DEFENSE NUCLEAR FACILITIES SAFETY BOARD

625 Indiana Avenue, NW, Suite 700, Washington, D.C. 20004-2901
(202) 694-7000

December 31, 2002

The Honorable Everet H. Beckner
Deputy Administrator for Defense Programs
National Nuclear Security Administration
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-0104

Dear Dr. Beckner:

The Defense Nuclear Facilities Safety Board (Board) is continuing to review the geotechnical investigation and proposed foundation design for the Highly Enriched Uranium Materials Facility (HEUMF) at the Y-12 National Security Complex. On March 25, 2002, the Board sent a letter to the Department of Energy (DOE) regarding foundation alternatives being considered for the HEUMF. On November 5–7, 2002, the Board's staff met with representatives of DOE and its contractor to discuss the foundation design. In general, the Board agrees with the chosen foundation alternative, but believes some aspects of the design require additional consideration to ensure that possible deficiencies are not overlooked during the ongoing facility design. The enclosed report, prepared by the Board's staff, summarizes observations and concerns noted during the staff's review.

Sincerely,

John T. Conway
Chairman

c: Mr. William J. Brumley
Mr. Mark B. Whitaker, Jr.

Enclosure

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Issue Report

December 4, 2002

MEMORANDUM FOR: J. K. Fortenberry, Technical Director

COPIES: Board Members

FROM: W. Linzau

SUBJECT: Geotechnical and Foundation Considerations for the Highly Enriched Uranium Material Facility

This report documents observations made by the staff of the Defense Nuclear Facilities Safety Board (Board) regarding the Highly Enriched Uranium Material Facility (HEUMF) at the Y-12 National Security Complex (Y-12). The Board's staff member, W. Linzau, and outside expert P. Rizzo participated in discussions at the site and observed the geological testing being conducted.

Background. The HEUMF is being built to store highly enriched uranium as part of the Y-12 Site Integrated Modernization Program. The contractor, BWXT Y-12, is responsible for identifying the design requirements and providing a scope of work to the architect-engineer firm. On September 25, 2002, Parsons Engineering was awarded the contract as the architect-engineer firm to perform preliminary and detailed design work.

On March 25, 2002, the Board sent a letter to the Department of Energy (DOE) that provided observations resulting from a January 2002 review by the Board's staff. Those observations addressed two general areas: building foundation alternatives, and seismic analysis and soil structure interaction (SSI).

Building Foundation. A major concern regarding the building foundation is the poor soil conditions at the proposed building site. The soil at the site is comprised of loose heterogeneous fill material which could cause a large amount of differential settlement. To prevent differential settlement problems, BWXT Y-12 selected a mat foundation coupled with the removal and replacement of existing fill with structural fill. BWXT Y-12 has also decreased the building footprint. The reduced footprint reduces the area of loose fill that must be replaced with structural fill.

The proposed structural fill is a crushed limestone that is found locally and will be used under the entire structure as a base for the concrete foundation. The limestone fill material will be examined by a geotechnical expert, Dr. Ken Stokoe of the University of Texas, to determine its structural properties. The limestone fill material has a maximum particle size of 1 to 1½ inches. It is our understanding that one of the proposed laboratory tests uses a cylinder that has a diameter of only 3 inches. The staff believes that insufficient volume exists in the cylinder, relative to the particle size, to accurately determine the structural properties of the limestone fill. In this situation, laboratory measurements of shear velocity, shear strength, and damping will be difficult to perform with any degree of reliability and confidence. It may be appropriate for

BWXT Y-12 to consider constructing a test fill area for field testing of the proposed fill material. The properties derived from field test data could then be confirmed by the laboratory testing and would provide accurate input to the detailed soil structure interaction models needed to determine the seismic response of the structure.

The current foundation plan requires the removal of approximately 30 feet of existing fill on the north and east sides of the foundation. The entire foundation will have the limestone fill material placed as a base to a depth of at least 5 feet. The foundation base of limestone fill will therefore vary in depth from 5 feet to approximately 30 feet. The variable thickness of the limestone material will have to be modeled accurately during the SSI analysis to predict the seismic response of the structure. In addition, the building site is located in an area with unique topography—a valley that will be more difficult to model than a flat landscape. The combined effect of a base of variable thickness and a unique topography will necessitate a three-dimensional SSI analysis to support the facility structural design.

Questions exist regarding the effect of the water table on the foundation design. The water table has a maximum elevation that is within the crushed limestone base. With the water table just below the concrete foundation, 4 to 5 feet of the base could be submerged. During the foundation design, the problems that could occur as a result of this condition, as well as remedies such as waterproofing or french drains, should be considered.

Seismic Analysis. The current site-specific PC-3 response spectrum was derived by the United States Geological Survey for bedrock with a peak ground acceleration of 0.25 g. BWXT Y-12 is updating this seismic design spectrum in response to the Board's letter of March 25, 2002. Law Engineering has completed the subsurface investigation and plans to issue the geology report by December 31, 2002. Dr. Stokoe is conducting field crosshole geotechnical tests and dynamic laboratory tests of the existing site material. The measured shear wave velocities will be used to update the seismic design basis. This work is scheduled to be completed by the end of December 2002 or early January 2003. It is critical that the updated design spectrum be completed before extensive structural design work begins on the building.

The proposed HEUMF site is located near two 1.5 million gallon water storage tanks. These tanks are located approximately 600 feet north of the site and 70 feet above the site. Neither tank is seismically qualified. Tank failure during a seismic event would create a sufficient flow of water to damage the building structure and the internal systems, such as electrical and ventilation systems. Early hazard evaluations proposed safeguards to mitigate the effect of such a catastrophic tank failure. One of the proposed safeguards was a reinforced concrete wall to be incorporated into the outer boundary of the new Perimeter Intrusion and Detection Assessment System with sufficient strength to divert the flow resulting from failure of both tanks. Another proposed safeguard was an exterior grade sloping away from the facility to reduce the hydraulic head of the flowing water. A calculation was completed in April 2002 that evaluated the consequences of a failure of the tanks. However, this analysis only evaluated the ability of the existing storm drains to divert the water from a partial failure of both tanks, not a total collapse. Without a detailed analysis of the performance of the tanks during a seismic event, a conservative assumption would be that the entire volume of the tanks is released in a short period of time.