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United States Government **Department of Energy**

memorandum

DATE: January 8, 2010 Audit Report Number: OAS-L-10-01

REPLY TO
ATTN OF: IG-32 (A09SR040)

SUBJECT: Report on "Seismic Design of Nuclear Facilities within the Department of Energy"

TO: Chief of Nuclear Safety, Office of the Under Secretary of Energy, S-3
Chief, Defense Nuclear Safety, National Nuclear Security Administration, NA-2.1

INTRODUCTION AND OBJECTIVE

The Department of Energy (Department) is required by Federal law and Departmental policy to design its nuclear facilities to reduce the risk of potential nuclear hazards to workers, the public, and the environment in the event of an earthquake. To this end, the Department has issued Orders, Guides and Technical Standards and adopted national consensus standards and building codes to govern the design of its nuclear facilities and to mitigate the potential impact of earthquakes and other natural phenomena. Specifically, the Department requires designers to use site-specific seismic and geological data in the design of its nuclear facilities. Such data includes historic seismic activity of the region, characterization of subsurface conditions of the soil and rock, calculated ground motion and soil settlement parameters, and the methodologies used in performing such analyses. Some of this information resides in existing site-specific probabilistic seismic hazard assessment reports. Additional seismic and geological data may be available from geological investigations performed for previously designed facilities.

The Defense Nuclear Facilities Safety Board (Safety Board) was established by Congress as an independent agency to advise the Department regarding safety issues related to the design, construction, operation, and decommissioning of defense nuclear facilities. During recent years the Safety Board has identified a number of seismic design issues for facilities being constructed by the Department. Due to the importance of identifying and resolving seismic issues in a timely manner, we initiated this audit to determine whether the Department had ensured the use of the best available seismic and geological data in the design of its nuclear facilities.

CONCLUSION AND OBSERVATIONS

Our review established that the Department had not always ensured the use of the best available seismic and geological data in the design of its nuclear facilities. Specifically, the Department had not used the best available site-specific data and methodologies in the design of two major nuclear facilities at the Hanford Site and the Savannah River Site. Not using this data during the early design of the facilities contributed to seismic issues in the design of the facilities which were subsequently identified by the Safety Board. The Department invested about $745 million and roughly five years of effort to remediate these issues.

At the Hanford Site's Waste Treatment Plant (WTP) in Washington state, the construction contractor had not obtained site-specific soil and rock characteristics necessary to analyze earthquake hazards. Rather, the contractor relied on a 1996 seismic study's assumption that the ground motion response of the soil and rock characteristics at the Hanford Site would be similar to that in California. In 2002, the Safety Board questioned this approach and noted that more representative approaches based on site-specific soil and rock properties were in use at other Department sites. In response, the Department developed a more demanding seismic criteria in 2005, to allow the contractor to continue with the design of the WTP while it initiated a deep drilling program to reduce uncertainties in the site characterization data by measuring soil and rock properties under the WTP. This geological work, completed in 2007, confirmed an increased level of hazard. However, site engineers told us that due to the robustness of the design based on the demanding 2005 seismic criteria, little change to the WTP structural design was necessary. The study and subsequent change was far from trivial, however, as the WTP's estimated cost increased by over $650 million and its schedule was delayed two to four years to address issues related to revising the ground motion seismic criteria.

At the Savannah River Site's Salt Waste Processing Facility (SWPF) the design contractor had not used existing site-specific soil property data in developing the preliminary design. In 2005, the performance level of the facility was changed to address concerns identified by the Safety Board in the facility's ability to provide adequate confinement of radioactive materials in the event of an earthquake. The higher performance level imposed more stringent seismic analysis requirements for the design. Despite the changes, in January 2007, the Safety Board identified remaining structural analysis deficiencies and noted that a geotechnical engineering report related to the facility's design had not been completed and thus was not used to justify the assumed soil properties.

According to Department officials, the SWPF design contractor was not familiar with the unique soil properties at the Savannah River Site. The Department did not initially require the design contractor to utilize the Savannah River Site's prime contractor's expertise and knowledge about the site's seismic and geological conditions. Department managers told us that seismic concerns could have been avoided, in part, if the design contractor had been required, as part of its contract, to use existing site-specific seismic and geotechnical information. In fact, in February 2007, the Department directed the prime contractor to conduct a geotechnical analysis using existing site specific information and assured the Safety Board that the results of this geotechnical analysis would be incorporated into the final structural design. The design contractor ultimately increased the proposed cost baseline by $95 million to address the Safety Board concerns identified in 2007.

