

**Independent Oversight Review of
Richland Operations Office and
CH2M HILL Plateau Remediation Company and
Mission Support Alliance Conduct of Operations**



April 2012

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

Table of Contents

1.0 Purpose.....	1
2.0 Background.....	1
3.0 Scope.....	2
4.0 Results	3
5.0 Conclusions	6
6.0 Opportunities for Improvement	6
7.0 Items for Follow-up	7
Appendix A: Documents Reviewed	8
Appendix B: Supplemental Information	10

Acronyms

CHPRC	CH2M HILL Plateau Remediation Company
CONOPS	Conduct of Operations
CVS	Confinement Ventilation System
D&D	Decontamination and Decommissioning
DNFSB	Defense Nuclear Facilities Safety Board
DOE	U.S. Department of Energy
DOE-RL	DOE Richland Operations Office
FR	Facility Representative
HSS	Office of Health, Safety and Security
ISM	Integrated Safety Management
MSA	Mission Support Alliance
OFIs	Opportunities For Improvement
ORP	Office of River Protection
PFP	Plutonium Finishing Plant
QA	Quality Assurance
STP	Sludge Treatment Project
WCH	Washington Closure Hanford

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1.0 PURPOSE

The purpose of this independent oversight review by the U.S. Department of Energy (DOE) Office of Enforcement and Oversight, within the Office of Health, Safety and Security (HSS), was to observe and shadow¹ a DOE Richland Operations Office (DOE-RL) assessment of its contractors at the Hanford Site.

The DOE-RL assessment examined CH2M HILL Plateau Remediation Company (CHPRC), Washington Closure Hanford (WCH), and Mission Support Alliance (MSA). The primary goal of the DOE-RL assessment was to determine the effectiveness of the contractors' plans, procedures, programs, and work management and control processes with regard to DOE requirements in the areas of conduct of operations (CONOPS), quality assurance (QA), and integrated safety management (ISM). The specific facilities and organizations assessed were the Plutonium Finishing Plant (PFP) and the 100 K area for CHPRC, and Electrical Utilities for MSA. The DOE-RL assessment was conducted on site at Hanford from November 7 to 18, 2011.

The HSS reviewer observed the implementation and effectiveness of the DOE-RL assessment of two of the contractors (CHPRC and MSA) from November 7 to 18, 2011. The HSS review was conducted in accordance with the HSS *Office of Safety and Emergency Management Evaluations Protocol for Small Team Oversight Activities*, dated May 2011.

2.0 BACKGROUND

The DOE Hanford Site sits on 586 square miles in the desert of southeastern Washington State. The area is home to nine former nuclear reactors and their associated processing facilities, which were built beginning in 1943. The reactors were used to produce plutonium, a manmade, radioactive, chemical element that was needed for atomic weapons associated with America's defense program during World War II and throughout the Cold War.

At present, the Hanford Site is undergoing extensive cleanup, overseen by two local DOE offices. DOE-RL oversees the projects associated with cleaning up the reactors, the soil, the groundwater, and the solid waste burial sites, and also manages the demolition of facilities and the disposition of the plutonium remaining on the Hanford Site. The Office of River Protection (ORP) is tasked with managing the liquid and semi-solid nuclear and chemical waste that is currently stored in 177 underground tanks on the Site. ORP is also in charge of constructing the Waste Treatment and Immobilization Plant, a massive complex of structures centrally located on the Hanford Site, that will combine the wastes from these tanks with glass-making materials in a process called vitrification.

DOE Policy 226.1B, *Department of Energy Oversight Policy*, establishes DOE expectations for the implementation of a comprehensive and robust oversight process that enables the DOE mission to be accomplished effectively and efficiently while maintaining the highest standards of performance for safety and security. The policy expectation is that DOE oversight is performed effectively by line management, both DOE Headquarters and field, as well as by independent oversight organizations.

¹ 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.

Collectively, effective assurance systems and oversight programs are intended to provide reasonable assurance that mission objectives are accomplished without sacrificing adequate protections.

