

**Independent Oversight Review of the  
Department of Energy  
Office of Science Assessment of the  
Pacific Northwest National Laboratory  
Radiochemical Processing Laboratory  
Criticality Alarm System**



**October 2012**

**Office of Safety and Emergency Management Evaluations  
Office of Enforcement and Oversight  
Office of Health, Safety and Security  
U.S. Department of Energy**

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## Acronyms

ADM	Administrative
ANS	American Nuclear Society
ANSI	American National Standards Institute
CAS	Criticality Alarm System
DOE	U.S. Department of Energy
DSA	Documented Safety Analysis
FIND	Finding
HSS	Office of Health, Safety and Security
JPP	Job Planning Package
L2	Level 2 Finding
L3	Level 3 Finding
LCO	Limiting Condition for Operation
LOI	Line of Inquiry
NCS	Nuclear Criticality Safety
OFI	Opportunity for Improvement
PM	Preventive Maintenance
PNNL	Pacific Northwest National Laboratory
PNSO	Pacific Northwest Site Office
RPL	Radiochemical Processing Laboratory
SC	Office of Science
SCMS	Office of Science Management System
SOP	Standard Operating Procedure
SPC	Single Point of Contact
SDD	System Design Description
TSR	Technical Safety Requirements
USQD	Unreviewed Safety Question Determination

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## **1.0 PURPOSE**

The Office of Enforcement and Oversight (Independent Oversight), within the U.S. Department of Energy (DOE) Office of Health, Safety and Security (HSS), conducted a shadow assessment of the Office of Science (SC) review of the Pacific Northwest National Laboratory (PNNL) Radiochemical Processing Laboratory (RPL) Criticality Alarm System (CAS). SC's Pacific Northwest Site Office (PNSO) coordinated the SC review.

The SC assessment focused on the operability of the CAS at the PNNL RPL (also called Hanford Building 325), including related items that help maintain or improve operability. The SC assessment was conducted as part of the SC program for periodic monitoring of field office oversight of site Nuclear Criticality Safety (NCS) programs. The onsite portion of the SC assessment was conducted during May 15 – 17, 2012. The SC assessment report was published on July 27, 2012.

Independent Oversight shadowed<sup>1</sup> the SC review to: (1) evaluate the effectiveness of the SC line oversight assessment and (2) to gain insights on the current status of this part of the PNNL NCS program. The shadowing review was conducted in accordance with the HSS *Office of Safety and Emergency Management Evaluations Protocol for Small Team Oversight Activities*, dated May 2011, and with the HSS Plan for the Independent Review of DOE Office of Science Assessment of the Pacific Northwest National Laboratory Radiochemical Processing Plant Criticality Alarm System, dated April 10, 2012.

Therefore, issues identified in this report are characterized in accordance with the Office of Science Management System (SCMS) procedure for issues management and are annotated in the report by level and number (for example, L2-1). The SCMS issues management process identifies a Level 2 finding (FIND) as an “issue that represents a nonconformance and/or deviation with implementation of a requirement” and a Level 3 finding as an “issue where it is recognized that improvements can be gained in process, performance, or efficiency already established for meeting a requirement.” Level 3 findings closely approximate opportunities for improvement (OFIs), which according to Independent Oversight protocols “are suggestions offered by the Independent Oversight appraisal team that may assist line management in identifying options and potential solutions to various issues identified during the conduct of the appraisal.”

## **2.0 ASSESSMENT BACKGROUND**

PNNL is responsible for managing and operating the RPL, a nonreactor hazard category 2 nuclear facility, pursuant to DOE-STD-1027, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*. PNSO, which is responsible for conducting oversight of this facility, coordinated a safety system oversight assessment of the RPL CAS using a recognized subject matter expert from the Office of Environmental Management (specifically, from the Office of the Deputy Assistant Secretary for Safety, Security, and Quality Programs) on loan to SC. The focus of the SC assessment was on the effectiveness of maintaining operational readiness of the

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<sup>1</sup> Shadowing is a specific type of oversight activity where HSS personnel observe a site office and/or contractor assessment and document HSS's evaluation of that assessment.

