November 15, 2016

MEMORANDUM TO: Robert K. Caldwell, Deputy Director
Division of Engineering Infrastructure
and Advanced Reactors
Office of New Reactors

FROM: Jim Xu, Senior Level Technical Advisor **/RA/**
Division of Engineering Infrastructure
and Advanced Reactors
Office of New Reactors

SUBJECT: TRIP REPORT FOR THE NOVEMBER 2016 AMERICAN SOCIETY OF CIVIL ENGINEERS COMMITTEE MEETING ON GEOTECHNICAL STANDARD FOR NUCLEAR FACILITIES

The bi-annual November meeting of the American Society of Civil Engineers (ASCE) Geotechnical Standard for Nuclear Facilities (ASCE1) was held in Reston, Va., during November 3-4, 2016, at the ASCE Headquarters. The U.S. Nuclear Regulatory Commission staff members who attended the meeting covered in this report include: Jim Xu, Alissa Neuhausen from Office of New Reactors, and Thomas Weaver from Office of Nuclear Regulatory Research. The attached trip report contains a summary of the major items discussed at the meeting in which the aforementioned staff participated.

Enclosure: Trip Report

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TRIP REPORT
ASCE Committee Meeting on Standard for Geotechnical Analysis, Design, Construction, Inspection and Monitoring of Nuclear Safety-Related Structures
November 3 – 4, 2016

Overview

The American Society of Civil Engineers (ASCE) is developing a new standard for geotechnical analysis, design, construction, inspection and monitoring of nuclear safety-related structures. The primary purpose for this standard (ASCE 1) is to address geotechnical related issues in support of the performance-based framework for seismic design and analysis of nuclear facilities (commercial power plants and the Department of Energy's (DOE) fuel and waste management facilities). The structural requirements for the performance-based seismic design and analysis are provided by ASCE 4 - Seismic Analysis of Safety-Related Nuclear Structures and Commentary and ASCE 43 - Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities.

The ASCE 1 Committee is responsible for this standard development. The committee holds bi-annual meetings to provide face-to-face technical discussions and ballots for the standard. Alissa Neuhausen and Jim Xu of Office of New Reactors and Thomas Weaver of Office of Regulatory Research participated in the committee meeting held in Reston, VA during November 3-4, 2016. The meeting agenda is provided in Attachment. This meeting focused primarily on Chapter 3 – site characterization and Chapter 5 – analysis and design functions. In addition, the committee discussed the standard language for the performance-based framework consistent with ASCE 43 and ASCE 4. The committee is targeting for completing a draft standard in CY2017 and for submitting a balloted standard to ASCE Nuclear Standard Committee in CY2018.

A brief summary of technical discussions is provided below.

Technical Discussions

- **Performance-based framework for geotechnical issues**:

  The committee members engaged a very productive discussion on the practical aspects of implementing a performance-based framework consistent with ASCE 43 and ASCE4. ASCE 43 provides the seismic design criteria to achieve the structural performance goal expressed in terms of annual probability of exceeding the design limit state. (Elastic limit state is designated for nuclear power plant structures)

  One method of demonstrating compliance with ASCE 43 performance goal is to reasonably achieve the following two criteria:

  1) Less than about 1 percent probability of unacceptable performance for the design basis earthquake (DBE);
  2) Less than about 10 percent probability of unacceptable performance for 150 percent of the DBE.

Enclosure

As demonstrated in ASCE 43, these two criteria can be met for structures by: 1) targeting the seismic analysis to establish the seismic demands at the 80th percentile level of non-exceedance probability (NEP) which is achieved by ASCE 4 for the structural analysis, and 2) targeting the seismic capacities at the 2 percent NEP level and structural energy absorption capability at the 5 percent NEP level as prescribed in ASCE 43 for the structural capacities. However, the geotechnical capacity determination and geotechnical hazard assessment are within the scope of the ASCE 1 standard.

The committee members recognized the importance of performance measures for geotechnical attributes as well as the difficulties associated with limited geotechnical and deterministic practice. To this end, the members agreed to provide additional descriptions in the introduction to provide the geotechnical support to the performance framework in ASCE 43. Furthermore, the committee members also recognized the severe consequences (cliff edge effect) of certain geotechnical hazards such as seismic induced liquefaction and therefore, the liquefaction triggering assessment should be performed at a higher than DBE level of ground motion. It was noted that ASCE 7-10 for commercial buildings requires the liquefaction assessment should be performed at 1.5 times the design basis seismic motion.

Another area of challenge was related to the seismic margin aspect. For U.S. Nuclear Regulatory Commission (NRC) regulated facilities, the staff expects the seismic margin of about 1.67 times the DBE. However, ASCE standards apply to both NRC regulated facilities and DOE facilities which are subject to much less stringent criteria, therefore, it is difficult to achieve consensus. Further discussions are required.

- **Approach for quantifying uncertainty**

  The committee members engaged in a productive discussion on the best way to quantify uncertainty for geotechnical issues. The options discussed were the current factor of safety approach, load and resistance factor design, and a distribution curve characterizing the mean and uncertainty for inputs/parameters. Several committee members have agreed to provide examples for bearing capacity, settlement, and liquefaction prior to the next meeting to demonstrate the use of a distribution curve characterizing the mean and uncertainty for inputs/parameters. The committee also discussed whether a minimum distribution should be provided for cases where not enough information is known. These examples may end up as part of the Commentary to the Code.

Going Forward

- The Code includes 7 Chapters. Draft Chapters 1 & 2 are mostly completed. Draft Chapters 3 & 5 code language is nearly completed. The Commentary Sections for Chapter 3 & 5 are in progress. An interim teleconference between the biannual meetings should help progress the Commentary for these Chapters. The remaining Chapters 4, 6, and 7 are not expected to require extensive and time-consuming discussions to complete. Work will commence on these Chapters once 3 & 5 are resolved. The next meeting is scheduled for late April/early May 2017.