances were identified where workers did not report injuries or incidents when they occurred, as required by UT-Battelle policies and procedures.

Preventive actions developed in the critique and ORPS report for a September 2003 event were not adequate. In this event, several unplanned changes were made by a task leader because work instructions for cleaning of hot cell lead glass windows were not sufficient to successfully accomplish the task, resulting in the splashing of sulfuric acid solution onto two workers. The only two actions specified were to reconnect an improperly disconnected vent line that provided the path for the exposure, and to revise the specific cleaning procedure for this window to note that the introduction of a pressurized sparging gas was not allowed. The failure of workers and supervisors to properly react to unexpected conditions or to adequately analyze hazards and properly plan changes in work control documents was not addressed. In several other cases, critiques and supervisors' incident reports did not describe fundamental ISM-related information, such as what work control documents applied, what PPE was specified/required, and what PPE was being worn.

In another case, an event was not conservatively categorized for reportability to the ORPS as a near miss or management concern/issue. In this case, three workers were sprayed with hot condensate water, with one suffering burns resulting in an OSHA lost workdays case. The maintenance task had been inadequately planned and managed by supervisors and workers to ensure that all hazards were identified and properly controlled. In addition, the corrective actions specified for this event were incomplete and not implemented in a timely manner. The only corrective action was to discuss the planning failure with that Facilities Management and Craft Resources Divisions of the Facilities and Operations Directorate. This action was not entered into ATS until 9 months after the event and is still open, 13 months after the event.

Many files did not contain the supervisor's incident report, which is required to be forwarded to OSSD by procedure. For several cases, OSSD had not adequately documented the basis for concluding that work restrictions specified by site medical personnel did not meet the restriction criteria of OSHA. No assessments have been conducted to evaluate the level of compliance of subcontractors in reporting injuries and illnesses as required, or to ensure that follow-up treatment and recurrences that could affect prior OSHA recordability decisions and CAIRS reporting have been forwarded to UT-Battelle. Weaknesses were also identified in the SBMS procedures for reporting injuries and illnesses. The following process steps and requirements are not addressed:

- Requirements for individuals to report or seek aid when injured on off-shifts or weekends, or a requirement to go to the site medical clinic at the earliest time when the clinic is open

- Specific requirements to take action to prevent recurrences resulting from investigations and to manage corrective/preventive actions (e.g., the use of ATS)

- The use of the critique process or a clear definition/ guidance on when "formal" investigations are needed

- The process or requirements for reporting information to the DOE CAIRS database

- The requirements for capturing, verifying, and reporting subcontractor recordable injuries and illnesses and work hours to CAIRS.

The above deficiencies are additional examples related to the above finding on inadequate management of safety issues.

Lessons Learned. A variety of lessons learned and safety alerts are posted to internal ORNL websites and communicated to ORNL workers through a variety of mechanisms. Published lessons learned are generated from local events and are extracted from lessons from elsewhere in the DOE complex and from consumer awareness sources. UT-Battelle has established an effective process to quickly communicate the details of injury incidents or operational events to site managers. Event details, as well as the apparent lessons learned and suggested actions, are compiled into a document called a Safety Flash, which is disseminated to a targeted audience and posted on the ORNL internal website. Lessons learned and Safety Flashes are well designed, detailed, and often contain photographs clearly showing the event scene. The website provides easy access to lessons learned, tools and instructions, and a template for developing lessons learned; a listing of local and externally generated lessons learned with search capabilities by subject area, type, and date; and links to other lessons-learned sources.

The Facilities and Operations Directorate lessons-learned coordinator actively manages a directorate lessons-learned website, with an internal listing of lessons disseminated from the ORNL coordinator, supplemented by lessons selected from additional searches of sources. Lessons posted to this website were current and pertinent, including special reports on electrical intrusions and hoisting and rigging events issued recently by the DOE Office of Environment Safety and Health (EH). The website has search capabilities and a collection of 150 safety meeting packages in 16 functional areas (e.g., electrical safety and confined space) for use by directorate supervisors (most based on lessons learned). The process for identification and dissemination of lessons learned is delineated in a directorate-level procedure. Other divisions are also disseminating lessons learned to staff, and selected lessons are posted on division or directorate websites.

Although many lessons learned are identified, disseminated, and discussed in safety meetings, the process is insufficiently rigorous to provide assurance that appropriate lessons learned are being reviewed for applicability to ORNL or that the lessons are being applied (i.e., needed preventive actions identified and implemented).

The two governing PBMS procedures for the lessons-learned process describe conflicting and overlapping responsibilities and do not delineate a rigorous program. An important program element, Safety Flashes, is not detailed in procedures, and the responsibility for reviewing external sources for applicability to ORNL is not clearly detailed (i.e., all SMEs are tasked with reviewing any or all sources). There is no formal documentation or tracking of review of external lessons learned, results of applicability determinations, or resulting actions (except for the rarely issued DOE red alerts that require response to DOE). The most recent red alert with documented actions at ORNL was in 2002. Although electronic mail transmits lessons learned to targeted audiences and requests feedback on whether any actions are taken, responses are extremely rare. Many recipients get lessons learned by subscribing to the system for specific broad topical areas, but no response/feedback is solicited. Similarly, the directorates and divisions do not document the evaluation and any actions needed. UT-Battelle has not conducted any formal self-assessment of the adequacy of the lessons-learned process or the application of lessons learned by line and support organizations.

Although the Facilities and Operations Directorate has appropriately written an implementing procedure, the procedure has similar weaknesses. The procedure does not describe the initiation and issuance of lessons learned from Facility and Operations events, describe the technical review for applicability or determination of needed actions, or direct users to actually apply the lessons. Consequently, there is no documentation of applicability reviews or feedback to the lessons-learned coordinator.

Several examples indicate that lessons learned are not always being effectively shared and employed to ensure that actions are taken to prevent recurrence of events at ORNL. The Physics Division response to the DOE "red/urgent" alert issued in May 2003 was inadequate. This alert detailed an event where the failure to properly inert pyrophoric materials resulted in a significant chemical fume hood fire. An internal review in the Physics Division identified that cesium was used in the division and that an operator aid existed that discussed handling this material, but an "informal survey of a few who work on these sources" found that some relied on "verbal training" and were not aware of the operator aid. The internal review, documented only in an electronic mail, did not evaluate the quality/accuracy of this uncontrolled aid or whether all of the numerous actions recommended in the lessons learned were reviewed for applicability to ORNL operations. No evidence could be located that indicated any corrective actions were taken to address the adequacy of the operator aid or the lack of staff knowledge of its existence. This aid, reportedly revised recently, is still an uncontrolled document (e.g., contains no issue revision or date, no names of preparer, reviewer, or approver, and is not listed on a log or master list of aids/procedures).

The sulfuric acid injury event at HFIR cited in the Issues Management section above also reflects untimely communication or consideration of lessons learned from incidents. No Safety Flash was issued, and the lessons learned drafted as part of the corrective action plan had not been issued, over four months after the event. Another example of inadequate application of lessons learned, involving an ammonia gas leak event in March 2004, is discussed in the Chemical Sciences Division portion of Appendix C.

Post-job reviews are employed for a number of Laboratory work activities. However, with the exception of HFIR, the use of this feedback tool to develop lessons learned is informal and inconsistent.

Finding #17. UT-Battelle has not been fully effective in consistently identifying, evaluating, and applying lessons learned from internal and external events and activities to prevent accidents and operational events from occurring at ORNL.

Employee Concerns Programs. UT-Battelle personnel can use any of several formal and informal processes to express and get resolution of employee safety concerns at ORNL. Prior to CY 2004, concerns were handled by an "ombudsman," the Human Resources Diversity Group for discrimination or harassment issues, the financial audits group for waste, fraud, and abuse issues, and an ES&H hotline. In January 2004 a new Employee Concerns Office was created along with a new Concerns Coordinator position, which reports directly to the Laboratory Director's office. An SBMS subject area and an associated SBMS procedure have been issued and are in the process of being revised. The revised program has been advertised several times in the online laboratory news bulletin, the Laboratory Director's weekly electronic message postings, and the Employee Concerns website. The new coordinator has also conducted briefings for several organizations, and the training module for group leaders has been revised to include more information regarding the management of employee concerns. The UT-Battelle policy is to encourage workers to first address concerns with their supervisors or to ES&H representatives when possible. The formal processes are seldom used by ORNL workers–there has been only one ES&H hotline call in the past four years. Although ESH&Q has no procedure for the hotline process, it maintains a website outlining the process for users, and a notebook is used to log calls and dispositions. Forty concerns, four of which related to safety, had been reported to the Employee Concerns Office in the first five months of CY 2004.

Weaknesses were identified in the processes and implementation of the employee concerns program. The SBMS procedure does not describe the current Employee Concerns Office or the process for handling concerns, and no interim procedure has been issued. The current SBMS subject area document provides minimal information about the employee concerns program. Expectations are not defined for such functions as the ES&H hotline, communicating resolutions to concerned individuals, methods to use to maintain confidentiality when requested, and record keeping requirements.

Documentation for the four safety-related concerns processed this year by the Employee Concerns Office is limited to a narrative about the concern and follow-up phone calls and analysis by the Employee Concerns Coordinator, and copies of associated electronic mail. Three of the four ES&H concerns had been closed. However, in two of the cases, the basis of closure was not clearly specified, and underlying issues were not fully addressed.

During the investigation of the recent concerns, new concerns related to a fear of retribution for raising safety concerns were expressed by several parties. Although senior management was made aware of these concerns, these cases were closed without addressing the fear of retaliation issue. The fear of retaliation issue had previously been identified and documented in a December 2002 special study, which was based on results of a survey of employee perceptions and a focus group study.

In April 2003, similar issues were identified at HFIR through an independent assessment, which identified numerous recommended corrective actions for addressing conditions at HFIR. A number of actions have been taken by the HFIR management team since April 2003 to address these concerns. For example, HFIR management has been actively soliciting feedback and input from employees on concerns, and the Reactor Research Division website has been updated to have an easy active link for anyone to submit a concern or issue for management action. In addition, a follow-up assessment was conducted in May 2004 to review progress in addressing weaknesses in HFIR communications; this review surveyed employees and concluded there was a marked improvement in communications between management and employees. OA interviews and discussions with numerous HFIR staff supports the results of the independent review. Although significant actions were taken at HFIR, the HFIR issues were not evaluated for extent of condition at other ORNL facilities.

The fear of retaliation issue raised by the recent concerns indicates that the issues previously identified in the 2002 special study may persist and that corrective actions identified to address the issues raised at HFIR should have been implemented at an institutional level. The fear of retaliation issue is complex; the existence and extent of the problem is difficult to determine, corrective actions take time to implement, and measuring effectiveness is challenging. However, assuring an atmosphere of freedom to ask questions and express concerns related to ES&H are essential to an effective safety management program.

Other Feedback Mechanisms. UT-Battelle management is demonstrating their commitment to continuous improvement through several other mechanisms. Monthly Leadership Team meetings provide an effective forum for communication of ES&H concerns and performance data between management and ES&H staff. Meeting minutes reflect a strong focus on safety issues and initiatives by senior Laboratory management. Management has also drafted an extensive five-year strategic plan for achieving excellence in operations and ES&H that comprehensively articulates many strategies and initiatives and management expectations for driving continuous improvement in safety performance.

D.3 Conclusions

ORO and OSO have made significant progress in the past few years in establishing adequate processes for DOE line management oversight of ORNL activities. In 2001, ORO and OSO did not have structured processes for line management oversight and were not rigorous and systematic in their approach to assessments and operational awareness. ORO and OSO have devoted significant attention and effort to developing a structured approach. With few exceptions, the current ORO/OSO procedures and manuals describe adequate processes for performing assessments, operational awareness, performance evaluations, and employee concern program activities. A number of feedback and improvement processes are relatively new but are adequately implemented, such as the operational awareness activities and assessments performed by OSO SMEs. However, the new programs are in various stages of maturity and some are not yet institutionalized in procedures. Weaknesses are evident in several areas, including implementation of the ORO independent assessment program, communication and follow-up of FR issues, and the OSO self-assessment program. Continued management attention is needed to ensure communication of expectations and rigor in implementation of existing requirements.

UT-Battelle has established and implemented many mechanisms that provide feedback on safety performance and conditions in work areas, and significant improvements have been made in the last year. Implementation of these mechanisms has resulted in improvements in safety at ORNL. UT-Battelle management has demonstrated a strong commitment to improvement in safety management through strengthening of the management team, realignment of processes and organizations, and development of specific initiatives to improve safety performance. A formal and comprehensive plant condition inspection process routinely identifies housekeeping deficiencies and unsafe working conditions. ES&H issues, including events, injuries, and illnesses, are formally evaluated, critiques of causes are performed, and corrective and preventive actions are identified, implemented, and tracked to closure. Lessons learned are shared and preventive actions are taken.

However, UT-Battelle feedback and improvement processes are not fully mature. Weaknesses exist in the procedures detailing these processes, and the rigor of implementation varies between organizations. Self-assessments are not sufficiently planned based on formal risk assessments and many still lack sufficient rigor to drive continuous improvement. Issues resulting from assessments and events, including injuries and illnesses, are not always adequately evaluated to ensure that the extent of condition and causes are determined and appropriate corrective and preventive actions are identified and implemented. Lessons-learned evaluations are not formally documented, and lessons-learned information is not always effectively evaluated, communicated, and applied.

D.4 Rating

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

D.5 Opportunities for Improvement

This OA review 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.

SC/NE/EH

1. **Reevaluate the current policy on assignment of systems engineers to nuclear facilities**. Base requirements for employing system engineers on nuclear facility hazards and risks, rather than on categorization as a defense nuclear facility.

ORO/OSO

1. **Clarify and institutionalize expectations for ORO/OSE line management oversight**. Specific actions to consider include:

   - Develop a lessons-learned procedure to institutionalize the program, including recently provided ORO expectations.
   - Communicate clear management expectations to FRs, and expedite efforts to finalize draft FR procedures.
   - As new FRs are recruited, ensure that expectations are clearly communicated to them.
   - Select a tracking system for follow-up and resolution of FR issues; ensure that quarterly reports are prepared timely, and that issues are entered into the system and resolved timely and effectively.
   - Set and enforce management expectations towards mature implementation of recent initiatives, such as work observations and independent assessments of ORNL programs.
   - Emphasize timely selection and implementation of an appropriate issue tracking system for documentation of self-assessments.

UT-Battelle

1. **Continue efforts to improve self-assessment processes and performance.** Specific actions to consider include:

   - Establish formal processes to identify and risk-rank safety-related activities and processes to ensure that resources are being efficiently applied and that all areas are periodically assessed based on an appropriate graded approach.

- Provide training to line and support personnel, including techniques and expectations for performing effective self-assessments.

- Clarify the expectations for performing management system self-assessments to ensure that the process results in both an evaluation of program adequacy and field implementation.

- Increase emphasis on the observation of work and rigorous review of how processes are being implemented rather than on surveys and subjective grading systems.

- Reconsider the approach to evaluating the implementation of the self-assessment program and the redundancy in workspace physical condition inspections to better allocate resources and broaden the number of safety processes that can be assessed.

- Facilities and Operations should establish clear expectations for the conduct of STOP and ACE observations.

2. **Strengthen the management of issues to ensure that assessment findings, operational events, and occupational injuries and illnesses are consistently and rigorously evaluated, with effective actions identified and implemented.** Specific actions to consider include:

   - Strengthen PBMS to ensure that extent-of-condition reviews are performed for issues and events and to clarify terminology and thresholds for entry of deficiencies into ATS.

   - Advance the modifications to ATS to provide a means for management system owners and organizational users to efficiently extract data for trend analysis and performance evaluation.

   - Increase the level of effort at evaluating assessment results, such as for the STOP, ACE, and Operational Awareness Programs and similar inspections, to identify problem areas and adverse trends so that resources are applied to preventive actions instead of additional assessment.

   - Conduct management system assessment(s) of implementation of ATS and other tracking systems for assessment findings and actions resulting from events.

   - Consider forming a corrective action review board or panel of institutional, division, and directorate counterparts responsible for issues management to periodically review processes, share information and techniques, and monitor the adequacy of corrective action plans (on a graded approach, sampling basis). This process has been effectively used at other DOE sites.

   - Review and revise injury and illness investigation and reporting procedures to fully address all elements of the program.

