The Secretary of Energy
Washington, DC 20585

March 6, 2003

The Honorable John T. Conway
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, NW, Suite 700
Washington, D.C. 20004

Dear Mr. Chairman:

Thank you for your letter in which you raised two issues related to the Waste Treatment and Immobilization Plant (WTP) at the Hanford Site in Washington State.

The first is a concern that the Department of Energy (DOE) and Bechtel National, Incorporated (BNI) have not instituted a formal strategy for maintaining design margins as a function of design uncertainties. The second concern is about Federal oversight of the project. This response and the enclosed report discuss actions that DOE has taken to address these concerns.

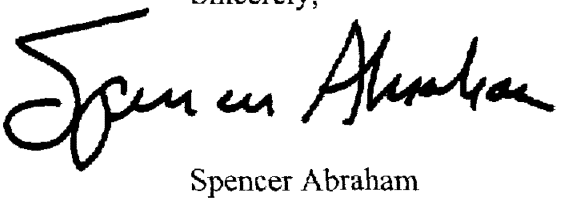
For a project of this size and complexity, it is important to carefully maintain and manage design margin. Design margin is managed by BNI, and assessed by DOE, as a part of an integrated set of requirements to address design uncertainty. Although requirements had not been formally documented in a single readily available format, they have been articulated in the enclosure to this letter. These requirements are being formalized and will be available for review by March 31, 2003.

Federal oversight is an important component of this project that needs improvement. The Office of River Protection (ORP) has been increasing its oversight activities of the detailed design and construction of the WTP. An integrated Oversight Schedule has been developed. The enclosure to this letter describes the combined elements of ORP's oversight of the WTP, actions taken and actions planned to improve existing day-to-day oversight, actions being taken to provide formal guidance for additional design reviews as the WTP design is evolving, as well as some of the important results of design reviews performed last year.

The Department's approach for systematic oversight of the WTP provides confidence in the BNI design process and confirmation that the BNI design meets functional, design, and operability requirements. By adopting these approaches, I believe that potential problems that may challenge or affect the functionality of safety significant systems or structures will be identified before they manifest themselves as issues. Your comments are helpful to me in focusing and strengthening our oversight activities for WTP, and I will keep you apprised of our progress.

If you have any further questions, please contact me or Ms. Jessie Hill Roberson, Assistant Secretary for Environmental Management, at (202) 586-7709.

Sincerely,



Spencer Abraham

Enclosure

Hanford Waste Treatment and Immobilization Plant (WTP)
Design Margin Management and
Federal Oversight

In a December 16, 2002, letter to Secretary of Energy Abraham, the Defense Nuclear Facilities Safety Board (the Board) requested a report that documents how WTP structural design margins will be managed as a function of design uncertainty, and how DOE plans to systematically review the WTP design to identify and address potential problems before they manifest themselves as significant safety issues. This report addresses the Board's concerns related to this request.

Bechtel National, Incorporated (BNI) Approach to Management of Structural Design Margin as a Function of Design Uncertainty

Discussion:

(1) The U.S. Department of Energy (DOE) and BNI agree with the Board that it is important to carefully manage design margins as a function of design uncertainty. BNI has an integrated set of requirements to address design uncertainty. These requirements include:

- directing early design activities to provide system and layout definition that has minimum uncertainty with respect to the structure;
- locking down external reviews and decisions that could impact the structural design (such as regulatory reviews);
- sequencing detailed design execution to deliver necessary input information to structural design activities that support construction;
- adding margin to input information to account for uncertainties and maturity of the information;
- adding margin to structural design to provide flexibility in implementing design details;
- implementing a "design freeze" process for equipment arrangements before finalizing structural design details in individual plant areas;
- aggressively resolving emergent design issues within the constraints of the design, where possible, safely, and cost effectively; and
- including contingency allowances in project cost and schedule estimates to resolve design development issues that emerge and impact the design despite application of the above requirements.