Since 2007, in response to these and other concerns about its design of facilities, the Department has been pursuing initiatives to strengthen controls over the seismic design of nuclear facilities. Specifically, the Department has:

- Revised Departmental directives related to seismic design and issued a new Technical Standard to provide guidance requiring, among other things, the use of national standards, issued by the American National Standards Institute/American Nuclear Society and the American Society of Civil Engineers/Structural Engineering Institute,

related to the seismic design basis for nuclear facilities. The new Technical Standard also provides format and content guidance for several required reports which will document design decisions prior to proceeding to the next design or construction phase;

- Initiated technical, independent project reviews of safety issues, including seismic design, earlier in the design process to allow issues to be identified and resolved internally in a more efficient and timely manner; and,

- Sponsored a biannual seismic lessons-learned panel for personnel throughout the Department, the Safety Board, contractors, and external consultants involved in seismic hazard assessments and facility design. The panel enables members to share experiences from their work and provide tangible suggestions to help improve performance in, and guidance for, seismic characterization and design of nuclear facilities.

During our review we identified additional opportunities for the Department to ensure the use of the best available seismic and geological data in the early design of its nuclear facilities. Specifically, the Department has not always included access to existing site-specific geotechnical data in design contract Requests for Proposal (RFP). Site engineers indicated that relevant information from geological investigations performed for previously designed facilities is not easily accessible as it resides in various project-specific documents rather than consolidated in a site-level database. According to Departmental officials this information would be beneficial to potential designers, however, including such information in a RFP is ad-hoc and requires knowledgeable site engineers to be involved in writing the RFP statement of work. A recently issued Department Guide notes that there is no chance of a design contractor developing an acceptable design without knowing what the Department requires. It suggests that a statement of work should address areas that have repeatedly proven to need greater depth of detail such as site-specific seismic data.

The Department may be able to mitigate significant cost and schedule overruns on future construction projects for nuclear facilities by ensuring that design contractors have access to previously completed and documented seismic and geologic analyses.

SUGGESTED ACTIONS

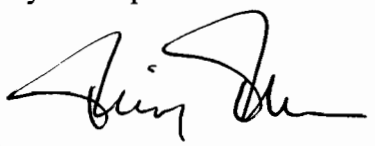
To avoid future cost and schedule impacts related to seismic design issues at nuclear facilities we suggest that the Chief of Nuclear Safety and the Chief, Defense Nuclear Safety advise program managers to require sites to:

- Accumulate current site-specific seismic related data and methodologies in a centralized format, such as a database, to make it accessible; and,

- Provide access to site-specific data to design contractors at the RFP stage to ensure that known conditions are disclosed and addressed.

Since no formal recommendations are being made in this report a formal response is not required.

We appreciate the cooperation of your respective staffs during the audit.



George W. Collard
Assistant Inspector General
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Attachment

cc: Chief of Staff
Manager, Savannah River Operations Office
Manager, Office of River Protection
Acting Director, Policy and Internal Controls Management, NA-66
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Diane Williams, Office of Risk Management, CF-1.2
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SCOPE AND METHODOLOGY

This review was performed between December 2008 and September 2009 at the Department of Energy's Savannah River Site in Aiken, South Carolina, and the Department of Energy's (Department) Headquarters in Washington, D.C. The scope of our audit included a review of the Department's current approach to incorporating seismic design criteria into the design and construction of its nuclear facilties. To accomplish the objective, we:

- Obtained and reviewed Departmental Directives, guidance, and standards addressing seismic design requirements;

- Held discussions with the Office of Environmental Management, the National Nuclear Security Administration, and the Defense Nuclear Facilities Safety Board representatives regarding current practices and implementation of seismic design requirements for nuclear facilities; and,

- Obtained information from Departmental and/or contractor officials at the Savannah River Site, Hanford Site, Los Alamos National Laboratory, and the Y-12 National Security Complex regarding seismic concerns identified on major nuclear facility construction projects.

We conducted this performance audit in accordance with generally accepted Government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objective. Because our review was limited, it would not necessarily have disclosed all internal control deficiencies that may have existed at the time of our audit. We also assessed performance measures in accordance with the *Government Performance and Results Act of 1993* and found that the Department had not established performance measures specifically related to the seismic design of nuclear facilities. We did not assess the reliability of computer-processed data since we did not rely on it to accomplish our audit objective. An exit conference was held on December 3, 2009, with the Chief of Nuclear Safety; Chief, Defense Nuclear Safety, and representatives from the Hanford Site and the Savannah River Site.