Department of Energy
Washington, DC 20585

July 25, 2011

The Honorable Peter S. Winokur
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, NW, Suite 700
Washington, DC 20004-2901

Dear Mr. Chairman:

Thank you for your April 26, 2011, letter expressing concerns on the waste transfer system at the Hanford Tank Farms.

The enclosure to this letter responds to the specific issues raised in your letter and those of the associated staff issue report dated March 8, 2011. The briefing you requested is scheduled on August 2, 2011. The Department of Energy looks forward to working with you and your staff in this area as we revise the documented safety analysis and technical safety requirements for the Tank Farms to address your concerns.

If you have any further questions, please contact me or Mr. James Hutton, Acting Deputy Assistant Secretary, Office of Safety and Security Program, at (202) 586-5151.

Sincerely,

David Huizenga
Acting Assistant Secretary for
Environmental Management

Enclosure

ENCLOSURE

The Office of River Protection (ORP) Response to the Defense Nuclear Facilities Safety Board (Board) on the Review of the Waste Transfer System at the Hanford Tank Farms

In the response letter, ORP addresses the Board's concerns by the issues related to waste transfer system qualification, performance, testing, and maintenance as identified by the April 26, 2011, letter from the Board. Responses to the specific concerns are outlined below.

Board Issue #1: *"Weaknesses in the qualification process for certifying that the system can perform its safety function and therefore meet the requirements in the DSA."*

Hanford Tank Farms use of an Independent Qualified Registered Professional Engineer (IQRPE) assessment to qualify grandfathered waste transfer primary piping systems to the level of safety significant and its reliance on operating practices to provide assurance that these systems will perform its safety function.

Response: In regards to the Board's concerns of the Tank Operations Contractor (TOC) reliance on the IQRPE assessment report to provide adequate assurance that grandfathered waste transfer primary piping system can perform its safety function, ORP is initiating several actions to address IQRPE recommendations, in particular, collection of pipe corrosion data:

- The TOC will implement a formal process by the end of Fiscal Year (FY) 2012 to address and resolve IQRPE recommendations prior to the next assessment and address specific issues associated with waste transfer primary piping systems identified in tank farms system health reports maintained by the system engineering program. This process will require the issuance of a Problem Evaluation Request for each issue identified by the IQRPE or system health report.

- Implemented an erosion and corrosion evaluation program of waste transfer piping by:

  - Examination of carbon steel pipe sample sections of out-of-service supernatant lines SN-285 and SN-286[1] from 200 West 241-SY tank farm to determine and document the level of pitting, cracking, and other forms of degradation and corrosion to both the inside and outside pipe surfaces. Completion of this analysis will be in FY 2012.

  - Examination of carbon steel pipe sample section of out-of-service supernatant line SN-278 from the 200 West 241-SY farm to determine and document the level of pitting, cracking, and other forms of degradation and corrosion to both the inside

[1] LAB-PLN-10-00015, Rev. 0, *Test Plan and Procedure for the Corrosion Analysis of SN-285 and SN-286 Pipeline from SY Tank Farm*, Washington River Protection Solutions LLC, January 2011.

and outside pipe surfaces. The sample was sent to the 222-S laboratory. Test plan development and execution will be in FY 2012.

- Examination of stainless steel pipe sample sections of supernatant and slurry waste lines removed from portable valve box POR 104[2] located at the 200 East C Farm to determine and document the level of erosion on the inside surface of the pipe sections. Sample sections include elbow assemblies with an attached straight section of pipe. Completion of this analysis will be in FY 2012.

- Corrosion and erosion sensor placement test plan that will use flexible dry-coupled ultrasonic arrays that is intended to measure the wall thinning of pipe bends in portable valve box POR 104[3]. C Farm planned retrievals of supernatant and slurry from tanks 241- C-105, C-107, C-108, C-109, and C-110 through POR 104 will provide a quantitative measurement of erosion and corrosion in 90 degrees pipe bends. The sensors will be in place by the end of FY 2011.

Additionally, the Tank Farms Documented Safety Analysis (DSA) and Technical Safety Requirements (TSR) will be revised to remove the allowance for drip leakage. However, it will be recognized in the DSA that valve stem leakage is an anticipated and acceptable condition. The applicable event that could result from valve stem leakage is a flammable gas deflagration resulting from flammable gases generated by the waste leaked into a waste transfer-associated structure accumulating to a concentration above the lower flammability limit. To address this event, an in-service inspection requirement will be added to the TSR Design Feature for waste transfer primary piping systems to verify that physically connected waste transfer-associated structures do not contain waste sufficient to pose a flammable gas hazard during and/or following each waste transfer. This additional TSR level requirement for the safety-significant (SS) waste transfer primary piping system provides another barrier preventing flammable gas hazards in waste transfer-associated structures. Incorporation of this change in the safety basis documents will be initiated by the end of FY 2011.