3.0 SCOPE

The DOE-RL CONOPS and work management assessment focused on the site contractors' compliance with the following chapters of DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*, and the contractors' associated implementing procedures:

- Chapter I. Operations Organization and Administration
- Chapter II. Shift Routines and Operating Practices
- Chapter VI. Investigation of Abnormal Events
- Chapter VIII. Control of Equipment and System Status
- Chapter XV. Timely Orders to Operators
- Chapter XVI. Operations Procedures
- Chapter XVII. Operator Aid Postings.

DOE Order 422.1, *Conduct of Operations*, was also identified as a requirements document for those contracts where the order has been implemented.

The work management portion of the DOE-RL assessment was performed in accordance with guidance on implementation of work control as it relates to ISM. The assessment was intended to determine whether the ISM core functions and guiding principles and applicable QA criteria are effectively incorporated into activity-level work planning and control activities. Specifically, the assessment emphasized determining, for a specific scope of work, whether:

- The scope of work was sufficiently defined to allow thorough analysis of hazards, identification of controls, and development of work instructions.
- Hazards were adequately analyzed and appropriate hazard controls implemented.
- The work was properly planned and work package instructions and procedures were adequate.
- Readiness to perform the work was adequately verified.
- The work was performed in accordance with the instructions and procedures.
- Post-work review activities were adequate, including the processing of feedback and lessons-learned information.

The HSS review was performed in accordance with DOE Order 227.1, *Independent Oversight Process*, and applicable Office of Safety and Emergency Management Evaluations guides, as well as HSS Criteria Review and Approach Document 64-17, Nuclear Facility Safety System Functionally Inspection Criteria, Inspection Activities, and Lines of Inquiry. The HSS review included examination of the contractor implementing procedures and specific requested documents, observation of team interactions, and an exit debriefing with senior contractor management. The HSS reviewer participated in discussions with operations personnel and managers of the Cold Vacuum Drying Facility, Electric Utilities, PFP, and K-Basin. Additionally, HSS observed and reviewed the use of long-term orders and governing procedures, determination of potential significant unanalyzed conditions and implementation of compensatory measures, operation of the Electrical Dispatch Center, and various facility operational issues.

Additional details of the CONOPS and work management assessments may be found in the following DOE-RL reports:

- Department of Energy, Richland Operations Office, Assessment of Mission Support Alliance, Assessment Number: A-12-OOD-MSA-001

- Department of Energy, Richland Operations Office Assessment of Plateau Remediation Company Conduct of Operations and Work Management, Assessment Number: A-12-OOD-PRC-001
- The DOE-RL assessment of WCH is found in Department of Energy, Richland Operations Office Assessment of Washington Closure Hanford, Assessment Number: A-12-OOD-WCH-001. HSS did not observe the assessment of WCH.

Appendix A provides a list of documents that were reviewed.

4.0 RESULTS

DOE-RL developed a detailed Conduct of Operations and Work Management Assessment Plan. The plan appropriately emphasized operational focus areas and ISM guiding principles, as detailed in Section 3.0 above. For example, the assessment examined and identified deficiencies in the areas of job package planning, work packages, hazard analyses, pre-job briefing checklists, work package technical requirements, and energized electrical work.

The DOE-RL team was composed of experienced DOE-RL Operations Oversight Division Facility Representatives (FRs). The site FRs were knowledgeable and properly assessed their assigned functional areas. For example, as part of a review of required management observations of operational activities, the assigned FR assessor reviewed automated entry control system logs and determined that operations and facility managers entered the facility only three times over approximately a four-month period. The FR assessor determined that the number of entries did not support the requirement to provide frequent management observation of operational activities. In another instance, an FR assessor conducted a field walkdown of essential electrical systems, reviewed the in situ results against the respective electrical drawings, identified discrepancies, and raised questions about whether sufficient attention had been given to configuration control. In addition to the FR assessor efforts, the assessment team leader provided comprehensive and insightful team direction and management.

The DOE-RL assessment activities identified eight findings² and eight observations at facilities managed by MSA. For the CHPRC-managed facilities, the assessment team identified seven findings, twelve observations, and one good practice at the Sludge Treatment Project (STP) 100K Operations area and five findings, six observations, and two good practices at the PFP facility.

