Independent Oversight Follow-up Review of Nuclear Safety Programs at the

Pacific Northwest National Laboratory

April 2009

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

ANSI	*American National Standards Institute*
ASME	*American Society of Mechanical Engineers*
CFR	*Code of Federal Regulations*
CRL	*Capability Replacement Laboratory*
DCF	*Dose Conversion Factor*
DOE	*U.S. Department of Energy*
DOP	*Dioctyl Phthalate*
DOS	*Dioctyl Sebacate*
DSA	*Documented Safety Analysis*
HEPA	*High Efficiency Particulate Air*
HSS	*DOE Office of Health, Safety and Security*
ISC	*Integrated Support Center*
LCO	*Limiting Condition of Operation*
MAR	*Material at Risk*
PISA	*Potentially Inadequate Safety Analysis*
PNNL	*Pacific Northwest National Laboratory*
PNSO	*Pacific Northwest Site Office*
REVS	*Radioactive Exhaust Ventilation System*
RL	*Richland Operations Office*
RPL	*Radiochemical Processing Laboratory*
SBMS	*Standards Based Management System*
SC	*DOE Office of Science*
SDD	*System Design Description*
SSC	*System, Structure, or Component*
TSR	*Technical Safety Requirement*
USQ	*Unreviewed Safety Question*
USQD	*Unreviewed Safety Question Determination*
wc	*Water Column*

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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), conducted a follow-up review of nuclear safety at the DOE Pacific Northwest National Laboratory (PNNL) during January and February 2009. The follow-up review focused on PNNL efforts to address nuclear safety deficiencies identified in a November-December 2003 HSS Independent Oversight inspection of environment, safety, and health programs at PNNL. The Independent Oversight team evaluated the functionality of the radioactive exhaust ventilation system (REVS) at PNNL's Radiochemical Processing Laboratory (RPL), with primary emphasis on the findings and corrective actions associated with REVS from the 2003 inspection.

PNNL is managed by Battelle Memorial Institute under contract to DOE. The DOE Office of Science (SC) has primary line management responsibility for PNNL. At the site level, line management responsibility for PNNL currently falls under the Manager of the Pacific Northwest Site Office (PNSO). At the time of the 2003 inspection, the DOE Richland Operations Office (RL) was the responsible safety basis approval authority. In December 2003, PNSO took initial steps to assume responsibility for RPL, and in November 2007, oversight responsibility shifted to PNSO.

The RPL is a hazard category 2 nuclear facility located in the 300 Area of the Hanford Site. The REVS boundary starts at the exhaust plenum in the RPL basement; includes the attached ductwork to the Filter Building Annex, the final stage high efficiency particulate air (HEPA) filter banks, housings, dampers, and exhaust fans; and ends at the top of the stack. The REVS is designated as "safety significant" in the documented safety analysis (DSA) and is intended to ensure safe confinement of radioactive materials under normal conditions and during certain accident conditions, including a fire or explosion in a laboratory room.

The mission of RPL has dramatically changed since the 2003 Independent Oversight inspection. From 2003 to 2007, RPL was designated as a limited mission-life facility, and its shutdown was expected as early as 2009. Although it had not been fully upgraded to the new DSA standards, the DSA for RPL that

Radiochemical Processing Laboratory

was in place in 2003 was considered adequate by DOE at that time, considering the limited mission and expectations of a shutdown. Also, in 2003, DOE and PNNL planned to build a replacement facility as part of the new facilities in the Capability Replacement Laboratory (CRL) project. In 2007, DOE and PNNL decided to extend the life of the RPL facility for another 20 years and retain its mission capabilities. The CRL project was re-scoped to include upgrades to the facility and programs important to continued safe operation. This change in plans has resulted in major shifts in committed resources; implementation of needed facility improvements; safety documentation upgrades, including DSA, technical safety requirements (TSRs), and procedures; and supporting management and technical staff organizational improvements at PNNL and PNSO.

Sections 2 and 3 of this report discuss the key positive attributes and items for management attention, respectively, identified during this follow-up review. Section 4 provides Independent Oversight's conclusions regarding the overall effectiveness of PNSO's and PNNL's management of the corrective actions for the identified deficiencies with RPL nuclear safety systems. Section 5 presents opportunities for improvement for consideration by PNSO and PNNL.

Appendix A provides supplemental information, including team composition.

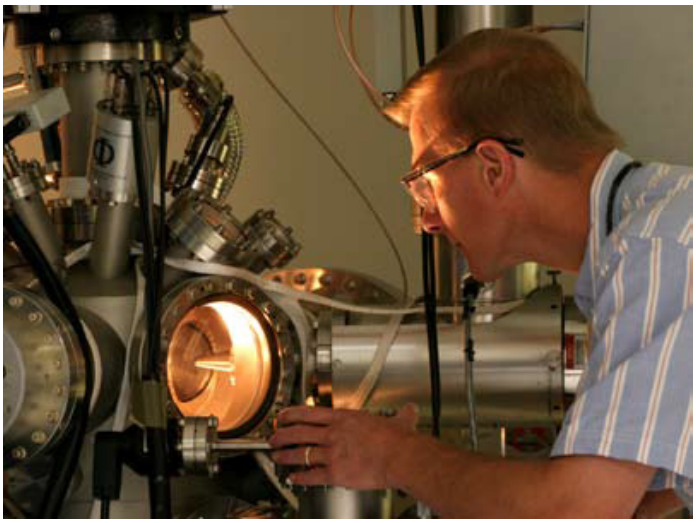
Appendix B presents the finding identified during this Independent Oversight review. The finding is also referenced in the applicable portions of Sections 3 and 4 of this report. The finding listed in Appendix B was derived from multiple individual deficiencies that are described in the report. In accordance with DOE Order 470.2B, *Independent Oversight and Performance Assurance Program*, SC must develop a corrective action plan to address the finding identified in Appendix B, including the associated individual deficiencies, and provide appropriate causal analyses, corrective actions, and recurrence controls for this finding.

Appendix C presents the Independent Oversight assessment of the elements that were reviewed, including an assessment of: (1) corrective actions for the 2003 findings, (2) the unreviewed safety question (USQ) process, and (3) PNNL corrective action reviews and PNSO oversight.

2 Positive Attributes

PNNL and PNSO have strengthened their organizations and staffing to support the safety needs of RPL, which is classified as a hazard category 2 nuclear facility. PNNL established the Nuclear Operations Division in 2007. This new organization has the responsibility to ensure safe operation of RPL and proper implementation of the nuclear safety program. PNSO has implemented several measures to ensure its ability to oversee nuclear operations at PNNL, including staff increases, establishing oversight procedures and processes, and arranging for support from the SC Integrated Support Centers. Both organizations have significantly improved their capabilities for managing nuclear facilities since the Independent Oversight review in 2003. In addition, there has been a marked improvement in the safety culture at RPL; attitudes have shifted away from resolving safety problems by doing just the minimum required, to implementing what is needed to improve safety.

PNNL was able to satisfactorily resolve questions regarding the required safety performance of REVS during accident conditions. PNNL's update of the RPL accident analysis provides a valid technical basis for demonstrating that REVS is not essential to ensuring that worker and public accident exposures remain within established limits in a design basis accident. PNNL reevaluated all accidents that could rely on the REVS (i.e., accidents in the 2003 DSA that cited the REVS as mitigating the consequences) using updated material-at-risk values and dose conversion factors. The evaluation demonstrated that the DOE risk evaluation radiation exposure guidelines for the public and workers would not be exceeded, even without crediting REVS. Although REVS is not required to be classified as either safety class or safety significant, PNNL and PNSO have conservatively designated it as a safety-significant system to support defense-in-depth strategies.



