Independent Oversight
Inspection of Nuclear Safety
at the

Oak Ridge National Laboratory
Radiochemical Engineering Development Center, Building 7920

October 2008

Office of Environment, Safety and Health Evaluations
Office of Independent Oversight
Office of Health, Safety and Security
Office of the Secretary of Energy

HSS
Office of Health, Safety and Security

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Abbreviations Used in This Report

ACTS	*Actions and Commitments Tracking System*
AMS	*Assistant Manager for Science*
CFR	*Code of Federal Regulations*
COG	*Cell Off-Gas*
DOE	*U.S. Department of Energy*
ES&H	*Environment, Safety, and Health*
HEPA	*High Efficiency Particulate Air*
HSS	*Office of Health, Safety and Security*
NNFD	*Non-Reactor Nuclear Facilities Division*
ORNL	*Oak Ridge National Laboratory*
ORO	*Oak Ridge Office*
REDC	*Radiochemical Engineering Development Center*
SBMS	*Standards-Based Management System*
SC	*Office of Science*
SSCs	*Systems, Structures, and Components*
TSR	*Technical Surveillance Requirement*
UT-Battelle	*University of Tennessee – Battelle Memorial Institute*
VOG	*Vessel Off-Gas*

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1 Introduction

The U.S. Department of Energy (DOE) Office of Independent Oversight, within the Office of Health, Safety and Security (HSS), inspected nuclear safety programs at the DOE Building 7920 of the Radiochemical Engineering Development Center (REDC) at the Oak Ridge National Laboratory (ORNL) during August through September 2008. HSS reports directly to the Secretary of Energy, and the nuclear safety inspection was performed by Independent Oversight's Office of Environment, Safety and Health Evaluations. This nuclear safety inspection was performed concurrently with an inspection of emergency management programs at ORNL, performed by Independent Oversight's Office of Emergency Management Oversight, and an Office of Environment, Safety and Health Evaluations inspection of environment, safety, and health (ES&H) programs at the East Tennessee Technology Park; the results are documented in separate inspection reports.

Within DOE, the Office of Science (SC) has line management responsibility for ORNL. SC provides programmatic direction and funding for research and development; facility infrastructure activities; and ES&H implementation at ORNL. At the site level, line management responsibility for ORNL operations falls under the Oak Ridge Office (ORO) Manager. Under contract to DOE, ORNL is managed and operated by University of Tennessee-Battelle Memorial Institute, LLC (UT-Battelle).

ORNL's primary mission involves research in the areas of neutron science, biological systems, energy, advanced materials, national security, supercomputing, and other such areas. To accomplish this mission, ORNL operates various scientific facilities, including the REDC. The REDC includes two hot cell facilities, one of which is located at Building 7920 that was the focus of this inspection. Within ORNL, the Non-Reactor Nuclear Facilities Division (NNFD) is the organization responsible for managing REDC.

Aerial View

Potential hazards that need to be effectively controlled at the REDC include exposure to radiation, radiological contamination, hazardous chemicals, and various physical hazards associated with facility operations (e.g., high-voltage electrical equipment). Radiological/irradiated materials and hazardous chemicals are present in various forms at REDC, Building 7920.

The purpose of this Independent Oversight inspection was to assess the effectiveness of nuclear programs at REDC, as implemented by UT-Battelle, under the

direction of ORO and SC. Independent Oversight evaluated essential system functionality for selected safety systems at the REDC, Building 7920. The systems selected were the Cell Off-Gas (COG) and Vessel Off-Gas (VOG) ventilation systems, including selected interfacing and/or support systems. In addition, Independent Oversight evaluated the ORNL cognizant system engineer program and selected elements of feedback and improvement processes, including a review of the progress and actions taken by ORNL to address weaknesses identified in the 2001 Independent Oversight ES&H Inspection at REDC. Independent Oversight also conducted a focused review of ORO assessment and Facility Representative programs, as they directly applied to the REDC safety systems that were selected for review on this inspection.