   - Review the content and use of the supervisor's incident report for occupational injuries and illnesses in the context of such related processes as critiques, ORPS reports, and ATS, which often address the same information in a more rigorous manner.

3. **Ensure that lessons learned are being properly evaluated and applied to prevent future adverse conditions, events, and occupational injuries.** Specific actions to consider include:

   - Strengthen PBMS procedures to clarify roles and responsibilities of the institutional coordinator and SMEs, including the review of external lessons for applicability to ORNL and the need for corrective/preventive actions. Require formal documentation of applicability reviews and of results and feedback to the institutional coordinator.

   - Consider establishing clearly designated lessons-learned coordinators in the divisions and directorates.

   - Consider forming a panel of institutional, division, and directorate counterparts responsible for lessons learned to routinely review processes and to enhance communication between organizations and consistent implementation of the program.

4. **Strengthen the employee concerns program to ensure that concerns are freely expressed and thoroughly evaluated and resolved.** Specific actions to consider include:

   - Issue revised SBMS procedures to accurately and thoroughly describe the structure and processes for assuring that employee safety concerns are thoroughly and effectively evaluated and resolved.

   - Establish a rigorous process to document employee concerns and subsequent investigation and resolution. Consider obtaining and including written or concurred-with statements of concerns and chronological logs of events related to the concern and investigation activities through notification of concerned individuals and closure.

   - Conduct a follow-up investigation of the fear of retribution issue to identify any changes from 2001, and evaluate the adequacy of recent process changes and enhanced communications. Consider using a standard survey that can be repeated to measure change.

APPENDIX E
MANAGEMENT OF SELECTED FOCUS AREAS

E.1 Introduction

The U.S. Department of Energy (DOE) Office of Independent Oversight and Performance Assurance (OA) inspection of environment, safety, and health (ES&H) at the DOE Oak Ridge National Laboratory (ORNL) included an evaluation of the effectiveness of the ORNL Site Office (OSO) and University of Tennessee-Battelle Memorial Institute, LLC (UT-Battelle) in managing selected focus areas. Based on previous DOE-wide assessment results, OA identified a number of focus areas that warrant increased management attention because of performance problems at several sites. During the planning phase of each inspection, OA selects applicable focus areas for review based on the site mission, activities, and past ES&H performance. In addition to providing feedback to DOE and contractor line management at ORNL, OA uses the results of the review of the focus areas to gain DOE-wide perspectives on the effectiveness of DOE policy and programs. Such information is periodically analyzed and disseminated to appropriate DOE program offices, sites, and policy organizations.

Focus areas selected for review at ORNL were:

- Management of legacy hazards
- Safety during excavation and blind penetration activities
- Unreviewed safety question (USQ) process
- Safety during protective force training.

The scope of the review activities for each of these areas is further discussed in the respective subsections in Section E.2.

E.2 Results

E.2.1 Management of Legacy Hazards

OA identified management of legacy hazards as a focus area across the complex because a number of sites have a number of legacy hazards that have not been addressed in a timely manner (e.g., unneeded hazardous materials in long-term storage, with no plan for disposition). At ORNL, the legacy hazards typically result from past use of hazardous materials, such as beryllium, volatile organic compounds, and polychlorinated biphenyls (PCBs), and past disposal practices. In addition, ORNL has a number of aging facilities that are not currently being used or that are deactivated and undergoing or awaiting environmental remediation. OA reviewed OSO and UT-Battelle management of facilities with legacy hazards, focusing on Federal, state, and local environmental regulations, Occupational Safety and Health Administration (OSHA) and DOE/site requirements, integrated safety management (ISM) expectations, oversight, and the requirements of DOE Order 430.1B, *Real Property Asset Management*, in the areas of facility condition assessment, disposition, and long-term stewardship. Remediation activities funded by the DOE Office of Environmental Management (EM) were not reviewed at ORNL because another Oak Ridge Operations Office (ORO) contractor manages the restoration program. The OA team reviewed policies, requirements, procedures, guidance, documents, plans, hazards control documents, and work practices for work within ORNL facilities; observed work associated with facility cleanup activities; and conducted walkthroughs of facilities with hazardous legacy concerns. Concurrent with the review of legacy hazards, the OA team also reviewed selected elements of the ORNL environmental management program.

Legacy Hazards

The DOE Office of Science (SC) created the Science Laboratories Infrastructure (SLI) program, in part, to address legacy hazards and fund cleanup and removal of excess facilities. By funding disposition of excess facilities, SC expects to reduce long-term costs, risks, and liabilities. These funds are for addressing only non-contaminated buildings or buildings with minor levels of contamination at ORNL as part of the SLI program, because SC's position is that EM is responsible for disposition of buildings with major process-related contamination.

SC Headquarters and OSO personnel providing ES&H and funding support for ORNL were proactive and demonstrated a good understanding of site conditions for the facilities and funds needed to address these conditions. UT-Battelle management has also provided effective leadership and is actively engaged in addressing legacy and environmental vulnerabilities. As one of the corrective actions to the High Flux Isotope Reactor (HFIR) tritium leak, a facility environmental vulnerability assessment was conducted in June 2001, which identified vulnerabilities beyond the groundwater concerns at HFIR. This led to the *Facilities Environmental Vulnerability Assessment Recommendations Implementation Project Final Report on ORNL Environmental Vulnerabilities*, completed in 2004, which identified environmental issues and concerns associated with older facilities. To address these concerns, the Legacy Materials Disposition Initiative (LMDI) and Facility Disposition Program organizations were formed to focus management attention on legacy and facility disposition issues. UT-Battelle management also invoked a legacy tax (i.e., a surcharge on research and development projects) to fund the removal of these legacy materials and the disposition of facilities, and established resolution of legacy issues and demolition of excess facilities as key priorities on the UT-Battelle Laboratory Agenda.

The LMDI program has been effective in identifying, characterizing, and removing legacy items. SC programmatic funds, the Health and Safety Initiative, division direct funds, and the ORNL legacy tax have been used to fund these activities. Funding levels have ranged from $1.1 million to $5.8 million over the past three years. UT-Battelle established a prioritized list of ORNL-wide legacy issues ("Challenges List") using an institutional risk-ranking process to consider safety and health, compliance, environmental protection, disposition pathway, and coordination with the Laboratory Agenda. This list has been effectively used to address the higher-risk issues on a prioritized basis. The LMDI program has used available funds to disposition significant amounts of hazardous legacy materials from the site over the past three years, including approximately 32,400 cubic feet of low-level waste, 56 cubic yards of asbestos, 4,327 excess chemicals, over 1,100 gas cylinders, 8.25 tons of lead, and 1,915 pumps and motors that were potentially contaminated. This LMDI work is performed using ORNL work plans, walkdowns, and an inventory hazards analysis checklist to manage cleanout activities. Before starting cleanout activities, a team including LMDI managers, ES&H personnel, radiation control personnel, and space and facility managers walkdown the areas or building to be cleaned. Work plans are developed that include job hazard evaluations, which identify permits and controls. LMDI work is performed under tight controls that include work stoppage when unexpected conditions occur. For example, the work area for cleanout of the 4505 high bay adjoins two laboratories; therefore, the training for the LMDI crew included the research safety summaries for the adjacent laboratory areas. The work observed by OA was effectively performed and included an appropriate work stoppage when removable contamination above the limit in the radiation work permit was discovered. Due to the effectiveness in identifying, characterizing, and implementing the removal of legacy items, the LMDI is considered a noteworthy practice.

The Facilities Disposition Program has effectively identified, prioritized, and dispositioned excess facilities using available funding provided by SC-82, the Health and Safety Initiative, and laboratory overhead, which has ranged from $3.0 million to $4.6 million per year over the past four years. Disposition activities for excess facilities, including those that contain chemical and radiological hazards, are prioritized using a process that considers risk reduction, results of condition assessment surveys, potential cost savings, and mission impact. This process has been effectively used to guide disposition actions based on available funding. Significant results have been achieved over the past four years using these funds. For example, 23 facilities have been cleaned out, 18 buildings have been demolished, and 9 buildings have been transferred to other DOE programs. Many of these activities involved the removal of hazardous materials and/or conditions involving radiological contamination, PCBs, lead, and asbestos.

The UT-Battelle Landlord-Tenant Model and Laboratory Space Management Program are being used to eliminate existing legacy material issues and prevent their recurrence by controlling the accumulation of excess materials. UT-Battelle established ownership of space within facilities through Facility Use Agreements (FUAs) and by appointing Complex Facility Managers (who are responsible for cleanup and removal of items within facility spaces not assigned to program divisions). Space return criteria have been established to ensure that any potential legacy conditions are properly addressed before a tenant is allowed to vacate a laboratory; this is an effective mechanism for ensuring that tenants remove hazardous materials and preventing accumulation of hazardous materials and associated future legacies. Laboratory Space Managers (LSMs) are formally assigned the responsibility of monitoring activities in their assigned laboratories to ensure proper housekeeping and that excess materials do not accumulate. UT-Battelle also requires that terminated employees dispose of or transfer all of their hazardous materials as part of the termination process. The Chemical Sciences Division has instituted a similar requirement for non-employee experimenters.

A current list of all ORNL excess facilities has been prepared as required by DOE Order 430.1B, *Real Property Asset Management.* The Facility Disposition Program organization maintains and regularly updates this list and includes cost estimates for disposition, including demolition, of each facility. In addition, DOE Order 430.1B requires that disposition processes be consistent with the principles of ISM. The Facilities Disposition Program meets this requirement by incorporating ISM requirements into its building demolition subcontracts. Specifications contained in these subcontracts require that each subcontractor implement ISM and have a written safety and health program and activity hazards analysis that are approved by UT-Battelle. The inspection team's observation of the demolition of Building 7010 indicates that subcontractors understand and are applying ISM principles.

The ORNL Facility Condition Assessment Program provides an effective tool for assisting the Facilities Disposition Program in prioritizing excess facilities for deactivation and demolition. Condition Assessment Surveys are performed on all active facilities once every four years (except for those ORNL facilities located at the Y-12 National Security Complex, which are covered by another contract). These surveys identify some ES&H-related hazards such as PCBs, lead paint, and asbestos, but do not identify such legacy hazards as hazardous chemicals and radiological materials. However, cost estimates for needed maintenance are developed for facilities as part of each assessment and are appropriately used by the Facility Disposition Program as a factor for identifying, accepting, and prioritizing excess facilities.

ORNL has been effective in using available funds for building deactivation and demolition activities. However, environmental and safety hazards are not being addressed because SC, EM, the Office of Nuclear Energy, Science and Technology (NE), and the National Nuclear Security Administration (NNSA) have not reached a consensus on funding activities to address legacy hazards, as discussed in the following paragraphs.

EM did not accept a number of legacy-contaminated buildings that were submitted by SC before an EM imposed deadline, including the Quonset Hut Complex, which consists of World War II-era buildings with peeling paint chips that contain PCBs. SC has restricted the use of the SLI program to non-contaminated buildings, which leaves the responsibility for these contaminated buildings unresolved. Although some actions have been taken to control the paint chips, ORNL exceeded the Federal Facilities Compliance Agreement (FFCA) action levels for PCBs in 1999 and 2002 in sediment samples from the storm drains that serve these buildings, and in sediment samples from First Creek, the receiving stream. The Environmental Protection Agency (EPA) had been informed that the buildings were scheduled to be demolished; however, funding for this work is uncertain. The status of demolition is an expected topic in the next annual meeting with EPA on the FFCA. Because of the continued exceedances and the uncertainty of demolition, DOE is now in a position where EPA may impose additional actions under the FFCA.

Transition of several facilities and programs from EM to SC is also unclear. For example, EM has proposed transferring the liquid and gaseous low-level waste treatment facilities to SC, along with the newly generated waste program. No firm transfer date has been agreed upon by EM and SC; however, this transfer could be as early as fiscal year (FY) 2006 if EM is successful in implementing their planned strategy. ORNL is in the process of requesting funds to construct new, more-efficient, facilities to treat the smaller waste volumes that will continue from SC operations. Based on the tentative schedule for these projects, SC is proposing that the liquid and gaseous low-level waste treatment facilities remain with EM until remediation at ORNL is complete. As a result, future responsibility for the operation and ultimate decontamination and decommissioning (D&D) of these old contaminated facilities remains unresolved.

At the Y-12 National Security Complex, SC funds were used for cleanout of several large buildings used by UT-Battelle to facilitate transfer to NNSA. NNSA has since decided not to accept liability for these contaminated buildings; however, because part of the contamination in these buildings pre-dates SC-funded activities, responsibility for demolition is unresolved. Another Y-12 National Security Complex building (9204-3) that contains Calutron equipment was originally used for a defense program function but is currently assigned to NE, which previously used some of the equipment. EM has responsibility to fund surveillance and maintenance of a portion of the equipment and infrastructure in the building; however, the scope of its role in eventual D&D of the building is not defined. At another Y-12 National Security Complex building, ownership and responsibility for the removal of certain legacy materials, such as chemicals and welding gases, remains in dispute between SC and NNSA. While this dispute is being resolved, compressed welding gasses have been abandoned in place, without the controls that would exist in an operating shop.

Discussions are underway, and a proposal was made to create a new Office of Future Liability; however, approval of the proposal remains uncertain, and there is no agreed-upon path forward among the involved program offices for assigning responsibilities and providing funding for disposition of these buildings. As a result, buildings with multiple potential owners have environmental and safety hazards that are not being addressed. Although these hazards are being managed through established controls, they continue to pose ES&H risks. For example, in the Calutron building uranium-contaminated equipment from past operations has no identified program owner and is being stored, with no date scheduled for its removal. A sump in the basement that contains used mineral oil that could be released to the environment in violation of DOE and external regulatory requirements has not been tested for leakage since 1991. World War II-era PCB transformers and equipment could expose workers to PCBs and/or release PCBs to the environment, and bagged low-level waste stored in an area with a badly deteriorated interior roof drain could burst and thereby spread contamination within the facility.

Uranium-Contaminated Equipment

Finding #18. SC, EM, NE, and NNSA have not reached consensus on funding responsibilities for addressing legacy hazards, resulting in environmental and safety hazards that are not being addressed.

In addition to funding uncertainties, legacy materials from past ORNL operations that no longer have an identified responsible owner and the lack of identified disposition pathways have hindered the removal of legacy hazards from ORNL facilities. Legacy items, including process residuals, spent irradiation targets, and target cladding, have accumulated in the Building 3047 hot cells and have been there as long as 15 years without an identified owner or an identified disposition pathway. Several hazardous legacy items at Building 2026 have not been addressed due to lack of both funding and identified disposition pathways. These items include archive samples, construction wastes, and a scrubber pit containing high-level remote-handled wastes with radiation levels of approximately 500 millirem per hour. The prior lack of established controls within laboratories has also contributed to the problem.

Although UT-Battelle has aggressively pursued the identification and removal of legacy hazards, a strategic plan for comprehensively addressing legacy hazards at ORNL has not been developed. Such a plan would provide DOE and UT-Battelle management with a valuable tool for ensuring that legacy hazards are addressed in an integrated and prioritized manner, given the challenge of limited funding. Several interdependent initiatives are underway to address legacy hazards, such as LMDI, Facility Disposition, Liquid and Gaseous Waste Treatment System, Non-reactor Nuclear Facility Consolidation, and Remote-Handled and Special Case Waste Management. However, there is no overall plan that describes the objectives of each initiative, their interrelationships, the supporting management programs (e.g., Landlord-Tenant, Laboratory Space Management) and systems (e.g., ISM, FUAs, Hazardous Material Inventory System [HMIS], Facility Condition Assessment), and processes necessary to safely and successfully manage laboratory legacy hazards. These initiatives will continue to have a significant impact on ES&H and require significant funding to successfully address legacy hazards in an integrated manner.

An overall strategic plan to ensure that funding shortfalls are addressed and that available funds are used optimally has not been developed. Shortfalls have been projected for the legacy hazard initiatives that collectively amount to approximately $400 million. For example, the LMDI Strategic Plan identifies approximately $81 million in funding that will be required through FY 2012. Current funding sources (SC programmatic funds, the Health and Safety Initiative, division direct funds, and a Laboratory legacy tax) are estimated to provide $32 million in funding through FY 2012. Even if a recent request for an additional $37 million to the Office of Future Liability (this office has not been formally approved and established) is funded, there would still be a $12 million shortfall.