Research Equipment at RPL

3 Items for Management Attention

The RPL DSA and the RPL operations and test procedures do not accurately describe the functions and/or detailed operational criteria of REVS in both normal and accident conditions to resolve some previously identified design faults. Although the current revision to the DSA that removed accident analysis credit for the REVS filtration safety function resolved the accident analysis concerns, the DSA still classifies the REVS as safety-significant, and it still describes the system's *performance* capabilities with respect to those accidents for which it was formerly credited (providing final HEPA filtration for all building exhaust and maintaining the building at negative pressure to prevent building out-leakage), with no exceptions or qualifications. However, the REVS design, as described in the DSA, does not account for all of the actual performance vulnerabilities and attributes related to its function as a safety-significant system that provides an additional layer of defense-in-depth and margin of safety. The following are the most significant REVS deficiencies that remain unresolved: (See Finding #1.)

- The REVS design did not account for potential building pressurization during a design basis fire due to rapid loading of the REVS HEPA filters. The DSA was not updated to clearly define the performance of REVS for this accident condition.

- The REVS design, as described in the DSA, did not include the basis for the revised building pressure of minus 0.03 inch water column (wc). This value does not appear to fully address potential positive building pressure differentials for expected wind velocities above 10 mph. Also, ventilation systems' design or performance factors are not discussed.

- The REVS filter isolation dampers' design was inadequate to accomplish their isolation function. The 2007 DSA and TSR were correctly revised to no longer describe a REVS damper design capability to isolate a defective final stage HEPA filter bank unit. However, several current RPL procedures still require tests of the capability of the REVS filter bank dampers to effectively isolate a failed filter bank unit and continue to state acceptance criteria that cannot be substantiated.

- REVS HEPA filter testing has been improved to ensure a more accurate filter efficiency measurement. However, a further review of HEPA filter testing against industry standards found additional deficiencies. The RPL procedure for in-place HEPA filter testing does not appropriately meet invoked industry standards. Resolution or documented justification of these deficiencies remains to be demonstrated. Further, there are inconsistencies in criteria for HEPA filter replacement outlined in the DSA, the System Design Description (SDD), the Standards Based Management System (SBMS), and the RPL HEPA filter test procedure. Also, RPL lacks a procedure for effectively isolating a failed HEPA filter bank.

The screening criteria in the RPL USQ procedure, required by 10 CFR 830, do not correctly reflect some of the appropriate thresholds for performing USQ evaluations of changes to the facility and facility procedures, as described in the DSA. The current USQ procedure includes directions that inappropriately attach qualifications, caveats, or reservations to the fundamental screening questions – for example, whether a change *impacts* a system, structure, or component (SSC) or procedure as described or implied in the DSA**,** including the generation of new procedures. Also, the current directions are not sufficient to ensure that the term "as described in the DSA" includes all safety basis documents and all SSCs described or implied in the DSA, regardless of whether the SSCs are safety-related or non-safety and whether they are credited in the accident analysis or not. A review of a sampling of USQ screenings identified several examples where proposed changes were inappropriately screened out of the process. Although process deficiencies exist, the review did not identify any examples where a proposed change that was inappropriately screened out of the USQ evaluation process appeared likely to have resulted in a positive unreviewed safety question determination (USQD).

Experimental Equipment at RPL

4 Conclusions

RPL has taken important steps to address the three nuclear safety findings identified during the 2003 Independent Oversight inspection. The most significant corrective action taken by PNNL was to redo the accident analysis, which showed that accident exposures for both workers and the public were less than the DOE guidelines, even without crediting the safety functions of REVS; thus, there is no requirement that REVS and its backup instrument air system be designated as safety-significant systems. Independent Oversight found no discrepancies or weaknesses in the revised accident analysis. Some other corrective actions were completed adequately, such as modifying sample points for testing HEPA filters and revising the TSRs with respect to REVS.

Although not required to meet the accident dose guideline, DOE (PNSO and RL) and PNNL conservatively decided that REVS and the backup instrument air systems would retain their safety-significant classification in the subsequently revised DSA to ensure that they could provide defense-in-depth for accident conditions. This decision makes it mandatory that REVS and the backup instrument air system be fully subject to DOE nuclear safety requirements. However, some weaknesses identified during the 2003 inspection still remain with respect to the rigor of defining, implementing, analyzing, operating, maintaining, and testing the safety-significant design functions of REVS and the backup instrument air supply and in the descriptions of these systems' performance and limitations in the DSA/TSRs. Some of the most significant areas that were not fully addressed included: the REVS final HEPA filter analyses do not provide adequate rigor to demonstrate their ability to withstand the effects associated with certain fire accidents; building negative pressure is not adequately maintained to prevent some building pressurization during windy conditions; HEPA filter testing is not fully performed to industry standards; and the backup instrument air compressor testing is not adequate.

Hot Cell at RPL

One new weakness was identified with respect to the non-conservative screening criteria in the RPL USQ procedure. Because of the procedure deficiencies, some USQ evaluations have not been performed in accordance with the expectations of 10 CFR 830. However, no missed evaluations were discovered during this review that appeared likely to have resulted in a positive USQD.

PNSO and PNNL have made significant progress in establishing an organizational safety culture that is consistent with the expectations for a hazard category 2 nuclear facility. During this follow-up review, attitudes throughout the organization were noticeably more aligned to the rigor, questioning attitude, and attention to detail expected of such a facility than in 2003. PNSO and PNNL have devoted significant effort to evaluating nuclear safety conditions at RPL and reviewing the corrective actions from the 2003 inspection. PNSO and PNNL have also made organizational changes that strengthen their ability to manage nuclear safety and perform evaluations. However, PNSO and PNNL efforts have not been fully effective in addressing certain aspects of the 2003 Independent Oversight findings and ensuring that the corrective actions were sufficient to address all aspects of the weaknesses, indicating that continued PNSO and PNNL management attention is needed to ensure that nuclear safety programs, nuclear safety culture, and oversight improvements are sustained. Interactions between the review team and facility staff during this review indicate that they are focused on making needed improvements to ensure that the requirements for a nuclear facility are fully implemented.

5 Opportunities for Improvement

This Independent Oversight 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 organizations and accepted, rejected, or modified as appropriate, in accordance with site-specific program objectives and priorities.

DSA, REVS, and Support Systems

1. **Consider updating the DSA to accurately reflect the performance limitations of the RPL safety-significant systems.** Starting with the REVS and its supporting backup instrument air system, revise the DSA to accurately and completely describe the safety performance limitations of all safety SSCs, including supporting SSCs, and including those supporting SSCs not currently classified as safety significant, such as the building supply fans vortex dampers, which provide building pressure control to prevent any building exhaust from bypassing the REVS final HEPA filters; the DSA describes this as a safety function for REVS. Additionally, for those currently non-classified SSCs, upgrade their classification to safety significant, as required by 10 CFR 830. Ensure that DSA descriptions of limitations include those SSCs that may be fully capable of performing required safety functions, but for which such capabilities are not demonstrated by credible analyses and/or testing. Perform analyses and/or modifications to all safety SSCs and required supporting SSCs so that they are demonstrably capable of fully performing their safety functions as described in the DSA; alternatively, downgrade all such systems to a non-safety classification.

2. **Consider providing a technically defensible analysis of the REVS final HEPA filters' ability to withstand the differential pressures that may be generated as a result of combustion product accumulation from a room fire accident.** Alternatively, protect these filters from this threat by providing a modification to trip the exhaust fans at a differential pressure below their rated value.

3. **Consider upgrading the pressure control system to the same safety classification as REVS.** Alternatively, modify the supply fan control logic to trip the fans upon sensing building positive pressure, incorporating such features as timers to prevent spurious trips for momentary pressure spikes and to ensure proper hood face velocities to allow sufficient time for workers to evacuate in case of a fire. Without such upgrade, revise the DSA to identify this REVS system vulnerability.