DOE Building 7920 of the Radiochemical Engineering Development Center (REDC)

Sections 2 and 3 discuss the key positive attributes and weaknesses, respectively, identified during this inspection. Section 4 provides a summary assessment of the effectiveness of the major integrated safety management elements that were reviewed. Section 5 provides Independent Oversight's conclusions regarding the overall effectiveness of ORO and UT-Battelle management of nuclear safety programs, and Section 6 presents the ratings assigned during this inspection. Appendix A provides supplemental information, including team composition.

Appendix B presents the findings identified during this Independent Oversight inspection. The findings are also referenced in the applicable portions of Sections 3 and 4 of this report. In most cases, the findings listed in Appendix B were derived from multiple individual deficiencies that are described in the detailed results provided to the site in a separate document.

In accordance with DOE Order 470.2B, *Independent Oversight and Performance Assurance Program*, SC must develop a corrective action plan to address each of the findings identified in Appendix B, including the associated individual deficiencies, and provide appropriate causal analyses, corrective actions, and recurrence controls for each finding. The weaknesses in Section 3 provide a management-level summary of the findings; these weaknesses do not need to be separately addressed in the SC corrective action plan because the findings encompass the scope of the weaknesses.

2 Positive Attributes

Positive attributes were identified in the improved implementation of NNFD nuclear safety programs in the areas of REDC operations and assessments.

NNFD has substantially improved its overall management of REDC facility operations and enhanced a number of key engineering and work processes to strengthen nuclear safety. Since the 2001 Independent Oversight assessment at REDC, significant improvements have been made in many aspects of REDC facility operations and nuclear safety programs. The physical condition of the safety-class ventilation systems that were reviewed has been improved. The quality of the safety basis documentation and many of the engineering documents, such as the piping and instrumentation diagrams, were also enhanced. NNFD has also established strong foundations and frameworks for configuration management of safety-related systems. NNFD management and staff demonstrated a very strong nuclear safety questioning attitude and culture to assure safe facility operations. In all cases where technical concerns were identified by the Independent Oversight team, facility management and engineering staff promptly initiated the appropriate responses to fully identify and characterize the concern. In particular, NNFD management promptly and appropriately responded to a high efficiency particulate air (HEPA) filter testing inconsistency by placing the facility in a safe standby mode, conducting an extent-of-condition review, notifying other potentially affected facilities, and generating appropriate reports.

NNFD has improved its programs for assessing and evaluating performance trend information and is using that information to continuously improve nuclear safety. In the past few years, NNFD management has improved feedback and improvements processes within the performance assessment program, as applied to its nuclear facilities. Through a series of initiatives and sustained management attention, the NNFD staff has enhanced the effectiveness of assessments, facilitated involvement of supervisors and workers in assessment processes, and implemented productive methods of performance trend evaluation. The enhanced NNFD processes are consistent with and support the broader ORNL safety improvement objectives. NNFD management has emphasized effective and comprehensive use of the Actions and Commitments Tracking System (ACTS), which has facilitated improved issue resolution and performance trend analysis. Additional efforts to record and track low-level precursor issues have augmented the ACTS information and have facilitated more focus on the resolution of potential problems. Significant attention and effort has been focused on performing periodic evaluations of performance trend information to identify potential improvements that can be applied to REDC and the other NNFD facilities. Managers have considered human performance factors in developing improved processes and procedures. The management emphasis on the evaluation of potential issues, careful analysis, and completion of planned actions has improved the safety culture within NNFD and helped to sustain the performance improvements.

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3 Weaknesses

Although aspects of nuclear safety are effective, there are a few weaknesses in some aspects of surveillance testing and engineering design at REDC Building 7920 and with the ORO Assistant Manager for Science (AMS) Facility Representative program.