The assessment of MSA determined that overall, the CONOPS and work management practices directed by the MSA were adequate. The assessment identified some issues with the thoroughness of a causal analysis of a power outage event. The review also revealed shortcomings in succession planning for the Electrical Dispatch Center and some aspects of procedural control of independent verification and configuration control within the Center. No significant work management issues were identified, although some concerns with identification of specific hazard controls in work instructions were identified. The findings and observations requiring closure are to be processed and addressed through the MSA's Corrective Action Management system.

³DOE-RL defines terms as follows: **Finding:** A non-compliance with requirements. Requirements basis can range from laws to contractor facility level procedures. Findings are communicated to the contractor through operational awareness/surveillances/assessment reports. **Observation:** A condition or practice that does not provide or promote effective protection of the health and safety of the public, workers, or the environment, but is not directly linked to compliance. Observations are communicated through assessments/surveillance reports. **Good Practice:** Activity or item that is particularly noteworthy. The contractor could potentially improve operations in other facilities or areas by implementing similar practices.

The DOE-RL assessment determined that CHPRC CONOPS and work management and control implementation at the STP 100K Operations area and the PFP facility was adequate. The assessment team identified some deficiencies in line management work observations, the flowdown of DOE Order 5480.19 into implementing procedures, operator rounds and routines, and awareness of unanalyzed conditions. Minor documentation issues were also identified in STP 100K work management. Operational deficiencies identified by the team for the PFP included issues with operator rounds and routines, configuration control of electrical systems, proper equipment labeling, and procedures accuracy. In work management and control, a potentially significant issue with respect to adherence to proper electrical safety procedures was identified. DOE-RL determined that an extent-of-condition review is warranted in the area of electrical safety. In addition, some work document errors were identified.

Generally, HSS agreed with the DOE-RL assessment team's review and overall evaluation of the facilities and contractor operations observed over the two-week period. Overall, the HSS representative found that the assessment was an appropriate activity for ensuring the maintenance of required safety standards and that conducting three consecutive assessments of the same topic was successful in developing a sense of each contractor's performance across a number of its managed facilities. The planned assessments were properly identified in the DOE-RL Integrated Evaluation Plan, and DOE-RL took actions to optimize the assessment team's productive onsite time (e.g., reducing time spent on inbriefings).

A number of events have brought PFP considerable attention recently, and DOE-RL has taken actions to increase oversight attention. At present, three FRs are assigned to PFP. In addition, DOE-RL conducted a significant surveillance in 2011 to evaluate the adequacy of planning and execution of radiological work at PFP. The surveillance identified significant weaknesses in the work planning and control processes for radiological work hazards, resulting in corrective actions and improvements in this area. While this DOE-RL assessment identified issues with work management and control, most were in the area of electrical safety. DOE-RL determined that an extent-of-condition review is warranted in the area of electrical safety, as a result of the work management issues identified during the PFP assessment.

PFP continues to be a hazard category 2 facility while undergoing decontamination and decommissioning (D&D). The D&D down to slab grade is scheduled to be completed in 2016. In December 2009, most plutonium material had been removed from the site, so the armed guard force was no longer necessary. The transition to a D&D facility appears to have presented an unaccustomed operational adjustment that has impacted the views of the workforce on the need for continued stringent adherence to requirements, commensurate with a hazard category 2 facility. PFP senior management has placed additional emphasis on attention to detail necessary to safely manage a hazard category 2 facility, and DOE-RL has continued to maintain its close oversight of the PFP facility,

Notwithstanding the additional emphasis placed on PFP operations, HSS elected to further explore the circumstances surrounding the catastrophic failure of exhaust fan EF-1 in the confinement ventilation system (CVS), based upon the number of recent operational issues confronting PFP. On August 29, 2011, the EF-1 drive shaft separated from the fan impellor, causing extensive damage to the fan housing impellor and resultant damage to the drive motor and drive belt system. A fire resulted when the drive belt ignited. PFP evaluations postulate that an imbalanced fan impellor was the most likely cause of the failure.