Effective planning and clear direction is also necessary to ensure optimal use of funds for disposition of facilities by the Facilities Development Division. As part of the modernization strategy at ORNL, UT-Battelle has a performance objective to vacate 1.8 million square feet of space by FY 2005. As part of that strategy, numerous excess facilities have been identified, many of which contain such hazards as asbestos, lead, and PCBs, as well as radiological hazards. The total estimated cost of deactivation and demolition of these buildings is approximately $240 million (included in the overall $400 million shortfall above). However, program funding for facility disposition has been significantly less than that requested by UT-Battelle, preventing the timely disposition of excess facilities, including those that contain chemical and radiological hazards. There is a current backlog of $50 million for facilities awaiting demolition, including facilities with significant health and/or environmental hazards. For example, the Quonset Hut Complex (as discussed above, funding between SC and EM is undecided) and the Biology Complex buildings remain in place and continue to release paint chips containing PCBs, lead, and/or asbestos to the environment. This situation has resulted in exceedances of environmental limits set by regulators for the Quonset Huts. Other excess facilities that are awaiting demolition continue to pose environmental and health hazards. For example, one building constructed in the 1940s at ORNL has radiological contamination inside and lead-based paint outside that is badly peeling and falling to the ground around the facility. Another building is also shutdown pending demolition and represents a potential biohazard due to mammal intrusion into the building. Funding for facility disposition has ranged from $4 million to $8 million per year since FY 2002, and is currently projected at $2.5 million for FY 2005. With these projected levels of funding and the costs of disposition, the current facility backlog and the associated ES&H impacts will persist.

Some aspects of the Facility Disposition Program have not been formalized, such as a program plan, required by DOE Order 430.1B to document Facility Disposition Program expectations and UT-Battelle's plans for meeting those expectations, budgets and planning estimates, and performance outcomes. The Facility Development Division has prepared a series of high-level procedures that address facility disposition, access to deactivated facilities, administrative limits, and surveillance and maintenance activities; however, they do not provide a sufficient description of the specific steps required to carry out these activities. Although progress has been made in the identification, prioritization, and deactivation of excess facilities, as discussed earlier, weaknesses exist in the development and documentation of surveillance and maintenance plans and implementation of an effective surveillance and maintenance program for facilities that are being held in a "cheap to keep" condition. Although excess facilities, including those that contain chemical and radiological hazards, are risk-ranked, the process used has not been formalized and does not utilize the UT-Battelle Risk Ranking Board as a resource for prioritizing excess facilities. In addition, the core functions of ISM have not been incorporated into some aspects of the deactivation planning and development and implementation of surveillance and maintenance plans. As a result, ES&H hazards continue to exist with insufficient controls in place.

Some aspects of the UT-Battelle Landlord-Tenant Model have not been sufficient for addressing hazardous legacy conditions and materials within facilities. For example, an area in 4500N that housed

Exposed CO_2 Fire Suppression System

computers was being cleaned out and had floor panels that were left open, exposing the carbon dioxide (CO_2) fire suppression system under the floor to the room and anyone in the area. An inadvertent release of the contents of the system could result in asphyxiation. High efficiency particulate air (HEPA) filters were found stored in attics or utility spaces in some buildings, which increases the fire loading and the risk of fire spreading contamination. FUAs, used as part of the Landlord-Tenant Model, provide a contract between facility managers and tenants, define operational boundaries, and ensure that activities are performed by these parties in compliance with facility requirements. However, FUAs, in their present form, do not adequately serve as a mechanism for establishing limits to control the accumulation of such hazardous materials as chemicals, biohazards, and explosives within facilities because the present HMIS system does not accurately reflect inventories of these materials in some buildings. A project is underway to upgrade the existing HMIS system and to integrate it with FUAs and the Research Hazard Analysis and Control System as a means to improve control and prevent accumulation of hazardous materials in facilities and laboratories by fire zones based on National Fire Protection Association codes. Although the system software is to be in place by the end of FY 2004, the upgraded system with accurate inventories of hazardous materials at the Laboratory will not be in place until the end of FY 2005.

Although implementation of the Laboratory Space Management Program is a positive step for controlling the accumulation of excess materials, some aspects of the program related to management of legacy hazards are not understood by some LSMs. In some instances, roles, responsibilities, authorities, and accountability are not completely understood by LSMs (e.g., the authority of an LSM to direct other individuals in multitenant laboratories), and some LSMs who were interviewed lacked knowledge of FUAs. The weaknesses in LSM knowledge of their responsibilities, authorities, and accountabilities needs to be addressed to ensure that legacy hazards are effectively managed and that LSMs effectively implement their broad ES&H responsibilities.

Selected Aspects of Environmental Management Program

The Environmental Management System as currently implemented within the Standards Based Management System (SBMS) effectively defines the UT-Battelle environmental compliance program for existing operations. DOE Order 450.1, *Environmental Protection Program*, is in the contract, and UT-Battelle plans to obtain DOE approval of their Environmental Management System a year before required by the order. In addition, UT-Battelle is in the process of strengthening the Environmental Management System by obtaining ISO 14001 registration using a third-party registrar to evaluate and register the site as being ISO 14001-compliant. In support of this goal, UT-Battelle has developed and implemented an environmental policy and developed objectives and targets in accordance with ISO 14001 requirements.

For existing operations, due to a buildup of waste across the site, waste services organizations in various ORNL divisions are taking actions to improve waste disposal or reduce the amount of waste generated to more effectively manage waste and prevent the creation of legacy hazards due to a buildup of waste. For example, UT-Battelle has streamlined the disposal process through use of ORNL vendors for direct hazardous waste disposal rather than relying on the EM contractor. UT-Battelle also is becoming certified to enable the site to dispose of low-level waste directly to the Nevada Test Site in lieu of relying on an EM contract that has a complex waste profile requirement. Within individual divisions, efforts are underway to reduce the number of waste streams. As part of waste management, UT-Battelle has continued to have a strong pollution prevention (P2) program. Senior UT-Battelle management strongly supports and drives the pollution prevention program and as a result many actions have been implemented, including tasking the divisions to achieve a 25-percent-per-year reduction in waste generation. As a result, UT-Battelle has received several awards for pollution prevention.

Although ORNL divisions have been taking actions to better manage wastes, a sitewide vulnerability has been identified with environmental compliance, caused by the long-term storage of hazardous waste in Satellite Accumulation Areas (SAAs) after the generating activity has terminated. It is expected that SAAs would only accumulate hazardous waste from an ongoing process. When the process ends, the hazardous waste must be moved to a compliant storage area. This concern is applicable to most ORNL divisions and has been identified as a vulnerability in the ORNL Five-Year Plan. The guidance for SAAs was modified in February 2004 to require waste to be removed within 90 days of curtailment of the generating activity, but several divisions still have legacy SAAs. Some divisions, such as the Chemical Sciences Division, are taking specific action to address this vulnerability by increasing in-house staffing trained in waste disposal and obtaining the services of subject matter expertise from the environmental compliance organization to assist in the disposal of legacy waste in SAAs. However, funding for these activities has been limited, and due to the number of legacy waste containers in SAAs, resolution of this vulnerability may take several years.

Summary. DOE and UT-Battelle managers and staff are proactively addressing legacy and environmental vulnerabilities. Two key actions, the LMDI and the Facility Disposition Program, along with several other initiatives are being effectively used by UT-Battelle to manage legacy hazards within available funding. However, the lack of consensus among DOE program offices on funding responsibilities for addressing legacy hazards has resulted in ES&H hazards that are not being addressed. In addition, several improvement areas were identified that would enhance the management of legacy hazards. Further, a sitewide vulnerability has been identified with environmental compliance caused by the long-term storage of hazardous waste in SAAs after the generating activity has terminated, and additional management attention is needed to address this concern.

E.2.2 Safety During Excavations and Blind Penetrations

Because a number of sites have process weaknesses and have experienced events and near misses, as evident from site occurrence reports and OA inspection results, OA identified safety during excavation and blind penetration activities as a focus area. OA reviewed excavation and blind penetration activities to evaluate whether adequate controls have been established to ensure that these activities can be performed safely and in accordance with requirements and ISM performance expectations. The OA team reviewed application of DOE complex-wide lessons, and systems to protect UT-Battelle and subcontractor workers. OA examined policies, safety program requirements, procedures, guidance documents, hazard control plans, permits, and work practices associated with excavation and blind surface penetration work and visited job sites and interviewed individuals who mark utilities. OA focused on the ORNL excavation process that is used for all ORNL facilities except the HFIR and the Spallation Neutron Source construction project, which use facility-specific permit processes.

UT-Battelle has established a formal excavation/penetration permit process to provide assurance that soil excavations and penetrations in ceilings, walls, and floors do not inadvertently expose workers to such hazardous energy sources as natural gas, pressurized water, steam, or electricity. The requirements for excavation/penetration permits were included in an SBMS subject area entitled *Excavation/Penetration*. Applicability of this internal requirement was extended to construction subcontractors through the Division 1 Technical Specifications in their contracts.

UT-Battelle has made significant improvements in its excavation/penetration controls in recent months. Prompted by recurring injuries during penetrations and excavations at other DOE sites, and near misses at ORNL, UT-Battelle has taken significant steps to reduce the risk of such injuries at ORNL by improving instrumentation, controls, and configuration management:

- Instrumentation to locate underground utilities was purchased in December 2003, and the requirement to mark prior to excavation was added to the excavation/penetration subject area early in 2004.

- The excavation/penetration permit was changed in February 2004 to require hand-digging within two feet of marked utilities.

- A lower-tier subcontractor specializing in utility marking was hired last month to support the new marking initiative.

- A Global Positioning System has been ordered to identify the location of underground utilities with greater precision.

- Special controls for floor, wall, and ceiling penetrations less than two inches in depth have been added to the excavation/penetration SBMS subject area and to Subcontractor Division 1 Technical Specifications.

- The excavation/penetration permitting process was recently changed to require requestors to provide updated information to Engineering when differences between drawings and as-built configurations are discovered during excavation.

Recent assessments by OSO and UT-Battelle have identified the need for additional improvements in the ORNL excavation/penetration program. A UT-Battelle internal assessment and an OSO surveillance identified the need for process improvements in several areas, such as clarifying procedures and responsibilities, strengthening the process for drawing updates, and establishing permit time limits to improve program efficiency and effectiveness. UT-Battelle expects to complete a corrective action plan by June 25, 2004, to address these findings.

Although significant improvements are being made as a result of OSO and UT-Battelle reviews, the OA team identified a number of additional program weaknesses, as discussed in the following paragraphs.

Responsibilities for identifying and marking underground utilities at construction sites were not clearly defined in the Excavation/Penetration Program. Permits at construction sites typically did not address underground piping and wiring that had been installed by the construction subcontractor, even if such utilities were known to be present. The construction subcontractor was responsible for identifying the location of such utilities and protecting them during excavation. This division of responsibilities was not documented in the UT-Battelle Excavation/Penetration Program and could lead to accidents if not understood by subcontractors.

Some of the permit exclusions specified by the SBMS subject area were not well supported with technical bases or performance data:

- Excavation Exclusion #1 excludes excavations for maintenance replacements of the same location, depth, and size as the items being replaced. This exclusion was intended to apply only to vertical soil penetrations such as signposts and poles, but this intended limited applicability was not clearly specified. Broader application could result in unanalyzed hazards.

- Excavation Exclusion #3 states that a permit is not required for excavations 12 inches or less in depth. While utilities were normally buried deeper than 12 inches, there is no design or installation specification to ensure that this is always the case.

- Penetration Exclusion #1 excluded fastener penetrations in walls, floors, and ceilings with two inches or less embedded depth. In at least four cases since January 2002, penetration events involving electrical hazards have occurred at ORNL in which the penetrations were less than two inches in depth. None of these events had gone through the permit process and associated hazards analysis.

The permits do not include some information that would be useful to excavators. The current permit form requires a signature to confirm that underground utilities have been surveyed and marked, but neither the form nor process instructions includes provisions for confirming multiple markings that may occur over an extended period of time. Without such updates on permits, excavators may mistakenly interpret the absence of ground markings to mean that a requested survey was done and no utilities were found when, in fact, no survey was performed.

Available instrumentation is not being used to its full potential to enhance safety, and instrument use is not governed by a written ORNL procedure. The instrument used to locate underground utilities can be used in an active mode to locate known utilities, which have been connected to a signal transmitter, or can be used in a passive mode to locate unknown utilities based on detection of ferrous metal or inductive fields caused by current in electrical conductors. The passive mode was not normally used by the locating sub-tier subcontractor. Thus, unknown utilities, such as those not identified on drawings, may not be identified. Because drawings of ORNL underground utilities do not always reflect as-built conditions, not using the passive modes could result in missing the presence of electrical wires or metal pipes. In addition, the instrument that was being used to locate underground utilities could also be used to locate utilities buried in walls, floors, and ceilings of buildings. This practice was not required by the permitting process. Further, the instrument used to detect underground utilities measures the depth of burial, but this information was not recorded on the permit or ground markings. This information is needed by excavators to assure compliance with the two-foot hand-digging requirement.

The location of proposed excavations was not precisely identified on some permit requests causing the locating contractor to survey an unnecessarily large area. Surveys could be more efficient and thorough if the location of proposed excavations were marked.

Finding #19. Weaknesses in the UT-Battelle excavation and penetration process reduce its effectiveness in protecting workers from energetic sources.

In addition to the primary ORNL excavation and penetration permit process, which was the focus of this review, two ORNL facilities have facility-specific permit processes. HFIR uses a facility-specific process that is similar to the primary ORNL process but more rigorous in some areas because of the unique hazards and level of facility knowledge associated with an operating nuclear reactor. The Spallation Neutron Source construction project uses a process that is similar to the primary ORNL process but differs in some aspects. UT-Battelle personnel indicated that the Spallation Neutron Source construction project process was different because of the unique aspects of the construction zone (e.g., a previously undeveloped area that had few pre-existing utilities, and most of the electrical wiring was not energized). While it is appropriate for excavation/penetration processes to be tailored to facility-specific hazards, the need for three separate and different systems at ORNL is not apparent. Further, the existence of three different systems could result in interface problems in situations where jurisdictions overlap.

Summary. UT-Battelle has made a number of improvements in the UT-Battelle program for controlling excavations and penetrations and more are planned. However, additional improvements are needed in a number of areas, such as permits and use of scanning equipment.

E.2.3 Unreviewed Safety Question Process

The USQ process is an important element of a nuclear safety program. OA inspections in the past few years have identified a number of generic deficiencies in site USQ procedures, which contribute to incorrect USQ screenings and evaluations. Some of these deficiencies stem from DOE guidance that is not fully effective in communicating the expectations of 10 CFR 830 requirements. OA has provided the Office of Environment, Safety and Health (EH) an analysis of weaknesses in the DOE guidance, and EH is evaluating potential changes. OA is reviewing the USQ process as a focus area at most sites to provide feedback to the sites on USQ processes and to provide continued feedback to EH on the generic problems that need to be addressed on a DOE-wide basis through improved guidance.

At ORNL, OA examined the sitewide USQ procedure to identify deficiencies that could lead to incorrect screenings. As part of its review of HFIR (see Appendix F), OA also examined application of the USQ screening process, including a review of eighteen USQ screens of changes to HFIR procedures and structures, systems, and components (SSCs). ORO has approved the ORNL USQ procedure in accordance with the established approval process. Most of the USQ procedure's directions are in accordance with 10 CFR 830 requirements. However, a few aspects of the approved procedure are not fully consistent with the provisions and intent of 10 CFR 830 requirements. Specific deficiencies identified are:

- Some procedure changes could be incorrectly excluded. Changes to procedures that are simply listed in the documented safety analysis (DSA) and not described in detail are incorrectly excluded from consideration.

- The procedure could lead to incorrect screening out of changes to SSCs. SSCs can be incorrectly screened out in two ways: (1) based on the effects of the changes rather than simply determining whether it is a change to the facility or the procedures described in the DSA, and (2) considering only SSCs described in the hazards and accident analyses sections of the DSA rather than the entire DSA.

- The procedure incorrectly directs the user to consider in USQ determinations only those new accidents or malfunctions that are as likely to occur as those previously considered in the DSA rather than all new accidents or malfunctions.

