DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Washington, DC 20004-2901

November 8, 2013

Mr. David Huizenga
Senior Advisor for Environmental Management
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-0113

Dear Mr. Huizenga:

The Defense Nuclear Facilities Safety Board (Board) issues project letters in advance of major project milestones to assist the Department of Energy (DOE) in evaluating the readiness of a project to move forward. This project letter and its enclosure summarize the Board's understanding of the status and safety posture of the Transuranic Waste Processing Center Sludge Processing Facility Buildouts (SL-PFB) project at Oak Ridge National Laboratory at the completion of conceptual design. The Board's review of the SL-PFB conceptual design and Safety Design Strategy identified no safety issues that would preclude the project from advancing to the next design stage (preliminary design).

The SL-PFB project team identified several risks to the project related to nuclear safety, including various accident analysis parameters and assumptions, as well as functional classification and seismic design of new and existing structures, systems, and components required for protection of the public and workers. Additionally, the Board's staff identified three concerns that the project team agreed to address during preliminary design. Expeditious resolution of these risks and safety concerns early in the preliminary design phase is necessary to ensure the early integration of safety into the design of the SL-PFB. The enclosure to this letter is included for your use and information, as appropriate. It provides further detail on the risks and safety concerns noted above. The Board will continue to follow DOE's efforts to address these items as the SL-PFB project proceeds through preliminary design.

Sincerely,

Peter S. Winokur, Ph.D.
Chairman

Enclosure

c: Mrs. Mari-Jo Campagnone

Enclosure

Summary of Transuranic Waste Processing Center Sludge Processing Facility Buildouts Project and Related Issues

Background. The Transuranic Waste Processing Center (TWPC) Sludge Processing Facility Buildouts (SL-PFB) project is a major modification to the existing TWPC, a Hazard Category 2 nuclear facility located at Oak Ridge National Laboratory (ORNL). The TWPC is located approximately one kilometer from the ORNL site boundary. The SL-PFB will transfer 2,000 m^3 of sludge and supernate from the Melton Valley Storage Tanks (MVSTs) to a new annex of the TWPC for characterization and solidification. The solidified sludge will be disposed as low-level waste at the Nevada National Security Site (NNSS).

The SL-PFB design contractor, Wastren Advantage, Inc. (WAI), submitted the project's Safety Design Strategy (SDS) to the Department of Energy (DOE) Oak Ridge Office of Environmental Management (OREM) on January 31, 2013. OREM approved the SDS on March 29, 2013. In addition to the SDS and OREM's approval letter, the staff reviewed the project's Preliminary Hazard Analysis Report and other supporting documents.

Design of the SL-PFB. The design of the SL-PFB consists of four primary process steps: (1) sludge mobilization, (2) mixing and characterization, (3) solidification and stabilization, and (4) packaging and shipping. The Sludge Mobilization System will add jet mixers to the MVSTs and use water or supernate to mobilize the sludge (e.g., diluted from approximately 25 weight percent suspended solids to approximately 5 weight percent) for transfer out of the tanks. A transfer line will carry the mobilized sludge to the Sludge Solidification Center, a new annex of the TWPC that will house the characterization, stabilization, and packaging processes. The Sludge Mixing and Characterization Tanks, currently planned to be a set of three 28,000-gallon tanks with mechanical mixers, will receive the mobilized sludge and homogeneously mix it for sampling and characterization. After characterization, the Solidification and Stabilization System will receive the mobilized sludge. In-line continuous mixers will add stabilizers and grout to form a solid waste product. The grouted waste will be added directly to carbon steel waste cask liners, and an overhead crane will place the liners in custom Department of Transportation Type A shipping casks for shipment to the NNSS.

