Department of Energy

Washington, DC 20585

November 16, 2011

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

Dear Mr. Chairman:

This letter responds to your September 13, 2011, letter regarding ammonia hazards at the Hanford Site Waste Treatment and Immobilization Plant (WTP). Your letter expressed the Defense Nuclear Facilities Safety Board's (Board) concerns that the ammonia system controls, as currently designed, may not adequately protect workers or other WTP facilities; and therefore, asked for a report addressing those concerns. The report you requested is enclosed.

The Department of Energy (DOE) also evaluated the existing hazards and accident analyses. Based on that review, DOE concurs with the Board that additional hazards and accident analyses are needed regarding Balance of Facility (BOF) interactions with other facilities (including potential ammonia reactions), main control room habitability (including viability of the carbon bed filters), and potential tanker truck events.

These analyses will result in generation of hazards analysis reports and in the development of new or revised accident calculations, which will be included in the design criteria. The results from these analysis efforts will be included in the overall facility's hazards analysis report to ensure an integrated approach to control selection. Any resulting changes in functional and performance requirements will be provided to the appropriate project engineering groups as updated safety functions and functional requirements.

As part of the hazards analyses for BOF interaction effects and control room habitability, the seismic rating of the ammonia vessels for safety class functions will be re-evaluated. This re-evaluation will consider whether the current rating of the vessels is adequate or needs to be revised based upon potential impairment to facilities or functions that could lead to radiological releases and resultant public doses that challenge project evaluation guidelines. A more detailed response to the specific issues identified in the report transmitted with your letter is enclosed.

If you have any further questions, please contact me or Mr. Matthew Moury, Deputy Assistant Secretary for Safety and Security Program, at (202) 586-5151.

Sincerely,

David Huizenga
Acting Assistant Secretary for
Environmental Management

Enclosure

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ENCLOSURE

WASTE TREATMENT AND IMMOBILIZATION PROJECT RESPONSE TO THE DEFENSE NUCLEAR FACILITIES SAFETY BOARD DESIGN OF AMMONIA CONTROLS

1. Background

The High Level Waste and Low Activity Waste (LAW) Facilities' melters are designed to control oxides of nitrogen (NO_x) emissions using a selective catalytic reduction operation using anhydrous ammonia. Anhydrous ammonia will be stored as a pressurized liquid in two outdoor 6,000-gallon vessels. The vessels will be refilled periodically from tanker trucks, which will also contain ammonia as a pressurized liquid.

As currently postulated, breaches in an anhydrous ammonia storage vessel or tanker truck confinement could result in high-pressure releases of a concentrated plume with the potential for vapor cloud explosions. High concentrations of ammonia could pose a toxicity hazard to workers or potentially affect operability of safety structures systems and components (SSCs) (i.e. operations of emergency turbine generators). Furthermore, the main control room (MCR) operators are relied on to perform safety-related functions in response to emergencies. Thus, controls have been designed to protect them from conditions (such as toxic levels of ammonia) that could prevent performance of credited safety functions when needed. Currently defined ammonia controls for the MCR include carbon bed filters in the intake ventilation system. The ammonia tanks were also designed to preclude fragmentation, eliminating the potential for missiles as another means of interactions among Waste Treatment and Immobilization Plant (WTP) facilities.

Because the ammonia system will contain more than 10,000 pounds of anhydrous ammonia, it will be required to conform to the Department of Labor, Occupational Safety and Health Administration Process Safety Management (PSM) standard (29 CFR 1910.119). This comprehensive standard contains 14 key management system elements addressing design, hazard analysis, operator training, pre-startup testing, operation, and emergency planning. The ammonia system will be required to comply with the Environmental Protection Agency hazardous chemical Risk Management Program rule (40 CFR 68). It includes all of the PSM elements and adds requirements for plume analysis of a "worst case" and "alternate analysis" release.

2. Hazards and Accident Analysis Plan

The following discrete hazards and accident analyses efforts will be completed by January 1, 2013.