- The procedure incorrectly implies that only margins identified in the technical safety requirement bases need to be considered when answering the USQ determination question concerning reduction in margin of safety.

To evaluate the impact of these procedure deficiencies, OA reviewed 18 USQ screenings for the HFIR systems to determine whether plant procedure changes or design modifications were being correctly screened. Six of these inappropriately screened changes out of the process that should have undergone complete USQ determinations. However, OA review of these six indicated that they were unlikely to have resulted in an actual USQ, which would have necessitated DOE approval for the changes. Nevertheless, the procedure deficiencies need to be addressed to prevent incorrect screenings in the future, which could result in USQ determinations not being performed when required.

Finding #20. ORO and ORNL have not ensured that the ORNL USQ process, procedure, and implementation are adequate.

Summary. Most aspects of the UT-Battelle sitewide USQ procedure are adequate. However, deficiencies in the procedure are contributing to incorrectly screening out changes in plant procedures or design.

E.2.4 Safety Management for Protective Force Training

A recent Inspector General (IG) report identified weaknesses in some aspects of Basic Security Police Officer Training, including safety aspects of protective force training. The DOE corrective action plan for the IG report committed OA to examine selected aspects of protective force training from a safety management perspective on OA ES&H inspections.

At ORNL, OA reviewed ongoing protective force weapons training sessions at the Wackenhut (the protective force contractor) central training facility to determine the effectiveness of the hazards analysis process. Specifically, OA observed classroom training on the M249 machine gun and preparations for conducting this training. OA selected this activity for review because firearms present a potential hazard and because the training was ongoing during the OA evaluation period. Firearms training and firearms safety are important elements of the Basic Security Police Officer Training program. OA also reviewed selected aspects of Wackenhut feedback and improvement and OSO line management oversight as they are applied to the protective force training activities.

Hazards Analysis During Protective Force Training

Prior to the live firing of any weapon, Wackenhut requires students to participate in extensive classroom training, which incorporates hands-on training for the students. Class size is typically small to encourage student interaction and enable hands-on interaction with the weapon. Training facilities (classrooms, firing ranges and the gun cleaning facility) are modern, well posted with safety precautions, with good housekeeping.

In preparation for the live firing of the M249 machine gun, students are required to successfully complete eight hours of classroom training, consisting of four training modules that address machine gun nomenclature, manipulation, malfunctions, and marksmanship. The class was limited to ten students, and one instructor and two assistants were present in the classroom to respond to questions and assist with the hands-on exercises. Each student was required to pass a quiz at the end of each module prior to proceeding to the live-fire exercise.

Overall the training was well organized, effectively presented, and resulted in the students being engaged in the training. The primary instructor was experienced in the operation and maintenance of the weapon, emphasized the safety aspects of assembly and firing the weapon, and was able to effectively answer all questions.

A strength of the Wackenhut protective force training process is that most lesson plans have an accompanying risk assessment that identifies procedure requirements, risks and hazards, and controls (similar to a job hazards analysis). The intent is then to incorporate these controls into the lesson plan. Instructors, students, line managers, and Wackenhut ES&H personnel are involved in the preparation and review of each lesson plan. In general, the risk assessments prepared for the M249 training identified, documented, and communicated the most significant hazards.

Although the risk assessment and protective force training process is robust, two concerns were identified by the OA team. One concern was that the risk assessments addressed only the hazards associated with the firing of the weapon, and not the initial assembly/ disassembly of the weapon or the final cleaning of the weapon. Although firing the weapon presents the most significant hazards, the OA team observed that some hazards in the disassembly/assembly of the weapon could result in significant injuries to the student. For example, the failure to properly position the bolt prior to removing the gun stock could result in the compressed spring being released as a projectile, potentially injuring anyone in the spring's path. A second concern is that the hazards and controls identified in the risk assessments are not always clearly identified in the lesson plans. As a result, in some cases, it is not clear whether the hazards and controls documented in the risk assessment will be adequately communicated to the students.

Feedback and Improvement

Wackenhut has established assessment, corrective action, lessons-learned and employee concerns programs that address ES&H programs and performance at the central training facility. Independent assessments of safety programs and processes are conducted by the Quality Assurance organization, including field examinations and implementation or performance reviews. The ES&H organization annually plans and conducts about a dozen audits, a firearms safety assessment, and an ISM evaluation.

The line, including the central training facility, conducts safety walkthroughs and an annual assessment against work smart standards requirements. The assessment program has undergone a recent overhaul, with new procedures to strengthen the line self-assessment element.

An innovative program called Immersion Days involves six teams comprised of safety, quality assurance, and management personnel "immersing" themselves and workers in a focus area, such as motor vehicle safety, ISM, or firearms safety. The teams spend from one-half day to several days in the field interfacing with and observing line personnel conducting routine work activities (e.g., riding with protective force officers on patrol or participating in training activities). The teams work to a formal agenda and checklist related to the focus area. Feedback is solicited from line staff participants. Observations and feedback information is reviewed by the team at the end of the week, and issues and corrective actions are developed as required. This program provides an effective tool for observing work activities, communication of management safety expectations to workers, and feedback from the workforce to management on safety questions and concerns.

Issues (e.g., findings and observations) from ES&H, ISM, and Quality Assurance assessments are input to a central Corrective Action Tracking system. Corrective action plans are required for findings but are optional for observations; all issues are tracked to closure. Quality Assurance and ES&H personnel perform corrective action verifications, typically on subsequent assessments of the same area or topic. A lessons-learned coordinator reviews external lessons learned, develops internal lessons, and disseminates lessons to staff, and maintains a website of lessons-learned information.

ORO Oversight

ORO has assigned a subject matter expert to oversee the safety of protective force activities. This individual is knowledgeable and experienced in this area and spends considerable time reviewing and observing training activities. The focus of his activities at the time of the inspection was the requirements of the DOE Firearm Safety standard, which requires that new lesson plans include a risk analysis.

The contractor performance for fee determination is evaluated based on performance objectives described in the performance evaluation plans (PEPs), which are prepared semi-annually. The performance objectives and measures in ORO PEPs for the Protective Services Program for 2004 are adequate for implementation of the safety program and ISM system, and include a provision for an annual self-assessment based on the DOE ISM guide.

Summary. The most significant hazards are effectively addressed in the Wackenhut training process for the activities reviewed. However, less significant hazards are not rigorously analyzed and controlled. OSO line management oversight and Wackenhut feedback processes are appropriately designed and implemented to address safety of the protective force training activities reviewed by OA on this inspection.

E.3 Conclusions

For the most part, DOE line management – SC, ORO, and OSO – and contractors – UT-Battelle and Wackenhut – have been proactive and effective in addressing the complex issues associated with the focus areas that were reviewed by OA on this inspection. SC, ORO, OSO, and UT-Battelle have been proactive in addressing legacy issues and have made considerable progress with the available funding. Similarly, OSO and UT-Battelle have responded to DOE-wide lessons learned in the area of excavation/penetration safety and conducted internal assessments and made a number of improvements. OSO and Wackenhut have also made safety a priority in protective force training activities.

However, a number of areas need increased attention and additional improvements. Close coordination among the major program offices – SC, NE, EM, and NNSA – will be needed to address and resolve responsibility for funding certain cleanup activities. Close coordination will also be needed between the program offices and ORO/OSO and UT-Battelle to ensure that available funds are used optimally, based on a clear overall strategic plan for addressing legacy hazards, and that issues with long-term storage of hazardous waste are addressed. Further improvements are also needed to enhance safety of excavation/penetration activities, deficiencies in the USQ procedure and its implementation, and worker safety aspects of protective force training.

E.4 Opportunities for Improvement

This OA review 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.

SC, EM, NE, and NNSA

1. **Coordinate efforts among SC, EM, NE, and NNSA to develop a comprehensive strategy that reaches consensus on the disposition and transfer of excess facilities and the funding of legacy activities to address the environmental and safety hazards at ORNL.** Specific actions to consider include:

    - Develop an SC and EM strategy for use and disposition of jointly used legacy facilities for restoration and laboratory operations.

    - Clearly define SC, EM, NE, and NNSA responsibilities for dispositioning and transferring facilities that are no longer needed, and for addressing legacy contamination and demolition, including funding for Y-12 National Security Complex buildings that have been jointly used in the past or where the scope of restoration/demolition is not clearly defined.

    - Define SC and NNSA responsibilities for cleanup of shop areas used by the Y-12 National Security Complex contractor to support UT-Battelle operations.

UT-Battelle – Legacy Hazards

1. **Prepare plans and formalize processes that address legacy hazards and the disposition of facilities no longer having mission requirements.** Specific actions to consider include:

    - Develop a strategic plan that describes how UT-Battelle will identify, manage, and disposition legacy hazards at ORNL. Identify all current or planned initiatives (LMDI, Facility Disposition, Liquid and Gaseous Waste Treatment System, Non-reactor Nuclear Facility Consolidation, and Remote-Handled and Special Case Waste Management) and how they will be integrated. Include a description of supporting programs (e.g., Landlord-Tenant, Laboratory Space Management) as well as management system tools that will be required (e.g., SBMS, ISM, FUAs, Challenges List, HMIS, Facility Condition Assessment). Address program priorities and funding requirements that will be needed to ensure an overall integrated approach.

    - Prepare a Facilities Disposition Program plan as required by DOE Order 430.1B that addresses program objectives, how program missions will be met, and funding plans.

    - Develop and formalize processes used for deactivation, surveillance, maintenance, and demolition activities, and determine how the principles of ISM will be applied to these processes.

2. **Strengthen surveillance and maintenance activities for deactivated facilities.** Specific actions to consider include:

    - Implement near-term corrective actions to address existing environmental vulnerabilities for deactivated facilities and institute effective hazard controls for these facilities as part of facility surveillance and maintenance.

    - Formalize, communicate, and implement the roles, responsibilities, authorities, and accountabilities for developing and implementing surveillance and maintenance activities for all involved parties.

    - Ensure that walkthroughs of deactivated facilities are conducted on a regular basis and include ES&H subject matter experts in those walkthroughs. Ensure that existing hazard controls and surveillance and maintenance plans are adequate or modified, as necessary, to meet changing facility conditions.

3. **Strengthen some aspects of the Laboratory Space Management and Landord-Tenant Model Programs.** Specific actions to consider include:

- Establish facility limits for laboratories and for space assigned to the Facilities and Operations Directorate. Complete the upgrade of the HMIS. Ensure that the system database accurately reflects the current inventory of hazardous materials, including chemicals, biohazards, and explosives, for each facility, and ensure that facility limits for these materials are incorporated in FUAs.

- Enhance the Laboratory Space Management Program by extending annual LSM training to tenants and Complex Facility Managers. Include a discussion of the roles, responsibilities, authorities, and accountabilities of LSMs, tenants, and Complex Facility Managers for preventing the accumulation of hazardous materials in facilities and laboratories.

4. **Ensure that legacy waste containers in SAAs are dispositioned in a timely manner.** Specific actions include:

   - Expand the uses of additional waste services, environmental compliance, and/or internal organizational resources in all divisions that have legacy SAAs.

   - Provide additional funds to expedite removal of legacy and unknown hazardous waste from SAAs.

   - Consider moving legacy wastes from SAAs into 90-day storage areas and/or permitted Treatment, Storage, and Disposal facilities operated by the ORO waste management contractor.

UT-Battelle – Excavation/Penetration

1. **Further enhance excavation/penetration safety by expanding the scope of ongoing corrective plans in the areas of permits, equipment usage, and program scope.** Specific actions to consider include:

   - Clarify responsibilities for marking underground utilities at construction sites.

   - Re-evaluate and clarify exclusions to the permit processes.

   - Revise the permit form to add provisions for confirming completion of multiple underground utility surveys.

   - Develop a written procedure for use of survey equipment. Re-evaluate the use of scanning equipment and consider when it would be beneficial to use the passive mode, record and communicate depths of utilities (with appropriate conservative error bounds), and use the equipment for penetrations.

   - Re-evaluate the need for three separate excavation/penetration processes. Consider developing a single system that includes the best features of each of the three systems and that has provisions for facility-specific conditions, where warranted.

UT-Battelle – USQ Procedure

1. **Revise the site USQ procedure and associated training programs to correct weaknesses, including areas where directions are not consistent with 10 CFR 830.** Specific actions to consider at HFIR and other ORNL facilities include:

   - Revise the procedure to address identified deficiencies in exclusions, screening of SSCs, accidents and malfunctions, and technical safety requirement basis margins.

   - Revise current USQ training course materials to reflect the above-described changes to the procedure, and implement this new training for all currently qualified and future USQ screeners, evaluators, and approvers.

   - Perform assessments to verify effectiveness of changes to the procedure, and determine the level of understanding by USQ screeners and evaluators.

   - Perform extent-of-condition reviews of changes previously screened out of the USQ process and perform USQ evaluations of changes determined not to be USQs per the current criteria. Perform corrective actions on discrepancies that are discovered, and expand extent-of-condition reviews as indicated by the extent of discrepancies found. Address all HFIR and other applicable ORNL facilities.

Wackenhut – Protective Force Training

1. **Review protective force training programs to ensure that the full range of worker safety hazards are addressed.** Specific actions to consider include:

- On an as-needed basis, review risk assessments and associated lesson plans to ensure that all hazards are addressed, particularly those hazards associated with the setup and dismantlement/closure of the training exercise.

- On an as-needed basis, review lesson plans to ensure that hazards and controls identified in risk assessments have been adequately integrated into the lesson plans.

APPENDIX F
HIGH FLUX ISOTOPE REACTOR IMPROVEMENT INITIATIVES AND ESSENTIAL SYSTEM FUNCTIONALITY

F.1 Introduction

The U.S. Department of Energy (DOE) Office of Independent Oversight and Performance Assurance (OA) evaluated improvement initiatives and selected essential safety systems at the High Flux Isotope Reactor (HFIR) at the Oak Ridge National Laboratory (ORNL). The HFIR is one of three Category 1 (high potential hazard) reactors operated by DOE and serves as an important tool for research activities and for production of isotopes useful for medical purposes, such as cancer treatment. The reactor is currently undergoing a major upgrade to support research using cold neutrons.

The evaluation consisted of two components:

1. **Improvement initiatives**. OA focused on ongoing improvement initiatives in HFIR management systems, including corrective action for a January 2003 unplanned shutdown event.

2. **Essential system functionality (ESF)**. The ESF assessment evaluated the functionality and operability of selected systems and subsystems that are essential to safe operation. This assessment addressed two safety systems at the HFIR: the primary coolant system (including emergency cooling pumps and pressure relief equipment) and the fuel pool (including pool structures, pool cooling and cleanup systems, pool water supply systems, and fuel handling and refueling equipment).

The HFIR management systems and essential systems reviewed by OA and specific OA team activities are discussed further in the respective results sections.

F.2 Results

F.2.1 Improvement Initiatives

HFIR experienced an unplanned manual shutdown event in January 2003. ORNL senior management took a series of actions to evaluate the cause of the incident, explore performance trends, and evaluate overall environment, safety, and health (ES&H) program rigor. ORNL completed a number of key reviews and assessments of HFIR performance and developed a corrective action plan based on the results of these reviews.

Because of potentially high hazards associated with a Category 1 nuclear reactor and the significance of the event, OA decided, during planning for this inspection, to perform a detailed review of the corrective actions at HFIR. Based on a review of the deficiencies that led to the event and the corrective action plan, OA evaluated three general areas:

- Roles, responsibilities, and interfaces with research and development (R&D) users/experimenters

- Work planning and control processes, and systems engineering

- Self-assessments.

These three areas encompass the corrective actions and their causes, and are discussed in the following subsections. In addition, OA reviewed DOE line management oversight activities as they related to HFIR, including DOE Office of Nuclear Energy, Science and Technology (NE) and DOE Office of Science (SC) roles and responsibilities for HFIR safety management and ORNL Site Office (OSO) oversight, with a focus on the Facility Representative program. The results of the review of DOE organizations are discussed in Appendix D.

F.2.1.1 Reactor Research Division Roles, Responsibilities, and Interfaces

The ORNL analysis of the shutdown event identified a number of weaknesses in the technical and operational interfaces between experimental areas and HFIR operations. The corrective action plan focused on improving these interfaces and enhancing the Laboratory Space Manager (LSM) approach. OA focused on roles, responsibilities, authorities, and accountability (R2A2) for organizations with safety responsibilities at HFIR, with emphasis on the organizational interfaces and the LSM function.