4. **Consider revising SOP-325-15, *Building Round Sheet Parameters*, to revise the building differential pressure acceptance parameter to be commensurate with more typical wind conditions at the Hanford Site.**

USQ Procedure

Analytic Equipment at PNL

5. **Consider revising the facility USQ procedure to correctly reflect the 10 CFR 830 expectations that changes to the facility or procedures, as described in the DSA, must undergo USQ evaluations.** Using guidance in DOE Guide 424.1-1A, *Implementation Guide for Use in Addressing Unreviewed Safety Question Requirements*, eliminate from the current procedure, at multiple locations, all directions, instruction, and guidance that incorporate reservations, conditions, qualifiers, and caveats that allow deviation from the Guide's provisions that "Screening is intended to be a simple go/no-go decision-making step without evaluative consideration," based on the basic screening question, "Is this a temporary or permanent change to the facility (a procedure) as described in the documented safety analysis?" Remove all requirements or implications, in multiple locations in the procedure, that only changes to safety SSCs and procedures, or only to those relied on or described in the accident analyses, need to undergo USQDs. Add directions that new procedures should be considered as a "change to a procedure, as described in the DSA." Expand the definition of "as described in the DSA" to include the TSR bases, as indicated by the DOE Guide, and eliminate all directions indicating that this phrase limits consideration only to the DSA "document," because, according to the Guide, it is applicable to virtually all safety basis documents.

6. **Using the revised USQ procedure screening directions described above, consider performing an extent-of-condition review of screenings involving proposed changes to the facility or procedures performed since the 2003 Independent Oversight inspection.** Report to DOE discovered deviations from the USQ expectations of 10 CFR 830. Perform USQDs on those that were improperly screened out, and report the results of these new USQDs to DOE.

HEPA Filter Testing and Damper Operation Improvements

7. **Consider revising PM-55440, *Final Stage HEPA Filter Set # 5*, and SOP-325-HVAC-1, *Operation of the Final Stage HEPA Filter Dampers*, to remove the inference that the dampers can be the sole means to effectively isolate a failed or damaged final stage REVS HEPA filter bank.** However, in revising these procedures, recognize the continuing need to confirm damper operability. For instance, consider the need to maintain or revise the filter differential pressure criteria to indicate that the tested damper closes on demand as required to demonstrate damper operability.

8. **Consider revising PM-55440, *Final Stage HEPA Filter Set # 5*, to require timely isolation of a final stage REVS HEPA filter bank as required by the RPL DSA when the filter acceptance criteria specified in ASME/ANSI AG-1, *Code of Nuclear Air and Gas Treatment*, ASME/ANSI N510, *Testing of Nuclear Air Treatment Systems*, and the REVS final stage HEPA filter design specifications are not met.** Determine and document the bases for the installed final stage REVS HEPA filter bank maximum design differential pressure. Also, revise for consistency the criteria for HEPA filter replacement specified in the PNNL SBMS, RPL DSA, REVS SDD, and PM-55440. In particular, consider the need to reduce the SBMS filter differential criteria of 10 inches wc when evaluating the need for replacement.

9. **Consider revising PM-55440, *Final Stage HEPA Filter Set # 5*, to be consistent (to the extent possible) with the requirements of industry standards.** Ensure that deviations from the committed standards based on "as low as reasonably achievable" (ALARA) or other reasonable considerations are justified in writing. In particular, consider revising PM-55440 for consistency with industry standards or justifying the deviations for visual inspection, verification of the uniformity of distribution of the challenge aerosol smoke across the filter face, and qualification of the aerosol smoke injection ports.

10. **Consider revising SOP-325-HVAC-003, *Operation of the Exhaust and Supply Fans*, or other appropriate procedure to define the steps necessary for effectively isolating a failed or damaged final stage REVS HEPA filter bank to maintain the required overall 99.95 percent REVS filter efficiency by installing a leak-tight cover on the upstream side of a filter exhaust damper that is manually disabled in the closed position.**

11. **Consider revising SOP-325-021, *325 Building HEPA Filter DOS* [dioctyl sebacate] *Testing*, to remove reference to secondary HEPA filters.**

12. **Consider justifying in writing the setup and operation of the hot aerosol smoke generator to demonstrate that the generator will be operated in a fashion that will assure proper HEPA filter testing, including:**

    - Whether factory settings were revised as required to compensate for generating the aerosol smoke from DOS rather than DOP (dioctyl phthalate) liquid
    - Whether the resulting aerosol smoke particle size distribution is consistent with industry standards
    - Basis for using an inert gas pressure regulator setting different from that specified in the operating manual (50 +/- 5 psig).

Standby Instrument Air System Improvements

13. **Consider implementing the proposed modification that installs a vent path with a manual isolation valve between the check valve and isolation valve separating the safety-significant backup instrument air system from the normal building 325 non-safety classified compressed air system, thereby facilitating periodic testing of the standby air compressor's ability to carry potential loads, including back-leakage through the check valve.**

14. **Consider investigating, identifying, and repairing the apparent excessive air leakage from the backup instrument air system.**

15. **Consider revising PM-20370, *Emergency Air Compressor*, and SOP-325-009, *Compressed Air System and Standby Air Compressor*, to ensure a valid demonstration of the operability of the standby air compressor.** Ensure that the revised procedure requires periodic standby air compressor capacity tests that confirm the ability of the safety-significant backup instrument air system to perform its DSA-defined functions under the most adverse conditions of demand that could reasonably be expected to be experienced. Ensure that the standby air compressor's capacity is demonstrated to exceed accident demand and backup air supply system and check valve leakage, with sufficient margin to account for anticipated adverse conditions, such as:

- Minimum allowable normal operating pressure, which would be the starting point for accident demands
- Minimum pressure required to operate and then hold equipment in safe positions
- Maximum anticipated air usage rates, including accident operations and holding in required positions
- Time required for safety functions to be performed using only the backup air supply
- Worst-case potential temperature drops during such conditions due to loss of normal building power and heating
- Staying within the air compressor's maximum load factor while at least maintaining minimum operating pressure.

APPENDIX A
Supplemental Information

A.1 Dates of Review

Planning Visit	January 12-15, 2009
Onsite Review Visit	January 26 – February 3, 2009
Report Validation and Closeout	February 25-27, 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, Acting Deputy Chief for Enforcement and Technical Matters, Office of Health, Safety and Security
John Boulden, Acting Director, Office of Independent Oversight
Thomas Staker, Director, Office of Oversight, Environment, Safety and Health Evaluations

A.2.2 Quality Review Board

Michael Kilpatrick	William Eckroade	John Boulden	Thomas Staker
Dean Hickman	Robert Nelson	William Sanders	Pete Turcic

A.2.3 Review Team

William Miller, Team Leader

Tim Martin	Joe Panchison	Don Prevatte

A.2.4 Administrative Support

Tom Davis, Technical Writer

APPENDIX B
Site-Specific Finding

	FINDING STATEMENT
#1	PNNL has not adequately ensured that safety-significant systems, including REVS and its supporting backup instrument air system, fully meet some of the performance capabilities currently described in the DSA.

APPENDIX C
Assessment

The 2009 U.S. Department of Energy (DOE) Office of Independent Oversight follow-up review assessed three aspects of nuclear safety at the Pacific Northwest National Laboratory (PNNL) Radiochemical Processing Laboratory (RPL), including:

- Assessment of corrective actions for the findings from the 2003 Independent Oversight inspection (Section C.1)
- Unreviewed safety question (USQ) process (Section C.2)
- PNNL corrective action reviews and Pacific Northwest Site Office (PNSO) oversight (Section C.3).

C.1 Assessment of Corrective Actions for 2003 Findings

The 2003 Independent Oversight inspection identified three findings (Findings #5, #6, and #7) in the essential system functionality topic that are the focus of this nuclear safety follow-up review. The essence of the three 2003 findings and the reference to the finding number are:

1. The radioactive exhaust ventilation system (REVS) contained fundamental design weaknesses that could prevent it from fully performing its design safety function (Finding #5).

