DEFENSE NUCLEAR FACILITIES SAFETY BOARD
Washington, DC 20004-2901

March 6, 2015

Mr. Mark Whitney
Acting Assistant Secretary for
Environmental Management
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-0113

Dear Mr. Whitney:

A review of the Department of Energy's (DOE) strategy for decommissioning safety systems at the Plutonium Finishing Plant (PFP) revealed the safety issues detailed in the enclosed report. Collectively, these issues illustrate a need to improve DOE's processes for evaluating, controlling, and accepting the safety risks inherent in hazardous cleanup activities at Hanford. While decommissioning activities at PFP are approaching completion, DOE is confronting other hazardous cleanup missions at Hanford. The enclosed report is provided for your information and use as DOE pursues these future missions. The Board will continue its oversight of the PFP project and DOE's other hazardous cleanup activities at Hanford.

Sincerely,

Jessie H. Roberson
Vice Chairman

Enclosure

c: Ms. Stacy Charboneau
Mr. Joe Olencz

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

December 10, 2014

MEMORANDUM FOR: S. A. Stokes, Technical Director

COPIES: Board Members

FROM: C. Shuffler

SUBJECT: Review of the System Back Out Plan and Ventilation System for the Plutonium Finishing Plant Project

This report documents safety issues identified by staff members F. Bamdad, J. Meszaros, J. Pasko, and C. Shuffler during a review of the decommissioning strategy for safety systems and the ventilation system for the Plutonium Finishing Plant (PFP) at the Hanford Site. The staff members conducted their review at Hanford during the week of November 3, 2014. Collectively, the issues illustrate the need to improve contractor and federal processes for evaluating, controlling, and accepting the safety risks inherent in hazardous cleanup activities at Hanford's aging facilities. The specific examples cited in this report highlight decisions by the PFP contractor, CH2M HILL Plateau Remediation Company (CHPRC), and the Department of Energy's Richland Operations Office (DOE-RL) that led to inadequate controls for high risk scenarios, unfiltered release pathways from the facility, and safety systems that may not perform their safety functions due to improper control of their support systems. Additionally, the review team identified the potential for bypass leakage around the safety-significant high-efficiency particulate air (HEPA) filters during certain accident scenarios.

Background. Operations at PFP began in 1949 to produce plutonium metal for defense purposes. In 1991, the mission changed to plutonium-bearing material stabilization, deactivation and decommissioning (D&D), and environmental restoration. CHPRC personnel are working to demolish the facility to slab-on-grade by the end of Fiscal Year 2016. Hazardous work remaining includes the removal of large gloveboxes, process piping, ductwork, filters, and other equipment with high levels of contamination and plutonium holdup.

CHPRC project team members developed a system back out plan to identify sequenced actions for securing and downgrading safety systems as the hazard level declines. One review objective was to determine whether this back out plan provides an adequate strategy for decommissioning safety controls. Notably, the review team focused on the safety-significant active confinement ventilation system due to the system's significant contribution to risk reduction and recent issues with fan reliability. The PFP Documented Safety Analysis (DSA) [1] credits the system to mitigate the release of radiological material in the event of an accident such as a fire, explosion, or spill of radiological material. In August 2011, one of the electric exhaust fans failed catastrophically. In response, CHPRC personnel undertook an extensive campaign to

refurbish fan components and improve fan reliability. Another review team objective was to determine whether these improvements reduce the risk of a future fan failure.

Review Conclusions. The review team observed that the back out plan does not yet contain step-out criteria for major safety systems. A conclusion regarding their adequacy can therefore not be reached at this time. CHPRC personnel will develop the step-out criteria in a future revision of the DSA. Concerning exhaust fan reliability, the review team concluded that CHPRC and DOE-RL personnel have made significant improvements to limit the risk of a future failure such as replacing aging fan components and enhancing predictive and preventive maintenance activities. However, in evaluating the back out plan and the ventilation system, the review team identified a number of safety issues concerning CHPRC's and DOE-RL's evaluation and acceptance of risk on the project. These concerns are presented in the remaining sections of this report.

High Risk Scenarios. Historically, the PFP safety basis has highlighted high risk accident scenarios for which controls are not identified to achieve risk reduction goals defined in site-specific guidance for developing DSAs [2]. In the majority of cases, DOE-RL accepted the risk on the basis that PFP is a limited life facility and has no cost effective means for controlling the accidents beyond the timely completion of the D&D mission. Specific scenarios designated as high risk in the DSA have evolved over time. High risk scenarios in the current safety basis include equipment and facility fires, equipment explosions, a seismic event, and an aircraft crash accident. None of these scenarios yield mitigated consequences to the public that exceed DOE's 25 rem Evaluation Guideline, though most yield mitigated consequences that exceed the 100 rem collocated worker dose threshold adopted by many DOE sites for identifying safety-significant controls.