1. Balance of Facility (BOF) interactions with other facilities;
2. MCR habitability; and
3. Transportation.

Each of these hazards analyses will systematically evaluate all potential hazards, including those associated with ammonia vessels and tanker trucks. This will ensure optimal control development, which considers the potential for simultaneous impacts from multiple hazards, control interactions (i.e., competing safety concerns), and control interfaces (e.g., certain controls may be selected due to coverage of multiple safety systems). These hazards analyses efforts will ultimately be folded into the appropriate facility hazards analysis reports and corresponding Preliminary Documented Safety Analysis (PDSA) volumes, as well as the final DSA, once developed.

Calculation 24590-WTP-Z0C-W14T-00023, *Main Control Room Concentrations of Chemicals due to Releases from Transportation, Process, and Storage Accidents,* which develops performance criteria for the carbon bed design, will be revised to reflect adoption of 15-minute wind speed data (Section 3.1). An evaluation of the MCR ventilation system safety margin will occur after the MCR habitability hazards analysis has been completed.

The following documents will be generated or revised:

- Hazards Analysis (HA) Report that addresses interactions between BOF facilities (including ammonia vessels) and other Waste Treatment and Immobilization Plant (WTP) facilities (Section 3.2).
- HA Report that addresses control room habitability (Section 3.3).
- HA Report that addresses on-site transportation events involving an ammonia tanker truck (Section 3.4).
- Revision to 24590-WTP-Z0C-W14T-00023, "*Main Control Room Concentrations of Chemicals due to Releases from Transportation, Process, and Storage Accidents.*"
- Revision to 24590-WTP-BOF-Z0C-W14T-00001, "*Impact on Emergency Diesel Generator Operation following a Postulated Release from the Liquid Carbon Dioxide and Anhydrous Ammonia Storage Vessels,*" (will also address changes to the use of turbine generators).

To ensure all assumptions are technically justified, development of supporting engineering calculations may be required covering topics such as: 1) ammonia vapor cloud explosions; 2) corrosive effects of ammonia; 3) emergency generator operability as a function of ammonia concentration; 4) carbon bed pre-loading (as a function of humidity, contaminants, dust, ambient chemicals, etc.); and 5) potential carbon bed breakthrough with high ammonia challenge concentrations.

2.1 Preliminary Wind Speed Evaluation for Ammonia Releases

Calculation 24590-WTP-Z0C-W14T-00023 employs a puff-plume model to evaluate airborne ammonia dispersion using 10 years of hourly-averaged meteorological data obtained from the Hanford Weather Station (HWS). The Defense Nuclear Facilities Safety Board (Board) noted in its letter that because the ammonia puff duration is short, the wind speed

determined from hourly data may not be appropriate. To address this issue, the WTP has obtained 15-minute data for the last 10 years from the HWS and has determined the associated fifth percentile wind speeds. WTP has compared the 15-minute average wind speeds with those that had been based on hourly data. The results of this comparison for selected locations where ammonia releases could occur are shown in Table 1.

Table 1: Comparison of 10 Years of Hourly and 15-Minute Wind Speeds

	Fifth Percentile Wind Speed ($m \cdot s^{-1}$)	
Location	**Hourly Data**	**15-min Data**
NH_3 Tanks[(a)]	0.4	0.80
NH_3 Unloading Station	0.4	0.80
Loop and B Roads	0.9	0.89
Loop and Parking 51	0.4	0.63
Loop and Parking 52	0.4	0.63
Loop and N Roads	0.4	0.85
Loop and L Roads	0.4	0.85
P Road and Visitor Parking Lot[(b)]	0.4	0.67
Main Parking Lot	0.4	0.74
Reagent Gate	0.9	1.12

Notes:
(a) Anhydrous ammonia storage vessels
(b) Most limiting transportation accident location

As can be seen, in all but one minor case, the 15-minute data yielded higher fifth percentile wind speeds, indicating that the original use of the hourly data was conservative and the one exception is on the order of a one percent difference. Because the ammonia puff release is a short-duration event, use of the 15-minute data is the more technically correct approach. Consequently, a forthcoming revision to the MCR habitability calculation 24590-WTP-Z0C-W14T-00023 will use the 15-minute Hanford 200 East Area meteorological data wind speeds for the short-term puff portion of the release. For the longer-term plume portion of an ammonia release, the hourly-averaged data will continue to be used.