2. The testing of this system and its supporting backup instrument air system were inadequate to demonstrate that they could perform their design basis safety functions (Finding #6).

3. There were inadequate formal, rigorous supporting analyses that demonstrated the REVS' capability of performing its design safety functions for all accident conditions for which it was credited (Finding #7).

PNNL's primary corrective action strategy was to demonstrate that, for all accidents for which REVS was credited in the 2003 documented safety analysis (DSA), the DOE risk evaluation radiation exposure guidelines for both the public and the workers would not be exceeded, assuming that the REVS was not functioning at all and therefore was not mitigating the consequences. This strategy was accomplished by revising the accident analyses to include two new factors:

- New dose conversion factors (DCFs), expressed in rem per Curie (Ci) exposure, from the International Commission on Radiological Protection (i.e., publications ICRP-68 and ICRP-71 for workers and the public, respectively). These new DCFs were the products of updated biokinetic dose models of the human respiratory system; the 2003 DSA accident analysis used values from ICRP-30. Although the DCFs in the analyses for tritium increased by 4 percent for workers and the public, the DCF for plutonium-239 (Pu-239) or the Pu-239 equivalent decreased by 90 percent for workers and by 81 percent for the public.

- Significant reductions in the tritium material-at-risk (MAR) limits. The area limit was reduced from 600,000 Ci to 180,000 Ci, and the facility limit was reduced from 3,000,000 Ci to 900,000 Ci.

Because of these changes, the calculated overall exposures to workers and the public were significantly lower in the revised accident analyses. For example, for one of the higher-exposure accidents (a room fire) in the 2003 DSA, the worker particulate and gas doses were 34 rem and 17 rem, respectively, and the public particulate and gas doses were 3.4 rem and 1.7 rem, respectively. With the new DCFs and reduced MAR values in the revised accident analysis, these doses were lowered to 3.4 rem and 3.0 rem for workers and 0.7 rem and 0.4 rem for the public. The recalculated values were below the applicable DOE consequence levels and risk evaluation guidelines, without credit for the mitigation provided by REVS. Therefore, the accident analysis demonstrated that the REVS is not essential for ensuring that the doses are less than the established guidelines. The Independent Oversight team review of the revised accident and radiation dose analysis did not identify any discrepancies or weaknesses.

Consistent with the revised accident analysis results, the DSA was revised to no longer credit REVS for accident mitigation. This revision effectively resolved the accident analysis aspects of the three relevant inspection findings.

Although the REVS is not credited in the DSA accident analysis, the REVS and the supporting backup instrument air system are still classified as safety-significant. As a result, the hardware, testing, and analytical aspects of the three nuclear safety findings required re-examination to determine whether, and to what degree, the concerns underlying the findings remained. These considerations are discussed below for each of the three findings from the 2003 Independent Oversight inspection.

Finding #5 from the 2003 Inspection

The 2003 Independent Oversight inspection identified weaknesses in the REVS DSA and TSR requirements, in its physical design, and in its operational and testing parameters. The design contained fundamental weaknesses that could prevent it from performing its design safety functions and was not adequately addressed in the DSA and associated TSRs. Three specific elements of this finding (labeled 2003-5A, 2003-5B, and 2003-5C) are described below, and the corrective actions taken to date are identified and evaluated.

2003-5A: The REVS design did not account for potential building pressurization during a design basis fire due to rapid loading of the REVS high efficiency particulate air (HEPA) filters. Under normal and accident conditions, the exhaust fans must operate at a higher flow rate than the supply fans to maintain the building at a slightly negative pressure. However, for a design basis fire in one of the laboratories, the REVS final HEPA filters could become loaded with combustion products in a relatively short period of time. The resultant increase in system resistance could cause the exhaust fans to operate at a lower flow rate, potentially less than the supply fans (normal flow modulation by the supply fans' vortex dampers could not be credited because they are not safety classified and are spring-loaded to fail open). This situation could cause the building to become pressurized, and building in-leakage would be changed to out-leakage, causing some bypassing of the REVS final HEPA filters.

Initially, PNNL evaluated the safety of continued operation of RPL and implemented fire safety compensatory measures that included, in part, doubling of operator rounds and evaluation of compliance with the fire protection program. Additionally, PNNL evaluated this issue against the RPL safety basis using the USQ process. Initially, a safety evaluation screen concluded that a potentially inadequate safety analysis (PISA) existed. The PISA and planned compensatory measures were reported in occurrence report RL--PNNL-

PNNLNUCL-2003-0009. The resulting unreviewed safety question determination (USQD) was negative and recommended incorporation of the technical concern in the next update of the RPL DSA.

PNNL subsequently revised the DSA to not credit the REVS filtration safety function when calculating accident exposures (also see 2003 Finding #7 below). Although not credited, REVS is still categorized as safety-significant. The current DSA states that the safety function of the REVS is to provide an additional layer of protection for onsite workers and the public by filtering radioactive material releases associated with certain accidents described in Chapter 7 of the DSA.

The Independent Oversight team concluded that the revision to the DSA that removed accident analysis credit for the REVS filtration safety function resolved the accident analysis concerns. However, the DSA still classifies the REVS as safety-significant, and it still describes the system's *performance* capabilities with respect to those accidents for which it was formerly credited (providing final HEPA filtration for all building exhaust and maintaining the building at negative pressure to prevent building out-leakage), with no exceptions or qualifications. However, the REVS design still has many of the same *performance* vulnerabilities or attributes described in the 2003 report, and these vulnerabilities or attributes are not identified in the current DSA. (See Finding #1.)

2003-5B: The REVS design did not include criteria for building negative pressure that adequately account for wind effects. The 2003 Independent Oversight inspection identified that the facility procedure for monitoring building pressure (the operator round sheets) allowed building pressures to be as high as minus 0.01 inch water column (wc), which corresponded to a wind velocity of only 5 mph; any velocity above this value would cause pressure reversal on most of the building's outside surfaces, and therefore, the REVS would not be performing one of its design safety functions of maintaining the building at a negative pressure to prevent unfiltered leakage from bypassing the final HEPA filters.

PNNL determined that this issue was a PISA. Subsequently, PNNL issued Occurrence Report RL--PNNL-PNNLNUCL-2003-0008. The safety evaluation concluded that this issue did not indicate an unsafe condition, and no additional compensatory measures were implemented. A USQD concluded that this technical issue was not a USQ and recommended incorporation in the next DSA update. This commitment was satisfied with implementation of the DSA update that removed REVS from the DSA accident analysis and downgraded the REVS limiting condition for operation (LCO) to an administrative control. (Also see corrective actions related to finding element 2003-5A above.) PNNL subsequently revised the REVS operating procedures to incorporate a higher minimum REVS differential operating pressure and more clearly communicate operator actions to be taken in the event that the differential pressure limit is not met. The operator round sheets (SOP-325-15) were revised to allow building pressure to be no higher than minus 0.03 inch wc. This revised pressure differential corresponds to a wind velocity of approximately 10 mph, which corresponds to the upper limit of the *average* ground-level wind velocities for this site, per the DSA.

The Independent Oversight team concluded that the revised minus 0.03 inch wc acceptance criterion, although an improvement, still does not fully address potential positive building pressure differentials relative to the outside for wind velocities above 10 mph, which occur approximately half of the time. Review of typical wind speeds at the Hanford Site documented by the National Weather Service reveals that maximum wind speeds of 10 to 20 mph occur on a frequent basis. Although building negative pressure must be maintained during normal operations for contamination control, it is especially important under accident conditions when normal primary confinement boundaries, such as gloveboxes and fume hoods, may be compromised by the accident. In order to assure that the required negative pressure is provided for accident conditions, it must be established and maintained during normal operations. Therefore, the acceptance value does not envelope the credible normal wind conditions at the Hanford Site. Furthermore, the DSA and technical

safety requirements (TSRs) do not specify a minimum building negative differential pressure requirement that will ensure no building outward leakage for credible normal wind velocities. These safety documents are therefore insufficient to provide positive assurance that an important design safety function of the REVS can be accomplished for prevalent site wind conditions. (See Finding #1.)