The review team sought to understand DOE-RL's process for evaluating and accepting the risk posed by high risk scenarios. In particular, the review team questioned DOE-RL's application of the process to one scenario in which a simple and cost-effective control appeared available to reduce the risk. The scenario is a transuranic waste drum fire in Building 242-Z initiated by a spill of flammable or combustible liquids. In approving the safety basis with this scenario, DOE-RL agreed with the contractor's determination that the risk is acceptable based in part on the position that "significant TRU [transuranic] waste drum staging is not expected in 242-Z due to the limited floor area and operational necessity to keep the pathway clear for continued D&D, and potential prompt egress from the facility" [3]. This position suggests that the CHPRC and DOE-RL could control the risk via an administrative limit on the quantity of transuranic waste in Building 242-Z. Neither CHPRC nor DOE-RL personnel, however, considered such restrictions practical or necessary.

During onsite discussions, DOE-RL personnel explained that even with additional waste restrictions they believed the overall risk posture would be unaffected. The basis for this position was not clear to the review team, nor was the position supported in the Safety Evaluation Report [4] that documented DOE-RL's acceptance of the risk. The review team concluded that (1) CHPRC and DOE-RL personnel do not necessarily require that high risk scenarios achieve risk reduction goals in site-specific safety analysis guidance even when effective controls are available, and (2) DOE-RL does not have a formal process for reviewing and accepting the risk for accident scenarios that cannot achieve risk reduction goals. In

response to this concern, CHPRC personnel committed to reviewing high risk scenarios for additional administrative controls that could further reduce the risk. They intended to capture these additional controls in a draft revision of the DSA submitted to DOE-RL in January 2015. DOE-RL personnel did not commit to further action. The review team has requested the draft revision of the DSA for review.

Unfiltered Release Pathway from Zone 3B Areas. Ventilation Zone 3B is the outermost and least contaminated zone requiring filtration in Building 234-5Z's cascading confinement strategy. The safety basis allows up to 3,000 grams of total plutonium[1] in Zone 3B areas to support packaging and repackaging of waste boxes, waste drum staging, and nondestructive assay activities. The PFP Technical Safety Requirements (TSR) [5] specify that the pressure indicated by facility instrumentation be maintained at least 0.05 inches water gauge below atmospheric pressure in the zone. The safety basis acknowledges that when accounting for the effects of instrument uncertainty and external wind, the differential pressure does not meet the recommended pressure guidelines in DOE's *Nuclear Air Cleaning Handbook* [6] and may be insufficient to assure 100 percent filtration of radiological materials released during accidents in Zone 3B areas. The accident analysis accounts for this condition by assuming a ground level unfiltered release of 10 percent of the source term for scenarios that credit active confinement (i.e., a 0.1 leak path factor).

The review team observed that when accounting for the uncertainty recommended by the contractor [7], Zone 3B could approach atmospheric pressure while meeting the TSR pressure requirement. Further, the ventilation system has sufficient capacity to maintain the zone at a more negative pressure that would meet DOE's guidelines and minimize the potential for an unfiltered release during an accident. The review team therefore questioned CHPRC and DOE-RL personnel on the basis for the Zone 3B pressure requirement.

CHPRC personnel explained that the pressure is set to ensure airflow is maintained from cleaner Zone 3B areas into adjacent and more highly contaminated confinement zones, thus protecting vital nondestructive assay equipment in Zone 3B from potential contamination. Neither CHPRC nor DOE-RL personnel analyzed the risk of an unfiltered release in support of their decision to base the Zone 3B pressure requirement on contamination control within the facility. Additionally, the DSA provides no basis beyond engineering judgment to support the 0.1 leak path factor assumed in the mitigated dose calculations for accidents in Zone 3B areas. Due to the difficulty in deriving a defensible leak path factor for the potential near atmospheric pressure condition in Zone 3B, this value may underestimate the consequence of an unfiltered release and therefore the risk accepted by DOE-RL and CHPRC for Zone 3B accidents.

In response to this concern, CHPRC personnel committed to evaluate implementing a more negative pressure requirement in Zone 3B to comply with DOE's guidelines. Due to resource constraints, they could not commit to a schedule for the evaluation. DOE-RL personnel were silent on the concern other than to amplify their prior acceptance of the risk in the PFP safety basis.

1 Total plutonium refers to a conservative estimate of the total plutonium isotopic mix based on nondestructive assay measurements and process history.