CAS. HSS selected this activity for an independent oversight shadowing review to observe the effectiveness of the assessment and gain insights on the PNSO oversight program as augmented.

### **3.0 SCOPE**

The PNNL Building 325 CAS operability assessment included related items such as preventive maintenance (PM) and control over modifications and configuration management that help maintain and ensure system operability. The SC assessor activities are discussed further in Section 4 of this report.

The HSS Independent Oversight review shadowed the SC assessment. The Independent Oversight assessor activities included reviewing documents, observing SC interviews with PNNL personnel, and touring facilities in a shadowing mode. The Independent Oversight assessor:

- Evaluated the effectiveness of the SC line oversight assessment with a focus on evaluating the adequacy of SC's planning for and conduct of the assessment
- Gathered information about the status of the Building 325 CAS, with a focus on whether the CAS is adequately documented for its current configuration as well as for planned modifications (e.g., document markups)
- Observed selected activities outside the scope of the SC assessment (i.e., final preparations for and part of the performance of a system modification).

Appendix A lists documents reviewed, and Appendix B provides supplemental information about the HSS Independent Oversight assessment.

### **4.0 RESULTS**

#### **Effectiveness of the SC line oversight assessment**

The SC assessor conducted this assessment in a graded approach through personnel interviews, document reviews, and field observations. Specifically, the SC assessment recognized that there is a limited risk of accidental criticality at this facility compared to some other DOE nuclear facilities for a variety of reasons; RPL operations involve gram quantities of fissile material, few processes involve solutions of fissile material, and thick shielding exists in hot cells. The SC assessor's graded approach was appropriate and commensurate with the risk. Interviews with several personnel were sufficient to confirm that PNNL personnel and other personnel who support the CAS are qualified and cognizant of their duties. Although the primary system engineer for the CAS was unavailable for the week of the assessment, the backup system engineer for the CAS demonstrated knowledge of the system performance requirements, technical safety requirements (TSRs), and items affecting operability during facility tours and formal interviews.

The SC assessment reviewed the contractor's surveillance records from September 2011 through March 2012. No issues were identified with the CAS surveillances. The SC assessor also reviewed the last CAS periodic assessment report (August 2009 – May 2011). This review included the system design description (SDD), preventive and corrective maintenance, maintenance backlog, instrument calibration, change control, and procedures. No issues were identified with the contractor's periodic assessment.

The SC assessor confirmed the location and operable status of the eight system neutron detectors, as well as the marked locations where personnel are to stand when they are performing audibility measurements.

All detectors and all but one howler were in proximity to the documented locations. The SC assessor identified the noncompliance of the howler location per DOE Order 420.1B, *Facility Safety*, and categorized this as a Level 2 finding which stated: FIND-L2-01: Physical Configuration of howler CRAL-40-HW does not match drawing, H-3-52813, as referenced in the CAS SDD. The howler had been moved approximately five feet from the location shown on the drawing due to a seismic modification. This change in location did not affect operability of the system. The howler had been tested following the relocation, and the sound levels met the acceptance criteria.

The SC assessor reviewed the Job Planning Package (JPP), JPP S681118, *Add Criticality Alarm System Reset, to the CAS*. Through other document review and interviews, the SC assessor identified that the requirement for prompt response to a system malfunction or loss of primary power was not supported in the SDD. The safety basis TSR and documented safety analysis (DSA) describes that the self-auditing circuits system transmits an abnormal condition signal to assure prompt removal of a possible defective detector from the system, and upon receipt of that signal, immediate correction actions commence. Additionally, from discussions with PNNL personnel, a prompt detection and response to a system failure was neither necessary nor actually credited in the safety basis (i.e., not factored into the safety analysis) given the limited criticality risk of actual fissile material operations. The SC assessor determined that the criticality risk was adequately addressed via implementation of the criticality safety program, and the residual risk mitigated via maintenance and operation of the CAS was not adversely impacted due to an undetected CAS failure. The SC assessor identified this inconsistency and categorized this as a Level 2 finding which stated: FIND-L2-02: Statements in DSA Section 4.4.2.4 relating to the CAS abnormal condition signal are not consistent with expectation in DOE-STD-3009.