2003-5C: The REVS filter isolation dampers' design was inadequate to accomplish their DSA-stated isolation function. The 2003 DSA indicated that one of the design basis functions of these dampers was isolation of the filter banks, which is desirable in some situations (e.g., instances where a bank may be found to be outside its TSR-required efficiency). However, the design of these dampers (shutter-type, without seals) is not consistent with achieving the level of isolation necessary to maintain overall system filtration efficiency within the 99.95 percent DSA and TSR limits. In 2003, the Independent Oversight team recommended that the DSA should be revised to remove any ambiguity regarding the dampers' isolation capability.

PNNL declared a PISA and documented this issue in a 2003 Occurrence Report. A USQD was also prepared that concluded this issue was not a USQ and recommended that the descriptions of the damper operation be clarified in the next DSA update. This recommendation was considered accomplished by PNNL/RPL by implementation of the DSA update that removed credit for REVS from the DSA accident analysis and removed the DSA description of the dampers' isolation capability. Additionally, the REVS final stage HEPA filter damper operations procedure was revised to require verification that a leak-tight cover had been placed over the outlet isolation damper for a HEPA filter bank that had failed and must be isolated. PNNL concluded that although the dampers do not provide a leak-tight seal, the covers placed over the dampers provide a leak-tight configuration that accomplishes the DSA-intended isolation function. With these corrective actions, PNNL/RPL concluded that this issue did not represent an unsafe condition for continued operation and that no additional compensatory measures were warranted.

This 2009 Independent Oversight follow-up review confirmed that the 2007 DSA and TSR no longer describe a REVS damper design capability to isolate a defective final stage HEPA filter bank unit, for the purpose of maintaining the overall final stage HEPA filter efficiency at greater than or equal to 99.95 percent. However, several current RPL procedures still require tests of the capability of the REVS filter bank dampers to effectively isolate a failed filter bank unit and continue to state acceptance criteria that cannot be substantiated. Contrary to PNNL's determination that the corrective actions and the rationale for concluding that the corrective actions taken were sufficient as outlined above, these procedures do not indicate the need to install a leak-tight cover over the closed exhaust damper to ensure isolation of a failed REVS final stage HEPA filter bank unit. For example, the PNNL/RPL preventive maintenance procedure for the final stage HEPA filters states that "The dampers shall have a differential pressure no greater than 0.2 in wc across closed damper" and that "The leakage associated with 0.2 in wc as measured across the filter banks is an acceptable isolation capability to isolate the final stage HEPA filters, in the case of a failed filter." The PNNL procedure for operation of the final stage HEPA filter dampers also states that "A filter bank is considered isolated (i.e. the inlet or outlet damper closed) if the differential pressure indication across the filter bank is less than or equal to 0.2 inches wc." (See Finding #1.)

The procedure for operation of the exhaust and supply fans states that "the Filter Bank Dampers are not leak tight and are not the sole means used to isolate a Filter Bank that has failed the efficiency requirements." This procedure also indicates that to completely isolate REVS flow through a failed final filter unit, a leak-tight cover must be placed over the failed filter bank unit's closed outlet damper. However, there is still no current RPL procedure detailing the needed steps to safely perform the required isolation. (See Finding #1.)

The REVS final stage HEPA filter dampers do not, by themselves, have the ability to effectively isolate a failed HEPA filter bank unit to maintain the required overall REVS filter efficiency. Also, the procedures

currently describe misleading tests and unsubstantiated acceptance criteria that could mistakenly lead to dependence on dampers as the sole means of isolating a failed REVS final stage HEPA filter bank unit. As discussed below (under 2003 Finding #6), RPL does not have a procedure for effectively isolating a failed HEPA filter bank in a timely manner, with consistent criteria for initiation based on the acceptance criteria specified in ASME/ANSI AG-1, *Code of Nuclear Air and Gas Treatment*, ASME/ANSI N510, *Testing of Nuclear Air Treatment Systems*, the RPL DSA, and the REVS final stage HEPA filter design specifications, to ensure that the required overall REVS filter efficiency is maintained. (See Finding #1.)

However, PNNL was developing revisions of several RPL procedures at the end of this follow-up review, to remove the requirements and unsubstantiated acceptance criteria for REVS filter damper isolation capability testing.

Finding #6 from the 2003 Inspection

The 2003 Independent Oversight inspection identified deficiencies in the PNNL/RPL procedures for verifying the operability of the safety-significant REVS and the REVS backup instrument air supply. The two specific elements (labeled as 2003-6A and 2003-6B) of this finding are described below, and the corrective actions taken to date are identified and evaluated.

2003-6A: The REVS HEPA filter efficiency testing procedure was non-conservative. The 2003 RPL DSA and TSR required the REVS final HEPA filter to have a particulate removal efficiency of at least 99.95 percent. The system contains four parallel filter banks, and the RPL surveillance test procedure tests each bank separately by isolating three banks and performing an aerosol smoke penetration test on the remaining in-service bank. The test is performed by introducing aerosol smoke upstream of the banks and sampling the smoke concentration upstream and downstream of the filter banks and comparing the concentrations. However, the test method and sample configuration did not meet industry standards and may have caused non-conservative results, principally because the 2003 downstream sample point was in the common outlet header for the four filter banks, rather than being limited to the downstream flow from the specific filter bank being tested. This discrepancy was significant because of the potential leakage of the final HEPA filter isolation dampers, as previously discussed. Any such leakage from the three "isolated" banks would mix with the outlet flow from the bank being tested and could cause non-conservative test results.

In response to the finding, PNNL revised the RPL DSA and TSR to remove accident analysis credit for the safety functions of REVS, as discussed previously. However, the DSA revision retained the REVS filter 99.95 percent efficiency requirement, and the REVS and its backup instrument air system are still classified as safety-significant to ensure that they provide defense in depth for accident conditions. Further, the revision of the TSR removed the REVS LCO and replaced it with an administrative control that required REVS to provide a filtered release pathway. PNNL also installed new individual aerosol smoke concentration sample points in the downstream flow path from each REVS final stage HEPA filter bank to eliminate the concern that leakage through "isolated" parallel filter banks could bias the test results in a non-conservative direction, and revised the test procedure accordingly. Subsequent to the 2003 inspection, PNNL also replaced the REVS final stage HEPA filter banks because of aging concerns unrelated to the findings of the 2003 inspection. PNNL deemed these corrective actions to be sufficient to resolve the 2003 inspection concerns about REVS final stage HEPA filter efficiency testing. The Independent Oversight team confirmed that the reported corrective actions for the REVS HEPA filter testing had been taken.

In addition, the Independent Oversight team evaluated the extent of condition of the concern with not meeting industry standards for this testing. The Independent Oversight team concluded that the current test

procedure still does not meet some of the specific requirements of industry standards – specifically, industry standards ASME/ANSI AG-1, *Code of Nuclear Air and Gas Treatment*, and ASME/ANSI N510, *Testing of Nuclear Air Treatment Systems*. AG-1 requires the performance of certain in-place HEPA filter tests (e.g., visual inspection, differential pressure, airflow distribution, air-aerosol mixing, and in-place leak tests) and verification that the test results are within the acceptance limits of the owner's design specification. ASME/ANSI N510 has similar in-service HEPA filter testing requirements. Examples of deficiencies in meeting industry standards for in-place HEPA filter testing include: (See Finding #1.)