The HWS determines hourly data by calculating a vector rather than a scalar average of the four 15-minute intervals in the hour, rounding the result to the nearest mile per hour. The effect of this can be seen in the cumulative distribution curve shown in Figure 1, where the rounded hourly data produces a jagged step curve that results in lower wind speeds than the smooth curve produced by the15-minute data, and explains why data yields higher wind speeds.

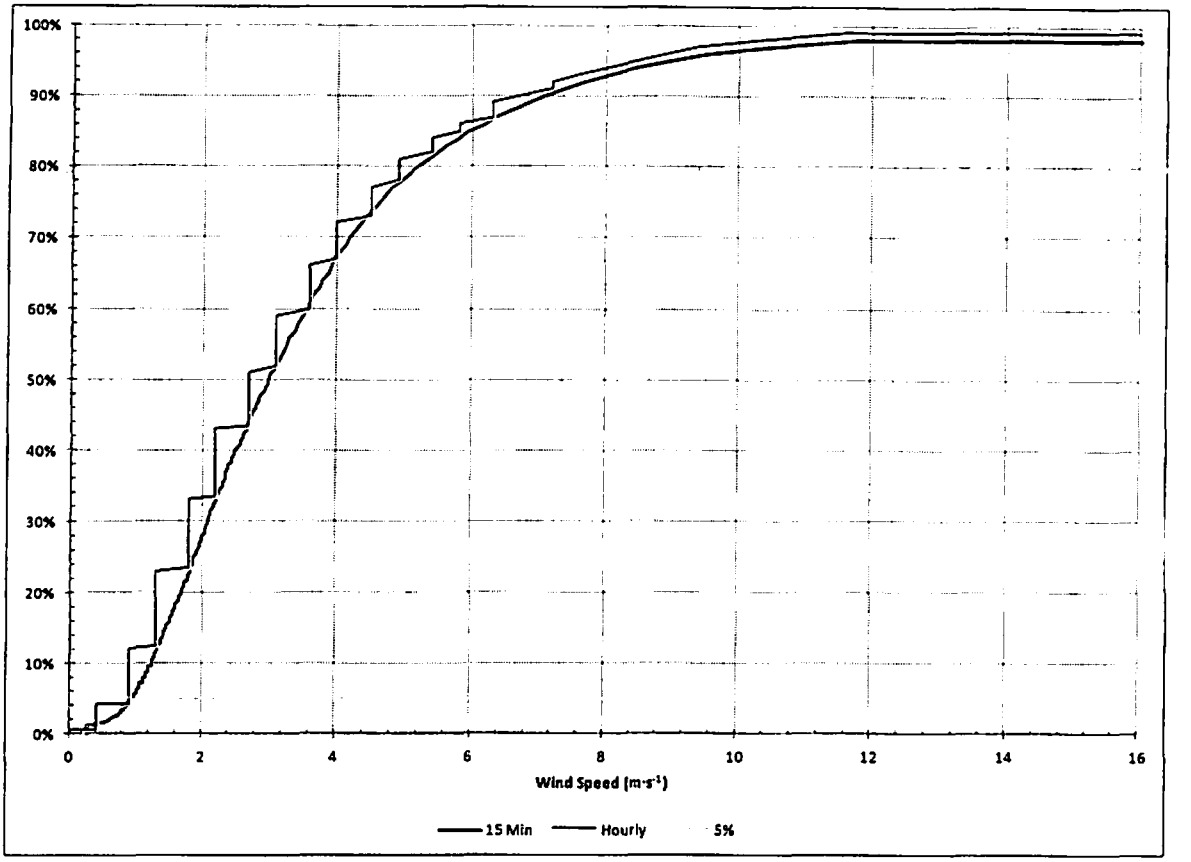

Figure 1: 2001 to 2010 Wind Speed Cumulative Distribution

2.2 BOF Interactions Hazard and Accident Analysis

24590-BOF-SIPD-ENS-05-0003, *CSDs for BOF System AMR* documents a hazards analysis for the ammonia storage vessels. It includes potential impacts from a vessel failure with safety class (SC) and safety significant (SS) SSCs at other WTP facilities. Early input from the process resulted in the re-siting of the ammonia storage tanks to the extreme southeast WTP boundary to maximize distances (reduce potential pressure wave impacts to some facilities). However, the re-siting was not deemed adequate for controlling the missile hazard. Thus, controls were implemented to reduce the likelihood of missiles from vessel fragmentation. The controls require the material properties and fabrication to preclude low temperature brittle fracture.