R2A2s for quality assurance and ES&H (including integrated safety management [ISM] implementation and the control of work activities and associated hazards) are generally well defined, documented, and understood by personnel in the Reactor Research Division (RRD), which is the ORNL division that has line management responsibility for HFIR. Based on results from a recent RRD self-assessment, RRD recently revised their procedures to reflect the current organization structure and management system practices. With a few exceptions, position descriptions within RRD are up to date, and the managers and technical staff who were interviewed were technically qualified and were very knowledgeable of their current job duties and assignments. R2A2s for a few positions have not been updated, including the RRD lead shift technical advisor position, which is the interface with the Center for Neutron Scattering (CNS) engineering support group, and the RRD maintenance coordinator positions; however, management was aware of this condition and has identified and documented actions to address these deficiencies.

The Physical Science Directorate has established and is effectively implementing the Laboratory Space Management Program at HFIR. For example, the CNS LSM is technically qualified, experienced, and very knowledgeable of the facility and laboratory spaces, and has ensured that sufficient mechanisms have been identified and established to carry out assigned functions. The CNS LSM conducts daily walkthroughs of assigned areas to verify compliance with the HFIR fire hazards analysis. In addition, more detailed walkthroughs of assigned laboratory spaces are conducted quarterly using the ORNL Standards Based Management System (SBMS) LSM checklist. Completed walkthroughs are documented, and there is evidence of issues being identified and appropriate actions being taken. The CNS LSM also participates in daily RRD plan-of-the-day meetings to ensure that potential impacts on HFIR operations and CNS research activities are identified and communicated. However, there was no ORNL formal training program, including refresher training, for LSMs other than the initial indoctrination seminar that only addressed R2A2s.

The CNS LSM is effectively using the Research Hazard Analysis and Control System process. The research safety summary is maintained current and is used as an authorization basis document for defining and authorizing the scope of research work activities, as a mechanism for the identification of hazards and linkage to hazard control mechanisms, and for establishing training requirements for personnel working within the HFIR facility and laboratory spaces.

The CNS LSM also develops and conducts annual facility-specific training given to experimenters that is based on the research safety summary and the memorandum of understanding between CNS and RRD. Lessons learned in such areas as configuration management and implementation of HFIR fire hazards analysis that had previously resulted in interface concerns between HFIR operations and CNS research activities are appropriately addressed. Other important ES&H areas that are also addressed include radiological controls for handling irradiated samples, chemical safety, and stop-work authority. The annual training requires testing of individuals' knowledge and understanding of interface areas between HFIR operations and CNS research activities, and the CNS LSM receives training and qualification status reports for all individuals that are identified on the research safety summary report.

The training sessions are also effectively utilized by the CNS LSM to reinforce line management expectations for performance, to solicit feedback on the accuracy of authorized laboratory activities and identification of hazard controls documented in the research safety summary, and to identify additional guidance and clarification on organizational interfaces for inclusion in the RRD/CNS memorandum of understanding.

Technical and operations interfaces between the experimental groups and HFIR operations have been strengthened. The RRD/CNS memorandum of understanding is very detailed and is being effectively used and maintained. It clearly defines interface boundaries, work process control requirements for experimental work, responsibilities of CNS and RRD for implementing configuration management processes, and expectations for research work control and modification processes. For example, the memorandum of understanding had been updated to address recent configuration control issues involving unauthorized modifications outside the HFIR configuration processes, and was being revised to address the changes in physical plant boundaries for recently implemented modifications to the HFIR instrument air system. Additional changes are also being made to address new organizational changes and the additional user groups, and to better define current processes used for the review and approval of CNS experiments.

RRD and CNS are working more closely together to ensure that modifications to experimental areas do not adversely impact HFIR safety basis and configuration management requirements. RRD has established the lead shift technical advisor position, which is the interface with the CNS engineering support group, to facilitate timely RRD involvement in the design process for CNS activities. Weekly RRD/CNS status review meetings on CNS-sponsored modifications are conducted to ensure that work scope is clearly defined, and that associated hazards and potential impacts on HFIR reactor operations are identified and analyzed early in the conceptual design process. For example, as part of the cold source project, a new physics experiment plans to introduce liquid hydrogen in a future design modification. The introduction of this hazard has been identified as an item that needs HFIR safety analysis input to determine whether this new hazard is allowable and whether controls could be established that would stay within the HFIR safety basis accident analysis.

RRD continues to identify some instances where modifications that were outside the configuration management process were previously installed by research organizations. OA's review of these cases indicates that these modifications were installed prior to the recent improvements to configuration and work control processes, and were being identified, captured, and analyzed as part of the current configuration management program requirements.

Detailed procedural processes have been established for performing and documenting the safety and operability reviews required for reactor vessel and gamma irradiation experiments. These processes have been strengthened to better define components and procedures that are subject to configuration control and to address and assess impacts of research-related maintenance activities. Similarly, processes have also been established for review and approval of experimental research activities related to neutron scattering, such as performing safety reviews and handling irradiated samples. However, the guidelines for the performance of experimental safety reviews for neutron scattering have not yet been updated to fully reflect current practice. RRD also recently self-identified a nonconformance involving several in-vessel experimental capsules that were found to be installed with non-conservative supporting calculations; while the safety significance was determined to be minimal, this nonconformance highlights a continuing need for attention to detail and rigor in the review and approval of experimental activities.

Summary. RRD has clearly defined the functional relationships and responsibilities among the operations and research groups, and has established and implemented processes to ensure that organizational interfaces are documented and understood. The establishment and implementation of the LSM position and the RRD lead shift technical advisor position for engineering support functions has been effective in ensuring that the technical and operations interfaces between the experimental areas and HFIR reactor operations are clearly understood by organizations. However, continued management attention is needed to ensure that experimental activities continue to be appropriately evaluated, reviewed, and approved.

F.2.1.2 Work Planning and Control, and Systems Engineering

ORNL identified a number of weaknesses in work planning and control that contributed to the unplanned shutdown event in 2003. The ORNL corrective action plan also identified the need for improvements in the system engineer program. OA examined various work packages and procedures, with emphasis on post-maintenance testing, configuration management, surveillance, and testing. OA also reviewed the status of the development of the system engineer program and its interfaces with maintenance, facility conditions, and work packages.

RRD has made good progress in effectively addressing previously identified deficiencies in implementing maintenance work planning and control, and system engineering processes. RRD has implemented a number of steps to strengthen maintenance work planning and control in response to previous operational concerns. For example, procedure upgrades require assigned task leaders to evaluate impacts of the potential use of temporary or transient equipment, such as scaffolding, and potential impacts to technical safety requirements (TSRs) as part of the planning process. In addition, follow-up review by the maintenance coordinator is now required to verify that work scopes have not changed and that the appropriate work package classification type is consistent with the scope of work.

Actions were also taken to strengthen post-maintenance testing requirements, such as separation of troubleshooting from repair activities to ensure that post-maintenance testing requirements are clearly defined and documented in work packages prior to authorization of repair activities. Increased requirements and changes to the post-maintenance testing form have also been implemented to include a requirement to demonstrate component and system operability. In addition, system engineering roles and responsibilities have been integrated into maintenance work planning and control processes to strengthen technical input in testing requirements and criteria. Other actions taken by RRD, such as the development of a comprehensive maintenance performance improvement plan, establishment of a central maintenance planning group, and the addition of closeout checklists in work packages, are driving improvements in the quality and consistency of documentation of performed maintenance. However, continued attention is warranted to ensure that vendor manual recommendations are captured in maintenance work instructions (see Section F.2.2.2).

OA's review of a sample of work packages revealed an increased level of rigor in the specificity of work package instructions, better definition in post-maintenance testing requirements, more frequent use of and feedback by the workforce to improve maintenance instructions and procedures, and improved quality in work package documentation. In addition, OA's review of a recent occurrence, involving self-identification of a less than adequate test and a potentially inadequate safety analysis (PISA) condition, provided further evidence of the effectiveness of RRD actions. A comparison of main coolant pump vibration test work packages for the June 2004 test to the work packages for the previous test conducted in December 2001 shows a noticeable increase in the level of planning and instruction to conduct the test. Instructions for documentation of as-found settings were very detailed and consistent with the vendor manual instructions for determining the as-found condition. Linkage to the safety basis requirement was clearly identified in the test procedure, and a requirement was added for notifying the RRD safety analyst if the setpoints were found to be different than the requirement. In the 2001 acceptance testing requirements, the criteria for the trip setpoint valves were based on the manufacturer's recommendations, rather than the safety basis requirements in the Updated Safety Analysis Report (USAR). The increased involvement of the system engineer and safety basis analyst in work package development was evident. The increased involvement by the systems engineer and safety analyst contributed to an increased level of specificity in definition of the acceptance testing values and the self-identification of inadequate as-found conditions and safety analysis report flowdown concerns.

While actions have been taken to ensure that safety basis requirements are better defined and flow down to test procedures, this event also identified weakness in the review process for development and implementation of USAR and TSR revisions. Specifically, the alarm setpoint on excessive vibration for the primary main coolant pumps referenced in the USAR was found to have an undefined technical basis, and the referenced trip setpoint was not addressed in maintenance and systems engineering procedures. Management has identified this area as a follow-up action to be completed as part of implementation of the documented safety analysis upgrade currently in progress.

Recognition for a need for a strong systems engineering program stemmed from prior operational occurrences that had revealed weaknesses in configuration management and equipment aging concerns. OSO, based on guidance from SC, directed the contractor to implement a systems engineering program in 2001. As discussed later in Section F.2.2.1, while much work remains, RRD has taken a number of positive steps to establish and implement an effective systems engineering program. For example, all configuration management procedures have been revised to improve the execution of plant modifications. The configuration management procedures, including the nonconformance report (NCR) process procedures, have been appropriately updated to prohibit the use of the NCR process as a means of performing plant modifications. NCRs were also appropriately receiving an unreviewed safety question (USQ) screening on reported discrepant conditions to evaluate potential impacts on the safety basis. The safety-related equipment list was previously updated and is being used in the engineering modification and maintenance work control processes to determine proper categorization of work type.

However, actions have not yet been fully effective in addressing identified weaknesses in configuration management and in surveillance and testing programs (see Sections F.2.2.1 and F.2.2.2). These continued weaknesses are, in part, attributable to the lack of a comprehensive systems engineering program, which is not anticipated for full implementation until fiscal year 2007. A number of key activities, such as detailed walkdowns of systems to document system status, development of system design descriptions, and establishment of system engineering files, are far from complete. It is likely that additional discrepancies in such areas as USAR supporting analyses, classification of equipment and components, and in-service inspection/in-service testing (ISI/IST) program coverage will also be identified as full implementation of the systems engineering program progresses. In addition, while assigned system engineers have made progress towards meeting qualification requirements, system engineers did not always display a detailed working knowledge of USAR accident analysis as it related to their assigned systems. Actions to strengthen system engineers' knowledge base of safety basis accident analyses are identified in systems engineering program plan future milestones. RRD management recognizes that the lack of a fully implemented systems engineering program poses a vulnerability to achieving success in meeting RRD's strategic goal (i.e., critical outcome) of outstanding nuclear facility operations.

Summary. RRD management is making progress in effectively addressing previously identified deficiencies in maintenance work planning and control and in systems engineering processes. However, the lack of a fully implemented systems engineering program poses a vulnerability to achieving success in meeting RRD's strategic goal of outstanding nuclear facility operations.

F.2.1.3 RRD Self-Assessment

The ORNL analysis of the unplanned manual shutdown event identified a weakness in the self-assessment program as a significant contributing factor because the ORNL self-assessments did not identify and correct the weaknesses that led to the event. ORNL determined that improvements in the self-assessment process were needed to prevent recurrence and that more ORNL and RRD management involvement was needed to establish and communicate expectations and monitor performance. OA examined the enhancements in the self-assessment program, focusing on management communication of expectations, management priorities, conduct of self-assessments, management field presence, performance indicators, and corrective action management.

RRD has established key management system processes for ensuring that RRD mission and goals are clearly linked to the ORNL strategic plan, and for balancing priorities and work scope to measure progress. The RRD Performance Management Plan defines the approach as well as the critical outcomes and strategic goals, and associated performance objectives and indicators. The plan also provides the framework and focus areas for the RRD self-assessment program. The plan appropriately addresses a number of ES&H issues, such as maintenance improvement initiatives, systems engineering implementation, and the need for clear and effective user interfaces. These issues are appropriately based on previous operational issues at HFIR. Key performance measurement activities, such as targeted assessments, performance trending, and performance metrics, are identified in the plan to track and measure progress.

In addition, RRD has established a comprehensive planning and work management tool to address the full scope of work at HFIR. The Integrated Work Plan addresses the many needs of the HFIR facility, including infrastructure needs (such as system modifications), program improvements (such as system engineering and maintenance program upgrades), mission needs, and routine operations and maintenance. Discussions with NE, SC, and ORNL managers indicate that the plan has been an effective tool in articulating resource needs to ORNL senior management and DOE Headquarters Program Offices. RRD and ORNL senior managers were knowledgeable of the plans' contents and priorities, and were actively engaged in using the plan for monitoring progress as well as assessing impacts of changes in priorities or funding. The plan links to the RRD Performance Management Plan and reflects the current overall priorities of the HFIR FY04 Critical Outcomes. In addition, the Integrated Work Plan priorities and actions adequately flow down to individual RRD managers and staff, and there are appropriate measures to hold individuals and organizations accountable for performance. A simple risk management tool provides a standardized approach for setting priorities. A change control process has been instituted to manage changes to the plan; the process includes HFIR Executive Steering Committee involvement, and assigns overall approval authority for changes to the Director of RRD. Although the Integrated Work Plan is an effective tool that is currently being used by senior management, the Integrated Work Plan process has not yet been formally documented and institutionalized in any RRD management systems description document or procedure.

RRD has established the framework for a comprehensive self-assessment program, which includes facility observations, facility inspections, functional and group assessments, Quality Assurance surveillances, RRD Performance Management Plan assessments, independent assessments and audits, and tracking and trending of performance information, including performance indicators. Requirements for a formal integrated assessment program and schedule were established in a recently (May 28, 2004) issued revision to the assessment procedure. Key improvements in the self-assessment process include: increased line management ownership of the process, linkage to the RRD Performance Management Plan, improved trending tools and reporting, and use of one integrated, annual self-assessment plan and schedule that is approved by the HFIR Executive Steering Committee.

The RRD Director has clearly communicated the expectations and requirements for management presence in the field in monitoring work progress, and several mechanisms are being used to accomplish this goal. The field observation program is an effective mechanism to increase management involvement and field presence. Facility observations provide performance-based feedback to the RRD Director on worker safety culture and also provide a mechanism for management to interface with the HFIR staff and communicate and reinforce management expectations. Facility observations focus on observing HFIR staff performing work activities in the field. The RRD Director regularly assigns HFIR managers to observe HFIR activities, which are selected from the plan of the day. Since reinstating the program in February 2004, there have been approximately 30 documented field observations, many of which were performed by the RRD Director.

In addition to facility observations, facility inspections are also being used by RRD senior management to increase field presence and ensure that managers periodically tour the facility and observe plant conditions. These inspections focus on material condition issues, and compliance with Occupational Safety and Health Administration (OSHA) and radiological controls. Participation by RRD senior management is high and typically includes the RRD Director, several of his direct reports, and the DOE Facility Representative. Since March 2004, nine walkthroughs have been completed, including in research laboratory space areas, and a number of deficiencies have been identified for corrective action. The OA team's walkthroughs of the facility identified no significant material condition equipment issues, such as equipment leaks or poor housekeeping, indicating the facility inspection program is effective in addressing material condition issues.

A variety of internal and external assessments have been conducted on key areas of HFIR operations. These assessments have provided meaningful feedback to management on HFIR performance. Most of these assessments were appropriately targeted on known areas of performance weaknesses. Assessments have been conducted on maintenance work planning and control, TSR implementation, hoisting and rigging, cold source project, RRD procedures, several RRD Performance Management Plan status assessments, and quality assurance surveillances, including lockout/tagout implementation. OA's review of several of these assessments indicates that the assessments were thorough, provided good feedback to management on identified areas for improvement, and appropriately included external expertise.