The intent of these initiatives is to provide an increased level of assurance that the waste transfer primary piping system will continue to perform its intended safety function. In its evaluation for assessing performance criteria of grandfathered waste transfer piping systems for nuclear safety considerations beyond those attributes addressed by the IQRPE, ORP used direction contained in DOE-STD-3009 Section 4.4.X.4, System Evaluation, for assessing performance criteria on existing components/systems:

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[2] LAB-PLN-11-00005, Rev. 0, *Test Plan and Procedure for the Erosion Analysis of POR104 Valve Box Pipe from C-Tank Farm*, Washington River Protection Solutions LLC, March 2011.

[3] ARES Letter from M. A. White to R. S. Robinson, WRPS, "Washington River Protection Solutions, LLC, Subcontract 30519, Release 103 – Transmittal of Draft Corrosion Sensor Placement Letter Report – ARES Task No. 09054402.03," 11RL03098, dated March 9, 2011.

"Safety-significant SSCs, are not required to consider performance criteria traditionally associated with safety-class SSCs or traditional nuclear standards in general. Performance criteria for safety-significant SSCs should be representative of the general rigor associated with non-nuclear power reactor industrial and OSHA practices. Performance criteria for safety-significant SSCs are developed by DSA preparers using engineering judgment based on the expected functions for which it was designated a safety-significant SSC and its overall importance to safety.

Evaluate the capabilities of the SSC to meet performance criteria. The evaluation should be as simple as possible, and rely on engineering judgment, calculations, or performance tests as opposed to formal design reconstitution."

ORP concurred with the TOC recommendation in 2008[4] for using the performance criteria of Washington Administrative Code [WAC] 173-303-640, *Tank Systems*, in order to provide adequate assurance that waste transfer primary piping is leak-tight and, thus would protect the co-located and facility workers from the DSA analyzed accidents. The WAC performance criteria are designed to ensure leaks to the environment are prevented. The IQRPE assessment of the system is the documentation attesting that the WAC performance criteria are met and the system is fit for use for the permitting period (in this case from 2006 to 2016). While the IQRPE assessment covers more than the waste transfer primary piping system and considers both the design and previous operating practices in the assessment, the only conclusion relied upon by the DSA is that the current waste transfer piping system is leak-tight. ORP considered these performance criteria sufficient to provide assurance that the primary piping system meets its credited safety function of confinement of waste to prevent fine spray leaks and to prevent leaks that could result in waste accumulation in waste transfer-associated structures. An applicable design code acceptable for piping systems in the WAC is the American Society of Mechanical Engineers (ASME) Code B31.3, *Process Piping*. In order to maintain the operability of the waste transfer primary piping, the TSRs have identified in-service inspections and tests in addition to the periodic assessment by the IQRPE.

The design of waste transfer primary piping and jumpers installed after October 1, 2008, are required to meet the leak testing requirements of ASME Code B31.3, or the proof pressure testing requirements of American Society for Testing and Materials D380-94, *Standard Test Methods for Rubber Hose*, and Rubber Manufacturer's Association (RMA)-IP-2, *Hose Handbook*. The piping and jumpers installed after October 1, 2008, will also be subject to the in-service inspection requirement identified above.

Board Issue #2: *"Insufficient criteria and controls for identifying and responding to waste leakage, including downgrading the functional classification of the leak detection system from safety-significant to defense-in-depth."*

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[4] ORP Letter from S. J. Olinger to J. C. Fulton, CH2M HILL Hanford Group, Inc., "Approval of Safety Basis (SB) Amendment-045 for Safety-Significant Designation of Waste Transfer Primary Piping Systems Required by the Corrective Action for Judgment of Need ENG-4.1," 08-NSD-036, dated July 18, 2008.

Response: The Board staff has stated concerns on the current functional classification of the leak detection system as a defense-in-depth feature and that it should be reclassified to SS based on its ability to detect large volumes of waste leakage during waste transfer. Waste leakage can potentially result in three distinct hazards: large pipe breaks, fine spray leaks that produce a fine cloud of aerosol, and flammable gas deflagrations resulting from large volumes of waste buildup in waste transfer-associated structures over an extended period of time.

