Department of Energy
Washington, DC 20585

August 28, 2014

The Honorable Peter S. Winokur
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue NW, Suite 700
Washington, DC 20004

Dear Mr. Chairman:

Enclosed is the Department of Energy's (DOE) response to the Defense Nuclear Facilities Safety Board's (Board) letter, dated June 18, 2014, transmitting the Board's Staff Issue Report, dated April 16, 2014: "Safety Basis Review of 242-A Evaporator at Hanford" (Staff Issue Report). Your letter requested a report within 90 days of its issuance, or prior to introduction of radioactive waste into the facility, that:

1. Identifies the compensatory measures to be applied to the existing safety-significant steam isolation valve until the valve is qualified to perform its safety function, or is replaced with a qualified system.

2. Describes DOE's plan and schedule to remediate the deficiencies with the safety control set identified in the Staff Issue Report.

3. Identifies the actions to be taken for the next annual update to the Documented Safety Analyses for the 242-A Evaporator and the Tank Farms that deal with the inappropriate screening of operational events, exclusion of chemical and toxicological hazards, and reliance on Safety Management Programs in place of credited controls.

As a result of the discussions held with the Board staff during the staff visit in March 2014, an unrecognized failure mode for the safety equipment was discovered. The Tank Operations Contractor (TOC) subsequently entered the unanalyzed condition into the Unreviewed Safety Question process, as required by 10 Code of Federal Regulation Section 830.203. The enclosed report describes additional actions the TOC is taking to implement compensatory measures as well as actions taken by the DOE Office of River Protection.

DOE appreciates independent reviews of major revisions to its facilities' safety bases. The revised 242-A Evaporator safety basis, approved in June 2013, is a significant improvement over its predecessor. As a result, safety-significant structures, systems, and components now comprise the primary elements of the facility's control strategy, which previously relied mainly on administrative controls. Additional protective actions and compensatory measures are in place to ensure safe operation of the 242-A Evaporator,

and that its safety basis complies with DOE safety regulations, and directives as required by the TOC contract.

If you have any questions, please contact me or Mr. James A. Hutton, Acting Deputy Assistant Secretary for Safety, Security, and Quality Programs, at (202) 586-0975.

Sincerely,

Mark Whitney
Acting Assistant Manager
for Environmental Management

Enclosure

REPORT

This report is provided by the Department of Energy (DOE) in response to the request by the Defense Nuclear Facilities Safety Board (Board) in its letter, dated June 18, 2014, transmitting the Board's Staff Issue Report, dated April 16, 2014, *Safety Basis Review of 242-A Evaporator at Hanford* (Staff Issue Report). The three items, about which the Board requested additional information, and DOE's responses, are set forth below.

Item No. 1: Identify the Compensatory Measures to be Applied to the Existing Safety-Significant Steam Isolation Valve Until the Valve is Qualified to Perform its Safety Function, or is Replaced with a Qualified System.

Response: Regarding installation of an upgraded steam isolation valve via a planned improvement without developing compensatory measures, the following information is provided.

When the Office of River Protection (ORP) approved the 242-A Evaporator safety basis in June 2013, it did not require, as a condition of approval, the use of an interim control (i.e., a compensatory measure) based upon the language in Section 3.3.2.3.1 of DOE-Standard (STD)-3009-94 CN 3, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses* (DOE-STD-3009-94), which provides that compensatory measures are to be included in the Documented Safety Analysis (DSA), if needed. The section provides in part:

> If the DSA preparer wants to make commitments to planned improvements not yet implemented (as a result of the hazard evaluation) … [s]ummarize the basis for committing to the improvement and, ***if needed***, any interim controls proposed until the improvement is implemented. [emphasis added]

ORP determined at that time, due to the planned improvement to replace the steam isolation valve and a low risk of a seismic event associated with the small number of Evaporator campaigns, that compensatory measures were not needed. Upon further evaluation, however, ORP agrees that compensatory measures are warranted. The 242-A Evaporator DSA now includes Design/Operational Improvement 1 to install a non-process, seismically-qualified, safety-significant steam valve by September 30, 2015. A recently approved safety basis amendment, 14-NSD-0023, dated June 24, 2014, includes the following compensatory measures that are required until Design/Operational Improvement 1 is completed:

- Technical Safety Requirement (TSR) 5.10.1, *E-A-1 Reboiler Steam Isolation Valve Verification*, addresses the fact that the current process control steam isolation valve is also a component of the safety-significant C-A-1 vessel flammable gas control system. TSR 5.10.1 requires the operator to immediately verify the steam isolation valve is closed following activation of the C-A-1 vessel flammable gas control system. If the steam isolation valve cannot be verified to

be closed, the operator is required to immediately stop the steam flow by manually closing an alternate steam valve.