RRD has established a comprehensive set of performance indicators in a number of key ES&H areas. Performance goals and targets have been established, and HFIR management is actively monitoring monthly trends. Examples of indicators being monitored include: corrective actions, occurrence reports and associated actions, reportable and non-reportable contamination events, maintenance and modifications work package implementation, recordable injuries/illnesses and first aid cases, and radiological exposures. In addition, analysis of Price-Anderson Amendments Act (PAAA) report trends are conducted on a quarterly basis and presented to the HFIR Executive Steering Committee for their review and action. The most recent draft report recommended that work control remains an area requiring continued management attention and that increased management attention is needed on implementation of quality assurance requirements (due to recent investigations and deficiencies with fuel pool tooling).

RRD management is placing increased priority on strengthening their analysis and trending of data. RRD self-identified this need based on analysis of operational discipline issues at HFIR. With the recent issuance of the revised RRD assessment program procedure, quarterly trend analysis is also required for assessment activities. The revised RRD assessment procedure requires that all types of assessments conducted at HFIR be forwarded to the assessment coordinator for logging and binning to facilitate trending.

RRD has also completed a benchmarking review of DOE and industry performance indicators, and is considering adding additional performance measures to complement the HFIR measures currently being monitored. Some of the additional indicators being considered include maintenance rework, lost time due to sickness, reactor coolant boundary leakage, and unplanned entries into limiting conditions for operations. The inclusion of these additional indicators is appropriate and can provide RRD management with additional insights on operational performance. Furthermore, more meaningful performance measures on maintenance program management should be considered that address the timeliness of work package execution and work package type to provide senior management increased insights into the significance of the maintenance backlog.

In addition, the HFIR Executive Steering Committee plans to conduct quarterly reviews covering all performance information from assessment activities, performance indicators, PAAA trend analysis, and trends. The first HFIR Executive Steering Committee review of assessment activities was recently conducted. Formal meeting minutes are taken and actions and assignments from the meeting are being tracked.

A number of mechanisms are being utilized by RRD to monitor corrective action tracking and effectiveness of corrective actions taken, including assessments, performance indicators, and increased senior management involvement. Examples include:

- A number of internal and external assessments have been conducted in problem areas that have provided increased assurance of progress and effectiveness of implementation of corrective actions. For example, ORNL Oversight and Assessment Services recently conducted an effectiveness review to determine whether management actions taken following an unplanned manual shutdown of HFIR on January 2003 were implemented and effective in improving operational discipline concerns at HFIR. This assessment was thorough and was conducted with sufficient depth, and the results of the review were consistent with the observations of this OA inspection. Additional internal assessments in the areas of experimental interfaces, maintenance work planning and control, and systems engineering are planned to further monitor progress and measure effectiveness.

- As part of the RRD Performance Indicator Program, performance indicators have been established to track and trend closure of corrective actions on a monthly basis, and are monitored by the HFIR Executive Steering Committee. To date, HFIR has been consistently meeting its goal of less than 10 overdue corrective actions per month for the 2004 calendar year, and has made progress in reducing the number of overdue actions in the ORNL assessment tracking system (ATS).

- Senior ORNL management presence and involvement in HFIR activities have been strengthened and include OSO and DOE Facility Representative involvement. ORNL senior management meets weekly with RRD managers to monitor actions, issues, and concerns on HFIR operations. Discussions and interactions in these meetings have focused on issues and resource needs for HFIR. For the meetings observed, most senior ORNL managers present were knowledgeable of HFIR operational performance, and follow-up inquiries about RRD management decisions and performance issues were evident. These meetings provide an effective mechanism to address the many challenges to successful HFIR operation that require support from ORNL organizations outside of RRD. Increased formality in the conduct of these meetings (i.e., documentation of meeting minutes, including management actions and tracking in ATS), and more focus on RRD Performance Management Plan objectives and performance indicators would further strengthen this activity.

In addition, recent ORNL actions to strengthen investigation of root causes for occurrences are having a positive impact. OA observed a critique for an occurrence relating to the HFIR primary coolant pump's vibration switch setpoints and subsequent identification of a PISA concern. This was the first critique conducted at HFIR since the implementation of the ORNL critique pilot initiative. With the exception of the operators on duty, all key personnel involved in the event were present at the meeting. Personnel brought such key documents as maintenance work packages, vendor manual instructions, procedures, and operator logs to facilitate the meeting. The critique appropriately focused on the timeline/sequence of events during the first phase of the critique and was reconvened later to address causal factors and immediate and long-term corrective actions. Overall, the critique was conducted adequately to identify the primary and contributing causal factors of the occurrence, and identified corrective actions to appropriately address immediate and generic implications of the occurrence.

Although the new RRD assessment procedure identifies types of assessment activities that will be tracked in ATS, HFIR is not always consistently entering actions taken (e.g., disposition of recommendations and findings) in response to self-assessments or management reviews and/or improvement initiatives into the ATS. Actions in response to recommendations from the December 2003 TSR implementation assessment and the recently completed hoisting and rigging assessment have not yet been entered into ATS, but are being tracked internally by HFIR management. The ORNL Office of Independent Assessment recently identified a similar observation in a May 2004 effectiveness review of

HFIR PAAA corrective action status. As the HFIR Executive Steering Committee gains more experience through quarterly reviews of assessment information, improved consistency in the use of ATS as a management tool is expected.

While RRD is making progress in strengthening its self-assessment program, some program aspects are not yet fully mature or implemented. For example, while an integrated schedule of assessments was identified for fiscal year 2004, an assessment by the ORNL Office of Independent Oversight identified that only one of the seven assessments identified in the RRD Performance Management Plan scheduled to be completed had been performed by June 2004. In addition, tools to effectively conduct assessment cause code trending are in the developmental phase. Furthermore, some assessments, such as facility observations, have not been forwarded to the assessment coordinator for logging and binning, and actions to strengthen existing performance indicators have not yet been fully implemented.

Summary. RRD is establishing a good foundation for an effective self-assessment program. Key management system processes, such as the RRD Performance Management Plan and the Integrated Work Plan, provide structure to guide the implementation of the self-assessment program. Increased RRD management team ownership and participation in self-assessment activities are evident, and increased attention to analysis of performance data is appropriate. In addition, a number of elements of the self-assessment program, such as the field observation program, are particularly effective. Furthermore, RRD is effectively using a number of mechanisms to track and monitor actions being taken and assess their effectiveness. Although RRD is making progress towards strengthening its self-assessment capabilities, continued management attention is needed to ensure that all aspects of the self-assessment program are effectively implemented in a timely manner. Improvement in the consistency and use of the ATS as a management tool is also needed (see Finding #16).

F.2.2 Essential System Functionality

OA reviewed two essential systems (primary coolant system and reactor/fuel pool) as part of its ESF assessment. OA selected the primary coolant system for detailed review because it is important in the prevention and mitigation of potential accidents at HFIR. The reactor/fuel pool structure and equipment were chosen because the HFIR undergoes frequent refueling and other operations using refueling equipment, which could potentially affect the fuel stored in the pool. OA evaluated the systems' design and configuration management; surveillances and testing; maintenance; and operations.

F.2.2.1 Engineering/Configuration Management

OA evaluated the adequacy of the design of selected systems and components to perform their safety functions and the configuration management program to ensure that the design remains adequate and within the requirements of the USAR. OA reviewed selected system calculations, drawings and specifications, vendor documents, and facility-specific technical procedures, and performed walkdowns and interviews with both system and design engineers.

Engineering Design

The HFIR was designed and constructed in the 1950s and 1960s and initiated operation in 1966. Since that time, HFIR has been modified and upgraded numerous times to improve operations and enhance safety. Significant design and operational changes were made in the mid 1980s to address concerns with vessel embrittlement, including lowering the operating power and pressure levels and adding an emergency depressurization system to the primary coolant system.

The USAR appropriately specifies the technical, functional, and performance requirements for the primary coolant system and reactor/fuel pool and refueling equipment, and most systems and components are well designed and analyzed. RRD has developed an extensive set of analyses to demonstrate that the primary coolant system and reactor/fuel pool will perform their safety functions. The safety functions include (1) preventing accidents (e.g., by maintaining pressure boundary integrity) during normal operation and upset conditions, such as seismic events, and (2) mitigating the consequences of accidents, such as loss of power or loss of coolant. Furthermore, the HFIR primary coolant system has some unique design features that enhance its safety, including a reactor pool to vessel check valve that requires no operator action or external power source to ensure makeup water to the reactor for loss-of-coolant accidents; battery-powered reactor coolant pump pony motors that are continuously running to ensure coolant flow through the core for loss-of-offsite-power events; and inherent cooling of the reactor by the reactor pool for normal cooling events.

With a few exceptions, the detailed analyses reviewed were appropriately performed and indicated an appropriate degree of engineering formality and rigor. RRD has established a procedure that supports development of calculations, and recent calculations that were reviewed by OA appropriately followed the procedure. Calculations typically included appropriate margins of safety and considered instrument uncertainty.

Although many design analyses for the HFIR systems and components reviewed were well performed and demonstrated that the systems and components would adequately perform their safety function, several design analysis weaknesses were identified, including: (1) incomplete seismic evaluation of non-seismically qualified equipment over safety-related equipment, (2) inadequate rigor in the analysis of the fuel pool dam lifting lug, (3) incomplete analyses of the impacts of fuel pool heatup on loss of normal cooling, and (4) absence of fuel handling tools structural analyses. These analysis weaknesses are discussed further in the following paragraphs.

RRD has not adequately evaluated the potential for and impact of failure of non-seismically qualified equipment above safety-related equipment. For example, cast iron bell and spigot piping and ventilation ductwork are located directly over the pony motor batteries and battery charger. This piping and ductwork do not appear to be seismically supported and HFIR does not have seismic analysis for them. A similar concern was identified with piping above the primary coolant pumps.

The design of and associated calculation for the pool dam lifting lugs do not provide sufficient assurance that adequate margins of safety have been established for performing the lifting and moving of this heavy load over the stored fuel. In 2001, HFIR redesigned the pool dam lifting lug configuration to address previous design deficiencies. The new lifting lugs with newly designed attachment hardware and previously existing attachment components on the dam are all combined in a design that is not conducive to confidently predicting the load path through the hardware. Further, the calculation of the loads and stresses for these components is lacking in rigor in several areas. Although there are several offsetting conservatisms in the analysis that indicate that the design is probably adequate to perform its intended function, additional assurance is warranted considering the importance of this component.

There are two aspects to concerns with the analyses of the impacts of fuel pool heatup on loss of normal cooling. First, specific structural analyses have not been identified that demonstrate the capability of the fuel pool to structurally withstand the worst-case temperature conditions (pool water temperature about 200°F per USAR Section 9.1.4.3) for loss of normal pool cooling. HFIR has no analyses that address fuel pool stresses due to thermal effects. Such analysis is needed to demonstrate that the stresses in the concrete and the rebar due to the worst-case temperature gradients across pool walls do not exceed the allowable limits. They should also demonstrate that the pool liner remains intact in spite of buckling stresses generated as a result of the differences in the coefficients of thermal expansion of the stainless steel liner and the concrete. These analyses are essential to ensure pool integrity for loss of normal pool cooling. Additionally, the structural adequacy of the pool for this design basis event was not addressed in the USAR.

Second, specific analyses have not been performed that demonstrate the integrity of spent fuel in the fuel pool for the USAR-described loss of normal pool cooling. Although several analyses were identified that indicate fuel integrity would be maintained for this event, this capability was not documented in any specific analysis, and it was not specifically addressed in the USAR, with appropriate supporting references.

Structural analyses for fuel handling tools required by the USAR are incomplete. The USAR states that static/dynamic stress (structural) requirements exist for the fresh-fuel handling tools and that each handing tool is designed using these limits and load tested beyond its rated capacity on a routine basis. Contrary to this statement, no analyses were located that addressed the fresh-fuel handling tools, and only two analyses, for the spent-fuel lifting tool and the reactor hatch lifting assembly, were located that addressed any of the other handling and lifting devices for reactor/fuel pool operations. Therefore, the load limits or rated capacities of these other tools could not be determined. The load testing that is performed is not adequate alone to demonstrate the tools' adequacy because it does not address the potential for fatigue failure. Additionally, the USAR does not adequately specify requirements for structural analyses for tools other than the fresh-fuel handling tool (although there are similar risks associated with tools other than the fresh-fuel handling tools, particularly the spent-fuel lifting tool).

Finding #21. Several analyses supporting the ORNL HFIR USAR are missing or incomplete for the primary coolant system, the reactor/fuel pool, and the refueling equipment.

In addition to these design analysis deficiencies, OA identified a design verification weakness. Specifically, RRD did not adequately verify that the ventilation in the pony motor battery room was adequate to ensure that the hydrogen generated due to battery offgassing would not exceed the lower flammability concentration (i.e., RRD did not measure the actual flow rates or perform a ventilation flow balance or flow measurement). In response to OA inquiries, RRD performed ventilation flow measurements that indicated there was adequate supply flow to the room. However, HFIR does not have a readily available method to periodically verify that the minimum required exhaust flow is maintained.

Configuration Management

The purpose of the RRD configuration management program is to maintain the integrity and accuracy required of the USAR, TSRs, the facility design, maintenance procedures, and operating procedures. The configuration management program is generally well defined and includes appropriate roles and responsibilities and references to subordinate programs that support configuration management.

HFIR has undergone several initiatives to improve its configuration management program. For example, in early 2003, an HFIR work management review identified weaknesses in the HFIR configuration management program. These weaknesses included quality issues related to safety basis as-built drawings, a backlog of open modification requests, and lack of a well-defined, readily-accessible, and understandable design basis. These weaknesses are being addressed by the systems engineering program.

RRD's systems engineering program was initiated in 2001. The system engineers have responsibility for supporting configuration management, overseeing system performance, and supporting modification and maintenance. Systems engineering assignments have been made for all safety-related systems; interim training and qualification guidelines for the system engineers have been established; and significant progress has been made by most system engineers in completing their general training and system-specific training requirements. The engineers, technical personnel, and managers who were interviewed were highly motivated, and possessed a very strong sense of ownership of their assigned systems. However, some system engineers lack detailed understanding of their assigned system, in particular, in regards to the safety basis for the system. RRD recognizes that additional actions are needed to fully establish a mature systems engineering program. The actions and priorities are under review by DOE, through ongoing discussions on the DOE Order 420.1A implementation plan.

Although RRD has many components of an appropriate configuration management program in place and has made important improvements, OA identified two program deficiencies that impact its effectiveness.

The first deficiency is that the safety-related equipment list, incorporated by reference in the USAR, is incomplete. The equipment list delineates all of the systems, structures, and components (SSCs) in the facility with safety or defense-in-depth functions, describes these functions, and tabulates the safety classification, the seismic qualification, and the environmental qualification of each SSC. A sample review of SSCs associated with the reactor/fuel pools and primary coolant system did not identify any concerns with the primary coolant system list. However, the following discrepancies were identified with the reactor/fuel pool and refueling equipment:

- One valve, V-1244, that forms the reactor pools' seismically evaluated, water retaining boundary was not included.
- The safety function of two of the pools' seismic boundary valves, V-1269 and V-8721, which is to close in the event of a seismic failure of the piping outside their boundaries, was not identified.
- The safety class reactor/fuel pool and spent fuel were not identified as potential impact targets for a failure of the overhead crane and personnel-pool bridge.
- A third similar mobile structure over the pools, the mobile pool platform, was not identified in the safety-related equipment list, yet it had similar potential for seismic interaction with SSCs in the pools.

In addition, the seismic qualification requirements of the overhead crane and the personnel-pool bridge are not identified in the list. These are examples of a generic concern that the list identifies seismic qualification requirements for items that perform active safety functions but does not identify requirements for items whose seismic qualifications relate only to seismic interactions with other safety-related SSCs.

Although no actual safety impacts were identified as a result of the above-described equipment list discrepancies, these deficiencies can result in configuration management errors in day-to-day activities, such as the qualifications of replacement equipment, the focus of USQ screenings and evaluations, and the level of quality control measures applied to activities associated with these SSCs. The number of discrepancies that were identified in this limited sample indicates a need for an expanded review of this list by RRD.

Finding #22. The ORNL HFIR USAR classification of equipment and components (as detailed in the safety-related equipment list) contains errors and omissions that can adversely affect configuration management in design, maintenance, procurement, testing, and other disciplines.

