From:	Edward Helvenston
Sent:	Thursday, October 5, 2023 5:18 PM
To:	Rusty Towell; Lester Towell; Benjamin Beasley; Tim Head; Jordan Robison; Alexander Adams
Cc:	Richard Rivera; Zackary Stone (He/Him/His); Mohsin Ghazali; Michael Wentzel
Subject:	ACU MSRR PSAR Section 2.5 Audit Questions (Round 2)
Attachments:	ACU Follow-up Audit Questions on Geotechnical Engineering.pdf

Dear Dr. Towell,

Attached are questions the NRC staff has prepared for Abilene Christian University (ACU) related to the ACU Preliminary Safety Analysis Report, primarily Section 2.5, "Geology, Seismology, and Geotechnical Engineering." The NRC staff would like to discuss these questions within the scope of the ACU construction permit (CP) application review Audit Plan for Chapters 2 and 3 (see audit plan dated 3/2/2023, ML23065A048), and I am providing in advance to facilitate discussion during an audit meeting. We will add this email, with the questions, to public ADAMS. If you have any questions, please let Richard, Mohsin, or I know.

Thank you,

Ed Helvenston, U.S. NRC
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Hearing Identifier: NRR_DRMA
Email Number: 2268

Mail Envelope Properties (BY5PR09MB59562D39DBD9BF0A88491057E0CAA)

Subject: ACU MSRR PSAR Section 2.5 Audit Questions (Round 2)
Sent Date: 10/5/2023 5:17:54 PM
Received Date: 10/5/2023 5:17:00 PM
From: Edward Helvenston

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Files	**Size**	**Date & Time**
MESSAGE	930	10/5/2023 5:17:00 PM
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Options
Priority: Normal
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:

ACU Chapter 2, Geotechnical Engineering Questions

The following regulatory basis covers, as applicable, the questions below related to ACU PSAR Section 2.5 and geotechnical engineering.

The regulation 10 CFR 50.34(a)(1)(i) requires, in part, that the PSAR include "[a] description and safety assessment of the site on which the facility is to be located, with appropriate attention to features affecting facility design."

Section 50.34(a)(4) requires, in part, that the PSAR include "[a] preliminary analysis and evaluation of the design and performance of structures, systems, and components of the facility with the objective of assessing the risk to public health and safety resulting from operation of the facility and including determination of the margins of safety during normal operations and transient conditions anticipated during the life of the facility, and the adequacy of structures, systems, and components provided for the prevention of accidents and the mitigation of the consequences of accidents."

Section 50.34(a)(7) requires, in part, that the PSAR include "[a] description of the quality assurance program to be applied to the design, fabrication, construction, and testing of the structures, systems, and components of the facility."

ORNL/TM-2020/1478 (ML20219A771), Part 1, Section 2.5, states that applicants should detail the seismic and geologic characteristics of the site and the region surrounding the site. The staff notes that consistent with common engineering practice, site investigations should be adequate to permit a proper determination of the geologic and geotechnical conditions that potentially could affect the design, performance, and safety of structures.

Question 2.5-9

On April 11, 2023, in response to Audit Question 2.5-2 (ML23086A017) and others provided by the NRC staff as part of the ACU PSAR Chapter 2 and 3 Audit (ML23065A048), ACU provided its "Geotechnical Investigation Report" for the MSRR for NRC staff audit. Part 1.2 of the geotechnical investigation report indicates that the "report is provided for general information only" and that the "owner or architect neither guarantee nor accept any responsibility for soil investigation data."

A. Please discuss how ACU concluded that the geologic and geotechnical conditions of the MSRR site, and associated uncertainties, have been appropriately determined and considered in light of the referenced statements in the "Geotechnical Investigation Report."

B. PSAR Section 12.9 states that the Quality Assurance Program Description for the design and construction of the MSRR was submitted as a topical report that was approved by the NRC (ML22293B802). However, PSAR Chapter 2 does not appear to include information about a quality assurance program for the site investigation. Please clarify what quality assurance plan ACU used for the site investigation, and explain and justify how ACU determined that there was adequate quality assurance for the site investigation.

Question 2.5-10

On April 11, 2023, in response to Audit Question 2.5-3 (ML23086A017) and others provided by the NRC staff as part of the ACU PSAR Chapter 2 and 3 Audit, ACU provided its "Geotechnical Investigation Report" for NRC staff audit. On June 5 and August 10, 2023, ACU also provided a written response and a draft PSAR revision (including draft revisions to PSAR Section 2.5.5), respectively, for audit in response to Audit Question 2.5-3. However, ACU did not appear to include information justifying the adequacy of the borings used for defining and assessing factors that affect the MSRR pit foundation system stability, specifically, the limited depths of the borings. In addition, in the draft PSAR Section 2.5.5 revision provided for audit, ACU updated the maximum allowable bearing pressure to be 40 kilopounds per square foot (ksf) instead of 17 ksf. but the information provided for audit including the "Geotechnical Investigation Report" does not appear to provide further details or discussion on the parameters and methodology used for determining the maximum available bearing pressure to be 40 ksf. The staff notes that the geotechnical conditions of subsurface materials underlying the site will influence the stability of the MSRR pit structures.

