



**Department of Energy**  
Washington, DC 20585

**FEB 09 2007**

The Honorable A.J. Eggenberger  
Chairman  
Defense Nuclear Facilities Safety Board  
625 Indiana Avenue NW, Suite 700  
Washington, DC 20004-2901

Dear Mr. Chairman:

This letter provides the enclosed report that you requested in your January 10, 2007, letter regarding geotechnical and structural issues associated with the design of the Salt Waste Processing Facility (SWPF) at the Savannah River Site (SRS). This report addresses the Defense Nuclear Facilities Safety Board issues identified in the letter and enclosed Staff Issue Report, and outlines planned actions for successful resolution. The report also identifies Department of Energy (DOE) actions to oversee the geotechnical and structural engineering design and demonstrates how the Department recognized these issues and is working with its SWPF engineering, procurement and construction contractor, Parsons, to address them.


We share your view that preliminary design must provide a sound technical basis for the final design. We will not proceed with Critical Decisions for this project until the geotechnical and structural issues have been adequately resolved to substantially reduce uncertainties in this area. To achieve this objective, Parsons has strengthened its geotechnical and structural engineering capabilities by augmenting its staff with nationally recognized technical experts in these areas. Additionally, the DOE Savannah River Operations Office (SR) has similarly augmented its staff in these areas by retaining its own set of experts. Further, the DOE Chief of Nuclear Safety had retained the services of a nationally recognized expert in soil-structure interactions and is providing the Office of Environmental Management (EM) access to this resource as a function of its nuclear safety technical support and oversight. EM is applying this resource to closely monitor and assist the SR integrated project team for the SWPF. Finally, DOE has directed Washington Savannah River Company to conduct geotechnical engineering analyses for the SWPF using existing SRS methodologies that have proven to be conservative for soil conditions and design of facilities on the site and that will be provided as Government Furnished Services/Items.



In order to document DOE's actions in this regard, the enclosure briefly describes the general path forward for addressing the issues identified as well as the specific proposed activities that will be addressed as the path forward is further developed.

We appreciate the Board's commitment to a timely review and we will make ourselves available for monthly meetings with you and your staff to ensure that project resolutions are technically sound and are being addressed in a timely manner.

If you have any further questions, please call me at (202) 586-7709 or Dr. Inès R. Triay, Chief Operating Officer, at (202) 586-0738.



James A. Rispoli  
Assistant Secretary for  
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Enclosure

cc:

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## **SALT WASTE PROCESSING FACILITY (SWPF)**

### **Response to Defense Nuclear Facilities Safety Board (DNFSB) Issues in January 10, 2007 Letter**

#### DOE Design Review Approach Summary

Department of Energy – Savannah River Operations Office (DOE-SR) has applied an integrated project team (IPT) approach in overseeing SWPF design activities. The IPT consists of full-time engineering and project management staff and is augmented as necessary with additional subject matter expertise. The IPT conducts technical reviews of in-process design and final design products in accordance with project procedures.

Technical oversight consists of four basic elements; IPT engineering, augmentation, Headquarters, and independent technical reviews (ITRs). Full-time engineering staff oversees day-to-day design activities and are supported by additional subject matter expertise. Where additional support is required, the full-time staff is augmented with additional subject matter expertise either through contract or obtained from DOE expertise at another site. The Chief of Nuclear Safety provides technical support during the resolution of complex design issues, and EM Headquarters conducts frequent project reviews. Further, the IPT technical oversight is augmented by ITRs or other external assessments (e.g., Headquarters oversight reviews in accordance with DOE Order 226.1).

Deficiencies or comments identified as a result of oversight reviews are documented and communicated to the Engineering, Procurement, and Construction (EPC) contractor and, where necessary, followed up with letters directing a project change. The IPT is involved daily with the SWPF EPC contractor to resolve issues.

#### Summary Path Forward

The DNFSB letter identified issues related to three design topics: 1) quality assurance of design software, 2) schedule delays associated with issuance of a geotechnical report, and 3) civil/structural design. The following table provides a crosswalk of issues identified in the DNFSB letter, the status of actions currently planned to address those issues and the corresponding DOE-SR oversight identification of the respective issues. Schedules are being put in place to complete activities described in the “Discussion/Path Forward” column of the table.