The second configuration management deficiency concerns the ORNL sitewide and RRD-specific USQ procedures. The USQ process is an important part of the configuration management program. As detailed in Appendix E, the ORNL USQ procedure has a number of deficiencies that can result in improperly screening out from full review certain procedure changes and modifications. Although, as described in Appendix E, instances of improper screening were identified during this review, OA did not identify any modifications or procedure changes that when fully evaluated would have identified USQs necessitating DOE approval.

In addition, OA identified a deficiency with the timeliness of evaluation of PISAs as described in 10 CFR 830. As discussed previously, OA identified four design analysis concerns that called into question USAR statements (or lack thereof) or their bases, including the structural adequacy of the reactor/fuel pool for the loss of normal cooling event, the structural analyses of the various reactor/fuel pool equipment handling tools, the adequacy of spent fuel heat removal for the loss of normal fuel pool coolant event, and the seismic analysis of piping above safety-related equipment.

At the completion of this assessment, RRD had started to process only two of these four concerns via the RRD USQ/PISA process to confirm whether an actual PISA existed (for one of these two concerns, RRD's analysis to confirm whether a PISA existed was inadequate because it concluded that a PISA did not exist based upon planned modifications rather than current system status). RRD indicated that they subsequently decided not to evaluate any of the four concerns via the current ORNL USQ/PISA process because it does not specifically address USAR upgrades that identify missing and incomplete design analysis. Instead, they applied guidance provided to the Idaho National Engineering and Environmental Laboratory (INEEL) by the Idaho Operations Office to determine whether to enter the PISA evaluation for these types of issues. However, this is not identified in RRD's USQ procedure for processing PISAs, and RRD has not obtained approval for using this guidance from DOE. Furthermore, the Idaho Operations Office guidance has potential DOE-wide implications warranting review by the DOE Office of Environment, Safety and Health to ensure that all potential design analysis deficiencies receive appropriate evaluation and formal documentation.

Finding #23. RRD did not invoke the current ORNL USQ/PISA process to address missing and incomplete design analyses.

RRD recognizes that timely and formal processing of issues identified during reviews, such as this ESF review, and during their own design basis reconstitution efforts is necessary and has initiated efforts to determine the most effective process based upon experienced gained during this review and experiences from similar reviews at the Advanced Test Reactor at INEEL. This is important so that appropriate resources can be applied in an efficient manner as part of safety improvement efforts, such as design basis reconstitution.

Summary. In general, the two systems reviewed were well designed and in accordance with the requirements of the USAR, TSRs, and applicable codes, standards, and good engineering practices. Supporting calculations and analyses for the USAR and TSRs were generally clear, concise, and complete, with the level of detail and rigor commensurate with the importance to safety of these systems. Furthermore, HFIR has the basic components of an effective configuration management program in place, such as a high-quality USAR; rigorous, comprehensive, and supporting hazards and accident analyses; and a developing systems engineering program, which is essential to monitoring and maintaining the health and fidelity of the facility configuration.

However, at the detailed component level, several analysis weaknesses were identified that warrant timely evaluation and correction to ensure that appropriate safety margins delineated in the USAR are maintained.

Weaknesses were also identified in two important configuration management components—the safety-related equipment list and the USQ program. These weaknesses can lead to errors in identification of the level of quality control measures applied to some SSCs and in the level of safety review performed on changes to the facility or procedures. Further, a concern was identified with the timeliness of formally evaluating the potential impact on the USAR of some design analysis weaknesses identified during this evaluation.

F.2.2.2 Surveillance and Testing and Maintenance

OA evaluated the surveillance and testing and maintenance programs to determine whether they are adequate to assure that HFIR SSCs can perform their safety function.

Surveillance and Testing

DOE's nuclear safety rule (10 CFR 830) requires that surveillances and tests be defined in the TSR to ensure that safety SSCs and their support systems required for safe operations are maintained, that the facility is operated within safety limits, and that limiting control settings and limiting conditions for operation are met. RRD has established a set of surveillance and testing requirements for the primary coolant system and reactor/fuel pool that is appropriate for ensuring that the primary coolant system and fuel pool will reliably operate in normal and emergency conditions. The TSR surveillance and test acceptance criteria are appropriately based on the USAR. A TSR basis document was developed that describes the rationale for the acceptance criteria and test frequencies.

RRD surveillance and test procedures implementing the TSR requirements were complete, clear, and concise, and have the appropriate level of detail and adequate data sheets. Surveillance, testing, and inspections are being conducted at their prescribed frequencies and have been rigorously performed and appropriately documented. RRD personnel have established an effective tracking system for managing the numerous surveillances, including routine surveillances and those performed during outages and startups.

HFIR has established an in-service inspection/in-service testing (ISI/IST) program, which is referenced in the TSR and supplements the specific surveillance and tests identified in the TSR. The HFIR ISI/IST program was first established in 1975 and was significantly upgraded in 1990 as a result of concerns associated with vessel embrittlement discovered in 1988. The current ISI/IST program uses American Society of Mechanical Engineers (ASME) Section XI as a guide and states that the selection of inspections and tests for each component is based on the HFIR TSR, operating experience, and accident analysis. The ISI/IST plan and the latest summary report (1998) of inspection results were well defined and documented. HFIR uses a unique approach for evaluating vessel integrity, which includes performing a hydrostatic proof test rather than some ultrasonic and liquid penetrate tests. The basis for this variation from the ASME Section XI criteria has also been well documented.

In-service test plans for the primary coolant system and fuel pool system were appropriate in most cases. However, two weaknesses were identified with the testing of safety-related check valves. The most significant weakness was that, while RRD performs leak checks on the primary coolant pump check valves, it does not perform internal inspections to look for wear. Based on lessons learned from industry experience, failure of check valves can occur, particularly for valves that experience low flow condition, such as is experienced by the primary coolant pump check valves while in pony motor operation. Given the importance of these valves (they are needed to ensure adequate flow during several accident scenarios), the operating conditions (they are subjected to low flow conditions and rapid closure during pump stops), and the age of the valves (approaching the end of their 40-year design life), the current in-service test of these check valves is not sufficient and does not meet the intent of the HFIR ISI/IST program (i.e., to select inspections and tests based upon operating experience and accident scenarios).

The second weakness was that the ISI/IST program does not include testing of the safety function of the cooling water supply lines to the reactor/fuel pool check valves, which is supposed to close to protect the pools from loss of water inventory as a result of seismic failure of piping outboard of their boundaries.

Finding #24. ORNL's RRD has not identified and included all appropriate in-service testing in its ISI/IST program.

In addition, two concerns were identified with the in-service test of the primary coolant pump vibration switch. The first concern is that the maintenance work package for the test, although an improvement over previous revisions, did not include all appropriate precautions and notes. The second concern is that the work was not rigorously documented (i.e., some steps were not filled in as being completed).

Maintenance Program

The HFIR maintenance program has been established using DOE Order 4330.4B, *Maintenance Management Program*, as a guide. The maintenance program is defined in the maintenance manual, which includes requirements for ensuring that all work performed on HFIR systems is accomplished in accordance with established policies. The maintenance management program includes procedures for maintenance work control, post-maintenance testing, planning/scheduling, records management, and administrative controls. In addition, RRD has established specific program documents defining the process for performing preventive maintenance, predictive maintenance, and corrective maintenance. The following provides the results of the OA evaluation of each of these elements.

Preventive Maintenance. RRD has a generally strong preventive maintenance program that is well defined and appropriately tracks the completion of preventive maintenance items. Effective aspects of the program include an HFIR preventive maintenance procedure that provides appropriate directions for development of preventive maintenance basis documents. The preventive maintenance basis process requires the maintenance staff to systematically review and apply the preventive maintenance requirements from various sources, including vendor manuals and standards, to establish a well-defined, site-specific preventive maintenance program. The basis documents reviewed were effective and reflected a sound engineering approach. Preventive maintenance work is performed on time and is tracked using the maintenance database system. RRD carefully tracks open items, and if any become past due they are designated as deferred and require a written justification. Justifications reviewed by OA were appropriate. RRD also has a separate program for preventive maintenance and calibration of instruments. The HFIR instruments' calibrations and test requirements are being effectively tracked through the ORNL MIDAS system. Currently, the instrument and control information is being integrated into the maintenance database, with the intent of establishing an independent tracking system that does not rely on MIDAS.

Preventive maintenance work packages were well defined and performed. For example, the preventive maintenance for the pony motor batteries incorporated vendor recommendations and recommendations from standards. Battery preventive maintenance is being routinely performed, including inspections for battery cleanliness, electrolyte level, battery connector tightness, and load tests. Preventive maintenance performed on the various facility pumps and motors is also effective.

Although preventive maintenance work documents and packages are generally well defined and performed, a few weaknesses with their rigor were identified:

- Following an equalizer charge to the pony motor batteries, the maintenance procedure does not check post-charging battery electrolyte levels (the charging process can reduce battery levels because offgassing can occur). However, battery levels are checked on a daily basis by operations.

- Direct ventilation flow indication is not available to verify adequate ventilation flow before performing preventive maintenance in the battery rooms for the pony motors. Ventilation flow is checked by ensuring that exhaust fan FN-5 is in the "ON" position. However, this check is not a direct verification because fan FN-5 is not dedicated to the battery room.

- Preventive maintenance basis documents have not been reviewed and updated for several years. There were some changes to the maintenance procedure for the pony motor batteries that were not referenced in the preventive maintenance basis document.
- The performance of oil change-out for the alternating current motor bearings requires independent verification that the plug is reinstalled. Only one verification signature was recorded.

Predictive Maintenance. RRD has a well-defined and implemented predictive maintenance program. The predictive maintenance procedure evaluates each major component and determines which predictive maintenance method will be used, including vibration, current signature, oil analysis, and thermograph. Vibration measurements are taken and analyzed on all key motors and pumps. The program has successfully identified components to be replaced prior to failure on a number of occasions. Similarly, bearing oil samples are taken and analyzed and have resulted in identifying components for corrective maintenance.

One weakness with the predictive maintenance program involves vibration testing following the completion of preventive or corrective maintenance on motors or pumps. In general, following maintenance of a motor or pump, the maintenance procedure or post-maintenance test does not require performance of a vibration test. However, the vibration test would provide additional assurance that the maintenance was correctly performed and would provide a new vibration baseline. For example, secondary motor PU-6A oil was changed in March 2004 because of poor oil sample results. It has not been run for any length of time since then and has therefore not been tested for vibration. The motor is expected to run during the next cycle, at which time vibration testing will be conducted. In contrast, following the recent preventive maintenance performed on pressurizer pump PU-4A, the pump was run as part of the post-maintenance testing and satisfactory vibration test results were required to pass the post-maintenance testing.

Corrective Maintenance and Aging Maintenance. RRD has established an aging equipment program, which includes an annual review of the material condition of systems and components to prioritize the replacement and upgrades of equipment. This program is described in MMP-0501, *Aging Equipment Program.* Upgrades and replacement of reactor components and instrumentation have been ongoing since the mid-1990s. Processes have been established to analyze, trend, and replace equipment on an ongoing basis. The Aging Equipment Program, in conjunction with the other maintenance programs described, has been established to extend the life of equipment and minimize unexpected component failures that could affect HFIR operations.

RRD has developed and is implementing an Integrated Work Plan to address aging components. The plan addresses refurbishing primary coolant motor pumps and seals, and replacing diesel generators and motor control centers over the next few years. One major task in progress is the replacement of the instrument air compressors. For the primary coolant system, plans are established to improve system components, including letdown block valves, limit torque valve operators, pressurizer line check valves, and the pool to vessel check valves.

RRD has an effective corrective maintenance backlog management program. Corrective maintenance issues are being tracked, and RRD has developed a "Top Ten" list of corrective maintenance items (both long term and short term) that identifies high-priority items based upon reactor conditions. The current "Top Ten" list is based upon reactor operational needs and was carefully reviewed by the operations and maintenance manager and associated leads. The primary coolant pump vibration switches were on the list and identified as a pre-startup item. Overall, the corrective maintenance list for the primary coolant system, the reactor/fuel pool, and the refueling equipment is reasonable (on the order of 20 items).

Systems that were walked down by the OA team were in good material condition. One exception was that the fuel pool contained some gasket material debris.

Corrective maintenance work packages were appropriate to repair the components. The work instructions in the work packages were clear and contained the appropriate detail, and work steps were arranged in logical order. In general, maintenance personnel carefully followed work instructions. The contents of the work packages were also adequate. Depending on the task, work packages contained maintenance instructions, vendor manuals, system drawings/prints, material datasheets, calibration sheets, pre-job safety briefing documents, and post-maintenance testing requirements. The quality of the work packages is good and it is evident that significant effort is being taken to ensure that the work instructions are correct. The effort devoted to creating good work packages has also helped maintenance self-identify deficiencies in the performance of previous work procedures, as exemplified by the significant revision to the primary coolant pump vibration trip work discussed earlier. Further, post-maintenance tests were generally specified and appropriate.

Although corrective maintenance was defined and based upon vendor recommendations, some deficiencies were identified in the work package for one important component (i.e., the primary coolant system rupture discs). Specifically, the corrective maintenance package for repair of the primary coolant rupture discs specified torque values for flange bolts that were higher (150 ft-lbs) than the vendor manual recommendations (80 ft-lbs). It was unclear whether the vendor and RRD had evaluated the higher torque values as acceptable (therefore the performance of the rupture discs would not be affected). Also, acceptance testing for the rupture disks supplied to HFIR did not account for the higher torque values. Furthermore, in the corrective maintenance package for the repair of the rupture discs, the process for adjusting torque values specified in the procedure to account for calibration inaccuracies in the torque wrench is not discussed in the procedure, and actual torque wrench settings are not recorded. RRD has issued an NCR to address this concern.

Some concerns were also identified with post-maintenance testing. For instance, post-maintenance testing involving pumps and motors sometimes only re-verifies the status of key parameters, such as oil level and/or cooling flow, rather than directly determining operability by running the pump and/or motor. Also, the leak check specified in post-maintenance testing for some work packages did not define the test pressure and how long the test pressure should be maintained. Finally, several post-maintenance testing data sheets do not contain information documenting the results of the test, except that the "Satisfactory" box is checked.

Trending of Equipment Performance. Several processes are being performed at HFIR to trend equipment performance. The shift technical advisors perform an analysis of plant data, which is collected by on-shift checks and readings, during routine maintenance and the performance of surveillance test procedures. The results are provided in a weekly summary report. This process is providing useful information to identify trends. Other effective trending processes include the condition-critical equipment trending, trending of preventive maintenance results by system engineers, and the predictive maintenance process.

Summary. Most aspects of the surveillance, testing, and maintenance programs are well defined and effectively implemented. Surveillance test procedures to support the TSRs are closely tracked and rigorously performed. Similarly, preventive maintenance is closely tracked, and any instances of overdue maintenance are carefully reviewed. An effective predictive maintenance program has been established and its results have improved reliability. Maintenance work packages are well written and include the appropriate information to perform the assigned work. Maintenance work instructions are clear and are rigorously followed. RRD closely tracks its corrective maintenance backlog, and work tasks are appropriately prioritized through the "Top Ten" list. Furthermore, the ISI/IST program is well defined. However, some weaknesses were identified with the testing of check valves in the primary coolant system and the reactor/fuel pool cooling system, and with corrective maintenance of the primary coolant system rupture discs.

F.2.2.3 Operations

The OA team evaluated operating procedures and operator training for the selected safety systems to determine how well operators are prepared to operate the systems under normal conditions and to take appropriate actions in the case of abnormal and accident events.

Operating Procedures

RRD has established an appropriate set of procedures to guide normal and emergency operations. RRD developed a procedure writers guide to support procedure development and to ensure consistency in procedure style, format, and organization. Procedures reviewed were developed in accordance with the guide. The RRD procedure change process includes an appropriate practice of having operators walkdown procedures before they are finalized. Furthermore, RRD developed a general procedure that details expectations for procedure usage as well as a specific procedure on emergency operating procedure (EOP)/ abnormal operating procedure (AOP) use. These require personnel to rigorously follow procedures and to initiate procedure change processes when procedures cannot be performed as written or are inadequate for the situation. RRD appropriately established an exception to this policy, to allow HFIR operations personnel to take such action as necessary to minimize personnel injury and damage to the plant; to return the plant to a stable, safe condition; and to protect the health and safety of the general public and personnel on site.