In the present phase of WTP design execution, and typical of other projects, structural design margin is applied to account for uncertainties in design details (for example, detailed actual equipment weights and locations vs. estimates; actual piping, duct, raceway locations and weights vs. estimates). Design margin is managed throughout the design process and documented in the engineering calculations. Engineering calculations are developed with a full understanding of the confidence-level of the information that support the calculations, and a clear statement of the assumptions, calculational basis, and application of codes, standards, and other requirements. As the elements that support engineering calculations change, engineering calculations are reviewed and revised as appropriate to confirm design adequacy and maintenance of appropriate margins. Consistency of practices and

assignment of margins across the Civil Structural design activities is guided through direction and communication at the manager-supervisor level, supplemented by formal and informal review processes, design criteria, and design guides. This activity is managed through day-to-day direction and oversight of the work by experienced senior Civil Structural engineering supervisors. Review and approval of the calculations by manager-supervisors assures proper implementation of the practices and margins. The way this margin is documented formally is that it is applied in structural calculations, and, in revisions to the calculations, the adequacy of remaining margins is considered in implementation of design changes and approved by the manager-supervisors.

In the pre-construction phase of WTP, when there was greater uncertainty in plant layout, plant equipment, and design of the major structural features, 15 percent margin for all load combinations was employed in design of the below grade features for which early construction authorization was requested. As details above grade have evolved, this margin remains un-utilized to date, and it was not extended to above grade features because of the more advanced definition and more advanced review status of the design.

Design margin also exists as a consequence of simplified analytical methods that are employed in the design process. It may be available if more detailed design methods are employed. In the present phase of WTP design execution, some margin in this form is in reserve, but there are no plans to refine analyses unless necessary. However, in the pre-construction phase of WTP, simplified and conservative methods were used in addressing seismic loads applicable to below grade structures (simplified static analysis). As planned, the project is performing more sophisticated dynamic analyses of the entire structure that reduces resulting conservatism (and structural costs) for above grade features. Structural features below grade, designed with simplified methods, now are shown to have substantial margin for seismic loads.

(2) The Board specifically noted that the DOE and BNI have not instituted a formal strategy for maintaining design margins as a function of design uncertainties. Although records of structural margin implementation are formal (such as design calculations), DOE and BNI acknowledge that a single formal criteria or requirements document is not available. However, the requirements described in this response, including additional specifics for managing design margin, will be formalized in a white paper and made available for review in March 2003. The white paper will also identify necessary changes to design guidance and/or procedures. Implementation of identified changes will be completed within 60 days. Elements of margin employed in the WTP design at present include:

For structures below grade:

- Before requesting construction authorization, a 15 percent margin was introduced into the basemat and the walls below grade by limiting demand-to-capacity ratio to 0.85 considering all load combinations (applicable to Pretreatment, High Level Waste [HLW], and Low Activity Waste [LAW]) in order to readily bound the influence of evolutionary changes in details of the upper elevations as those features were finalized. At the point this margin was selected, plant process definition was substantially complete, Piping & Instrument Diagrams and the 3D model were sufficiently developed to support

preliminary equipment location in the plant model, operations and maintenance reviews, and safety and environmental analyses had advanced to the point of supporting the design of major plant and system features. Known uncertainties with plant layout and equipment definition were not expected to encroach significantly on the structural margin. This margin was not extended to upper elevations because of the increased maturity of front-end definition (equipment and layout) that would be available to support finalizing those structural details.

- Additional margin exists in the basemat and below grade walls since the final seismic loads derived from detailed analysis of the facility are only 60 percent of the conservative initial seismic loads used in design of the below grade structures. Again, the decision to proceed conservatively with design of the below grade structures based on simplified methods that now translate into design margin was to deliver a constructible design that was unlikely to be challenged as design features in upper elevations and detailed seismic analyses are completed. Above grade structures are being designed based on detailed analyses and conservative local load definition as discussed below.

For structures above grade:

- Approximately 10 percent to 20 percent margin for seismic loads results from a detailed design process that uniformly applies maximum seismic forces to structural elements. This is a consequence of the methodology used, but is not intended as margin for specific design input uncertainties. These structural elements also are designed conservatively using elastic design methods that preserve significant margin available in the inelastic response of the structure (as much as 50 percent).

For accommodation of systems and equipment in the structure at all elevations:

- Design practice for embeds (number and location of embeds for equipment, hangers, etc.) and penetrations provides capacities for total loads in excess of that typically associated with commodity requirements. Embeds are located and sized based on preliminary information, but standard and conservative details are implemented such that there is capability to accommodate a range of attachments.