Post-event internal inspections of the remaining exhaust fans identified cracks in some of the impellor blade welds. In all probability, EF-1 may have developed impellor blade cracks from induced axial vibration as a result of the facility's historical upkeep practices (exhaust fan operational practices are highlighted in a following paragraph). A number of other programmatic, system engineering, and maintenance processes that might have ameliorated the event outcome were not fully implemented.

Maintenance records, although incomplete, reveal that formal maintenance of the fan bearings was inactivated in 1995 and replaced with an informal approach. The informal maintenance regime relied on sporadic lubrication of the exhaust fan bearings and did not include such aspects of predictive maintenance, as vibration analysis, including band pass sound analysis of the bearing foundation for resonance frequencies. Determination of bearing resonance frequencies can identify faults and defects in the bearing components for additional monitoring and thus prevention of catastrophic failures. Considering the operational age of the exhaust fans, a thorough predictive maintenance program, including aging related degradation aspects would have enhanced the vital safety system reliability and served as a means to identify onset failures. Thus the bearing lubrication approach may have been a contributor to induced vibration in the exhaust fans.

The exhaust fans are approximately 60 years old, well past their design lifetime of 40 years. A system operating beyond its design lifetime could be expected to experience age and operational utilization degradation. However, with proper system engineering assessment, maintenance, and configuration management programs, such a system may continue to be operationally reliable under normal and abnormal conditions. In the case of the PFP CVS, mission needs assessments did not support significant system upgrades, since the PFP was expected to be decommissioned during a number of budget cycles. This expectation of decommissioning also contributed to lapses in the maintenance history of the PFP CVS and a limited implementation of the predictive and preventive maintenance program. With regard to predictive maintenance, the HSS review found no evidence of programs addressing aging equipment assessment or rotating equipment vibration analysis, prior to the EF-1 failure.

The exhaust fans have been modified over their operating life. These design modifications have included replacement of some of the original oil-filled bearings with grease-lubricated bearings and shaft replacements, requiring keyway machining. The bearing replacement made it necessary to adjust the bearing pedestal height to accommodate the new bearings. Collectively, these modifications may have induced unknown effects on fan vibration, frequency, and amplitude.

The exhaust fan operating regime may also have contributed to the EF-1 failure. Typically, the exhaust fans operate in parallel, and they should be operated at the same point of their fan curve to optimize performance. However, some fans were operated at full flow, while others were damped or operated in a partial flow mode. In addition, two of the exhaust fans were replaced; these two have the same fan performance curves, but they differ from those of the rest of the exhaust fans. This mismatch could have introduced flow instabilities and resulted in axial fan vibration.

After the EF-1 failure, PFP conducted a vibration analysis of the exhaust fans. There are no records of maintenance history or any past vibration analysis. With respect to maintenance history, all the supply fan impellor wheels were replaced in the 1990s. The maintenance history is incomplete with respect to the exhaust fans at that time. In the 1990s, fatigue stress cracking was found on some of the impellor blades on EF-6, which were weld repaired. The maintenance history is not dispositive with regard to inspection of the other exhaust fan impellors.

CH2M HILL Plateau Remediation Company Administrative Procedure PRC-GD-MN-16276, Periodic Maintenance and Calibration Program Implementation Guide, identifies various predictive maintenance methods for rotating equipment, including vibration monitoring, lubricating oil analysis and ferrography, bearing temperature monitoring, and insulation resistance. Administrative Procedure PRC-PRO-MN-19304, Periodic Maintenance Process, describes an evaluative process for periodic maintenance that includes the following options: no maintenance or “run-to-failure”; and predictive maintenance and/or preventive maintenance. The procedure provides a reasoned explanation for selection of each option. Administrative Procedure PRC-PRO-EN-8323, Management of HEPA Filter Systems, indicates that most

CVS applications warrant comprehensive maintenance and surveillance programs to maintain a system at a high level of readiness at all times. The procedure also indicates that the design authority is responsible for establishing a surveillance program that assures timely identification of declining CVS component performance. A thorough implementation of the existing procedural guidance could have resulted in early identification of the exhaust fan vibration anomalies.