Potential exposures of the public, facility workers, and co-located workers to airborne ammonia from the bounding release were evaluated. Preventive and mitigative controls were established to prevent large ammonia releases (e.g., level controls during filling, vaporizer pressure interlocks, vessel emissivity requirements, pressure relief to prevent catastrophic failure due to over-pressurization). These controls also protect SS SSCs at other facilities from high ammonia concentrations. Ammonia impacts will be reexamined as part of the systematic, comprehensive BOF interactions hazards and accident analysis. This HA will include an evaluation of effects on other facilities from possible energetic reactions (e.g., vapor cloud explosions, missiles from pressurized releases), potential corrosive effects from

high airborne concentrations of ammonia, and damage to the emergency generators due to high ammonia concentrations. It will build on previous efforts captured in the PDSA, 24590-WTP-BOF-Z0C-W14T-00001, and 24590-WTP-Z0C-W14T-00023. The efficacy of the existing controls will be evaluated and additional or replacement controls developed if needed. The MCR habitability analysis will be covered in a separate, discrete HA effort (see Section 2.3).

2.3 Main Control Room Habitability Hazards Analysis

Evaluation of ammonia impacts on main control room habitability is addressed in 24590-WTP-Z0C-W14T-00023, *Main Control Room Concentrations of Chemicals due to Releases from Transportation, Process, and Storage Accidents*. Based on this calculation, carbon bed filters were identified as a potential means of protecting MCR occupants from large-scale ammonia releases, to comply with Safety Criterion 4.3-7 of the Safety Requirements Document (SRD).

However, ammonia impacts on MCR habitability will be re-examined via a systematic hazards and accident analysis. The hazards and accident analysis will assume an initial carbon bed loading of contaminants based on: 1) the carbon bed design; 2) bounding operational airborne contaminants and humidity and carbon bed loading rates; and 3) sampling and change out criteria. The hazards and accident analysis will also investigate the potential for carbon bed breakthrough under challenge by high ammonia concentrations. The results of the analyses will be used to derive the necessary controls.

Sampling and change-out criteria are integral to the carbon bed control because all designs have a limited capacity. Over a 40-year life-span, any carbon filter should be assumed compromised after some duration, and thus, unable to adequately perform its functional requirement of removing ammonia vapors. Thus, the assumed initial bed loading must be based on a reasonable sampling and analysis protocol to verify the carbon media's functional capability. The assumed protocol will become part of the MCR Ventilation Operability technical safety requirement(s). It will be based on common industry practice (such as Nuclear Regulatory Commission Guide 1.52). A preliminary vendor estimate indicates the carbon bed, as currently designed, would need replacement every six months due to contaminant loading from background emissions.

The reevaluation of control room habitability may result in a change in carbon bed functional and performance requirements. Engineering will be notified of such changes to redesign the carbon beds and ventilation system.

The hazards and accident analysis will be used to describe the safety margin given revised ammonia concentration determinations, initial loading assumptions, change-out protocols, and the carbon bed design.

2.4 Ammonia Tanker Truck Hazards Analysis

The impacts from an ammonia tanker truck hazards will be examined via a systematic hazards and accident analysis. This effort will be part of a broader evaluation of transportation hazards, which has been identified as an area requiring further development in a "Project Issues Evaluation Report" (PIER) (24590-WTP-PIER-MGT-08-2206).