Support System Classification. The PFP DSA classifies systems supporting the safety-significant active confinement ventilation system as equipment Important to Safety (ITS) rather than safety-significant per the expectations in DOE Standard 3009, *Preparation Guide for US Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses* [8]. Further, a review of the instrument air system indicates that the CHPRC project team is not properly emphasizing and prioritizing surveillance and maintenance of ITS systems to ensure their availability to support credited safety functions. Consequently, the risk of safety system failure at PFP may be higher than assumed in the safety basis.

Section 4.4.X.2 of DOE Standard 3009 states the following expectation regarding the functional classification of support systems to safety-significant systems:

> Identify SSCs [structures, systems, and components] whose failure would result in a safety-significant SSC losing the ability to perform its required safety function. These SSCs would also be considered safety-significant SSCs for the specific accident conditions or general rationale for which the safety-significant designation was made originally. [8]

Though the PFP DSA adopts DOE Standard 3011, *Guidance for Preparation of Basis for Interim Operation (BIO) Documents*, as a safe harbor, it also states the project team's intent to meet the guidance and requirements in DOE Standard 3009. The review team observed that the functional classification for systems supporting the safety-significant active confinement ventilation system—electrical power, instrument air, and building zone pressure control—is ITS rather than safety-significant. Failure of these systems would prevent the safety-significant ventilation system from performing its safety function. Therefore, the PFP safety basis does not meet the guidance in DOE Standard 3009 regarding support system functional classification.

During the onsite review, CHPRC and DOE-RL personnel agreed with the staff's concern, but disagreed that any safety benefit would be realized by crediting PFP's aging support systems. They offered the lack of design pedigree for support systems and the rigor applied by CHPRC personnel to operation and maintenance activities to support their position. The review team questioned this basis after observing that CHPRC personnel had not completed inspections and repairs of a potential leak in the instrument air system[2] discovered during a December 2013 test of the ventilation system, despite a recommendation in the test report [9] to do so. Further, CHPRC personnel had not evaluated the impact of the potential leak on the ability of the ventilation system to perform its safety function. DOE directives would require such an evaluation if the safety basis credited the instrument air system as safety-significant. A higher functional classification would also necessitate enhanced inspections and maintenance activities to detect degradation such as system leaks. Discussions with DOE-RL personnel suggested that this issue may be applicable to multiple defense nuclear facilities at Hanford. DOE-RL personnel agreed that support systems should carry a higher functional classification if their failure could prevent a safety system from performing its safety function. They committed to investigating the issue further.

2 The ventilation system relies on instrument air to operate pneumatic pressure transmitters and modulating dampers to control airflow and building pressures.

*Other Concerns***.** The review team identified additional concerns with the adequacy of the TSR surveillance requirement relied upon to ensure the operability of the safety-significant HEPA filters and with the potential for bypass leakage around the filters during certain accident scenarios. The latter could result in a filtration efficiency that is less than that credited by the PFP safety basis.

The PFP HEPA filter plenum includes a unique capability to mitigate the effects of potential leakage around the HEPA gaskets that seal the filter to the plenum (see Figure 1). The design includes a gasket on the up and downstream faces of each filter, creating an annular space around the filter case. For ~45 years, a separate air supply system provided the annular space with clean, pressurized air to ensure that any gasket leaks resulted in the flow of clean air into the filter plenum rather than the flow of contaminated exhaust air around the filter gaskets. In the mid-1990s, PFP personnel terminated operation of the system's supply fan due to high vibration. The supply system continued to operate passively, relying on the negative pressure in the filter plenum to pull clean air from the supply system through any gasket leaks. Over time, the HEPA gasket seals deteriorated and flow through the supply system increased. Recent repairs and changes in damper position have reduced the flow through the system to a negligible level.