After the exhaust fan failure, the facility implemented enhanced maintenance efforts for the exhaust fans, including weekly vibration analysis. At the time of the HSS assessment, PFP was evaluating repair or replacement options (e.g., weld repairs to those exhaust fan with impellor blades cracks, versus impellor or fan replacement), with consideration of the present PFP mission and the status of D&D efforts.

DOE-RL reviewed the current exhaust fan operational status in a safety evaluation report and approved its operational mode with the steam turbine driven exhaust fans as an operational backup.

The health of aging CVSs has been a concern of the Defense Nuclear Facilities Safety Board (DNFSB). DNFSB Recommendation 2000-2, *Configuration Management, Vital Safety Systems*, and Recommendation 2004-2, *Active Confinement Systems*, provide the DNFSB's perspective on the health of CVSs.

In summary, a thorough system engineering approach to the operational and maintenance management of the CVS could have prevented the exhaust fan failure. However, over the operating history of PFP, there have been periods where plans to terminate the mission may have influenced maintenance decisions.

5.0 CONCLUSIONS

The HSS independent review concluded that the DOE-RL CONOPS and work management assessment was performed in accordance with DOE Policy 226.1B and DOE Order 5480.19 expectations. The DOE-RL CONOPS and work management assessments of MSA and CHPRC were well planned and conducted, and the findings and conclusions documented in DOE-RL assessment reports accurately reflect the assessment team's inspection efforts and the facility conditions at the time of the assessments.

In addition, HSS determined that sustained DOE-RL oversight emphasis and review are warranted for PFP operations for various reasons, including the number of operational issues identified at the PFP, the transition to a hazard category 2 D&D facility, questions about staffing of operations management, and the lack of a timely proactive system engineering approach to the main ventilation fans issues.

6.0 OPPORTUNITIES FOR IMPROVEMENT

The following opportunities for improvement (OFIs) should be evaluated by DOE-RL management in accordance with site issues management processes. These potential enhancements are not intended to be prescriptive or mandatory. Rather, the OFIs are offered to the site to be reviewed and evaluated by the responsible line management and accepted, rejected, or modified as appropriate, in accordance with site-specific program objectives and priorities. This review identified the following OFIs:

1. Consider the merits of a broader work management review to be conducted by CHPRC at PFP, given the results of the 2011 radiological work management surveillance and the DOE-RL determination that an extent-of-condition review is warranted in electrical work management. Fundamental issues in work planning and control may be present in the contractor's management of work.

2. Evaluate options for enhancing the approach to scheduling reviews with the goals of facilitating a more in-depth analysis of developed findings and further resolution and determination of the extent of the identified issues (e.g., allowing additional time for more comprehensive team meetings to exchange findings and develop insights and synergistic outcomes) and ensuring that assessors remain fresh (e.g., possibly interspersing the consecutive assessment approach, which entailed three consecutive weeks of reviews, with focused reviews of one facility and one contractor)..

7.0 ITEMS FOR FOLLOW-UP

HSS plans to continue its operational oversight awareness activities at the STP and to monitor PFP activities.