Independent Oversight agrees that both of the above SC findings were appropriate and accurately represented the conditions at the facility.

Some aspects of the SC review plan and assessment report were not sufficiently detailed to support the scope cited in the assessment plan, including focus on the effectiveness of maintaining operational readiness of the CAS. Specifically, the Evaluation Criteria section of the plan merely cites some pertinent DOE directives and the mandatory American National Standards Institute (ANSI)/American Nuclear Society (ANS) 8.3 on CAS design and operability. No specific criteria were cited from any of these documents to meet the stated scope of the assessment. No lines of inquiry (LOIs) were included in the plan. Independent Oversight discussed this potential concern with PNSO and the assessor prior to the onsite review. The SC assessment plan indicated one of the resource needs was “LOIs used by the CAS Cognizant System Engineer.” However, the list of these LOIs was not obtained, and no LOIs were cited in the report. DOE Guide 226.1-2, *Federal Line Management Oversight of Department of Energy Nuclear Facilities*, recommends the use of LOIs. (See OFI-L3-1 and OFI-L3-2.)

Due to the absence of LOIs, the SC review did not ensure that a representative sample of criteria from the DOE directives and ANSI/ANS 8.3 standard were used to evaluate the focus of the assessment. For example, one operability detail is related to the requirement in Section 4.3.2 of ANSI/ANS 8.3 “The signal generators shall be automatically and promptly actuated upon detection of a criticality accident.” Independent Oversight reviewed PM-13070, *Criticality Alarm System Semiannual Test Procedure*, and concluded that the document does not contain either a qualitative or a quantitative acceptance criterion for the delay in howler actuation from the time the radiation protection technician places the neutron source close to a given detector and its blue light illuminates – indicating neutron source strength is sufficient to trip it – and when the howlers achieve 75 dB output.

During the March 2012 performance of this test procedure, the systems engineer noted that when Breaker #5 was opened, it took about 30 seconds for the power loss alarm to annunciate. There was no acceptance criterion for the delay between performing the power loss and the trouble alarm annunciation. The

systems engineer demonstrated good conduct of operations by having a questioning attitude and noting the anomaly on the test procedure. The testing was repeated, and when the delay was not reproducible, the anomaly was evaluated and the component was accepted as satisfactory. The system engineer subsequently had the component replaced.

Independent Oversight determined from shadowing the SC assessment, independent observations and document reviews, and subsequent discussions with the SC evaluator, that PNNL is taking appropriate actions to maintain the RPL Building 325 CAS in an operable state.

### **CAS Modification to Install Remote Reset Capability**

With the encouragement of PNSO, PNNL had been working for several months to prepare a modification package to install remote reset capability (JPP S681118, *Add Criticality Alarm System Reset to the CAS*). ANSI/ANS 8.3, Section 4.3.3, recommends having a manual reset capability outside areas that require evacuation. The secondary purpose of the remote reset capability is to silence the howlers as a convenience and avoids damaging them when operated long beyond the time for evacuation and management's acknowledgment for recovery actions. The installation of the modification had been scheduled to commence the day after the close-out of SC's onsite assessment on the effectiveness of maintaining operational readiness of the CAS. The SC assessment determined that the installation of the modification was out of the scope of this review and was not documented in the SC report.

Independent Oversight reviewed the modification package and provides the following observations. Although the unreviewed safety question determination (USQD) states that the proposed change will add a power supply reset relay as part of the CAS (a safety-significant system), PNNL staff stated during the assessment that the relay is outside the CAS boundary and does not introduce a new failure mode to the CAS. Facility management acknowledged that the USQD could have been more clearly written. Independent Oversight noted that the SDD had not been red-lined or revised to acknowledge this modification or to indicate that this new remote reset functionality does not result in the component (i.e., a Metasys® building automated control system) to be considered part of the CAS. Facility management acknowledged that RPL maintains configuration control of drawings and does not maintain the SDDs in real time.