A. Justify the adequacy of boring depths for defining and assessing factors that potentially affect the MSRR pit foundation system stability (such as soil bearing capacity and settlement), including the basis for characterizing geotechnical properties to a depth of 60 feet, which is only 5 feet below the drilled pier toe, as described in the "Geotechnical Investigation Report" provided for audit. Specifically, discuss how ACU concluded that the borings, particularly B-8 and B-9, were adequate to characterize the soil strata below the MSRR pit foundation system, such that no additional site investigation was necessary to identify if layers of weaker material may exist below the MSRR pit foundation system that potentially could affect the soil bearing capacity, structural integrity, performance, and intended function of the MSRR pit drilled piers.

B. The "Geotechnical Investigation Report" provided for audit reports the recommended allowable bearing capacities. However, the NRC staff notes that the "Geotechnical Investigation Report" does not appear to adequately characterize the rock mass conditions needed to evaluate the rock mass bearing capacity. In discussions of Audit Question 2.5-2 and others on May 17-18, 2023, as part of the ACU PSAR Chapter 2 and 3 Audit, ACU stated that it will revise the PSAR to explain how the MSRR pit drilled piers are designed to bear loads considering adequate margin of safety for rock condition variations. However, the NRC staff notes that the draft PSAR Chapter 2 revisions provided for audit in response to Audit Question 2.5-2 and others on August 10 and 14, 2023, do not appear to include the stated revisions. Please provide information to demonstrate that the geotechnical conditions and associated uncertainties of the soil and rock mass conditions encountered through the depth of influence have been adequately investigated, determined, and considered, as appropriate. For example, please discuss as appropriate:

- Rock mass condition consideration. (The NRC staff notes that in general, bearing capacities must be reduced where the rock is weathered, fractured, or is non-homogeneous and contains seams of weak and decomposed rock.)
- Sufficient minimum depth of exploration. (The NRC staff notes that common engineering practice provide guidance for minimum depth of exploration. For example, where appropriate, exploration should be conducted at least to a depth where stress increase due to estimated foundation load is less than 10 percent of the effective overburden stress at that depth, and/or a minimum of 10 feet below the pier tip elevation, in order to

determine the geotechnical characteristics of rock/soil within the zone of foundation influence.)

C. In discussions of Audit Question 2.5-2 and others on May 17-18, 2023, as part of the ACU PSAR Chapter 2 and 3 Audit, ACU stated that it will revise the PSAR to include a discussion of steps of how soil bearing capacities were obtained and why the margin of safety is adequate. However, the NRC staff notes that the draft PSAR Chapter 2 revisions provided for audit in response to Audit Question 2.5-2 and others on August 10 and 14, 2023, do not appear to include the stated revisions (as discussed above, ACU provided a draft PSAR Section 2.5.5 revision for audit which updates the maximum allowable bearing pressure to be 40 ksf, but does not provide a clear basis for this updated value). The NRC staff notes that ACU's As-Built Design Drawing S-001, provided for audit on May 5, 2023, reports the MSRR pit foundation system drilled pier soil allowable bearing capacity to be 40 ksf, with allowable skin frictions ranging between 3 and 5 ksf depending on the depth of piers.

a. Please justify how the reported bearing capacity (40 ksf) in the draft PSAR Section 2.5.5 revision provided for audit was determined. In addition, please discuss how ACU determined the pier skin frictions values for the MSRR site and confirm they are consistent with those reported in As-Built Design Drawing S-001. As appropriate, provide the factor of safety (FOS) applied from the ultimate capacities to the allowable capacities.
b. The NRC staff also notes that the existence of subterranean water, as noted in PSAR Sections 19.3.4.2 and 19.3.5.2, may challenge bearing capacity and skin friction values. Clarify whether the bearing capacity and pier skin friction values determined for the MSRR site took into consideration the existence of below grade water for the piers (see also Audit Question 2.5-12.B).

Question 2.5-11

In response to NRC staff questions in the PSAR Chapter 2 and 3 Audit, ACU provided a draft PSAR Section 2.5 revision for audit indicating that local building codes, which are based on ASCE 7-10, "Minimum Design Loads for Buildings and Other Structures," were followed for the SERC building that will house the reactor, including site investigation and preparation. In specific response to Audit Question 2.5-4 (ML23086A017), ACU provided a draft PSAR Section 2.5.2 revision for audit which states that the structural design of the SERC provides sufficient slab and pier rigidity to avoid differential settlement. However, based on information in the PSAR and information provided for audit, it is not fully clear to the staff how ACU analyzed potential foundation settlement and other potential geologic hazards consistent with engineering common practice and standards (e.g., ASCE 7-10). Consistent with ASCE 7-10, please discuss, as appropriate, how ACU considered the following in its evaluation of the MSRR site: total and differential settlement (the draft PSAR Section 2.5.2 revision referenced above mentions differential settlement but does not provide details of any analysis), lateral earth pressures (at rest, passive, and active) at the MSRR pit structures, pier skin friction capacity, and drilled pier end bearing capacity. Please include, as appropriate, information summarizing the methodologies and selected geotechnical engineering properties and parameters used for analyses, with the basis of your assumptions; as well as the results of the foundation stability analyses.