DOE-SR has reviewed the fundamental issues identified within the DNFSB letter and agrees that they indicate problems may exist with some of the design bases developed for the civil/structural design. The significance of these problems must be understood to ensure a sound technical basis is established before the project moves into final design, and the EPC has contracted a team of nationally recognized civil/structural experts to facilitate identification and resolution of those problems. This team provides additional expertise to define the evaluations/analyses necessary to develop a detailed analysis plan to be used for final design. The EPC has defined work scope

for the team related to adequacy of the soil-structure interaction stick model to evaluate the dynamic equivalencies between the lumped mass model and the finite element model; and perform a load path evaluation to identify areas subjected to high stress concentrations. The EPC is evaluating additional team scope related to a sensitivity study of the impact of various soil settlement profiles and a review of calculations and assumptions made in structural design. DOE-SR has directed Washington Savannah River Company to complete an evaluation of the settlement profile using preliminary geotechnical data which will be provided to the EPC as a government furnished service/item.

The SWPF project team has been strengthened by the addition of an experienced Project Director to manage the project, reporting directly to the Deputy Manager, DOE-SR to assure visibility and resolution of project issues. Additional technical resources are being applied to strengthen DOE oversight of SWPF design activity. Action is underway to increase the IPT federal engineering staffing. DOE-SR is also expanding the design deliverable review capabilities of federal IPT engineering staff through the acquisition of professional engineering services. Further, expertise from the ITR team will be brought back to review resolution of geotechnical and civil/structural issues identified in their report. These actions are expected to expand and further strengthen technical oversight of design activities.

The SWPF project team will keep the Board staff apprised of the status and resolution of issues identified in the DNFSB letter via regular, periodic meetings (which commenced on February 2, 2007).

With regard to the Board request that a Summary Structural Engineering Report (SSR) be prepared upon completion of the final design for the Central Processing Area (CPA), it is DOE's intent that the EPC complete a SSR of sufficient scope and technical content to demonstrate the functional adequacy of the SWPF structural design. The SWPF technical calculations are being performed to demonstrate that the requirements of the Structural Acceptance Criteria (SAC) are met. Additionally, it is the intent to provide supplemental summary discussions of the Demand/Capacity ratios and load transfer paths. In the interim, a conceptual load path evaluation is planned to identify areas of high project risk.

DNFSB Issues from 1/10/2007 Letter	Discussion/Path Forward	DOE Oversight
<p><i>Issue 1: Finite Element Model Results</i></p> <p>It is expected that the foundation displacements resulting from the 3-inch dynamic settlement will be nearly symmetrical with respect to the longitudinal building axis, but the reported results are not symmetrical and reflect anomalous behavior. This problem is indicative of errors in modeling and/or analysis. Until the source of this erroneous behavior is determined and corrected, the acceptability of the CPA building design cannot be verified.</p>	<p>Given that the mass loading and the stiffness of the CPA structure is not symmetrical about either horizontal building axis, some asymmetry in the building settlement was to be expected. Additionally, certain simplifying assumptions associated with the soil spring values were made during preliminary design which may have contributed to the observed asymmetry. These assumptions will be refined prior to initiation of final design analyses.</p> <p>The finite element model will be reviewed with respect to the observations provided by the Board to identify potential improvements or corrections. Recognized external experts in structural analysis and design have been retained by the EPC contractor and DOE to assist with this review and commenced work on the project on February 1, 2007. These experts are to review inputs, assumptions, and analysis methodology and the results of the structural models.</p> <p>Any identified improvements or corrections to the finite element model are to be incorporated prior to commencement of final design analyses.</p>	<p>DOE Letter dated January 9, 2007, Spears to Amerine, "SWPF, Request for Rationale for Nonlinear Spring Values Assumed for Finite Element Model"</p> <p>Independent Technical Review Team Areas of Concern 3.3-9 &amp; 3.3-10 dated November 22, 2007</p>

DNFSB Issues from 1/10/2007 Letter	Discussion/Path Forward	DOE Oversight
<p><i>Issue 2: Assumed Settlement Profiles</i></p> <p>Given the inherent variability of geotechnical conditions at the site, other non-uniform settlement profiles should be considered in the building analysis.</p>	<p>The SWPF preliminary dynamic differential settlement assumptions were set to be reasonably conservative relative to expected settlements for preliminary design. Previous data from the SWPF site and analyses of nearby areas were reviewed to determine the magnitude of the dynamic differential settlement used in preliminary design. For the settlement profile, recommendations provided for the nearby Glass Waste Storage Building #2 were considered in developing the SWPF preliminary design assumptions.</p> <p>Ultimate resolution of this issue is to be provided by the settlement profiles derived from the geotechnical analyses based on field measurements and aggressive measures are being pursued to accelerate the completion of the geotechnical analyses to support SWPF final design as discussed in response to Issue 9.</p> <p>In the interim, development of dynamic settlement profiles is being initiated. A sensitivity study of slab demands from various settlement profiles is to be performed to evaluate the margin associated with the current design. Initiation of final design analyses for the CPA will be contingent upon completion of the sensitivity study and no final design analyses will be approved until the adequacy of the relevant design assumptions are confirmed by the geotechnical results.</p>	<p>DOE Letter dated January 9, 2007, Spears to Amerine, "SWPF, Request for Rationale for Nonlinear Spring Values Assumed for Finite Element Model"</p>