In response to the question of whether the proposed activity increases the probability of an accident previously evaluated in the DSA, the USQD states that the proposed modification is an enhancement to the current CAS to ensure that it will continue to provide the alarm function through the remote reset capability after the initial detection of the criticality event. Although the USQD does not explain how the alarm function after the initial detection of the criticality event will be used, PNNL facility management and criticality support engineers stated that they would not rely solely on the CAS during recovery. Reliance on the CAS following a criticality event is not compliant with Section 6.2 of ANSI/ANS 8.3, which states that the system shall be requalified after "events which call system performance into question." There is no documentation that describes how the CAS would be used following a criticality event.

In answering the question of whether the proposed activity increases the consequences of a malfunction of equipment important to safety previously evaluated in the DSA, the USQD states that the new alarm reset provides for enhanced detection capability in the area of concern in the RPL following the initial criticality accident. However, the USQD does not explain how that new feature will enhance the detection capability.

The USQD stated that the installation of the new alarm reset capability does not introduce new failure mechanisms. One potential failure mechanism is that the Metasys software controlling the reset function

enters an infinite loop that causes the CAS to continually reset, thereby rendering it effectively inoperable. The USQD is not clear whether the power supply reset relay is inside or outside the safety system boundary, and therefore does not adequately support the conclusion on whether a new failure mode is introduced. The alarm is transmitted to the Power Operator's office alarm panel and pager (the Power Operator also performs rounds at an adjacent facility). Independent Oversight agrees with the SC assessor that the Power Operator's use of the paging system to detect CAS failures is not a credited safety system. Per Standard Operating Procedure (SOP)-325-19, the Power Operator is to respond to the alarm and take appropriate action. SOP-325-19 had not been revised to specifically include a response to the alarm in the event of continuing resetting of the system. (See FIND-L2-1.)

The SC assessor and Independent Oversight interviewed the Power Operator prior to the installation of the CAS modification. With the alarm response procedure, the Power Operator informed the assessors that upon loss of electrical power to the CAS, he would take actions different from and out of sequence with those listed in Procedure SOP-325-19, RPL Building Annunciator Call List. The alarm procedure requires the Power Operator to use the building paging system to announce that the criticality alarm system is out of service and all further work with fissionable material is not allowed. Contrary to these actions, the Power Operator stated that he would contact the PNNL Single Point of Contact (SPC) by phone, report the situation to him/her, and request he/she notify the Building Manager who would make the appropriate announcement. The procedure directs the Power Operator to contact the PNNL SPC after performing the paging announcements and notifying the Building Manager.

Independent Oversight observed the pre-job brief and a portion of the work associated with the CAS modification. The following information was obtained from the Building 325 Facility Representative who performed oversight of the task. The facility entered limiting condition for operation (LCO) 3.1.1 to work on the CAS. Appropriate building inspections, building postings, and announcements were made. These actions included ensuring the suspension of operations with significant quantities of fissile materials, declaring the CAS inoperable, performing the modification, restoring to service, performing post-maintenance testing, declaring the system operable, exiting the LCO, removing the postings, and communicating to building personnel the authorization to resume fissile material handling operations.

Following the completion of the pre-job brief, Independent Oversight and the PNSO Facility Representative discussed the performance of the pre-job briefing and agreed that it was inadequate and incorrectly focused. Only after the conclusion of the formal brief did a few of the participants discuss the aforementioned criticality safety implications of the modification. The modification was installed and declared operable. (See OFI-L3-3.)

## **5.0 CONCLUSIONS**

Independent Oversight agrees with the two Level 2 findings identified by SC. Additionally, Independent Oversight identified a Level 2 finding associated with the technical quality of the CAS reset modification, and three Level 3 findings or OFIs associated with the planning and execution of the assessment, PNNL procedure quality, and procedural adherence by facility personnel.

The SC assessment did not provide a detailed evaluation or definitive conclusion for some technical topics to support the focus of the assessment (i.e., effectiveness of maintaining operational readiness of the alarm system). Independent Oversight concurs with the SC assessor that the facility management has maintained a highly reliable system. Independent Oversight also determined from shadowing the SC assessment, independent observations and document reviews, and subsequent discussions with the SC evaluator, that PNNL is taking appropriate actions to maintain the RPL Building 325 CAS in an operable state.