Question 2.5-12

In response to Audit Question 2.5-6 (ML23086A017) in ACU PSAR Chapter 2 and 3 Audit, during audit discussions on May 17-18, 2023, and in a draft Audit Question 2.5-6 response provided for audit on June 5, 2023, ACU indicated that the liquefaction analysis for the MSRR site is complete and therefore it would remove information from the PSAR deferring a liquefaction analysis to a MSRR operating license application, and add detail to the PSAR referencing the "Geotechnical Investigation Report" (provided for audit on April 11, 2023) with respect to liquefaction analysis. However, the NRC staff notes that the "Geotechnical Investigation Report" does not appear to contain information about the liquefaction potential analysis (i.e., method of analysis, calculations, soil properties used, etc.).

In a draft revised PSAR Section 2.5.7 provided for audit on August 10, 2023, in response to Audit Question 2.5-6, ACU indicates that ASCE 7-10 requirements were followed to evaluate possibility for liquefaction.

ORNL/TM-2020/1478, Part 1, Section 2.5.7 states:

> The applicant should discuss soil structure. If the foundation materials at the site adjacent to and under safety-related structures are saturated soils or soils that have a potential for becoming saturated, the applicant should prepare an appropriate state-of-the-art analysis of the potential for liquefaction at the site. The applicant should also determine the method of analysis based on actual site conditions, the properties of the reactor facilities, and the earthquake and seismic design requirement for the protection of the public.

A. In PSAR Section 2.5.7, ACU indicates that the soil at the MSRR site is not typically saturated, and that the soil at the site is primarily silty clays; therefore, the risk of liquefaction is low (this portion of PSAR Section 2.5.7 is unchanged in the draft revised PSAR Section 2.5.7 provided for audit on August 10, 2023). However, the NRC staff notes that some silts and clays can be subject to liquefaction, and that liquefaction susceptibility criteria are commonly used to determine liquefaction susceptibility for silts and clays based on engineering common practice. Please discuss the liquefaction susceptibility criteria ACU used to determine that there is no need to perform a state-of-the-art analysis for potential soil liquefaction, and/or provide information on how the ASCE 7-10 requirements were followed to evaluate the liquefaction potential as indicated in the draft revised PSAR Section 2.5.7 provided for audit on August 10, 2023.

B. PSAR Sections 2.5.2, 19.3.4.2, and 19.3.5.2, and the "Geotechnical Investigation Report" provided for audit indicate that groundwater exists at 9 to 11 feet below grade in the majority of the boreholes which extend to a depth below this depth. In addition, the NRC staff notes that ACU construction drawing S-501, provided for audit on May 5, 2023, shows the existence of a sump pump at 6 feet below grade, which suggest potential concerns regarding water infiltration in SERC areas below grade, including the MSRR pit. PSAR Section 2.5.2 also states that "[t]he groundwater table is estimated to exist at depths greater than 35 ft (11 m) below current grades." (The referenced portions of PSAR Section 2.5.2 are unchanged in the draft PSAR Section 2.5 revisions provided for audit on August 10 and 14, 2023). PSAR Section 19.3.4.2 states that based on soil moisture content, the groundwater table is considered to exist below 35 feet across the site. However, given other information in the PSAR and provided for audit, it is not clear to the NRC staff how ACU concluded that the groundwater table is at depths greater than 35 feet below grade. In the draft revised

PSAR Section 2.5.7 provided for audit on August 10, 2023, in response to Audit Question 2.5-6, ACU indicated that following drilling for the foundation piers, there was minimal observable water in only one hole, but this draft PSAR revision does not provide additional information on the groundwater table. The response to Audit Question 2.5-6 that ACU provided for audit on June 5, 2023, also did not include information about the groundwater table. Please clarify the location and depth of the groundwater table at the site, and justify how ACU concluded that the soil is not typically saturated (see PSAR Section 2.5.7) above and below the drilled pier foundation level when most of the boreholes show existence of groundwater between 9 to 11 feet.

C. PSAR Figure 2.5-17 indicates that the MSRR site soil, in general, has a plasticity index (PI) > 17 and a liquid limit between 32 and 47 percent. PSAR Sections 19.3.5.2 and 19.3.4.2 note the existence of groundwater either below 35 feet below grade and/or at 9 to 11 feet during the rainy season. However, neither the PSAR nor the “Geotechnical Investigation Report” provided for audit appear to discuss the chemical properties or condition of the ground water as they pertain to assessment of the degradation potential for the foundational piers. As appropriate, please provide information regarding ground water conditions and evaluation of chemical properties of the groundwater such as sulphate, chloride and pH that may potentially impact long-term behavior of foundation drilled piers (concrete and reinforcing steel).