Department of Energy
Washington, DC 20585

March 29, 2010

The Honorable John E. Mansfield
Vice Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, NW
Suite 700
Washington, DC 20004-2901

Dear Vice Chairman:

This is in response to your December 2, 2009, letter requesting that the Department of Energy (DOE) provide a report presenting its assessment of the issues associated with existing designs of Waste Treatment Plant (WTP) facilities described in the enclosure with your letter. The enclosure to this letter is the initial response for each issue.

The WTP project will prepare calculations which will demonstrate that as-built conditions will provide acceptable design margins in accordance with applicable codes. The Office of River Protection (ORP) will also provide these calculations to your staff for their review as they are completed and continue a technical dialogue with you as the Project develops these calculations to ensure that they address the Board staff comments.

In addition, you requested that the Board be kept apprised of the status of the Peer Review Team (PRT) efforts through a list of issues developed, and their status and resolution until all issues have been resolved. The PRT is a key element in our oversight efforts and will continue to assist ORP efforts in closing these issues.

As a result of recent discussions between ORP, the contractor and your staff, we received additional comments on our approach. Consequently DOE agreed to modify its analysis approach. DOE and staff also mutually agreed that a face-to-face discussion would further ensure our intended analysis will address the Board's underlying concerns. Accordingly, we now intend to complete our analysis and provide it to the Board by May 31, 2010.

If you have any questions, please contact me at (202) 586-7709 or Dr. Steven L. Krahn, Deputy Assistant Secretary for Safety and Security Program at (202) 586-5151.

Sincerely,

Inés R. Triay
Assistant Secretary for
Environmental Management

Enclosure

cc: D. Chung, EM-2
F. Marcinowski, EM-3
S. Krahn, EM-20
M. Whitaker, HS-1.1
S. J. Olinger, ORP
G. A. Girard, ORP

ENCLOSURE

ISSUE DEFINITION AND RESPONSE

Out of Phase Motion:

Based on the input response of the High-Level Waste (HLW) superstructure motion, anchorages do not appear to act as a rigid body in the vertical direction. The motion of the support points in the vertical direction is out-of-phase throughout most of the seismic time history. This behavior results in deformation effects not addressed in the Response Spectrum Analysis (RSA), and if significant, needs to be considered in the analysis. Information regarding Pretreatment (PT) ought to be developed and similarly reviewed.

Response:

In the response spectrum analysis of the HLW and PT PC-3 steel structures, the input spectrum for all three directions is an envelope spectrum of all point of contacts between the steel structure and the concrete structure obtained from the System for Analysis of Soil Structure Interaction (SASSI) analyses of the respective buildings. The enveloping spectra represent conservative seismic input, but the RSA approach does not allow consideration of out-of-phase vertical motion of the support points. To respond to this issue, the seismic member forces for steel structures from the full 3D SASSI model (which include the effect of out-of-phase motion, as well as any inter-story relative displacement) were obtained and compared with the corresponding member forces from the RSA. The RSA forces were generally much higher than the SASSI member forces, which included the out-of-phase motions, supporting the conclusion that out-of-phase effects are enveloped. The results and comparison from this evaluation are documented in calculation 24590-HLW-S0C-S15T-00229 and 24590-PTF-S0C-S15T-00062. These calculations show that the forces used for design are controlled by the RSA results.

The Peer Review Team (PRT) has reviewed and commented on the calculations, and in particular, on the modifications that address the out-of-phase issue and concur with the results, with the exception of some minor points. No further actions, other than to provide responses to the PRT comments, are planned on this issue.

Modeling Issues:

Framing members between adjacent columns in HLW, PT, and Low-Activity Waste (LAW) are not modeled in the analysis, as attached to or supporting the concrete floor slab. The resulting analysis is inconsistent with actual behavior. In addition, the stiffness of the supporting member (secondary framing), *as well as members acting compositely with the concrete floor slab, affects load distribution in the building. These*

factors need to be considered in the analysis and compared with the previous results to determine the potential impact on the existing design.

- *The supporting girders or beams are not modeled as attached to or supporting the concrete floor slab, but as independent members framing between adjacent columns.*

- *A 1-inch-wide elastomeric joint exists around the perimeter of the steel column, preventing load transfer between the concrete floor slab and supporting members in (PT and HLW) invalidating the assumption concerning floor slab-column connectivity. In LAW, the concrete floor slab is cast directly against the face of the steel columns. The Defense Nuclear Facilities Safety Board's (Board) staff determined that the concrete at this interface would crush well before the predicted loads are reached.*

- *Because of the modeling approach used, load transfer from the concrete floor slab to the columns was not properly considered. Further, the stiffness of the supporting members acting compositely with the floor slab affects load distribution.*

- *While a composite cross-section exhibits greater load-carrying capacity than a comparable noncomposite cross-section, the design adequacy of the composite cross-section must be validated by comparison with code acceptance requirements, even if the girders or beams are capable of carrying their share of the total load separately.*

- *These (composite) effects need to be considered in the analysis to enable comparison of the originally modeled behavior and a mode more representative of actual behavior. If the difference is significant, the analysis and design of record should be revised to reflect actual behavior.*

- *(In terms of hand calculations of beams for composite design), It would be prudent, in highly loaded areas of each building, to compare design results based on the approximate method (in hand calculations for seismic loads) with results obtained from Finite Element Model (FEM) analyses to confirm the adequacy of the design.*

Response:

To evaluate differences between the as-constructed and as-modeled conditions, hybrid models will be developed for each facility using the existing FEMs, but with refinements in specified areas.