DNFSB Issues from 1/10/2007 Letter	Discussion/Path Forward	DOE Oversight
<p><i>Issue 3: Soil Compressibility Properties</i></p> <p>The soil compressibility properties used in the analysis are not representative of values typically encountered at SRS. They are based on the premise that when the soil-bearing pressure reaches twice its allowable value (6 ksf [kips per square foot]), the soil reaches its maximum capacity and is no longer capable of resisting additional load. In fact, soil-bearing capacities at SRS are typically much higher than those used in the analysis. The use of more typical soil compressibility properties, including non-linear behavior at higher strain levels, would likely result in a significant load increase in the building structure.</p>	<p>The EPC contractor intends to update the nonlinear soil spring values used for final design to be consistent with previous precedents for analyses at SRS. The updated nonlinear spring values are expected to increase the estimated structural loads. As part of the analyses discussed in Issue 2, the EPC contractor is to assess the potential design impacts associated with implementation of the higher soil compressibility values.</p>	<p>DOE Letter dated January 9, 2007, Spears to Amerine, "SWPF, Request for Rationale for Nonlinear Spring Values Assumed for Finite Element Model"</p>

DNFSB Issues from 1/10/2007 Letter	Discussion/Path Forward	DOE Oversight
<p><i>Issue 4: Finite Element Mesh Refinement</i></p> <p>The finite element model was generated using four node quadrilateral shell elements. At least four elements are provided between floors and an average of eight elements between walls for modeling the basemat and floor slabs. While this mesh size may be reasonable for representing overall behavior in the preliminary analysis of a shear wall building, it is not clear that such a level of refinement will be appropriate when the final analysis is performed. In general, four elements are capable of accurately modeling in-plane forces and moments, but may not be adequate for estimating out-of-plane forces and moments. During final analysis, detailed cut section analyses are typically performed around openings and at wall-to-slab junctions to develop detailed reinforcement requirements. The mesh refinement employed in the preliminary analysis does not appear to be adequate for this purpose. Lack of adequate substantiation of the mesh will necessitate preparing mesh refinement studies before completing the final analysis.</p>	<p>It is noted that the CPA is being designed to minimize out-of-plane load transfer with a goal of having 85% of the inertial loads carried by in-plane forces. Additionally, during final design, buttresses will be added to the “top hat” of the Central Processing Area (CPA) to ensure this goal is achieved, consistent with the recommendation of the DOE Independent Review Team.</p> <p>Finite element mesh sizing was an issue for the Waste Treatment Plant (WTP) and Hanford prepared a mesh sizing study. At Hanford the program SAP 2000 replaced GTSTRUDL as the software used to determine force and moment distribution in the building structures. Prior to implementing this software, studies were completed to provide guidance on the mesh refinement to be used in the FEM models. This guidance was included in the WPT Structural Criteria. In the process of converting to SAP 2000, a detailed study was performed to show that the shell element used in GTSTRUDL, which is the same shell element being used by the EPC in their FEM model of the CPA, converge to the same level of accuracy when sufficient number of elements are used. It is concluded that, this being the case, the guidance for FEM meshing for the WTP High-Level Waste (HLW) facility can be applied to the CPA as a minimum meshing requirement. In addition, the engineers on the HLW, while preparing their FEMs, provided additional mesh refinement for certain conditions, such as wall openings. (This was made easy through the use of the SAP2000 software through remeshing features not available in GRSTRUDL).</p>	<p>DOE 35% Design Review – Structural Review Comment No. 118 dated October 16, 2006</p> <p>Independent Technical Review Team Area of Concern 3.1-3 dated November 22, 2006</p>



DNFSB Issues from 1/10/2007 Letter	Discussion/Path Forward	DOE Oversight
	<p>To assure adequate meshing is applied to the CPA model, the DOE is reviewing the existing 35% design model to identify areas where the meshing does not meet the minimum requirements set forth in the Hanford HLW Structural Criteria and to evaluate meshing required for local discontinuities not specifically included in the criteria. The results of the DOE review will be provided to the EPC for implementation on their FEM model used for final design.</p>	