- Revisions to TSR 5.9.6, *Emergency Preparedness*, provide protective actions to address the current steam isolation valve not being seismically qualified.

- The revisions to TSR 5.9.6 direct operator response actions that shut off the feed pump and drain or dump the waste from the 242-A Evaporator C-A-1 vessel to prevent both a flammable gas accident in the C-A-1 vessel and the overflow of waste from the C-A-1 vessel into the process condensate system (prevents a flammable gas accident and direct radiation hazard in process condensate tank TK-C-100).

Item No. 2: Describe DOE's Plan and Schedule to Remediate the Deficiencies with the Safety Control Set Identified in the Enclosure to the Board's Letter [the Staff Issue Report]

Deficiencies in the Engineered Safety Control Set

Response: To address identified vulnerabilities of the safety instrumented systems to failures caused by fires, a recently approved safety basis amendment (14-NSD-0023) includes Design/Operational Improvement 2 to implement design changes to ensure that three credited valves in both the safety-significant C-A-1 vessel flammable gas control system and the safety-significant C-A-1 vessel waste high-level control system fail safe in the event of a facility fire. This upgrade will be completed by September 30, 2016. This time is needed because of the technology development, vendor surveys for requisite quality assurance capabilities, testing for applicability in the Evaporator facility, and engineering design efforts associated with proposed changes to the facility air systems to allow for successful operation of the credited valves (i.e., their opening to allow for draining of the Evaporator vessel) under all fire scenarios.

Until Design/Operational Improvement 2 is complete, new TSR 5.10.2, *Emergency Response Actions Following Facility Fires*, is required as a compensatory measure to address facility fires that could prevent the C-A-1 vessel flammable gas control system or the C-A-1 vessel waste high level control system from performing its safety functions.

TSR 5.10.2 requires actions to press an emergency stop button within 40 minutes following recognition of the fire, and if C-A-1 vessel has not been verified to have drained or dumped, then shut down air compressors CP-E-1 and CP-E-2 within 12 hours following recognition of the fire. Compressed air is used to position the actuators for these valves. Shutting down the compressors allows air in the actuator lines to bleed down to allow the valves to open. These actions would prevent a flammable gas accident in the C-A-1 vessel by either draining waste from the C-A-1 vessel (stop feed pump 241-AW-P-102-1 and open feed valve HV-CA1-1), or emptying waste from the C-A-1 vessel (open dump valves HV-CA1-7 and HV-CA1-9). These actions also prevent the overflow of waste from the C-A-1 vessel into the process condensate system by either stopping

waste feed (stop feed pump 241-AW-P-102-1) or by emptying the C-A-1 vessel (open dump valves HV-CA1-7 and HV-CA1-9).

In addition, new TSR Specific Administrative Control (SAC) 5.8.3, *Evaporator and Pump Room Transient Combustible Material Control*, is required to preclude unsafe conditions in the event of failures of feed valve HV-CA1-1 and dump valves HV-CA1-7 and HV-CA1-9 due to fires, by minimizing the size of any potential fires in the Evaporator rooms where these valves are located. SAC 5.8.3 limits the loading of transient combustible materials in the Evaporator Room and the Pump Room below allowable values, and prohibits the presence of transient flammable or combustible liquids in these rooms. The SAC also establishes exclusion zones where no transient combustible materials can be present around the susceptible valves (the dump valves in the Evaporator Room and the feed valve in the Pump Room). This SAC will remain in place after the completion of the planned improvement.

Deficiencies in the Administrative Safety Control Set

Response: Regarding the issue that SAC 5.8.1, *Flammable Gas Controls for Waste Feed Transfer Piping, Waste Slurry Transfer Piping, and C-A-1 Vessel Drain (Dump) Piping*, has an Administrative Control (AC) key element imbedded within the SAC which confuses the violation criteria, the following information is provided.