In response to this PIER, a plan was developed to conduct a comprehensive hazards analysis for transportation-related events, including ammonia tanker trucks traveling on or near the WTP site. This plan is documented in 24590-WTP-PL-ENS-11-0006, *WTP Transportation Hazard Analysis Preparation Plan.*

The hazards analysis of postulated transportation events in the balance of facilities will include information from the Department of Transportation program (as appropriate) in the analysis and control selection.

2.5 Seismic Hazards

The Board stated concerns regarding the current seismic categorization of the ammonia storage vessels related to facility worker protection as prescribed in 10 CFR 851, *Worker Safety and Health Program,* and Department of Energy (DOE) Order (O) 420.1B, *Facility Safety.*

The Safety Requirements Document (SRD) provides the DOE approved approach for development of natural phenomenon hazard (NPH) design criteria for worker protection from chemical hazards (24590-WTP-SRD-ESH-01-001-02). The SRD is specified in Standard 7 of the WTP Contract (DE-AC27-01RV14136) as containing the DOE approved set of tailored requirements for WTP.

The SRD contains the formal documentation of requirements and standards related to classification of systems as safety versus non-safety, functional classification of safety systems as safety class (SC) or safety significant (SS), and the NPH design requirements of safety SSCs based on both their functional classification and their NPH-related safety functions.

Consistent with Appendix A of the SRD, SSCs determined by safety analysis to perform a preventive or mitigative function necessary to limit the chemical consequences from an event that exceed worker or public exposure standards in Safety Criterion 2.0-2 are assigned a SS classification. Therefore, for worker safety considerations, the ammonia vessels are functionally classified as SS for the seismic safety function of providing confinement during an earthquake to prevent chemical exposures that exceed established guidelines. SC functional classifications are reserved for protection of the public against radiological doses beyond the site boundary.

Safety Criterion 4.1-3 of the SRD requires Safety SSCs be designed to withstand the effects of NPH events (including a seismic event). The SRD adheres to DOE-STD-1020-94

(Change 1, 1996), as tailored in SRD Appendix C. The NPH design criteria in DOE-STD-1020-94 provide the means of implementing DOE Order 420.1 (and associated Implementation Guides, and Executive Orders 12699 and 12941 for earthquakes). SRD Safety Criterion 4.1-3 stipulates that SS SSCs with a seismic safety function be assigned a seismic classification of SC-III (equivalent to Performance Category-2). This classification is consistent with WTP facilities that have similar chemical hazards (e.g., the LAW facility, which establishes the building structure and melter off-gas systems as SS, SC-III based on the potential consequences of NO_x and ammonia chemical hazards.) Some WTP facilities are designed to the more stringent SC-I criteria because the safety function relates to protecting the public from radiological doses (not chemical exposures).

10 CFR §851.21(a)(8) provides upper tier design requirements which requires consideration of "*interaction between workplace hazards and other hazards such as radiological hazards.*" WTP accomplishes this specific requirement according to processes described in the following procedures, which are compliant with the SRD criteria described above:

- Accident Analysis (24590-WTP-GPP-SANA-001); and
- Hazard Analysis, Development of Hazard Control Strategies, and Identification of Standards (24590-WTP-GPP-SANA-002)

The updated hazards analysis described in Sections 3.3 and 3.4 has the potential to impact the final seismic category of the ammonia storage vessels, as discussed below.

The revisited hazards analyses (described in Sections 2.3 and 2.4) will address the seismic rating of the ammonia vessels for any safety class, safety functions identified. In accordance with the SRD, safety class is the only functional classification that drives SC-I categorization for seismic-related safety functions, and is reserved for public protection from radiological events (directly or indirectly caused). WTP will reevaluate whether the SC-III rating of the vessels is adequate or needs to be revised because of potential releases that could drive safety class functional classification, including protection of control room operators who may have SC functions to perform. This reevaluation will occur in concert with engineering groups as part of the hazards analysis processes described above.

2.6 Conclusion

WTP agrees with the Board's position that the hazards and accident analyses relate to ammonia need to be updated and expanded as part of the ongoing process of final design completion and the development of the DSA for the facilities as outlined above.

DOE will continue to address the commitments in this response, and is fully committed to the safe operations of the WTP, and the protection of the workers, the public, and the environment.