Safety Strategy of the SL-PFB. The primary radiological hazard associated with the SL-PFB is alpha-emitting radionuclides in the MVST sludge waste. The SL-PFB project team conducted a Preliminary Hazard Analysis and identified a set of Design Basis Accidents (DBAs). The DBAs are grouped into two release mechanisms: spray releases and spill releases. Based on the results of the Preliminary Hazard Analysis and analysis of the DBAs, the SL-PFB project team identified a set of potential safety-class and safety-significant controls. It should be noted that the TWPC's proximity to the site boundary contributes to the need to credit safety-class controls for the protection of the public. Structures, systems, and components (SSCs) credited as safety-class in the SL-PFB SDS include the following:

- Active pump high pressure protection to prevent high pressure conditions in piping and minimize spray and spill releases;
- Seismic detection and shut off to minimize releases during seismically initiated spray release and spill events;
- Integrity of elevated piping in the Sludge Solidification Center to provide confinement of liquids;
- Integrity of elevated piping in the transfer system to provide primary (transfer pipe) and secondary (double wall pipe) confinement of liquids;
- Leak detection in the annulus of double wall transfer pipe to minimize releases; and
- Leak detection for the MVST vault and the existing TWPC Process Building to minimize releases (OREM's SDS approval letter instructed WAI to classify these SSCs as safety-class).

SSCs credited as safety-significant in the SL-PFB SDS include the following:

- Vaults, tanks, piping, valve galleries, and valve boxes to provide confinement of liquids;
- Active confinement ventilation, ventilation housings, vault and facility structures, and backup power to provide confinement of airborne material;
- Valves and piping to prevent inadvertent transfer of waste;
- Vehicle impact protection to prevent damage to transfer piping; and
- Vault leak detection to minimize releases.

Risks to the Project. The TWPC SL-PFB team identified risks to the project to be resolved during the preliminary design. Among these risks are several technical issues related to nuclear safety, including three risks related to accident analysis parameters and assumptions (atmospheric dispersion analysis, spray release analysis, and damage ratio for vessel spills), and the functional classification and seismic design of existing SSCs. Details regarding these risks are provided below.

Atmospheric Dispersion Analysis—In the December 2012 letter establishing Safety-in-Design goals for the SL-PFB project, OREM directed WAI to calculate off-site consequences "without regards to plume depletion and surface deposition of airborne materials in calculations used (i.e., consistent with NRC Regulatory Guide 1.145)" until site-specific atmospheric dispersion modeling is completed. In a preliminary review of this approach, the Board's staff review team identified potential concerns with the project's analysis (e.g., selection of minimum wind speed and atmospheric stability class). As part of a separate effort, URS CH2M Oak Ridge (UCOR), another ORNL site contractor, developed a site-specific approach for atmospheric dispersion analysis recommended for use at ORNL. In June 2013, OREM provided direction to WAI to either follow the approach outlined by UCOR for dispersion modeling, or follow an alternative approach using UCOR-recommended values for surface roughness, stability class, minimum wind speed, and deposition velocity. According to information provided to the Board's staff review team in June 2013, initial scoping calculations by WAI indicated that employing UCOR's approach could increase the calculated off-site dose consequences for accidents in the SL-PFB by a factor of 2.6. WAI noted in the SL-PFB SDS that if site-specific modeling results in a more conservative dispersion analysis, it could drive changes to functional

classifications and seismic design categories of affected SSCs. Among the Guiding Principles of DOE Standard 1189, *Integration of Safety into the Design Process*, is that "important safety functions ... and associated seismic design bases are addressed during conceptual design." It is therefore important that the SL-PFB project develop and implement a defensible approach to atmospheric dispersion analysis as soon as practicable to support early integration of safety into the design.

Spray Release Analysis—WAI did not perform a project-specific analysis of spray releases for use during the conceptual design stage, but instead performed a qualitative comparison to spray releases analyzed for the Hanford Tank Farms. From this qualitative analysis, WAI identified the need for safety-class controls to protect the public from high pressure spray releases. OREM directed WAI to develop a site-specific methodology for selecting defensible airborne release fractions and respirable fractions for spray release accidents. OREM and WAI consulted with Pacific Northwest National Laboratory (PNNL) to discuss implementation of the results of PNNL's spray release testing. DOE initiated testing at PNNL to develop a defensible basis for modeling spray release events in response to an April 5, 2011, Board letter on spray release modeling at the Waste Treatment and Immobilization Plant. WAI and OREM believe that PNNL's correlations will produce defensible airborne release fractions and respirable fractions for spray release accidents for the SL-PFB. Based on a preliminary analysis using draft results from PNNL, WAI found that offsite doses from spray releases will likely exceed 5 rem Total Effective Dose (TED) and therefore require consideration of safety-class controls in accordance with DOE Standard 1189. As noted above, WAI conservatively identified safety-class controls for high pressure spray accidents. As the project moves forward, the use of technically defensible spray release analysis will be needed to ensure controls are appropriately designed to perform their safety functions as required by DOE Order 420.1B, *Facility Safety*.