Weaknesses in some aspects of engineering design and surveillance testing result in safety analyses and testing procedures that are non-conservative. NNFD did not fully and effectively analyze some aspects of the COG and VOG designs. Most notably, the ability of the HEPA filters to perform their function in the event of a fire was not adequately analyzed. Isolated deficiencies were also identified in the analysis of HEPA filter procedural controls, structural adequacy of the VOG components, and classification of components that attach to the COG and VOG. Some weaknesses were also evident in a few aspects of surveillance testing for HEPA filters and a few other test procedures. Although the safety impact of these weaknesses was limited because of the robust system design and other conservative assumptions, the identified weaknesses indicate that NNFD has not always placed sufficient attention on the technical adequacy of surveillance testing by ensuring that: (1) complete and validated translations of the design and safety bases are adequately flowed down into facility procedures, and (2) that procedure setup, administrative controls, system lineups, and test sequencing establish test parameters that adequately represent the accident conditions under which safety systems may be required to perform. In addition, NNFD has not always ensured that sufficient supporting analyses for details and assumptions in the design and the safety bases, and for the bases of surveillance test acceptance criteria, exist for all modes, events, and responses of systems, structures, and components (SSCs). (See Findings #1, #2, and #3.)

ORO has not effectively managed some aspects of the Facility Representative program, limiting its potential value to safety performance improvement at ORNL. Implementation of the qualification program falls short of DOE program requirements, and continued professional development of assigned Facility Representatives has not received sufficient management attention. Recurrent or consistent weaknesses have been identified in program implementation, in such areas as the methods and effectiveness of recording and reporting observations to ORO's Office of the AMS management and to the contractor andthe Facility Representative qualification program. Staff vacancies are another recurring concern with that has not been addressed through sufficient compensating measures. Administrative weaknesses have included out-of-date AMS directives and lack of timeliness of oversight reports. Although management has identified actions to improve performance in this area, these program weaknesses have been identified in the past by internal and external evaluations, but corrective actions taken to date to improve the program performance have not achieved sustained improvement; there has been no rigorous causal analysis or sufficient follow-up (i.e., effectiveness reviews) to ensure that corrective actions were fully effective and sufficient. (See Finding #4.)

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4 Results

The following sections provide a summary assessment of the ORO and NNFD activities that Independent Oversight evaluated during this inspection.

Engineering Design and Safety Basis. The overall design of the facility, of the systems reviewed, and of their supporting and interfacing systems, with respect to nuclear safety, is very robust, with conservative safety margins and multiple redundancies in most areas. The systems and components are generally designed to fail in safe configurations during off-normal conditions, such as loss of instrument air or loss of normal power. Operating experience demonstrates that the systems are very reliable. Additionally, significant improvements have been made in the systems that were reviewed to enhance their safety, reliability, and ability to demonstrate their performance. The quality of the safety basis documents is very good overall, with clear, complete descriptions of the facility, its systems and components, normal operations and accident conditions, and the accident analyses. NNFD has made significant improvement in several important aspects of nuclear safety since the most recent Independent Oversight assessment in 2001, including the physical condition of the systems that were reviewed, the quality of many of the engineering documents, the quality of the safety basis documentation, and the rigor and attention to detail typically applied to safety-related activities by facility staff.

However, weaknesses and opportunities for improvement were identified in a few areas. Supporting analyses for details and assumptions in the design and the safety bases for all modes, events, and responses of SSCs were lacking in some areas, such as an analysis demonstrating that soot loading deposited on the COG HEPA filters as a result of a design basis cell fire would not result in a differential pressure across these filters in excess of their design rating. In addition, no formal analyses exist supporting the safety classifications of components within the COG and VOG systems' branches. Some weaknesses were also found in translating the design and safety bases into valid and complete facility procedures, particularly with regard to surveillance test procedures (e.g., incorrect and/or inadequate differential pressure procedural controls for HEPA filters). Furthermore, opportunities for improvement exist in the areas of the technical quality of design engineering and attendant technical reviews for some of the modifications reviewed during this Independent Oversight inspection. (See Findings #1 and #2.)