- A 20-25 percent margin is applied typically to individual equipment loads in the seismic analysis, which in turn are based on conservative or bounding estimates by the equipment groups. Also, although large equipment loads may govern local wall/slab design, equipment loads tend to be of limited significance to the overall seismic design.

- Additional uniform floor loads (dead loads) are assumed along with equipment loads that are conservative with respect to expected commodity layout requirements (for example, the loads associated with HVAC ductwork or fire protection piping).

(3) The Board also expressed concern over learning that the demand-to-capacity ratio limit of 0.85 applied to the WTP structural design was applicable only for the basemat and walls to grade and not for other portions of the HLW. DOE and BNI regret this misunderstanding over the extent of application of this factor in the design. As noted above, the intent of

this margin was to address uncertainties in design definition at an earlier phase of design in support of early construction authorization for below grade plant features.

(4) The Board observed that "the approach of erosion of margins does not appear to be reasonable since it is the Board's experience that problems manifest themselves throughout the process of design development." As noted above, margin is retained to support design development, and it is not intended that margin be reallocated away from its original purpose unless there is confidence that it is available. In a related observation, the Board noted that "structural design margins should be reduced only after more detailed design development has been completed and/or a better understanding of the specific hazards (e.g. the seismic hazard) has been gained. This is not the case for the current Waste Treatment Plant structural design or the development of any new information related to the seismic hazard." For clarification, the current WTP design is based on seismic ground motion predictions that were established prior to award of the BNI contract and that have been adopted as a design basis. Margin has not been allocated for accommodation of changes in this basis.

Summary:

BNI has an integrated set of requirements to address design uncertainty. In the present phase of WTP design execution, design margin is applied to account for uncertainties in design details, and as a consequence of simplified analytical methods that are employed in the design process. The requirements described in this response, including additional specifics for managing design margin, will be formalized in a white paper and made available for review in March 2003. The white paper will also identify any appropriate changes to design guidance and/or procedures.

ORP's Approach to Systematic Oversight of the Waste Treatment Plant

Discussion:

(1) The Board states that subsequent to DOE's decision to authorize construction of the HLW, LAW and portions of Pretreatment facilities, more detailed assessments of the design should be performed to identify and address potential problems before they manifest themselves as issues. DOE agrees that Federal oversight of the WTP could be improved by performing more detailed assessments of the design. As a result of the Board's concern, the ORP accelerated its ongoing examination of how responsibility for design, construction and operability oversight of the WTP was being implemented. The result of this examination was a determination that the project would benefit by augmenting existing ORP regulatory design reviews and inspections with additional design reviews by the ORP project organization, formalizing the ongoing ORP day-to-day oversight process, and providing formal guidance for performance of such reviews of the design in progress. The need for these improvements was further emphasized by BNI Engineering quality issues identified by an ORP design process surveillance, BNI reviews of its design process and products, and input from reviews performed by the Board. (Item (2) below explains how ORP has begun to implement additional project design reviews.)

(2) The Board goes on to state that it recognizes that DOE used the Safety Evaluation Report (SER) as the basis for authorizing construction, but also believes that DOE has yet to initiate a program of design reviews at a sufficient level of detail to identify potential problems and ensure that they are being addressed properly. DOE agrees in part with the Board. Detailed design reviews performed in 2002 as part of the review of the Preliminary Safety Analysis Report (PSAR) submittals were at a sufficient level of detail to identify potential problems. Findings from these reviews include items such as identification of: non-conservative analysis of hydrogen deflagration events; inadequate analysis of internal flooding events for HLW; incomplete analysis for control room habitability for some transportation events; incomplete structural analysis to account for a postulated catastrophic molten glass spill event for HLW; and incomplete analysis of a mis-transfer of waste feed intended for the HLW facility to the LAW facility, to name a few.