## 6.0 FINDINGS AND OPPORTUNITIES FOR IMPROVEMENT

During the review, Independent Oversight identified one Level 2 finding and three opportunities for improvement (corresponding to SCMS Level 3 findings), which are summarized below and are provided to PNSO for evaluation and follow-up in accordance with SC procedures and processes.

**FIND-L2-1** USQD RPL-2012-095D, *FMP/JPP S681118: Add Criticality Alarm System Remote Reset*, is not clear whether the power supply reset relay is inside or outside the safety system boundary, and therefore does not adequately support the conclusion on whether a new failure mode is introduced. (10CFR830.203, Unreviewed Safety Question; 10CFR830.122, Quality Assurance Criteria)

During the review, Independent Oversight also identified a number of OFIs in the implementation of the safety basis controls. As with Level 3 findings, OFIs are not mandatory and do not require formal resolution by management through the corrective action process.

**OFI-L3-1** PNSO should consider ensuring that when LOIs are referenced in the plan but not listed, that the assessor have an alternate set of LOIs that can be used to perform the review to meet the plan's objectives.

**OFI-L3-2** PNSO should consider having the contractor review the CAS procedures to ensure that quantitative or qualitative acceptance criteria are provided from DOE directives and ANSI/ANS standards, where appropriate.

**OFI-L3-3** PNSO should consider performing a Conduct of Operations surveillance focused on the quality of pre-job briefs and procedural adherence.

## 7.0 ITEMS FOR INDEPENDENT OVERSIGHT FOLLOW-UP

Independent Oversight will follow up on the closure of corrective actions developed to address the two findings identified during the SC assessment, as well as actions for Finding L2-1 in this report.



## Appendix A Documents Reviewed

- DOE G 226.1-2, *Federal Line Management Oversight of Department of Energy Nuclear Facilities*
- DOE G 424.1B, *Implementation Guide for Use in Addressing Unreviewed Safety Question Requirements*
- DOE P 226.1B, *Department of Energy Oversight Policy*
- DOE O 226.1B, *Implementation of Department of Energy Oversight Policy*
- DOE O 414.1D, *Quality Assurance*
- DOE O 420.1B, *Facility Safety*
- ANSI/ANS-8.3-1997, *Criticality Accident Alarm System*
- ANSI/ANS-8.23-2007, *Nuclear Criticality Accident Emergency Planning and Response*
- ANSI/ASME NQA-1-2000, *Quality Assurance Requirements for Nuclear Facility Applications*
- SC Review Plan, *Criticality Accident Alarm System Assessment of the Hanford 325 Building at the Pacific Northwest National Laboratory*, May 2012, dated Mar. 29, 2012
- Criticality Safety Program Assessment of the Pacific Northwest National Laboratory, May 2012 (SC)
- 325 Building Radiochemical Processing Laboratory Documented Safety Analysis PNNL-DSA-325, Revision 3, Jul. 2011
- 325 Building Radiochemical Processing Laboratory Technical Safety Requirements PNNL-TSR-325, Revision 5, July 2011
- Letter, Snyder to Kluse, *Approval Of The 2011 Update Of The 325 Building Documented Safety Analysis And Technical Safety Requirements*, Sep. 28, 2011
- PNNL-MA-250, *Nuclear Safety and Facility Authorization Nuclear Criticality Safety Program Manual*, Mar. 2012
- RPL-CAS-SDD, *325 Building Criticality Alarm System Design Description*, Rev. 1, June 2009
- Memorandum, Prichard to Dec, *Nuclear Criticality Safety Basis Memo 09-01*, May 18, 2011
- ADM-RPL-702, *325 Building Criticality Alarm System Outage Procedure*, Rev. 0, Dec. 7, 2011
- OPSA-CAS-001-2011, *325 Building Criticality Alarm System Periodic Assessment 2011*, Sep. 2, 2011
- PM-13070, *Criticality Alarm System Semiannual Test Procedure*, Rev. 18, Aug. 17, 2011 and attachments
- ADM-016, *Work Control Procedure*, Rev. 15c, Aug. 21, 2009
- JPP Risk Assessment of S681118, CAS Remote Reset, Apr. 18, 2012 and attachments including:
  - SR681118B, *Criticality Alarm Remote Reset*, Apr. 11, 2012
  - Pre-Job Briefing Checklist, S681118B, *Crit. Alarm Remote Reset*, Apr. 24, 2011
  - Workplace Exposure Assessment, *Criticality Alarm Remote Reset*, Apr. 11, 2012
  - PNNL Radiological Work Permit, CS1, Rev. 01, Jan. 1, 2008
  - Facility Modification Permit, S681118A, *Install Relay to Reset the Criticality Alarm Panel*, Feb. 14, 2011
- USQD, FMP/JPP S681118: *Add Criticality Alarm Remote Reset*, RPL-2012-095D, Apr. 26, 2012
- JPP, *Criticality Power Fail Alarm (Planning)*, S685567A, May 12, 2012
- JPP, *Refurbish ESY Switchgear*, S678958B, Rev. 1, Mar. 29, 2012
- Facility Modification Permit, *Add Two Criticality Howlers in Basement*, S6549219A, Oct. 12, 2010
- Excepts from SOP-325-19, RPL Building Annunciator Call List, Rev. 5, Jun. 30, 2011:
  - P. 12, *Annunciator 7, Criticality Alarm Trouble*