- RPL's test procedure requires the performance of a visual inspection of the external portion of the HEPA filters for obvious leaks or damage, as required by industry standards. However, in practice, the inspection of each filter bank is limited to viewing through glass ports in the doors that provide access to the inlet and outlet sides of each HEPA filter bank. The inspection does not include the outlet side of one half of each HEPA filter bank, because they are not visible from the viewports.

- RPL's test procedure requires a scan of the upstream HEPA filter face or bank to assure that 100 percent challenge aerosol smoke is present across the filter. However, this test is not physically possible without major facility, test procedure, and/or test equipment modifications, given the limitations imposed by the access hallway, the access port configuration, and the length of the probe.

- RPL's test procedure allows the system engineer to designate DOS (dioctyl sebacate aerosol smoke) injection points other than those specified, but does not cite the criteria that the alternate injection points must meet, including the required qualification testing of those injection points.

- RPL has not yet provided documentation supporting the setup and operation of the Hot Aerosol Smoke Generator that demonstrates that the generator is being operated in a fashion that will ensure proper HEPA filter testing in a number of areas:

  – Whether factory settings were revised as required to compensate for generating the aerosol smoke from DOS rather than alternative test liquids (dioctyl phthalate, DOP)

  – Whether the resulting aerosol smoke particle size distribution is consistent with industry standards

  – Basis for using an inert gas pressure regulator setting different from that specified in the operating manual (50 +/- 5 psig).

A proposed revision of RPL's test procedure was under development at the end of this follow-up review to resolve each of the identified concerns.

The Independent Oversight team also concluded that the current test procedure does not meet the requirements of the 2007 DSA, and that the RPL criteria for replacement of the REVS final stage HEPA filter banks is not consistent between the DSA, the System Design Description (SDD), the Standards-Based Management System (SBMS), and the RPL test procedure, and is also not consistent with industry standards AG-1 and N510. Examples of these deficiencies include: (See Finding #1.)

- The 2007 DSA, Section 4.3.1.3, states that the REVS exhaust system final HEPA filters are periodically tested and are changed out when the airflow through a filter bank becomes restricted to the point that flow and differential pressure specifications are not met or that the particulate removal efficiency of the filter bank is below the minimum value of 99.95 percent, as determined by testing. The RPL

test procedure records filter bank differential pressure but does not measure or record the flow, and does not include criteria for filter replacement for these parameters, as required by the DSA. Further, neither the DSA nor the RPL test procedure requires evaluation of the need for HEPA filter replacement based upon identification of visible damage, as required by AG-1 and N510.

- The RPL SDD-REVS-R3 states that HEPA filters are changed out when the airflow through the filter becomes restricted (criteria otherwise unspecified), the filter has visible damage or is suspected of being damaged, or the efficiency of the filter does not meet the minimum efficiency required (99.95 percent). The SDD does not reflect a need to measure flow or differential pressure or specify an acceptance criterion for these parameters identified in the DSA.

- The PNNL SBMS has different criteria for HEPA filter replacement; specifically, the SBMS requires evaluation of the need to replace a HEPA filter if the filter fails the in-place test (i.e., DOS test), if the filter is plugged to the point that the upstream air flow requirements are not being met (i.e., fume hood face velocity too low), if the filter poses a hazard by producing an elevated radiation field, or if the filter approaches a design limit of 10 inches wc differential pressure. It does not appear that this last criterion provides any margin between an operating limit and the asserted 10 inches wc differential pressure design limit to provide for accident loading conditions.

The addition of new downstream DOS concentration sample points addressed the stated 2003 concern with in-place REVS final stage HEPA filter efficiency test downstream sample locations. However, the corrective action failed to consider the extent of condition of the deficiency of the test procedure in meeting industry standards. As shown above, RPL does not currently have a procedure for appropriately meeting industry standards for in-place HEPA filter testing and for effectively isolating a failed HEPA filter bank in a timely manner, with consistent replacement criteria based on ASME/ANSI AG-1, *Code of Nuclear Air and Gas Treatment*, ASME/ANSI N510, *Testing of Nuclear Air Treatment Systems*, the RPL DSA, and the REVS final stage HEPA filter design specifications, to ensure that the required overall REVS filter efficiency is maintained. There are also inconsistencies in criteria for HEPA filter replacement outlined in the DSA, the SDD, the SBMS, and the RPL HEPA filter test procedure. (See Finding #1.)

2003-6B: Functional testing of the REVS backup air supply was not adequate. The safety-significant REVS backup instrument air system is designed to provide the required air pressure for operation of the REVS damper actuators upon loss of the normal compressed air supply to ensure that the dampers remain in the correct position for all design safety basis conditions. As a safety-significant system, REVS must be tested periodically to ensure that it can perform its safety functions. Although it was periodically tested in 2003 to verify that the backup air compressor would automatically start on loss of normal air supply pressure, no testing was performed to show that system leakage, including back-leakage through the check valve, which separates the backup air supply from the non-safety-related normal air supply, is less than the backup air compressor's capacity. Such leakage would not necessarily be detected during normal operation, because the larger normal air supply capacity may be capable of maintaining system pressure in spite of the leaks, whereas the backup air compressor may not.

PNNL/RPL replaced the REVS backup air system air compressor (now identified in documentation as the emergency or standby air compressor) in 2008. The current RPL test procedure for the standby air compressor is still limited to demonstrating that the compressor automatically starts when the normal compressed air supply pressure is lost. In PNNL's assessment of the need to implement corrective action for the 2003 finding, PNNL noted that the backup air supply is intended to function to provide compressed air to close the exhaust isolation dampers when needed; that the dampers are of a spring-to-open, air-to-close design; and that the dampers would open to provide an open REVS flow path on loss of backup air pressure, as

required by the REVS TSR for operability. Because an open pathway is ensured, even with a failed normal and standby compressed air system, PNNL concluded that additional testing of the backup air supply was not needed and that appropriate measures were available to prevent backflow through the exhaust fans and HEPA filter banks from causing an unfiltered release.

The 2009 Independent Oversight team reviewed the procedure for periodically testing the standby air compressor and verified that it was still limited to demonstrating that the compressor would automatically start and supply a source of backup air pressure for REVS damper controls following loss of the normal compressed air system supply pressure. The backup air supply is only necessary to close or maintain closed the REVS dampers; the dampers can be locally closed by manual operator action; and loss of the backup air supply pressure would result in all REVS dampers failing open, which is consistent with the 2007 TSR administrative control requirement. The 2007 DSA indicates that a design function of the emergency (standby) air compressor is that it "…provides a backup supply to the building compressed air system and is considered the safety significant source of compressed air to operate the REVS exhaust fan and filter dampers to support REVS operability." However, the DSA does not recognize the additional safety function of the system for providing operating air for controlling the building supply fans' vortex dampers, which perform the safety function (also unrecognized in the DSA) of maintaining building pressure negative, as addressed in the discussion of 2003-5A above. Additionally, contrary to the expectation that DSA-specified safety-significant design functions will be periodically confirmed, PNNL still does not periodically confirm that the standby air compressor capacity is sufficient to maintain adequate air pressure to meet system demands and system leakage, the latter including potential back-leakage through the isolation check valve separating the safety-significant REVS backup air supply from the non-safety-related normal compressed air system. (See Finding #1.)

Following installation in November 2008, the new standby air compressor was functionally tested to demonstrate its ability to control and maintain system pressure under normal system loads and existing system leakage. However, the functional test did not include any potential leakage through the check valve separating the safety-significant system from the non-safety-related compressed air system, because the manual isolation valve upstream of the check valve was closed, and therefore, there was no vent path for check valve leakage to escape between the check valve and upstream isolation valve. Subsequent calculations by the system engineer concluded that even without accounting for this back-leakage, about 42 percent of the standby air compressor's 52.2 cubic feet per minute (cfm) capacity was consumed by normal loads and leaks. The Independent Oversight team considers this level of normal demand on the standby air compressor to be excessive and to warrant further investigation to identify and repair system leaks. (See Finding #1.)