For LAW, the area selected for additional refinement is in the southwest corner of the building, between gridlines D-L and 1-6 at elevations 27 and 48. This area was selected due to its representation of the braced-frame load path and it contains all modeling

attributes noted in the reference. In HLW, the proposed refinement region will be the bays between column lines 12-20 and A-J at elevations 37 and 58. For PT, the proposed refinement region will be the bays between column lines 1-17 and A-G at elevation 77 and 98'. The selected locations in PT and HLW encompass areas for the following attributes: 1) where the primary load path exhibits frame action and is influenced less by shear wall; and 2) locations where there is significant load transferred in the floor slabs within the structure. The height of the refined area of the hybrid verification models will be extended to higher and/or lower elevations, as applicable, to assure adequate representation of the refined condition. The Project proposes an expeditious review of these selections with the Board staff, BNI staff and the ORP PRT to assure that the selections capture the issues specified by the Board staff. This review is scheduled to be held on March 26, 2010, in the Board offices.

The following guidelines will be used for model development for LAW, PT, and HLW:

- Add all framing at the local area identified, both primary and secondary beams.
- The concrete plate elements in these areas will be modeled and meshed according to Bechtel National, Inc.'s (BNI) meshing guidelines in the structural criteria.
- The structural steel framing elements in these areas will be attached to the concrete plate elements at all externally meshed joints. This attachment is achieved by a link element that models the as-constructed offset between the slab and supporting steel beams. Framing members with studs will have links that model composite action and secondary steel, if modeled, will have links that only transmit vertical load.
- Beams have pinned connection at columns and the concrete interface at the column will be modeled to reflect as-built construction.
- The effects of the stiffness of concrete slabs will be included in the model when considering the cases where the concrete has set (i.e., normal loading and normal plus seismic loading).
- In slab areas that are supported and contained by thick reinforced concrete walls and have slab thicknesses greater of at least two feet and are not highly loaded relative to other slab regions as determined by stress trajectories, the Project may propose, and with Board staff concurrence, not to include the composite construction refinements in order to expedite the modeling process.
- Secondary steel members may be omitted from the HLW and PTF model to expedite the modeling process.

The responses from the effects of this refinement will be evaluated and compared to the original model results to demonstrate adequacy and identify differences in the responses between the two models. Where members were not originally modeled under slab

elements, the model results will be compared against hand calculations. The model results will also be reviewed against the issued project calculations to evaluate impacts to any project reported Demand to Capacity (D/C) ratio or installed design. This approach will not only evaluate the verification from the composite behavioral standpoint, but also confirm the adequacy of the structural steel design in terms of code compliance. The following items will be reviewed based on results from the refined models:

- Check as-constructed column condition for local model loads.
- Check steel beam and composite beam for stress levels in the post-hardened condition.
- Check the number of studs in the composite case.
- Evaluate load transfer to columns for cases without isolation joints.
- Review model loads vs. localized hand calculation for both distributed loads and simple span conditions.

Steel Stud Adequacy:

The project team did not develop calculations to validate the adequacy of the steel stud patterns or evaluate the effect of the actual stress distribution of composite members for the HLW, PT, and LAW building designs. These issues need to be thoroughly evaluated so their impact on the existing designs can be determined.

- *No calculations exist to validate code allowable load transfer for the various stud spacing patterns used.*

Response:

The stud adequacy in LAW was evaluated for the most sensitive area at the collector elements, where the stud configuration was continued across the beams supporting slabs (reference calculation 24590-LAW-DBC-S13T-00036). In addition, Calculation 24590-LAW-SSC-S15T-00156 was prepared to respond to this issue in LAW and has been provided to the Board staff. This calculation shows that the number of studs required is less than those actually provided. Similar calculations will be made for the HLW and PT Facilities. D/C ratios for steel studs will be calculated to show that there are an ample number of studs and the design is within code and allowable limits.

The PRT has reviewed and concurs with the LAW calculation and will review HLW and PT calculations when completed.

Secondary Beams:

The simplified approach used to evaluate the design adequacy of members involves approximating seismic loads and neglecting the action of secondary beams and may not always be conservative. These assumptions need to be thoroughly evaluated so their impact on the existing designs can be determined.

- *It is nonconservative to neglect secondary beams when calculation midspan (maximum) moment. Concentrated loads at the one-third or one-quarter points equal to the total uniform load previously determined result in midspan moments greater than those calculated based on uniform loading.*

Response:

A preliminary calculation has been completed to demonstrate that the point loads from secondary beams do not cause larger maximum moments in the beam design, as opposed to the distributed load. This calculation will be completed for design loads and as constructed member geometry in the LAW facility to demonstrate design adequacy, using loading from the hybrid LAW verification model developed for addressing the modeling issue.