As the WTP design has evolved to more detailed structural and system design, the opportunity and need for detailed design reviews by the ORP project organization has become apparent. ORP has drafted formalized guidance (Office of River Protection Procedure Directive, ORP PD 220.1X-DRAFT) for systematic oversight of the BNI WTP design. Oversight activities are planned and scheduled in a disciplined manner using the ORP Integrated Oversight Schedule that integrates assessments, inspections, surveillances, and design reviews. The objective of this oversight is to develop confidence in the BNI engineering, procurement, and construction process and determine if the design meets functional, design, and operability requirements. ORP plans to use the following approach for oversight of the BNI design.

The design oversight process includes:

- Continued reliance on DOE design review as part of the regulatory process. In 2003, a revised PSAR will be submitted that corrects the deficiencies identified as conditions in the Construction Authorization Agreement. ORP will review the revised and updated PSAR to ensure that the current design deficiencies identified in the SER have been corrected. As discussed above, the most significant of these conditions related to design concerned inadequate hydrogen deflagration analysis, flooding analysis, glass spill analysis, and HLW to LAW misfeed controls, but the conditions span the entire preliminary design that was reviewed beginning late in 2001 and continuing throughout 2002. In addition, as the design evolves to final design, commencing in 2003, ORP will review the safety of changes to the authorization basis as they are initiated through: inspections of safety evaluations of design changes performed by BNI without prior DOE approval; review of authorization basis change requests for design changes requiring prior DOE approval; and review of the annually updated PSAR for an integrated perspective on changes to the design of the facility.

- Review of design (engineering and procurement) process and construction product deliverables; e.g., BNI's Design Process, Functional Specifications, Radiological and Nuclear Process Safety deliverables such as the PSAR, and the Construction, Procurement, and Acceptance Testing Plan.

- Day-to-day interaction between BNI and ORP personnel. ORP personnel attend regular meetings and maintain a continuous dialogue with BNI on design development and review, risk assessments, Research and Technology progress and results, material balance, tank utilization, operations, arrangement model development, and reliability, maintainability and inspectability considerations. The areas of discussion and interaction between BNI and ORP are contained in meeting minutes, handouts, internal correspondence, and personal communications. The expectations for the level of oversight and interaction are outlined in the draft guidance.

  These expectations include checklists for pre-work and specific attributes to be addressed by attendees at BNI design oversight meetings, including documentation requirements. Some examples of the attributes that are considered include: the appropriate functional requirements and design criteria have been identified; the design is consistent with the functional requirements and design criteria; the design is conservative and includes margin and redundancy where appropriate to compensate for uncertainties in the design process; and the design is constructible, operable, maintainable, and inspectable.

- Focused technical design oversight in selected areas. These ORP project design reviews will seek to identify any problems and areas of risk that may have been overlooked in the detailed design. The considerations for selecting an area for review include: risk to the project; cost of construction; schedule (lead time, float available); potential safety issues; and project risk management. The draft guidance addresses selection of the design review team, development of the design review plan, conduct of the design review, preparation of the final report, and recommendations for actions requiring follow-up. The draft guidance was utilized to pilot the reviews discussed under the Implementation Progress topic. It was written in part to implement instructions for additional design reviews beyond those performed as a part of regulatory oversight. In February 2003, ORP issued guidance for performing design reviews and also provided a copy to DNFSB staff.

To assure that the depth of the focused technical design oversight and safety reviews and inspections is appropriate to the area being assessed and that potential areas of concern are fully developed and investigated, ORP has found it necessary to utilize contract support staff. The specialized experience and education of contract support staff is necessary when ORP staff either do not possess the required skills or cannot be assigned to perform the review due to exigencies of other work. Most of the support contractors utilized to date have advanced degrees, are registered professional engineers, or hold industry certifications. These personnel have an average of 27 years of professional experience in the areas being examined.

In addition, the ORP construction oversight program (including its inspection program) has provided and will continue to provide insight into the safety adequacy of the design process. For example in 2002, inspections (IR-02-012 and IR-02-015) examined the design process, and design standards implementation, with three significant findings. The inspections found that two implementing design standards were not being properly implemented in the design, design inputs to calculations and drawings were not consistently documented, and the process for resolution of unverified assumptions in calculations was not adequate. As a result of these findings, BNI has developed a detailed and thorough action plan to correct

these deficiencies, and has implemented interim mitigative actions to ensure that ongoing construction work is acceptable. DOE accepted the action plan, verified the interim mitigation was in place and effective, and will ensure that final corrective action for these design process weaknesses is effective.