Appendix A Documents Reviewed

- 10 CFR 830, Nuclear Safety Management
- DOE Policy 226.1B, Department of Energy Oversight Policy
- DOE Order 226.1B, Implementation of Department of Energy Oversight Policy
- DOE Order 227.1, Independent Oversight Program
- DOE Order 5480.19, Conduct of Operations Requirements for DOE Facilities
- DOE Order 422.1, Conduct of Operations
- DOE-STD-1032-92, Guide To Good Practices for Operations Organization and Administration
- DOE-STD-1034-93, Guide to Good Practices for Timely Orders to Operators
- DOE-STD-1036-93, Guide to Good Practices for Independent Verification
- Conduct of Operations and Work Management Assessment Plan, (DOE-RL, November 1-18, 2011)
- PRC-PRO-OP-696, Conduct of Operations
- PRC-PRO-OP-22991, Timely Orders
- PRC-OP-2-020, Timely Orders
- FSP-PFP-0821, PFP Conduct of Operations
- PRC-PRO-WKM-12115, Work Management
- PRC-PRO-WKM-079, Job Hazards Analysis
- PRC-PRO-WKM-14047, Pre-job Briefing and Post Job Reviews
- PRC-RD-WKM-8524, Supervision of Fieldwork
- Conduct of Operations Applicability Matrix CHPRC-01137, PFP
- Deactivation and Decommissioning (D&D) Project Conduct of Operations (CONOPS) Applicability Matrix (CHPRC)
- CHPRC-00312, CH2M HILL Plateau Remediation Company Conduct of Operations Program Improvement Plan
- Contract No. DE-AC06-08RL14788- Transmittal Of Surveillance Report Planning and Execution of Radiological Work (S-11-SED-CHPRC-PFP-002)
- MSC-PRO-696, Conduct of Operations
- MSA CONOPS Matrix – Electrical Utilities
- MSC-PRO-12115, Work Management
- MSC-PRO-14047, Conducting Pre-Job Briefings and Post-Job Reviews
- MSC-MP-47124, Inter-Contractor Work Control
- MSC-RD-8524, Field Work Supervision
- MSC-PRO-079, Job Hazards Analysis
- MSC-PRO-066, Electrical Utilities Lock and Tag Program
- UE-A-22.01, Electrical Utilities Administrative Procedure Electrical Utilities System Dispatcher Duties
- UE-A-00.62, Electrical Utilities Administrative Procedure Conduct of Operations Applicability Matrix
- MSC-PRO-29401, Control of On-Shift Training
- MSC-PRO-26025, Developing Training Programs
- MSC-POL-11337, Employee Training
- MSC-POL-179, Obtaining Training Equivalencies, Waivers and Extensions
- Occurrence Report EM-RL--MSC-ELEC-2011-0002

PFP CVS Exhaust Fan Failure Document Review

- CHPRC-01085, Rev 5, Vital Safety System Health Report for the PFP-25 Ventilation System at the Plutonium Finishing Plant, January 2012
- CHPRC-01085, Rev 4, Vital Safety System Health Report for the PFP-25 Ventilation System at the Plutonium Finishing Plant, October 2011
- CHPRC-01085, Rev 3, Vital Safety System Health Report for the PFP-25 Ventilation System at the Plutonium Finishing Plant, July 2011
- CHPRC-01085, Rev 2, Vital Safety System Health Report for the PFP-25 Ventilation System at the Plutonium Finishing Plant, April 2011
- CHPRC-01085, Rev 1, Vital Safety System Health Report for the PFP-25 Ventilation System at the Plutonium Finishing Plant, January 2011
- CHPRC-01581, Rev 0, Evaluation of Safety of the Situation – Reduction in reliability of the 291-Z Exhaust Fans, September 2011
- CHPRC-01581, Rev 1, Evaluation of Safety of the Situation – Reduction in reliability of the 291-Z Exhaust Fans, September 2011
- CHPRC-01636, Rev 0, Exhaust Fans EF-1-25A Failure Evaluation with Recommendations, November 2011
- HNF-51021, Rev 0, Enhanced Maintenance Plan for the Plutonium Finishing Plant (PFP) Exhaust Fans, Motors, and Steam Driven Turbines ion 291-Z
- ZPR-006, Technical Procedure, Loss of Ventilation, 01/11/12
- 2Z22077, Exhaust Fan Motors – 291-Z System 25A, Plutonium Finishing Plant Infrastructure Technical Procedure, 05/29/2008
- 2Z23065, Exhaust Fans – 291-Z System 25A, Technical Procedure, 08/17/2010
- ZO-060-117, Power and Ventilation Equipment Surveillance, Technical Procedure, 01/31/12
- PRC-PRO-EN-8323, Administrative Procedure, Management of HEPA Filter Systems, 02/09/11
- PRC-PRO-MN-19304, Administrative Procedure, Periodic Maintenance Process, 07/26/11
- PRC-GD-MN-16276, Administrative Procedure, Periodic Maintenance and Calibration program Implementation Guide, 05/24/2010

**Appendix B
Supplemental Information**

Dates of Review

Onsite Review: November 7-18, 2011

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