Configuration Management. REDC has made significant improvement in configuration management since the 2001 Independent Oversight inspection. Key elements of the REDC configuration management program are identified in the computer-based Standards-Based Management System (SBMS), and most aspects of the configuration management program meet applicable DOE standards. NNFD has established an effective procedural framework of key elements such as change control, document control, and work control. In addition, NNFD has taken appropriate actions to further strengthen its change control processes to address previous gaps and weaknesses in their program. NNFD effectively applied the change control

procedure for selected modifications (reviewed by Independent Oversight) to safety systems. In addition, system design descriptions have been developed for all Building 7920 safety class and safety significant systems. Significant improvements have also been made to the quality and accuracy of engineering drawings. With a few exceptions, reviewed REDC unreviewed safety question screenings and determinations were performed appropriately and consistent with the DOE implementation guidelines. REDC's use of categorical exclusion covering permanent and one-time changes to chemical processing operating procedures for the hot cells was appropriately implemented.

Although progress has been made, a number of shortcomings in configuration management still exist. NNFD does not have a formal configuration management program document that integrates all elements of the program. Additionally, NNFD lacks adequate processes and procedures to define and control the design process, such as procedures to control and develop design inputs, new calculations, drawings, and specifications, and to define the requirements for design verification and independent design review. As noted in Independent Oversight's review of some engineering design products, NNFD does not have a comprehensive design process that is integrated with the configuration management program to ensure that the benefits of the improved configuration management are realized in the design and modification process. Although there are some shortcomings in configuration management, the overall program has been substantially improved. Further, for the most part, NNFD has identified similar shortcomings through its assessment program, including the need for a formal configuration management program document, and has developed appropriate plans and corrective actions to address the identified shortcomings. Independent Oversight's review of a representative sample of design modifications, performed to the most recent revision to the change control procedure, identified no significant concerns, verifying that NNFD's process improvements have had a positive impact.

Surveillance Testing. In many cases, the quality of the surveillance test procedures reviewed was adequate. Mechanisms for tracking of technical surveillance requirement (TSR)-required surveillances have been formally established and are being effectively implemented. Instrumentation and measurement and test equipment for system surveillances reviewed were calibrated and maintained.

HEPA Filter Efficiency Testing

However, weaknesses were identified in several areas. The design and safety bases were not always completely and accurately translated into facility surveillance test procedures. The structuring of test procedures, controls, and sequencing did not always establish test parameters that conservatively represented the accident conditions under which safety systems may be required to perform. In one case, a deficiency in a TSR surveillance test procedure did not ensure an adequate test of safety systems. Specifically, HEPA filter particle removal efficiency testing arrangements

were not consistent with the facility's final safety analysis report for the VOG system. NNFD's investigation found that this concern also applied to the safety-class Hot Cell Support Area and the Laboratory Area exhaust systems. In the case of the Laboratory Area exhaust system, HEPA filters were operating below the TSR efficiency limit, and the surveillance testing was not sufficient to detect the condition. Several other weaknesses were also identified regarding the absence of administrative controls for inlet valves for cave vacuum relief valve testing, unanalyzed/untested VOG system conditions for loss of instrument air, inappropriate VOG system lineup and procedure step sequence for fan check valve testing, and the potential for preconditioning of TSR functional surveillance tests due to improper sequencing of calibrations and functional tests. Several opportunities for improvement were also identified in the areas of supporting analyses for details and assumptions for acceptance test parameters and in the clarity of test procedures. (See Finding #3.)

Hot Cell Support Area Exhaust Filter Plenum

Maintenance and Procurement. Although some further improvements are warranted, most elements of the maintenance and procurement program are effectively implemented and meet applicable requirements. Reviewed and observed maintenance work activities demonstrated NNFD and Facilities and Operations staff routinely meet the requirements and process expectations of the NNFD work control procedure, including a rigorous and disciplined approach to work identification, planning, reviewing, approving, scheduling, coordinating resources, authorizing, pre-job briefing, implementing, post-job briefing, and documentation. The NNFD Configuration Items Lists identify or descriptively envelop safety-related and defense-in-depth SSCs; however, these lists lack component level specificity necessary for the Master Equipment List required by the DOE maintenance order. Efforts are underway to populate the computerized maintenance management system database to meet the requirements of the DOE maintenance order for a Master Equipment List and to provide comprehensive readily retrievable SSC maintenance histories. The NNFD program to manage safety-related aging equipment and to establish and implement aging equipment plans provides an appropriate process for maintaining vital equipment availability and reliability, and is a good initiative; however, additional effort is warranted to keep the plans current in order to remain compliant with the DOE Order. The NNFD procedures for procurement of safety-related and defense-in-depth SSCs was recently revised in response to a self-assessment of vulnerabilities identified at another site in the DOE complex. Reviewed elements of the new NNFD procedure for quality-significant procurement, receipt inspection, and commercial grade dedication met the requirements of 10 CFR 830 and DOE orders. Further, reviewed procurement documents demonstrated acceptable procedure conformance.