Contrary to the PNNL conclusion that no corrective action was needed to resolve the 2003 concern about the adequacy of the backup air supply operability test procedure, as indicated above, corrective actions are still needed to ensure that the capacity of the standby air compressor is periodically confirmed to be sufficient to maintain the required pressure for REVS damper operability while subject to system air demands and leakage, including any potential leakage into a depressurized normal compressed air system that must be assumed to be vented to atmosphere. (See Finding #1.)

PNNL provided the Independent Oversight team with a draft of a proposed facility modification permit. If implemented, this permit would establish a new preventive maintenance procedure and install a manual valve and vent path between the check valve and isolation valve separating the safety-significant instrument air system from the normal, non-safety-related compressed air system, thereby facilitating periodic testing of the standby air compressor's ability to carry potential loads, including back-leakage through the check valve.

Finding #7 from the 2003 Inspection

The 2003 inspection identified that PNNL has not ensured that the REVS design and operating requirements and capabilities are adequately supported by formal, rigorous analyses. The DSA and TSRs for the REVS were developed without sufficient formal technical analyses to support the design, operating parameters, or limits. The two specific elements (labeled as 2003-7A and 2003-7B) of this finding are described below, and the corrective actions taken to date are identified and evaluated.

As discussed above, the primary element of the facility's corrective action strategy was to demonstrate that, for all accidents inside the facility for which REVS was credited in the 2003 DSA, the DOE Richland Operations Office (RL) risk evaluation radiation exposure guidelines, for both the public and the workers, would not be exceeded, even without crediting REVS for mitigating the consequences. The Independent Oversight team identified no discrepancies or weaknesses in its review of the revised radiation dose analysis.

2003-7A: The REVS filter accident loading analysis was incomplete and incorrect. The REVS final HEPA filter combustion product loading analysis for a room fire reviewed in the 2003 inspection contained the following deficiencies:

- It did not account for the DSA-allowed isolation of one bank of filters, which would substantially increase the flow rates, and hence the differential pressure, through each of the three remaining banks. Because such isolation had no corresponding TSR LCO, it could remain in effect indefinitely.
- The flow data upon which it was based was not normalized to actual worst-case flows through the filters.
- It did not account for the 36 percent standard deviation in the data that formed its basis.
- It was based on data for clean filters and did not account for a normal operating allowance pre-accident loading.
- No corresponding pre-accident normal allowable loading filter differential pressure limits were procedurally specified.
- No corresponding combustible/flammable material room limits were procedurally specified.

In response to these concerns, PNNL engaged Hughes Associates to review the analysis. This contractor concluded that the analyses were appropriate and satisfactory as is. Based on this input and PNNL's qualitative assessment of the concern, and on the fact that the revised accident analysis demonstrated that worker and public accident doses were below DOE guidelines without crediting REVS, PNNL elected to not update the final filter loading analysis. The elements of this qualitative assessment were:

- The non-safety primary HEPA filters will plug, thus protecting the safety-significant final filters from the combustion products.
- The plugged primary filters will reduce air flow to the room with the fire, thus reducing the combustion products produced, and the combustion products will be rerouted to adjacent rooms where their primary filters will trap them.
- The combustion products will be deposited on building surfaces and not on the final filters.

- The fire protection program controls room combustibles below the level required to plug the final filters.

- The accident analysis demonstrates that even with failed final HEPA filters, the DOE exposure guidelines are not exceeded.

This 2009 Independent Oversight review of these responses concluded that PNNL and its contractor did not adequately address this finding element. A fundamental principle of defense-in-depth is that each layer of the defense must be capable of performing its defensive function independently of the defenses of the other layers. The primary HEPA filters credited in the above rationale for protecting the safety-significant final filters are non-safety, and thus cannot be credited in assuring the safety function of the final filters, particularly because the primary filters are located in close proximity to the rooms where a fire might occur, and therefore, they could be subjected to the heat of the fire, for which they are not qualified. Also, although some combustion products would undoubtedly be deposited on room surfaces, the relative extent of this reduction and its adequacy in preventing overloading of the final filters has not been analyzed. Further, the room combustible loading controls of the fire protection program cannot be credited with protecting the final filters for two reasons: (1) as previously noted, this concern is whether the analysis that would be the basis for establishing such combustible loadings is acceptable; and (2) the existing fire protection programs do not provide such quantitative controls. Finally, even though the new accident analyses demonstrated that accident doses would not exceed DOE guidelines without REVS, the potential accident exposures are still reduced a significant amount by REVS during the event when it performs its safety-significant function as described in the DSA. Because the REVS system is classified as safety-significant, it must perform as described in the DSA, and its performance must be demonstrated by credibly supportable analyses and/or testing, which do not presently exist. (See Finding #1.)

2003-7B: The REVS HEPA filter isolation damper surveillance test procedure did not demonstrate the dampers' isolation capability. The 2003 DSA indicated that the safety-significant final stage HEPA filter bank isolation dampers were required to be capable of isolating a defective final stage filter bank "to meet the REVS [99.95% filter efficiency] requirements." Periodic testing is required to confirm the DSA-specified design capability remains. The 2003 REVS filter damper test procedures indicated that the dampers should be considered operable if the filter bank differential pressure with the dampers closed was less than 0.2 inch wc. However, no valid analytical basis could be provided for this value. The 2003 Independent Oversight inspection team was concerned that leakage past unsealed dampers through a failed final stage HEPA filter bank could reduce the overall REVS filter efficiency below the 2003 DSA and TSR requirement of at least 99.95 percent.

The 2009 Independent Oversight team's assessment of the current status and evaluation of the corrective action for this aspect of Finding #7 is discussed under Finding #5. As indicated there, the 2009 Independent Oversight team concludes that additional corrective action is necessary to resolve the 2003 inspection concern about the adequacy of the REVS filter bank isolation damper operating and test procedures. (See Finding #1.)

C.2 Unreviewed Safety Question Process

In assessing the contractor's responses to the 2003 inspection concerns, the Independent Oversight team reviewed several associated USQ documents and identified concerns about those documents. As a result, the Independent Oversight team performed further review of recent USQ screenings. Of eleven screenings reviewed, seven were identified as incorrectly screened out from having USQDs performed. Subsequent

review of the facility's USQ procedure, RPL-SA-002, *Unreviewed Safety Question Procedure for the Radiochemical Processing Laboratory,* revealed that the probable cause was non-conservative screening directions in the procedure with respect to the expectations of 10 CFR 830. Subpart B, Section 830.203 of this Rule, *Unreviewed Safety Questions*, requires that contractors must determine whether a USQ exists per a DOE-approved USQ procedure for the following four different types of proposed activities: "(1) Temporary or permanent change in the facility as described in the existing documented safety analysis; (2) Temporary or permanent change in the procedures as described in the existing documented safety analysis; (3) Test or experiment not described in the existing documented safety analysis; or (4) Potential inadequacy of the documented safety analysis because the analysis potentially may not be bounding or may be otherwise inadequate." The RPL procedure's process inadequacies lie with the first two of the above listed activities, which are discussed in the following subsections. These procedure inadequacies, though not explicitly addressed in the Rule, could and have allowed deviation from the Rule. These inadequacies were, however, commonplace in the DOE complex before the latest revision of DOE Guide 424.1-1A, *Implementation Guide for Use in Addressing Unreviewed Safety Question Requirements* (July 24, 2006), which recognized them and provided appropriate guidance to assure that such deviations would not occur.