SAC 5.8.1 contains within it the requirements of AC 5.9.2, *Ignition Controls (an AC Key Element)*. ORP agrees that a one-time failure to adequately implement ignition controls via AC 5.9.2 would constitute a TSR violation. To ensure that this expectation is clear, ORP has informed the Tank Operations Contractor (TOC) to modify the violation criteria in the 242-A Evaporator safety basis to ensure a single failure would be declared a violation. This change will be incorporated into a safety basis amendment and is expected to occur within the next several months.

In response to the issue that actuation of the seismic dump system is implemented through an AC, rather than with an automated engineering control (e.g., a seismic switch), the following information is provided.

A recently approved safety basis amendment (14-NSD-0023) includes Design/Operational Improvement 3 to modify the C-A-1 vessel seismic dump system to automatically initiate upon detection of a seismic event (e.g., a seismic switch). This upgrade will be completed by September 30, 2016. This period of time is necessary because of the design changes associated with the previously mentioned planned improvement for the failsafe nature of the air system within the facility. These improvements are linked. Until the planned improvement is completed, AC 5.9.6, *Key Element Emergency Preparedness*, has been revised to add compensatory measures to minimize the risk of a flammable gas accident in the C-A-1 vessel and a flammable gas accident and direct radiation hazard in process condensate tank TK-C-100 due to a seismic event. Shutting off the feed pump (or draining or dumping the waste from the

C-A-1 vessel) within 40 minutes following a seismic event prevents the overflow of waste from the C-A-1 vessel into the process condensate system (prevents a flammable gas accident and direct radiation hazard in process condensate tank TK-C-100). Draining or dumping the waste within 24 hours of a seismic event prevents a flammable gas accident in the C-A-1 vessel. Automatic actuation of the C-A-1 vessel seismic dump system eliminates the need to manually actuate the system via an AC. Operator actions in AC 5.9.6 are considered adequate compensatory measures until Design/Operational Improvement 3 is completed.

Item No. 3: Identify the Actions to be Taken for the Next Annual Update to the DSA for the 242-A Evaporator and the Tank Farms that Deal with the Inappropriate Screening of Operational Events, Exclusion of Chemical and Toxicological Hazards, and Reliance on Safety Management Programs in Place of Credited Controls

A. Response: Regarding exclusion of operational events that are "beyond extremely unlikely" (BEU), the following response is provided.

ORP has examined the adequacy of the screening of operational events pursuant to DOE-STD-3009-94. The treatment of BEU events in the 242-A Evaporator (and the tank farms) DSA and hazard evaluation database reports is consistent with the requirements of DOE-STD-3009-94 and thereby (given its safe harbor status) compliant with 10 Code of Federal Regulations (C.F.R.) 830 as described below.

The staff issue report quotes from DOE-STD-3009-94, "There is no predetermined frequency cutoff value, such as 1E-6 per year, for excluding low frequency operational accidents (i.e., internally initiated)." However, the "accidents" being discussed in this section (design basis accidents [DBAs]) are referring to events having offsite "consequences [which are] compared with the Evaluation Guideline [of Appendix A] to identify safety-class structures, systems, and components." Appendix A of DOE-STD-3009-94 indicates that for calculation of offsite radiological consequences for comparison to the Evaluation Guideline, there is no predetermined frequency cutoff value, such as 1 E-6 per year, for excluding low frequency operational accidents (i.e., internally initiated).

DOE-STD-3009-94 defines the term "hazard analysis" as one that: "examines the complete spectrum of potential accidents that could expose members of the public, onsite workers, facility workers, and the environment to hazardous materials." Table 3-5 of DOE-STD-3009-94 provides an example of a qualitative ranking scheme within which "no impact or [BEU]" are considered an "acceptable" risk evaluation. The accident selection activity described in DOE-STD-3009-94 provides that unmitigated low likelihood operational events should not be selected as derivative DBAs:

> For operational accidents, a derivative DBA is defined based on the physical possibility of phenomena as defined in the hazard analysis. Use of a lower binning threshold such as 10^{-6}/yr is generally appropriate, but should not be used as an absolute cutoff for dismissing physically credible low probability

> operational accidents (e.g., red oil explosions) without any evaluation of preventive and mitigative features in hazard analysis. This distinction is made to prevent "pencil sharpening" at the expense of objective evaluation of hazards. Examples of a candidate derivative DBA would be an ion exchange column or a red oil explosion at a facility where the phenomena is physically possible and documentation is not available substantiating ventilation and building confinement systems were specifically designed for such an occurrence.