DNFSB Issues from 1/10/2007 Letter	Discussion/Path Forward	DOE Oversight
<p><i>Issue 5: Finite Element Model Soil Impedance Functions</i></p> <p>Soil stiffness and impedance effects were represented using relationships for uniform soil sites as presented in American Society of Civil Engineers (ASCE) Standard 4-98, <i>Seismic Analysis of Safety-Related Nuclear Structures and Commentary</i>. However, the soil conditions beneath the CPA are not uniform and, as indicated in Section C3.3.4.2.3 <i>Layered soil sites</i> of ASCE Standard 4-98, “layering of soil deposits can have a significant effect on impedance functions.” For this condition, ASCE 4-98 recommends that frequency-dependant impedance functions be developed. It is not clear that the approach used in the current analysis is conservative.</p>	<p>The EPC contractor project team concluded that the simplifying assumption of uniform soil conditions and the subsequent application of frequency independent soil impedance functions were acceptable for preliminary design given the relatively narrow range of measured shear wave velocities and observed soil layer characteristics.</p> <p>The EPC contractor has retained external seismic experts to review the soil stiffness and impedance function assumptions and to provide assistance in developing and executing any identified improvements. The external experts commenced support of the SWPF project on February 1, 2007.</p> <p>The experts are tasked to evaluate the significance of variability in S and P-wave velocity profiles on impedance functions and the impact on In-structure Response Spectra. The experts will review and evaluate the Soil/Structure Interaction (SSI) analytic approach used by the EPC contractor and compare with the current recommendations in ASCE 4-98.</p>	<p>DOE 35% Design Review – Structural Review Comment No. 115 dated October 16, 2007</p> <p>Independent Technical Review Team Area of Concern 3.1-1 dated November 22, 2007</p>

DNFSB Issues from 1/10/2007 Letter	Discussion/Path Forward	DOE Oversight
<p><i>Issue 6: IRS Calculation Error</i></p> <p>According to the analysis results, seismic floor acceleration levels are attenuated as compared with the input (free-field) acceleration levels. This is contrary to expected behavior, whereby floor and IRS acceleration levels should increase as a result of soil-structure interaction effects. Subsequently, DOE determined that the IRS in the calculation were incorrect since relative acceleration was erroneously output instead of absolute acceleration.</p>	<p>The EPC project team confirmed that an error in the input file resulted in In-Structure Response Spectra (IRS) being calculated based on relative, not absolute, accelerations. The analyses have since been rerun and the resulting IRS were found to exhibit higher response in the lower frequency ranges as expected. These results were cross checked against results generated from a different software package (SAP2000), as recommended by DOE's Independent Technical Review, and are considered correct.</p> <p>Broader cultural and programmatic improvements in quality assurance and conduct of engineering have also been identified by the EPC contractor management and are being implemented as outlined in the response to Issue 8 below.</p>	<p>DOE 35% Design Review – Structural Review Comment Nos. 196 and 198 dated October 16, 2006</p> <p>Independent Technical Review Team Technical Issue 3.1-1 dated November 22, 2006</p>

DNFSB Issues from 1/10/2007 Letter	Discussion/Path Forward	DOE Oversight
<p><i>Issue 7: IRS Modeling Approach</i></p> <p>Inherent in the IRS analysis is the assumption that the building's behavior can be characterized as a shear beam. However, examination of the mode shapes in the seismic analysis results from the <i>CPA Enhanced Design</i> indicates that this shear beam assumption is not correct and appears to be non-conservative. A more detailed analysis considering wall and floor slab flexibility and soil-structure interaction effects is required.</p>	<p>The EPC contractor project team followed generally accepted practices when calculating the overall stiffness and inertial properties for the lumped-mass model and considers the walls to be adequately modeled.</p> <p>During DOE's Independent Technical Review, the EPC project team acknowledged that the assumption of rigid floor slabs would require further evaluation. This evaluation and any supplemental calculations necessary to account for vertical amplification effects are to be completed prior to completion of final design analyses.</p> <p>Additionally, the EPC project team agreed that the overall stiffness of the CPA, as modeled in the lumped-mass model versus the finite element model, would be evaluated by applying a 1g "body force" to both models and comparing the resulting displacements. DOE's Independent Technical Review concluded that this approach would provide sufficient comparison between the two models to establish fidelity. Any adjustments identified during the comparison will be incorporated prior to performing final IRS analyses.</p> <p>Recognized external structural experts were retained by the contractor and DOE to support the project on February 1, 2007. They are providing any needed assistance in establishing the adequacy of the lumped-mass model for calculating IRS for final design.</p>	<p>DOE 35% Design Review – Structural Review Comment Nos. 110, 111, 119, 193, 194, 199 and 200 dated October 16, 2006</p> <p>Independent Technical Review Team Areas of Concern 3.1-2, 3.1-4, &amp;3.1-5 dated November 22, 2006</p>