Screening caveats. If a proposed activity involves either of the first two conditions described in the Rule for entering the USQD process, a USQD must be performed. There are no qualifiers, conditions, or caveats based on expectations in the Rule for either of these entry conditions (e.g., a conditional statement that if the proposed change does not "impact" the DSA, entry into the USQD process is not required). The Rule expects only a simple go/no-go decision; if a proposed activity would change the facility or a facility procedure as described in the DSA, it must undergo a USQD to determine whether such change would involve a USQ. Whether or not and how the proposed change would "impact" the DSA is what is expected by the Rule to be determined in answering the seven USQD questions. Contrary to this expectation, the current facility procedure, in numerous locations, provides screening directions that depart from simple go/no-go decision-making, by the addition of reservations, conditions, qualifiers, and caveats to the primary screening questions. An example was identified in the procedure's Section 11.0, *Screening,* second paragraph, which states "The change should have the potential to *impact* [emphasis added] the facility's DOE-approved safety basis in order for it to be considered a change that requires a USQD." According to this direction, the screener must perform an evaluation that takes the character of answering the seven USQD questions in determining whether the change has the potential to "impact" the safety basis in any of the seven ways of potential concern outlined in a USQD's seven questions, rather than simply determining whether the proposed change is to a system, structure, or component (SSC) described in the safety basis. Such determinations are improper at the screening stage but rather are properly the purview of the USQD questions.

Screening of new procedures. New procedures relating to SSCs or processes described in the DSA have an even greater potential to involve a USQ than changes to existing procedures, since everything in them is a change from what existed before, rather than just a change to one or more details. Therefore, new procedures fall within the intent of the Rule to assure that a USQ is not created by any new proposed activity. This expectation that new procedures must be evaluated by the USQD process is not reflected in the facility's USQ procedure, and one example was identified where a recent new procedure was screened out because it involved a new procedure rather than a change to an existing procedure.

Described versus implied procedures. The facility procedure, in Attachment 3, *Guidance for USQ Screens and Determinations,* indicates that the only procedures to be included when considering changes to procedures "…as described in the documented safety analysis…" are those "…*specifically* [emphasis added] outlined, summarized, or described in the facility documented safety analysis document." It also states: "If a procedure is simply listed or referenced, then it would not need a USQD." However, any procedure,

regardless of how it is described, or any procedure that relates to SSCs or processes described in the DSA are, in effect, procedures as described in the DSA. Therefore, these directions in the facility USQ procedure are non-conservative with respect to the Rule's expectations.

Scope of "as described in the documented safety analysis." From the facility procedure statement quoted in the previous item, the procedure's requirement to perform USQDs for procedure changes applies only to those described in the DSA "document." However, the accepted scope of the Rule's usage of the term "documented safety analysis" includes all documents that make up the safety basis, including the TSRs and their bases, safety evaluation reports, etc. Therefore, the facility procedure is non-conservative with respect to the Rule's expectations in this regard.

Safety versus non-safety, credited versus non-credited. The facility procedure wording, in several places, requires USQDs to be performed *only* for changes to SSCs or procedures that are safety-related or to those relied on in the accident analyses. For example, Attachment 3, page 26 states that only changes to "…SSCs, programs, procedures, work control, and any other actions/activities *that are relied on in the accident analysis* [emphasis added]..." have to be considered in USQDs. These provisions are contrary to the expectations of the Rule, which does not limit the requirements for performing a USQD to just those changes to safety SSCs or SSCs credited in the accident analysis.

Other facility USQ procedure discrepancies. The following additional weaknesses or discrepancies were identified in the facility USQ procedure:

- In Section 3.0, Definitions, under *Minor Change*, the first bullet is ambiguous with regard to whether step sequencing changes are considered as minor changes. The correct interpretation is that they should not be considered as minor changes.
- Under *Safety Basis*, several document types are listed as being included in the safety basis, but TSR bases are missing.
- In Section10.0, *USQ Review Process*, under *Outputs*, "Unreviewed Safety Question" should be replaced with "proposed change."

C.3 PNNL Corrective Action Reviews and PNSO Oversight

Since the 2003 inspection, PNNL has strengthened its organization and staffing to support the safety needs of a hazard category 2 nuclear facility. PNNL established the Nuclear Operations Division in 2007. This new organization has the responsibility to ensure safe operation of RPL and proper implementation of the nuclear safety program.

In March 2005, PNNL conducted a review of the adequacy and completion of corrective actions addressing Independent Oversight findings. The review concluded that the actions taken by PNNL to resolve the findings, as well as the technical issues, were generally adequate. In addition, an effectiveness review was also performed for PNNL by an independent contractor that also concluded that the corrective actions for Findings #5, #6, and #7 were generally effective. In contrast, Independent Oversight, in this 2009 follow-up review, determined that the PNNL actions addressed some of the important concerns (primarily through revising the accident analysis to reduce accident exposures below DOE guidelines and thus not requiring REVS to be treated as a safety-significant system). However, measures taken to resolve hardware design and analysis

issues in the REVS and backup instrument air system were insufficient to ensure that the safety-significant systems were *fully* capable of performing their design safety functions as described in the DSA.

PNSO has only recently assumed full responsibility for oversight of nuclear safety at RPL. At the time of the 2003 inspection, RL was the responsible safety basis approval authority. In December 2003, PNSO took initial steps to assume responsibility for RPL, and in November 2007, oversight responsibility formally shifted to PNSO. To ensure proper fulfillment of its responsibility for RPL, PNSO defined and implemented a transition plan that included completion of procedures and documents, identification of resources needed for providing oversight and support, and other specific actions.

One of the main resources supporting PNSO is the DOE Office of Science Integrated Support Center (ISC). The ISC has the responsibility to provide nuclear safety oversight support for safety-significant systems, including the necessary functional area and facility-specific qualifications. With the support of safety system oversight and the nuclear safety specialist from the ISC, PNSO completed annual assessments of safety-significant systems for RPL during 2008. In addition, with ISC support, PNSO approved updates of key RPL operational documentation, including the conduct of operations matrix, the training implementation matrix, the maintenance implementation plan, the USQ procedure, and an annual update of the DSA.

PNSO receives assistance from the ISC in performing safety system oversight baseline reviews of the key RPL systems. Some reviews have been completed and have identified significant deficiencies in some systems. A safety system oversight baseline review was recently completed on REVS; however, the review was not well performed and did not identify a number of deficient conditions. The weakness in that review was recognized by PNSO management, and PNSO plans to redo the inspection in the near future.

PNSO and PNNL have made significant progress in establishing an organizational safety culture that is consistent with expectations for a hazard category 2 nuclear facility. In 2003, the Independent Oversight team determined that PNNL and DOE (primarily RL at the time) had not established the rigor, questioning attitude, and attention to detail expected for a hazard category 2 nuclear facility at RPL. The weakness at that time was most dramatically illustrated by a DSA and TSRs that did not accurately and completely reflect the requirements for and actual conditions of the facility. Since 2003, PNSO and PNNL have made significant strides. During this follow-up review, attitudes at all levels in the organization were noticeably more aligned to the rigor, questioning attitude, and attention to detail expected of such a facility than in 2003. Interactions between the review team and facility staff during this review indicate that they are focused on making the needed improvements to ensure that the requirements for a nuclear facility are fully implemented.

Overall, PNSO and PNNL have devoted significant effort to evaluating nuclear safety conditions at RPL and reviewing the corrective actions from the 2003 inspection. PNSO and PNNL have also made organizational changes that strengthen their ability to manage nuclear safety and perform evaluations. Also, PNSO has made significant progress in developing organizational capabilities, with ISC support, to implement the nuclear safety management responsibilities that historically had been performed by RL. Further, both PNSO and PNNL have identified additional efforts, including evaluations, that are needed to further improve their nuclear safety management programs. For example, a significant revision to the DSA to further enhance administrative processes and programs is in the review and approval stages. However, as noted above, PNSO and PNNL efforts have not been fully effective in addressing certain aspects of the 2003 Independent Oversight findings and ensuring that the corrective actions were sufficient to address all aspects of the weaknesses.