OA evaluated normal procedures and EOPs for the primary coolant system during operator plant walkdowns and during simulated emergencies and found that they effectively supported operations. The procedures were clearly written and provided appropriate actions, such as verification of automatic actions, additional actions to take, and contingencies if actions could not be accomplished. Transfers to functional recovery procedures were also appropriate and clear. Setpoints identified in the EOPs are related to TSRs or setpoints for equipment automatic actions, with some additional margins provided. The rationales for the setpoints are maintained in the procedure history file.

Some weaknesses were identified in utilizing the EOPs, in particular when no information is provided in the "response not obtained" column of the EOP or if steps cannot be performed in the "response not obtained" column. The weaknesses did not have a major impact on the response, but additional guidance on actions operators should take when response information is missing or contingency actions fail is warranted.

OA also evaluated refueling procedures and found them to be adequate to support fuel movement and other associated refueling operations. RRD has established a hierarchy of procedures covering fuel movement activities, from general controls to specific operations. The procedures include appropriate precautions, limitations, and directions for performing the activities. RRD also developed a procedure for uprighting fuel in case of an accident, and operators get hands-on practice on this procedure with a dummy fuel assembly as part of their initial certification.

Some weaknesses were identified in the refueling procedure. Specifically, the procedure does not provide direction or precautions on the clearance to maintain above potential obstacles or the amount of water shielding to maintain when transferring fuel. Furthermore, HFIR pool work procedures do not address storage of spare fuel handling tools in the storage rack, including locking the tools in place (to prevent falling during a seismic event).

Operator Training

The training program is well defined in the USAR and implements the requirements of DOE Order 5480.20A. Qualification requirements include four years' nuclear plant experience and reactor or senior reactor operator certification. All HFIR reactor operators and shift supervisors have many years of reactor experience, with most having previous Navy and/or commercial nuclear experience. Certification requirements are well documented and include requirements for three months of reactor operator fundamental and reactor plant systems courses, three months of on-the-job shift training, written and oral examinations, a plant walkthrough, and scenario evaluation. Continuing training is on a 2-year cycle, is well defined, and includes examination and walkdowns.

To ensure that operator training is maintained current with plant changes, the training department reviews all plant modifications and procedure changes to determine their impacts. Training is provided in the form of required reading and/or shift briefings (with follow up incorporation into training material for operator certification) if the need is identified.

Some weaknesses were identified in the accuracy of the control room mockup (used in place of a simulator to support some aspects of operator training and evaluation). Specifically, the mockup does not reflect the actual control room in several areas, including the emergency depressurization system valve indications and the primary flow indicators.

Operator Knowledge and Performance

The three reactor operators and two shift supervisors who were interviewed during the evaluation demonstrated a good understanding of the primary coolant system, integrated plant operations, and the process and equipment used for refueling. The operators and supervisors accurately described the steps involved in pressurizing the plant and demonstrated good knowledge of automatic system operations. During simulated accident scenarios, the operators effectively utilized alarm, abnormal, and emergency procedures in conjunction with plant indications and appropriately put the plant into a safe configuration.

Some weaknesses were noted in knowledge of details of some component operations. For example, some operators and supervisors were not certain about the operation of some control valves (particularly the secondary cooling system to primary system heat exchanger control valves) during loss of air and of the emergency pressurization pump during loss of power conditions, and the meaning of illuminated indications for emergency depressurization system valves. In addition, none of the operators were familiar with the differences between design basis versus beyond design basis loss-of-coolant accident in terms of break size and system response.

Summary. RRD has established an effective program for training operators and establishing procedures for operating HFIR. Operators understood the operations of HFIR components well and demonstrated the capability to safely operate HFIR during normal and emergency conditions.

F.3 Conclusions

Improvement Initiatives

RRD has made considerable progress in improving safety management at HFIR in response to the unplanned shutdown, and their corrective action plan is detailed and comprehensive. Many of the corrective actions are complete or underway.

In most cases, OA's review indicated that the corrective actions are appropriate and are being effectively implemented. A number of new systems, such as the RRD Performance Management Plan, LSM and RRD lead shift technical advisor positions, the integrated work plan approach, and field observations and inspections, are having a positive impact on safety management and promoting continuous improvement. Increased RRD management team ownership and participation in self-assessment activities are evident. Additionally, RRD management is making process in effectively addressing previously identified deficiencies.

Although RRD is making progress towards strengthening management systems, a number of programs are relatively new or in various stages of maturity. Continued management attention is needed to ensure that these programs are fully and effectively implemented and are adequately institutionalized through formal procedures. In addition, the lack of a fully implemented systems engineering program poses a threat to achieving success in meeting RRD's strategic goal of outstanding nuclear facility operations. While additional improvements are needed in a number of areas, OSO, ORNL, and RRD management demonstrated a good understanding of the remaining weaknesses and have appropriate mechanisms in place to address them.

Essential System Functionality

The systems and components reviewed are generally well designed and analyzed. Furthermore, most aspects of the maintenance program are well defined and implemented. For example, the preventive maintenance program includes effective provisions for tracking maintenance and evaluating the impact of overdue maintenance; basis documents have been developed; and the surveillance and testing program is effective. HFIR has also established an effective program for training its operators and a good set of procedures to support system operation in both normal and emergency modes. Operators who were interviewed were very knowledgeable and demonstrated their ability to effectively operate plant systems and respond to emergency conditions.

However, several design analysis weaknesses have been identified, including (1) incomplete seismic analysis of non-safety-related equipment over safety-related equipment, (2) inadequate rigor in the analysis of the fuel pool dam lifting lug, (3) incomplete analyses of the impact of fuel pool heatup upon loss of normal cooling, and (4) absence of structural analyses for fuel handling tools. Furthermore, the safety-related equipment list contains errors and omissions that adversely impact the configuration management program, and weaknesses were identified in the ISI of the primary coolant pump check valves, IST of the reactor/fuel pool isolation check valves, and corrective maintenance of the primary coolant rupture disc.

Although some weaknesses were identified during this review, the HFIR systems reviewed are generally well designed, maintained, tested, and operated. Furthermore, RRD took some appropriate actions to address weaknesses that have been identified and has initiatives underway, such as the systems engineer program, to improve their safety management performance.

F.4 Ratings

Engineering and Configuration Management .... NEEDS IMPROVEMENT
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.

ORNL

1. **Develop a formal training and qualification program for LSMs.** As part of development of a training program, conduct a benchmarking review on Laboratory Space Management Program practices presently in use at HFIR and other select ORNL facilities to identify best practices and lessons learned to be included in the training program.

2. **Consider establishing a forum to drive continuous improvement in the implementation of the Laboratory Space Management Program across ORNL.** Evaluate the benefits of a forum, such as an LSM Steering Committee, where LSMs meet periodically to discuss issues, share lessons learned, and identify needed actions.

3. **Conduct a benchmarking review of ORNL organizations' performance management plans, using the RRD Performance Management Plan as a model.** Evaluate the positive attributes and identify areas for improvement to provide further institutional guidance and direction to achieve continuous improvement in performance management plan execution across all ORNL organizations.

RRD

1. **Continue ongoing efforts to further strengthen technical and operational interfaces between experimental groups and HFIR operations**. Specific actions to consider include:

   - Ensure that experimental guidelines and procedures that define experimental safety review processes are maintained up to date and reflective of current practices.

   - Ensure that experiment review processes specifically determine the need for independent verification of hazard control requirements, and perform that independent verification where appropriate.

   - Ensure that experimental review processes are clearly defined and captured in existing memoranda of understanding with RRD.

2. **Continue efforts, such as the HFIR Maintenance Performance Improvement Plan, to further improve the execution of maintenance work planning and control processes.** Specific actions to consider include:

   - Ensure that actions to improve the computer maintenance management system appropriately consider the system engineers' function as an "end user," in particular, for equipment trending and performance analysis, such as capturing equipment as-found conditions and apparent failure mechanisms during the conduct of maintenance.

   - Continue ongoing efforts to more clearly define the status of maintenance work package documentation within the maintenance backlog. Consider linkage to timeliness of completion (i.e., 30, 60, 90 days old) as well as work package type to provide more meaningful performance indicators on maintenance program implementation and backlog significance.

3. **Accelerate plans to fully implement the systems engineering program at HFIR.** Specific actions to consider include:

   - Prioritize systems, based on their safety significance and function, and develop more detailed milestones based on those priorities for accomplishment of system status reviews, development of system design descriptions, and establishment of system engineering files.

- Assign a program manager, dedicated to specifically oversee the implementation of the systems engineering program.

- Increase efforts to transfer the safety basis accident analysis knowledge base from safety analysts to system engineers using formal (i.e., oral boards) and informal (i.e., seminars) mechanisms.

4. **Formalize ORNL/RRD senior management meetings through documentation of meeting minutes and tracking of all management actions within ATS.** Increase focus on RRD Performance Management Plan objectives and performance indicators in meetings.

5. **In coordination with ORNL, re-evaluate current guidelines for use of ATS for assessment activities.** Clarify expectations on purpose and use to improve consistency, and revise RRD assessment procedures accordingly.

6. **Revisit the design and analysis of the reactor/ fuel pool dam lifting lugs to address the following apparent areas of weakness or uncertainty.** Specific actions to consider include:

   - Revise the design to exclude the potential for any alternative load paths through the existing components, two of which have identified weld cracks. Such alternate load paths do not allow for either assembly or analysis confidence.

   - Revise the analysis to conform with the current calculation procedure with respect to the level of rigor and documentation. Ensure that the revised calculation accounts for and documents all factors, both conservative and non-conservative, that were not addressed in the current calculation, including: the angle from vertical of the applied load from the lifting bridle, the stress in the lifting lug cap screw versus allowable, torque requirements/limits for the stud nuts, and the resulting preload and fatigue considerations, assembly nut-to-load plate face contact stresses, and comparison of shear stress against shear allowable instead of tensile allowable.

7. **Perform analyses that demonstrate the structural adequacy of the reactor/fuel pool at 200°F, the worst-case pool water temperature for loss of normal pool cooling.** Specific actions to consider include:

   - Ensure that such analyses demonstrate acceptable stress in the pool structures and liner as a result of differential temperatures and differential coefficients of thermal expansion.

   - Revise the USAR to specifically state that the pools are structurally adequate for this design basis condition, complete with appropriate references.

   - Perform a new reactor/fuel pool heatup analysis for the loss of normal cooling that specifically accounts for modifications that have increased the spent-fuel storage capacity and for fuel cycle changes that have occurred since the original analysis.

8. **Document in a formal calculation that the integrity of the fuel will not be compromised for the worst-case pool water temperature.** Revise the USAR to specifically state that the fuel integrity is not compromised for this design basis condition, complete with the appropriate references.

9. **Perform structural analyses for all fuel handling tools as required by the USAR.** Address all other tools used in and around the reactor/fuel pools for handling loads of significant magnitude.

10. **Revise Calculation Procedure SBP-1000 to provide a means for classifying calculations and to integrate calculation logs.** Specific actions to consider include:

    - Identify calculations that have since been superceded.

    - Provide a means of classifying a calculation as to whether it is current, superceded, historical for reference, etc.

- Integrate the safety analysis calculation list and the systems engineering calculation list into one log.

11. **Perform periodic flow measurement of air movement out of the battery room.** To ensure proper hydrogen dilution consistent with the design calculation, periodically measure exhaust flow in the pony motor battery rooms.

12. **Perform a comprehensive review of the safety-related equipment list.** Ensure that it identifies all safety-related SSCs and all of their safety functions, including seismic integrity required to prevent interaction with other safety-related SSCs.

13. **Enhance surveillance, testing, and maintenance performance in a few specific areas**. Specific actions to consider include:

    - Consider performing in a timely manner inspections/tests in accordance with the HFIR ISI/IST program on primary coolant pump check valves and the cooling water supply to the reactor fuel pool check valves.

    - Review and revise as required the preventive maintenance basis documents.

    - Improve the content of maintenance instructions to ensure that steps requiring a signature are signed, especially when requesting the technician to record deficiencies.

    - When determining the testing required for post-maintenance testing following maintenance on pumps or motors, consider including running the pump or motor and performing vibration testing.

    - Improve the rigor associated with post-maintenance testing by ensuring that the results/remarks section for each acceptance criteria is filled out. Ensure that the tests are adequately defined, including the pressure of the test and the time at test pressure for leak tests.

14. **Enhance operator training, knowledge, and procedures**. Specific actions to consider include:

    - Update the HFIR mockup to reflect current control room indications and controls. Add guidance to the training manual on expectations for maintenance of the mockup.

    - Consider additional training on design basis and beyond design basis accidents that have been identified in the USAR. Consider whether simplified desktop simulation of the thermal-hydraulic response based upon the RELAP model in the USAR may be a cost-effective method of enhancing understanding of the plant response to accidents.

    - Reinforce understanding of the automatic response of energized equipment to loss of air, hydraulics, or electricity. Consider adding malfunction of equipment to accident scenarios to evaluate how well the operators understand potential failure and indications of failures.

    - Revise the EOP/AOP use procedure to address actions to take when the right-hand column of an EOP or AOP cannot be completed. Ensure that direction provided in this general procedure is appropriate for all applicable procedures and steps in these procedures.

    - Enhance the following procedures:

      E-1: Add information to the "response not obtained" column of steps 3, 10, and 14.

      PWP-1106 and 1000: Add precautions on clearance from obstacles and shielding during fuel movement.

      NOP-2107: Revise step 5.8 to provide information on how to maintain delta pressure.

      ADMF-0152: Add a check for exhaust flow from the pony motor battery room. Consider adding a simple telltale indicator to support the check.

Abbreviations Used in This Report (Continued)

FHA	Facility Hazards Analysis
FR	Facility Representative
FUA	Facility Use Agreement
FY	Fiscal Year
HEPA	High Efficiency Particulate Air
HFIR	High Flux Isotope Reactor
HMIS	Hazardous Material Inventory System
HRIBF	Holifield Radioactive Ion Beam Facility
IG	Inspector General
ISI/IST	In-Service Inspection/In-Service Testing
ISM	Integrated Safety Management
ISO	International Organization for Standardization
JHA	Job Hazards Analysis
JHE	Job Hazard Evaluation
LMDI	Legacy Materials Disposition Initiative
LSM	Laboratory Space Manager
MIRF	Multicharged Ion Research Facility
MSDS	Material Safety Data Sheet
NCR	Nonconformance Report
NE	Office of Nuclear Energy, Science and Technology
NNFD	Nonreactor Nuclear Facilities Division
NNSA	National Nuclear Security Administration
NSTD	Nuclear Science and Technology Division
OA	Office of Independent Oversight and Performance Assurance
ORELA	Oak Ridge Electron Linear Accelerator
ORNL	Oak Ridge National Laboratory
ORO	Oak Ridge Operations Office
ORPS	Occurrence Reporting and Processing System
OSHA	Occupational Safety and Health Administration
OSO	Oak Ridge National Laboratory Site Office
OSOCATS	Oak Ridge National Laboratory Site Office Corrective Action Tracking System
OSSD	Operational Safety Services Division
PAAA	Price-Anderson Amendments Act
PBMS	Performance Based Management System
PCB	Polychlorinated Biphenyl
PEP	Performance Evaluation Plan
PISA	Potentially Inadequate Safety Analysis
POD	Plan of the Day
PPE	Personal Protective Equipment
R&D	Research and Development
R2A2	Roles, Responsibilities, Authorities, and Accountability
RBA	Radiological Buffer Area
RCT	Radiation Control Technician
REDC	Radiochemical Engineering Development Center
RRD	Reactor Research Division
RSC	Research Support Center
RSS	Research Safety Summary
RWP	Radiation Work Permit
SAA	Satellite Accumulation Area
SAD	Safety Assessment Document
SAR	Safety Analysis Report
SBMS	Standards Based Management System
SC	Office of Science
SLI	Science Laboratories Infrastructure
SME	Subject Matter Expert
SOP	Standard Operating Procedure
SSCs	Structures, Systems, and Components
TSR	Technical Safety Requirement
USAR	Updated Safety Analysis Report
USQ	Unreviewed Safety Question
UT-Battelle	University of Tennessee – Battelle Memorial Institute
WSS	Work Smart Standards