(3) The Board is particularly concerned that the current structural design for the HLW facility could result in levels of seismic floor response that would significantly challenge the ability of safety systems and equipment to withstand seismic loadings, and that to address this challenge more robust equipment would need to be procured and installed. The Board goes on to state that until recently this problem was largely unrecognized by DOE.

With respect to the seismic floor response of the HLW facility cited as an example of the Board's concern about Federal oversight, ORP also is concerned that as the design evolves, the accelerations of the upper floors must be adequately addressed by both lowering the accelerations through additional design measures and ensuring that purchased equipment is adequate for resultant loadings prior to equipment delivery. BNI has been resolving this problem with a number of additional design features to lower the upper floor accelerations and has been obtaining vendor input regarding equipment capabilities to withstand seismic loadings.

ORP acknowledges that some ORP personnel were not aware of the upper floor accelerations of the HLW facility until recently. ORP expects improvement in the knowledge of important design issues like the example cited by the Board due to re-alignment and re-assignment of technical and project management resources (described below) along with the improved communication that will result from the relocation of Federal Project Managers (FPM) with their counterpart BNI Area Project Managers. The actions identified in Item (2) above with respect to day-to-day interaction of ORP and BNI personnel also will improve the knowledge of ORP personnel regarding important design issues.

Implementation Progress:

The implementation of focused technical design oversight initiatives, which began in the fall of 2002, continues to mature and is producing results. To date, focused reviews have been completed on the ultra-filtration system and the cesium ion exchange system. Both of these reviews identified issues with the design process and with specific design features of these systems. Some of the issues with the design features concern the availability of margin in the design to accommodate potential variations in the feed composition and functionality of system components to meet Contract requirements for production and operability. The reviews identified uncertainties with important design features including the ability to concentrate solids, sludge washing efficiencies, filter back-pulsing system design, and lack of clearly identified functional requirements for the ultra-filter design. These are being evaluated by BNI.

ORP will provide design oversight of the resolution of the seismic floor response of the HLW facility as this aspect of the design evolves. Other aspects of the design that are currently being planned or considered for design reviews include: WTP system erosion, corrosion and material selection; Balance of Facility support systems; application of process models in WTP design,

construction and commissioning; vessel design including design process, instrumentation, and related components such as pulse jet mixers, fluidics devices and ejectors; and the LAW melter feed preparation system.

Other improvements initiated during the summer of 2002 included re-alignment and re-assignment of technical and project management resources to better ensure that project teams are staffed with knowledgeable, inquisitive, and experienced personnel who are not intimidated by the issues and challenges of managing a project of this size and importance. This was done to improve ORP's knowledge of developing project issues (including design issues) and provide for improved oversight of the WTP. This is a work in progress and refinements in this area of day-to-day design oversight are expected to continue.

ORP budgets approximately $8 million annually for support contractors for the WTP for both technical and administrative services. The ORP senior management team continues to monitor the use of this significant resource and is re-directing focus on technical rather than administrative tasks. The use of resources from other DOE organizations and sites has been emphasized and will continue to be a source of specific expertise to provide technical assistance including conduct of design reviews. While the FPMs' knowledge of their facilities and attendant design issues has improved, and two focused technical design oversight reviews have identified important problems, additional improvement in oversight of the WTP is expected as these initiatives mature.

Conclusion:

In summary, the foundation of ORP's approach for systematic oversight of the WTP design is the combination of the following:

- WTP design reviews performed for nuclear, chemical, radiological, industrial, and process safety;
- the review of engineering, procurement, and construction process and product deliverables;
- the ORP initiatives to improve day-to-day interaction between BNI and ORP personnel;
- the initiative for focused technical design oversight in selected areas; and
- construction oversight to ensure that the design process is being executed consistent with program requirements.

The objective of this systematic approach to oversight is to develop confidence in the BNI design process and confirm that the BNI design meets functional, design, and operability requirements. By adopting these approaches, DOE believes that potential problems that may challenge or affect the functionality of safety significant systems or structures will be identified before they manifest themselves as issues.