The 242-A Evaporator hazard evaluation assessed each BEU event for potential identification of safety class controls by either providing them directly to the accident analysis process or by ensuring these events are bounded by a similar event already analyzed as a DBA. Thus, frequency was not used as a criterion for any conditions that had not already been shown to be bounded by an accident that had been analyzed and shown to be below the offsite guideline. For the facility worker and onsite (co-located) worker events determined in the Hazard Evaluation to be BEU based on physical implausibility (e.g., 242-A-FG-05), these were documented as such and not evaluated further. Thus, the facility worker and onsite (co-located) worker events determined in the Hazard Evaluation to be BEU were based on scenarios that require multiple, independent, simultaneous events before the hazardous conditions result (e.g., 242-A-FG-03). Therefore, these multiple, independent, simultaneous events were documented in the Hazard Evaluation database and not evaluated further. Controls were not allocated for these BEU events.

In the case of the slowly developing hazardous condition 242-A-FG-05, physical configuration of the slurry cabinet (i.e., not capable of retaining a liquid inventory sufficient to generate a flammable atmosphere and not capable of retaining that atmosphere without dilution until the lower flammable limit is reached) is documented as a basis for the hazardous condition being BEU in the facility's hazard database (RPP-48900) and is controlled in the facility through application of the Unreviewed Safety Question (USQ) process under 10 C.F.R. § 830.203. USQ procedure TFC-ENG-SB, C-03, *USQ Process*, directly requires USQ evaluators to review these hazardous conditions for potential changes they are evaluating. DOE-STD-3009 discusses, in Appendix A, that an "unmitigated release should characterize both the energies driving the release, and the release fractions in accordance with the physical realities of the accident phenomena at a given facility or process. As a result, there may be assumptions that are necessary to make in order to define a meaningful scenario, but which also impact the magnitude of the resultant consequences."

In addition, wording in DOE-STD-3009-94 regarding TSR implementation states that:

> It is important to develop TSRs judiciously. TSRs should not be used as a vehicle to cover the many procedural and programmatic controls inherent in any operation. Excessive use of TSR limits to manage operations will result in distortion of the regulatory structure DOE is attempting to develop and will dilute the emphasis intended for the most critical controls.

In summary, ORP has evaluated this issue and has determined that the methodology applied in the Hazard Evaluation Database correctly implements DOE nuclear safety regulations and DOE directives.

B. Response: Regarding treatment of pure chemical (toxicological) hazards by safety management programs (SMP) rather than through safety basis controls, the following response is provided.

The TOC has implemented the direction of ORP letter 09-NSD-026, as updated by 14-NSD-0015, *Revision on Direction to Implement New Safety Classification Process for the Tank Farms and 242-A Evaporator DSA and New Capital Projects*, which provides that hazard analyses for Hazard Category 2 and 3 nuclear facilities must consider toxicological hazards to the public, co-located (onsite) workers, and facility workers. In accordance with that direction, section 3.3.1 in the 242-A Evaporator DSA states that the chemical hazards that may be considered to be occupational hazards are defined as:

- Non-radiological (chemical) hazards such as chemicals used during condensate sampling.

- Chemical burn hazards from exposure to waste (i.e., skin contact with caustic waste) during planned work activities such as waste sampling. (Note: Chemical burn hazards due to skin contact with caustic waste resulting from waste leaks or accidents causing the release of waste in the C-A-1 vessel, waste transfer feed piping, and waste transfer slurry piping are considered non-routine hazards and are evaluated in the hazard and accident analyses.)