DNFSB Issues from 1/10/2007 Letter	Discussion/Path Forward	DOE Oversight
<p><i>Issue 8: Quality Assurance Program</i></p> <p>It is not clear why the internal review process employed by the architect-engineer failed to identify and correct the erroneous IRS. Therefore the internal review process is also suspect.</p> <p>Three quality assurance issues arose during the staffs review. First, the architect-engineer reviewers failed to identify the erroneous IRS. Second, the architect-engineer did not follow proper quality assurance procedures (i.e., did not file a non-conformance report) when it was determined that the software being used, GTSTRUDL, was predicting unrealistically large membrane forces. As a result, the architect-engineer assumed, but did not verify, that the problem was corrected by using a newer version of the GTSTRUDL software. Finally, the architect-engineer used prerelease (unverified) software capabilities in its analysis, which is inconsistent with software quality assurance requirements. The root cause and required corrective actions for these problems are still being developed by the architect-engineer and DOE.</p>	<p>The process described below is indicative of how all significant issues and discrepancies are planned to be addressed by the project team.</p> <p>EPC contractor management has taken broad and timely action to identify the causes leading to the deficiencies, determine the extent of condition, explore the potential for related systemic problems, establish corrective actions for the immediate issues and the broader cultural issues, and ensure the effectiveness of corrective actions taken.</p> <p>The EPC contractor Project Manager has established a Senior Review Board (SRB) process to bring proper and timely management attention to the resolution of identified issues, fostered a cultural shift that emphasizes and rewards problem recognition and reporting. Both DOE and DNFSB have been participating in the process since November 2006.</p> <p>The SRB process (as applied to the quality assurance issues referenced) included the formation and execution of a thorough independent review that drew upon industry quality assurance experts. Once the issues were clearly understood, a Corrective Action Development team of Subject Matter Experts was chartered to develop appropriate corrective actions.</p> <p>The quality assurance issues referenced have been thoroughly addressed and appropriate corrective actions are in place and being executed. The advent of the NQA-1 requirements and the broad cultural changes being implemented are significantly strengthening the project quality assurance program efficacy.</p>	<p>E-Mail Montgomery to Somma, et.al., "Pre-Release Features, 10/27/2006 (based on Gutierrez E-Mail)</p>

DNFSB Issues from 1/10/2007 Letter	Discussion/Path Forward	DOE Oversight
<p><i>Issue 9: Geotechnical Report Delay</i></p> <p>The Board's staff understands that DOE will accept the current design with the expectation that the assumed geotechnical design parameters can be justified, but will add cost and schedule contingencies to the baseline cost estimate to account for the indeterminate uncertainties. Unfortunately, this approach unnecessarily distorts the proposed project performance baseline and it is not clear how these cost and schedule contingencies can be rationally developed given the indeterminate level of uncertainty.</p>	<p>The SWPF project team agrees that the delays experienced to date with the geotechnical report are clearly undesirable.</p> <p>The following steps are being taken to accelerate the conclusion of the geotechnical investigation and obtain the necessary results. DOE has directed the Washington Savannah River Company to conduct geotechnical engineering analyses for SWPF using existing Savannah River Site methodologies that have proven to be conservative for soil conditions and facility design. The EPC contractor is revising the scope of work of its subcontractor to delete dynamic geotechnical analyses and to accelerate the conclusion of their remaining work scope.</p> <p>In the interim, dynamic settlement profiles will be developed. A sensitivity study of slab demands from various settlement profiles is to be performed to evaluate the margin associated with the current design. Initiation of final design analyses for the CPA will be contingent upon completion of the sensitivity study and no final design analyses will be approved until the adequacy of the relevant design assumptions are confirmed by the geotechnical results.</p> <p>Cost and schedule impacts are to be factored directly into the baseline as applicable.</p>	<p>DOE Memorandum 12/1/06, Assessment of Geotech Investigation</p> <p>DOE Memorandum 12/12/06, Status of Geotech Investigation</p> <p>Independent Technical Review Team Area of Concern 3.3-8</p>