NNFD System Engineering and Oversight. The system engineer program defined in SBMS and implemented in NNFD generally meets the requirements of DOE orders. Interviewed NNFD system

engineers and engineering support staff were technically well qualified, typically had many years of applicable experience, and clearly demonstrated their ownership for assigned programs, plans, systems, and facilities. NNFD system engineers are generally aware of the operability, reliability, configuration, and material condition of their assigned systems and perform a variety of activities. Improvements are warranted in the areas of requirements for more frequent assessments and system walkdowns, assignment of a single qualified cognizant system engineer to each system, and clarity in the respective roles of cognizant system engineers and system engineers. Some of these concerns were also self-identified in NNFD self-assessments, and plans exist for corrective action.

NNFD is taking positive steps in developing a process and set of requirements for system engineering to establish and then maintain vital safety system health reports. NNFD is also working to enhance the role of system engineers in specifying or approving post-maintenance testing requirements, acceptance criteria, and results, to ensure the objectives of maintenance/modifications are achieved, and that operability is fully restored.

ORNL management direction has ensured that effective oversight processes are in place to provide useful feedback and improvement to operations at REDC. Substantive improvements have been made in the performance assessment and management oversight processes within NNFD during recent years. These improvements have been driven by clear management expectations to sustain a positive safety culture within the NNFD staff, and to critically evaluate performance effectiveness. The management processes in place have ensured that there is a sufficient amount of various types and levels of assessment activities to provide a useful scope of information to NNFD management. Assessment and issue information is clearly recorded in the ORNL issues management system for all types of assessments. NNFD managers are actively evaluating and determining trends of assessment results, and implementing corrective actions to impact assessment trends. This trending process has been continually improved since its implementation in fiscal year 2006; information is provided to NNFD managers and contributes to a better understanding of safety performance within NNFD.

ORO Oversight of REDC Nuclear Safety Systems. Independent Oversight's review of ORO oversight focused only on the aspects of ORO oversight that are directly relevant to the REDC nuclear safety systems and do not constitute an evaluation of ORO's overall oversight of ORNL. ORO personnel perform various oversight activities at REDC that provide ORO with information about the status of nuclear safety at REDC. Although the ORO AMS Facility Representative program provides an adequate process to ensure that AMS is kept informed of ongoing operations at REDC, a number of weaknesses in the rigor of program implementation are limiting its overall effectiveness. ORO AMS performed a recent self-assessment of the Facility Representative program that identified some of the same issues that were identified by this Independent Oversight inspection. AMS management is working to develop a corrective action plan to correct these weaknesses and issued a memorandum on August 21, 2008, to provide immediate correction of many issues. (See Finding #4.)

5 Conclusions

Overall, significant improvement was evident in all areas reviewed since the 2001 inspection, when ORNL lacked effective processes for systematically addressing facility material condition and configuration management of safety-related systems to ensure continued operation within the safety basis and management of the condition of aging and deteriorating components. Since then, NNFD has made significant progress in these areas as well as establishing a technical staff that demonstrated very strong nuclear safety questioning attitudes, commitments to teamwork, ownership of assigned responsibilities, safety consciousness, prompt and appropriate responses to safety questions and concerns, and disciplined conformance to approved procedures – all of which are elements of a strong nuclear safety culture. ORNL management direction has ensured that effective oversight processes are in place to provide useful feedback and improvement to operations at REDC. Substantive improvements have also been made in the performance assessment and management oversight processes within NNFD during recent years. These improvements have been driven by clear management expectations to sustain a positive safety culture within the NNFD staff and to critically evaluate performance. Further process refinements and improvements in implementation are underway to ensure that effective processes are established and sustained for mission work activities.