The unmitigated dose consequences of large pipe breaks, as documented in the DSA, are not a concern for the off-site and co-located receptors. In addition, waste leaks into waste transfer-associated structures are not a significant facility worker hazard since they are not normally occupied areas. (Note: Significant facility worker hazards [i.e., caustic burns] only result from waste leaks directly to the environment where the facility worker could be impacted [e.g., from unburied waste transfer piping, hose-in-hose transfer lines {HIHTL}] or from waste leaks due to misroutes, and leak detection is not an effective control for these hazards.) Therefore, no controls are required for large pipe break accidents into waste transfer-associated structures, although the safety-significant waste transfer primary piping systems and HIHTL primary hose assemblies selected for other accidents also address large pipe break accidents. Other large pipe break accidents (i.e., directly into the environment or due to misroutes) would receive no mitigation from leak detection since leak detectors would not be present. Also, leak detection is not an effective control for spray leaks since sprays producing a large fraction of respirable droplets would not pool to produce significant liquid quantities needed to activate the leak detection system. The current control strategy credits the waste transfer primary piping system, HIHTL primary hose assemblies, and double valve isolation thus providing adequate protection for the worst case spray leak.

As identified in the response to the Board's issue #1, an in-service inspection requirement will be added to the TSR Design Feature for waste transfer primary piping systems to verify that physically connected waste transfer-associated structures do not contain waste sufficient to pose a flammable gas hazard following waste transfers. This additional TSR level requirement for the SS waste transfer primary piping system provides another level of assurance that flammable gas hazards are prevented in waste transfer-associated structures.

Furthermore, the TOC commits to a new TSR level control that requires stopping waste transfers and evacuating personnel from the tank farms following a detected seismic event. Leak detectors would provide no frequency or consequence reduction for such an event since they would not be qualified to function in a waste transfer-associated structure during or following a seismic event. This new requirement will be identified as a TSR Administrative Control key element. Incorporation of these changes in the safety basis will be initiated in FY 2012.

Board Issue #3: *"Inadequately defined leak test requirements for the system."*

The Board raised a concern regarding the effectiveness of leak test requirements as a TSR control and recommends requirements for leak testing end and intermediate connections for HIHTL. Another concern was a lack of formal life-cycle qualification testing of SS isolation valves used in double valve isolation.

Response: Leak tests as currently defined in the TSRs for waste transfer primary piping systems in Section 6.1 will be revised to include all waste transfer primary piping systems and HIHTL primary hose assembly connections that are unmade and remade. Minimum leak test requirements will be added to the in-service inspection description in chapter 4 of the DSA for waste transfer primary piping systems and HIHTLs. Due to the many configurations, there are a number of acceptable methods, each with its own criteria. For instance, when the piping containing the connection can be isolated, a leak test at a minimum pressure can be used. The test could be with water or air (pneumatic). However, there are many cases where a leak test at pressure is not possible. In these cases, other methods and criteria will be specified (e.g., a specific volume of water at a minimum flow). Incorporation of this change in the safety basis will be initiated in FY 2012.

This revision to the DSA and TSR for in-service leak testing of remade mechanical connections draws upon good engineering practices. For newly installed components, hydrostatic leak testing in accordance with applicable ASME codes complies with this requirement. For those cases in which no code requirement exists, such as mechanical end or intermediate connections that are unmade and remade during normal operations, the current TSR requirement for waste transfer primary piping will be expanded to HIHTL to require an additional in-service leak test to confirm that leak tightness is maintained. TSRs will continue to require, for both waste transfer primary piping and HIHTL, that any visually detected leakage be corrected before a waste transfer.

The TOC has developed a formal test plan for performing life-cycle testing for SS isolation valves credited for double-valve isolation using waste stimulants representative of abrasive slurries as part of a planned improvement. The safety basis revision reflecting the test plan will be in FY 2012.

Board Issue #4: *"Deficiencies in the methodology for extending the service life of hose-in-hose transfer lines."*

The TOC plan for extending the current 3-year service life for HIHTL on the basis of calculated or measured exposures to specific temperatures, pressures, radiation, and chemicals, and that the service life extension methodology assuming radiation induced damage acting independently of thermal aging is not supported by published literature. The material lifetime under simultaneous elevated-temperature and high-radiation conditions could be shorter than the lifetimes estimated by considering each factor alone. Therefore, the contractor's service life extensions may not be based on conservative analysis. Also of concern was the technical basis supporting other polymer components that have no service life restrictions. Of particular interest are jumper connection gaskets fabricated from Teflon®, a polymer known to degrade readily in the presence of ionizing radiation. Hanford-specific operating experience with Teflon has not identified leaks or other problems that would accompany such degradation.

Response: The qualification of HIHTL design used for single-shell tank waste retrieval is described in RPP-6711 Rev. 3, *Evaluation of Hose-in-Hose Transfer Lines Service Life for*

Hanford's Interim Stabilization Program, Appendix L, BANDED (BAND-IT) and SWAGED Hose-in-Hose Transfer Line (HIHTL) Assembly, Service Life Verification Program. The service life of HIHTL is calculated using an empirical expression developed in order to extrapolate to temperatures and pressures of concern. The expression results in a service life for a given operating condition. Miner's Rule is then applied to calculate a cumulative damage (or service life remaining) with a 1500 psi burst pressure as the definition of end-of-life. The current allowable service life of tank farms HIHTL is for an equivalent of a maximum of 3 years of continual operation. The life extension process provides for a significant safety margin by requiring a burst pressure of 1500 psi (four times the design pressure of 375 psi and 3.5 times the design pressure of 425 psi) at end of life. The code requirement (RMA IP-2) only recommends a burst pressure of four times the design pressure for new hose qualification. The code requirement for new hoses is to account for degradation during operation. In addition, the design life calculated through the application of Miner's Rule is further reduced by a factor of 0.8 to provide additional margin.