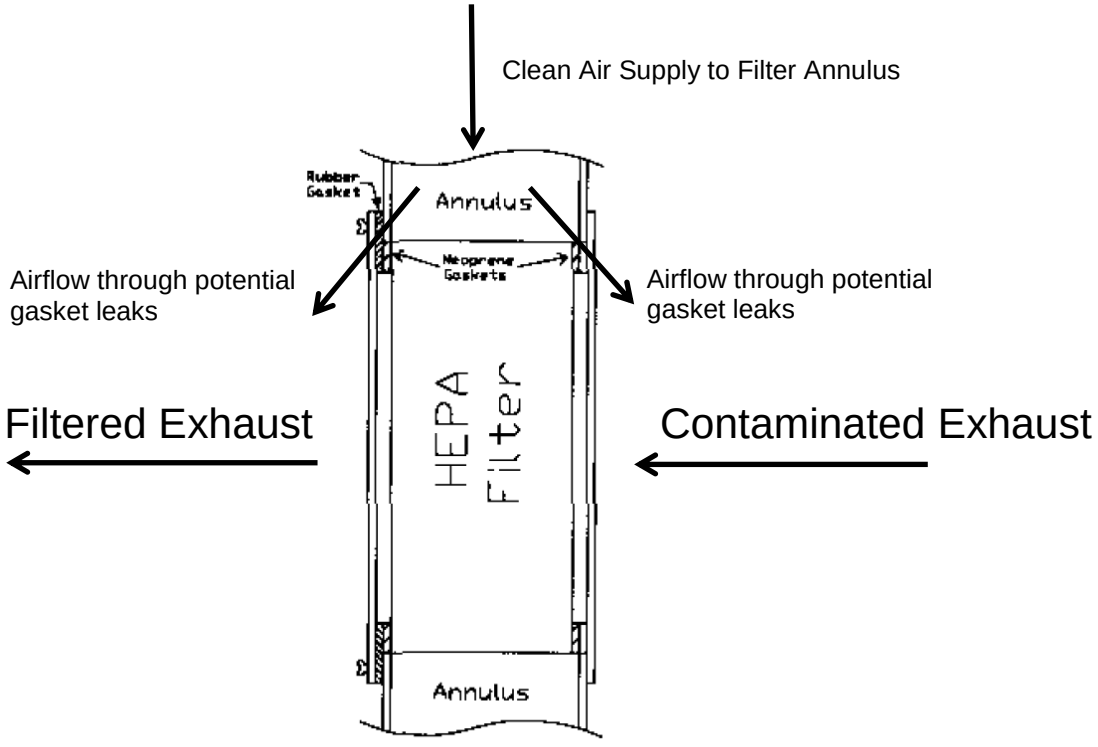

Figure 1. PFP HEPA Filter Design

The PFP TSR requires an annual aerosol leak test of the HEPA filters to ensure that leakage around or through the filters remains within the limits prescribed by the safety basis. The review team questioned the adequacy of the leak test to detect leakage around the filters given their unique design. Specifically, because the supply system communicating with the annular space around the filters provides clean air to any leak sites, the aerosol leak test would not be capable of detecting a potential leak path around the filters (i.e., the influx of clean air

would preclude test aerosol from leaking past the gaskets). The only indication available to detect HEPA gasket degradation, and thus the potential for bypass leakage, is a differential pressure gauge on the supply system that provides a crude estimate of the airflow leaking through the gaskets into the filter plenum. The TSR, however, does not establish requirements to monitor this flow. Consequently, the review team concluded that the TSR does not establish an adequate surveillance for confirming HEPA filter operability.

The review team expressed further concern that the system configuration could lead to an unanalyzed bypass leakage condition during accidents that result in high filter loading such as a major fire. As HEPA filters load with particulate during an accident, the ventilation control system maintains the pressure upstream of the HEPA filters constant while the pressure downstream becomes more negative. The increasing pressure drop across the HEPA filters could facilitate a bypass leakage pathway around the filters if the gaskets are not leak tight and the leakage through the downstream gasket is sufficient to draw the annular space negative with respect to the plenum upstream of the HEPA filters.

The review team acknowledges that significant dilution would be expected for any bypass leakage due to the elevated release from PFP's stack. However, the review team concluded that the bypass scenario could challenge the efficiency credited in the DSA for the safety-significant HEPA filters. CHPRC and DOE-RL personnel did not disagree with this concern. Before committing to address it, they are reviewing previous technical analyses that they believe evaluated potential bypass leakage pathways. They committed to providing the staff with the results of their investigation upon completion.

References.

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[2] Marusich, R.M., *Hanford Safety Analysis and Risk Assessment Handbook (SARAH)*, HNF-8739, Rev. 2, CH2M HILL Plateau Remediation Company, Richland, WA, April, 2012.

[3] Shoop, D.S., *Contract No. DE-AC06-08RL14788 – Response to CH2M HILL Plateau Remediation Company (CHPRC) Transmittal of Annual Update to the Plutonium Finishing Plant (PFP) Safety Basis and Unreviewed Safety Question (USQ) Report*, letter to J.G. Lehew III, December 21, 2011.

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[6] Department of Energy, *Nuclear Air Cleaning Handbook*, DOE HDBK-1169-2003, Washington, D.C., November, 2003.

[7] Silvan, G.R., *Differential Pressure Correction Factor for the Plutonium Finishing Plant (PFP)*, HNF-32024, Rev. 0, Fluor Hanford, Inc., Richland, WA, December, 2006.

[8] Department of Energy, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses*, DOE-STD-3009-94, Change Notice 3, Washington, D.C., March, 2006.

[9] Christensen, S.A., *PFP Ventilation System Test Report*, CHPRC-02160, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, WA.