While NNFD has made considerable progress, further work is needed. There are weaknesses in some aspects of system engineering and surveillance testing, and continued effort is needed to ensure effective implementation of the enhanced systems. However, NNFD has a good understanding of the remaining weaknesses and, in most cases, has appropriate ongoing initiatives to address them. Sustained management attention and additional focus on flow down of design and safety basis details and assumptions is needed to ensure that the ongoing initiatives address remaining deficiencies and are effectively implemented.

ORO has supported the ORNL improvement efforts and has an adequate understanding of the status and needed improvement at REDC. ORO is aware of weaknesses in some aspects of the Facility Representative program and has recently taken actions to address them.

6 Ratings

The ratings (see below for purpose of ratings) reflect the current status of the reviewed elements of REDC nuclear safety programs at Building 7920.

ESSENTIAL SYSTEM FUNCTIONALITY	
Engineering Design and Safety Basis	Needs Improvement
Configuration Management	Effective Performance
Surveillance and Testing	Needs Improvement
Maintenance and Procurement	Effective Performance
NNFD System Engineering and Oversight	Effective Performance

Ratings

The Office of Independent Oversight uses a three-tier rating system that is intended to provide line management with a tool for determining where resources might be applied toward improving environment, safety, and health. 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 rating system helps to communicate performance information quickly and simply. The three ratings are:

- Significant Weakness (Red)
- Needs Improvement (Yellow)
- Effective Performance (Green).

APPENDIX A
Supplemental Information

A.1 Dates of Review

Planning Visit	August 4-7, 2008
Onsite Inspection Visit	August 18-28, 2008
Report Validation and Closeout	September 16-18, 2008

A.2 Review Team Composition

A.2.1 Management

Glenn S. Podonsky, Chief Health, Safety and Security Officer
Michael A. Kilpatrick, Deputy Chief for Operations, Office of Health, Safety and Security
William Eckroade, Director, Office of Independent Oversight
Steve Simonson, Director, Office of Emergency Management Oversight (Team Leader)
Thomas Staker, Director, Office of Environment, Safety and Health Evaluations
William Miller, Deputy Director, Office of Environment, Safety and Health Evaluations

A.2.2 Quality Review Board

Michael Kilpatrick	William Eckroade	Thomas Staker	William Miller
Dean Hickman	Robert Nelson	William Sanders	

A.2.3 Review Team

Bob Freeman, Essential Systems Functionality Team Leader
Don Prevatte
Joe Panchison
Tim Martin
Robert Guy

A.2.4 Administrative Support

Mary Anne Sirk
Laura Crampton
Tom Davis

APPENDIX B
Site-Specific Findings

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

	FINDING STATEMENTS
#1	Potential challenges to safety-related systems as a result of some accidents and credible off-normal conditions have not been sufficiently addressed by rigorous, formal engineering analyses, to ensure that they can fully perform their design basis safety functions, as required by 10 CFR 830 and DOE Standard 3009-94, Change Notice 3, *Preparation Guide for DOE Non-Reactor Nuclear Facility Safety Analysis*.
#2	TSR-required HEPA filter efficiency test procedures on the safety class Vessel Off-gas System and the Hot Cell Support Area and Laboratory Area Exhaust Systems were non-conservative with respect to the Final Safety Analysis Report, and corrected retests found the Laboratory Area Exhaust System HEPA filters outside TSR requirements, contrary to 10 CFR 830.
#3	Surveillance procedure setups, controls, lineups, and sequencing do not always establish test parameters that conservatively represent design basis accident conditions or that do not minimize risk to equipment and operational stability, as required by 10 CFR 830 and DOE Standard 3009-94, Change Notice 3, *Preparation Guide for DOE Non-Reactor Nuclear Facility Safety Analysis*.
#4	The Oak Ridge Office Assistant Manager for Science has not fully implemented some program requirements necessary to ensure an effective Facility Representative program at ORNL, in accordance with DOE-STD-1063-2006, Facility Representative.