Based on a literature search of polymer irradiation, it was not apparent that there is a significant difference in the extent of degradation when polymers are simultaneously, rather than sequentially exposed to both temperature and radiation. The lack of comparison data may be due to the inherent limitations typical of the irradiation facilities where the test specimen radiation exposure is delivered. Most of the irradiators used an intense source, and the exposure was completed in a matter of hours or less. It is, therefore, unlikely that synergistic effects on degradation of polymers resulting from an acute exposure can be detected. So far as can be determined, most high radiation exposure testing is conducted in this manner. In 2000, Sandia National Laboratories reported results from testing ethylene propylene diene monomer (EPDM) rubber in Hanford tank waste simulant.[5] Sample irradiation was performed at planned test temperatures; after irradiation the samples (dose exposures of 143, 286, 571, and 3670 krad of gamma radiation) were maintained at set temperatures of 64 – 140 °F for periods of 7, 14, 28, and 180 days. The synergistic effect of simultaneously accumulating an acute radiation exposure and elevated temperature was embedded in the experimental tests. The report concluded that EPDM rubber has excellent resistance to exposure of radiation, waste simulant, range of temperatures, and a combination of these factors. While the test conditions do not mimic Hanford tank farms operating environment for low radiation exposure levels and thermal aging effects, the report appears to indicate the durability of EPDM for the conditions tested.

The HIHTL qualification tests included a single burst test using 15 weight percent NaOH solution in place of water. While this sample burst at a lower pressure (~10 percent lower) than water samples aged under identical conditions, the report concluded that the effect of NaOH on the HIHTL was negligible based on the experimental uncertainty between similar tests.

The TOC reviewed the ability to perform post-mortem inspection and destructive examination of non-metallic materials previously in contact with tank waste and determined that worker exposure concerns would ultimately outweigh the benefits of such tests. In addition, the quality

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[5] SAND2000-0466, *Response of Ethylene Propylene Diene Monomer Rubber (EPDM) to Simulant Hanford Tank Waste*, Sandia National Laboratories, Albuquerque, NM, February 2000.

of test results based on limited ability to perform the post-mortem work on contaminated HIHTL in shielded facilities would do little to improve the basis for the service life. Furthermore, the exposure of existing HIHTL to radiation, temperature, and tank waste has not been accurately measured, thus any data gathered from post-mortem inspections could not be adequately correlated with exposure level.

However, ORP recognizes the value in further enhancing the technical basis for extending the service life of the HIHTL. In the absence of published data for subjecting monomers/polymers to low intensity radiation and thermal aging effects on material properties, the TOC will develop a test plan outlining a well-designed set of experiments that closely resembles the irregular/occasional or episodic exposure to Hanford tank farms low dose rate radiation, waste chemistry, and temperatures on commonly used non-metallic materials (e.g., HIHTL EPDM rubber, Teflon, and other commonly used polymers and elastomers) to enhance the basis for assessing service. This testing will be identified in the DSA as a planned improvement. Incorporation of this change in the safety basis will be initiated by the end of FY 2011.

Board Issue #5: "*The absence of credited safety controls (in lieu of reliance on multiple layers of defense-in-depth controls and frequency arguments) for particular hazards associated with the waste transfer system.*"

Response: The Tank Farms DSA has relied on multiple layers of defense-in-depth and frequency arguments to demonstrate an acceptable level of risk for some hazards that require consideration of safety-significant/TSR-level controls. To enhance the safety posture, revisions will be made to the DSA and TSR for the following events that exceed control evaluation criteria or for conditions for which the safety-significant structure, system, or component is not qualified:

1. Pump seal failure: This will be addressed by the new in-service inspection requirement identified for waste transfer-associated structure inspection during and/or following a waste transfer.

2. Seismic induced gas release event: This will be addressed by a TSR Administrative Control key element to evacuate following a detected seismic event.

3. Failure of waste transfer system components (i.e., primary piping system, HIHTL, isolation valves for double valve isolation, pressure relief devices) during waste transfers for which the components are not qualified as identified in chapter 4 of the DSA: A new key element of a TSR Administrative Control will be established to terminate the transfer in response to identified off normal events.

The safety basis implementation will be completed in FY 2012.