Damage Ratio for Vessel Spills—For analysis of accidents involving vessel spills, WAI assumed a damage ratio of 25 percent (i.e., 25 percent of the vessel contents are impacted by the accident and available to contribute to an airborne release of radioactive material). This assumption is employed in the documented safety analyses of other ORNL facilities; however, it lacks a defensible technical basis. Without a technical basis, the project cannot confirm that the functional and seismic classifications of related SSCs are adequate for vessel spill accidents.

Functional Classification and Seismic Design of Existing Structures, Systems, and Components—The conceptual design of the SL-PFB relies on several SSCs from the existing TWPC and other Oak Ridge facilities. The Preliminary Hazard Analysis credits various existing SSCs as safety-significant, and assigns seismic design categories 2 and 3 to several existing SSCs. However, many of these SSCs do not currently perform safety functions and were not designed or procured to meet the seismic design categories assigned them in the SDS. Appendix A of DOE Standard 1189 provides guidance for application of seismic design classification and collocated worker safety-significant criteria to major modifications of existing facilities. In particular, the standard discusses the need to perform "backfit" analyses to determine "(1) the need to upgrade interfacing structures, systems, and components in accordance with these criteria; and (2) whether there should be relief for the modification from the design requirements that application of these criteria in design would imply." WAI indicated it would perform and

submit to OREM backfit analyses for existing SSCs that identify the gaps between their current capabilities and design criteria for new facility designs. If the backfit analyses reveal significant gaps, the SL-PFB project team may have to upgrade the SSCs, modify the design to include additional SSCs, or seek relief from the design requirements from DOE.

Staff Concerns and Project Responses. The staff team's review of the SL-PFB SDS and supporting documentation identified the following concerns. The team discussed these concerns with WAI and OREM during its review, as well as strategies to resolve each of the concerns as described below.

Selection of Respirable Fraction for Free-Fall Spills of Slurries—In the SDS, the project stated its intent to use bounding airborne release fractions and respirable fractions from DOE Handbook 3010, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, for calculating dose consequences. However, the staff noted that the project used a respirable fraction for free-fall spills of slurries (this represents accidents involving pipe or tank ruptures and subsequent spills) that did not match the bounding value provided in DOE Handbook 3010, contrary to the intent of the SDS. For spill heights less than 3 meters, the project used a respirable fraction of 0.7 instead of 0.8. When compounded with uncertainty in the damage ratio for spills and the atmospheric dispersion analysis, this increase in respirable fraction could lead to changes in functional and seismic classifications of SSCs. During a video teleconference with members of the Board's staff, the project committed to using the bounding value contained in DOE Handbook 3010, consistent with the intent of the SDS. The project indicated that the change will be reflected in future revisions of the SDS, and be incorporated in future safety analyses.

Assignment of Seismic Design Category—In the SDS, the project indicated that it would assign seismic design categories (SDCs) to safety SSCs in accordance with Table A-1 of DOE Standard 1189. WAI identified as a design basis accident a seismic event concurrent with a waste transfer into the affected tank. The radiological consequences to the collocated worker for this combined event exceeds 100 rem TED. Above this threshold, DOE Standard 1189 recommends the identification of SDC-3 controls. WAI, however, identified SDC-2 SSCs for the event. During a video teleconference with members of the Board's staff, the project committed to identify SDC-3 SSCs for this accident in future revisions of the SDS and hazard analyses.

Analysis of Vessel or Pipe Detonation Events—The project analyzed hydrogen gas deflagrations in various vessels and pipes as part of the Preliminary Hazard Analysis. Dose consequences of these events were bounded by those for spills and sprays, in part because WAI assumed the components maintained integrity following the deflagration. WAI did not analyze the potential for detonation events in these same vessels and pipes, nor did they analyze the potential for deflagrations to fail the confinement boundary. During a video teleconference with members of the Board's staff, WAI indicated it has initiated analyses to address these scenarios and will incorporate the results into future revisions of the SDS and hazard analyses. Analysis of these scenarios could lead to identification of additional safety related SSCs.