- Pp. 13-14, Annunciator 8, Criticality Alarm Power Fail
- Key Drawing, Elec Neutron Sens Criticality Alm Sys Wiring and Intcon Diag, H-3-29015, Rev. 9, Oct. 11, 2001
- Key Drawing, Elec Neutron Sensitive Criticality Alm System Basement Plan, H-3-52813, Sheet 1, Rev. 5, June 6, 2011
- Key Drawing, Elec Neutron Sensitive Criticality Alm System Basement Plan, H-3-52813, Sheet 3, Rev. 1, Nov. 15, 2001
- Key Drawing, Elec Neutron Sensitive Criticality Alm System Bsmt Sect & Det, H-3-52813, Sheet 3, Rev. 1, Nov. 15, 2001
- Key Drawing, Elec Neutron Sensitive Criticality Alm System First Fl Plan, H-3-52814, Sheet 1, Rev. 5, Nov. 15, 2001
- Key Drawing, Elec Neutron Sensitive Criticality Alm System First Fl Plan, H-3-52814, Sheet 2, Rev. 2, June 9, 2011
- Drawing, Elec Neutron Sensitive Criticality Alm System Second Fl Plan, H-3-52815, Rev. 5, June 9, 2011
- Drawing, Electrical Criticality Alarm Sys Specs & Legend, WS9743, Sheet 1, Mar. 13, 2012
- Drawing, Electrical Criticality Alarm Sys Plan & Elevation, WS9743, Sheet 2, Rev. 0, Mar. 13, 2012
- Drawing, Electrical Criticality Alarm Sys Plan and Wiring Diag, WS9743, Sheet 3, Rev. 0, Mar. 13, 2012
- Criticality Power Fail Alarm (Planning), S685567A, May 12, 2012
- Metasys Log Notes relating to CAS, circa Mar. 27 -28, 2012

## **Appendix B Supplemental Information**

### **Dates of Review**

Onsite Review: May 15-17, 2012

### **Office of Health, Safety and Security Management**

Glenn S. Podonsky, Chief Health, Safety and Security Officer  
William A. Eckroade, Principal Deputy Chief for Mission Support Operations  
John S. Boulden III, Director, Office of Enforcement and Oversight  
Thomas R. Staker, Deputy Director for Oversight  
William E. Miller, Deputy Director, Office of Safety and Emergency Management Evaluations

### **Quality Review Board**

William Eckroade  
John Boulden  
Thomas Staker  
William Miller  
Michael Kilpatrick  
George Armstrong

### **Independent Oversight Site Lead for PNSO**

Joseph Drago

### **Independent Oversight Reviewers**

Joseph Drago – Team Lead  
Ivon Fergus