The 242-A Evaporator DSA further states that some occupational hazards may also be, depending on timing and location, potential initiators of uncontrolled releases of hazardous material and in such instances are subject to further evaluation. AC 5.6, *SMP*, documents the TOC commitment to establish, maintain, and implement the SMPs including Hazardous Material Protection as described in Chapter 8 of the DSA. The Chapter 8 description states that the TOC hazardous material protection program implements 10 C.F.R. Part 851, *Worker Safety and Health Program*, regarding all chemicals in the facility. It also describes the flow-down of requirements from codes, standards, regulations, DOE orders, and DOE directives as applicable to the TOC. ORP has determined that, given this linkage between the AC commitment and the DSA description, this meets the requirement of 10 C.F.R. § 830. 204(b)(5) to "[d]efine the characteristics of the safety management programs necessary to ensure the safe operation of the facility." Failure to effectively implement 10 C.F.R. Part 851 would constitute a TSR violation.

Additionally, DOE STD-3009-94 states the following regarding inclusion of standard industrial hazards within the safety basis in Section 3.3.1.1:

> It is important not to expend DSA resources on those hazards for which national consensus codes and/or standards (e.g., [Occupational Safety and Health

> Administration] regulations) already define and regulate appropriate practices without the need for special analysis. As noted in this Standard's definition of "hazard," standard industrial hazards are identified only to the degree they are initiators and contributors to accidents in main processes and activities. For example, worker electrocution from electrical wiring faults is not a DSA issue. However, the existence of 440 volt AC cabling in a glovebox would be identified as a potential accident initiator for a scenario (i.e., fire) involving hazardous materials.

C. Response: Regarding treatment of direct radiation hazards by SMP rather than through safety basis controls, the following response is provided.

Appendix A of DOE-STD-3009-94 states that "[t]he protection of the public and workers during normal operations is governed by 10 C.F.R. Part 835, *Occupational Radiation Protection*, which states "unintended releases of sufficiently high frequency as considered a part of normal operations would also be governed by this regulation." Consistent with this guidance, section 3.3.1 in the 242-A Evaporator DSA, draws a clear distinction between the treatment of direct radiation hazards that are caused by accidents (direct release or misroute to an unintended location) and those that are occupational. To clarify this point, the DSA states that occupational hazards include:

> Hazardous conditions that result in direct radiation exposure during normal operation to facility workers (i.e., no radioactive material release and no misroute of radioactive material to an unintended location) and exposure to minor amounts of fugitive radioactive contamination not associated with other release accidents.

An example of a TSR control that is derived from a potential misroute of waste to an unintended location is SAC 5.8.2, *Evaporator and Pump Room Access and Pump Room Cover Block Control*. This SAC (among other functions) protects against direct radiation hazards from misroutes of waste from tank farms to the 242-Evaporator while it is in the shutdown mode.

It is further noted that AC 5.6 documents the TOC commitment to establish, maintain, and implement the SMPs including Radiation Protection as described in DSA Chapter 7. The characteristics of this SMP described in DSA Chapter 7 include, for example, responsibility for radiation protection program compliance with 10 C.F.R. Part 835, *Occupational Radiation Protection*. Again, ORP has determined that, given this linkage between the AC commitment and the DSA description, failure to effectively implement 10 C.F.R. Part 835 would constitute a TSR violation.

Summary Conclusions

The Board staff issues identified in Items 1 and 2 in the Board's letter are being addressed through compensatory measures: new TSR-level controls, planned upgrades to safety-significant control systems, and planned clarifications to the violation criteria for SAC 5.8.1/AC 5.9.2.

The issues identified in Item 3 have been evaluated by ORP. ORP has determined that the hazard analysis process for operational events ensured that all BEU events were evaluated for potential identification of safety class controls by either carrying them directly to the accident analysis or by ensuring they were bounded by a similar event already analyzed as a DBA. For the facility worker and onsite (co-located) worker, events determined in the hazard evaluation to be BEU based on physical implausibility or that required multiple, independent, simultaneous events, were documented as such and not evaluated further. Controls were not allocated for these BEU events. In addition, ORP has determined that the methodology used by the TOC for evaluation of non-radioactive chemical and toxicological events, and the reliance on SMP in place of specific credited nuclear safety controls, complies with the ORP direction within 14-NSD-0015 as well as DOE-STD-3009-94 and thereby (given its safe harbor status) complies with 10 C.F.R. Part 830.