Comanche Peak Units 3 & 4

NRC Geology Safety Site Visit – July 28-30, 2009
RAIs 19 and 22

RAI 2.5.4-1

The Comanche Peak Units 3 and 4 (CPNPP) Final Safety Analysis Report (FSAR), in Section 2.5.4 (for example pages 121 and 129), states that the site "conforms to a relatively uniform site condition." The laboratory data obtained for samples tested from immediately beneath and to the sides of the power block structures, indicates potentially significant variability in properties (see, for example, Figures 2.5.4-219 and onward, data ranges described in Sections 2.5.4.2.3.1.1 and 2.5.4.2.3.3). Please provide the criteria used to make the judgment that the proposed site "conforms to a relatively uniform site condition[,]" and indicate if the assessment is appropriate for both site response and soil-structure interaction (SSI) assessments for which specific uniformity criteria are assumed.

RAI 2.5.4-2

Section 2.5.4.1.2 (page 124) of the FSAR indicates that the materials beneath the footprint of the facilities may contain localized zones or thin beds of poorly cemented or soft materials. These materials are discounted from having an important effect on response of performance or stability of the plant foundations on the basis of the small percentage of thickness of these materials as compared to the total thickness of the layer. Please provide information on the variability of these softer materials across the footprint of the facilities, and describe any potential impact these softer materials have on soil-structure interaction and structural response of the basemat. Please provide specific criteria on assessing their impact on uniformity assessments.

RAI 2.5.4-3

Section 2.5.4.2.3.3 of the FSAR discusses the dynamic properties of rock and soil, but only discusses shear wave velocity and damping properties, and indicates that these were determined from the geophysical program. . Please provide additional information about how material damping was measured for both S- and P-wave velocities, and how material hysteretic damping was determined for site materials for both the shallow and deep velocity profiles.

RAI 2.5.4-4

Calculation No. TXUT-001-FSAR-2.5-CALC-004 "Engineering Stratigraphy" indicates measured variability of the stratigraphic profile in the vicinity of the power block structures. Please provide additional information to demonstrate that this variability is within the range associated with the uniformity assumptions made in the site response and soil-structural interaction analyses conducted to estimate seismic response.

RAI 2.5.4-5

Appendix D, "Spacing and Depth of Subsurface Explorations for Safety-Related Foundations," to Regulatory Guide 1.132, "Site Investigations for Foundations of Nuclear Power Plants," Revision 2 (October 2003), provides guidance for site exploration plans for safety-related foundations. One of the recommendations suggests spacing one principal boring, which is used to explore site soil or rock strata and define the site geology and the properties of the subsurface materials, per 30 m (100 ft) for tunnel or essentially linear structures. Figure 2.5.4-202 of the FSAR illustrates the exploration locations. For the west side Essential Service Water Pipe Tunnel (ESWPT) of both Units 3 and 4, the figure indicates a couple of boring locations on the side east of the structures. However, the proposed borehole is neither within the footprint nor on the side west of the structures. Taking into consideration the complexity of anticipated subsurface conditions, please explain why there is not a boring location within the footprint of west ESWPT for both Units 3 and 4.

RAI 2.5.4-6

FSAR Section 2.5.4.2.2.2.16 "Laboratory-Based Shear Wave Velocity" mentions that laboratory measurements of shear wave velocity on relatively undisturbed samples of shale, limestone and sandstone were performed. This section indicates that this testing was performed to determine the rock's degree of disturbance. FSAR Figure 2.5.4-238 provides Laboratory Shear Wave Velocity measurements vs. elevation. Given the large degree of variability in shear wave velocities encountered in the limestone layer, please discuss how this meets the uniformity criteria mentioned in FSAR Section 2.5.4.2.

RAI 2.5.4-7

FSAR Subsections 2.5.4.2.2.2.5 and 2.5.4.2.3.4.4 state that the organic content of specimens was determined in general and the test results are provided in the Laboratory Test Data Report. Please clarify whether any test results for undocumented fill are included in these test results. In addition, were any tests for chemical properties performed to determine chemical contents of the undocumented fill, such as pH value, chlorides, sulfates, etc? Please provide information on these chemical contents, and assess the potential impact on the groundwater chemicals due to these chemical contents.

Comanche Peak Units 3 & 4

RAI 2.5.4-8

TXUT-001-FSAR 2.5-CALC-003 "Shallow Velocity Profile Development-Slope Method," Page 8, indicates that no velocity measurements were taken from depths 415 ft to 465 ft. In this region, the velocities are inferred from other data.

1. **Please explain why the variability in properties for this region is not increased, since the velocities are not based on measurements.**
2. **On the basis of the lack of actual measured data, explain why the apparent larger uncertainty associated with this portion of the profile is or is not reflected in increased variability of the design velocity profile in this section, as opposed to the level of variability one would expect when using the maximum range from the measured data.**
3. **In the alternative, demonstrate quantitatively, that there is good correlation between the parameters used to extend the measured velocities and the actual measured velocities.**

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Comanche Peak Units 3 & 4

RAI 2.5.4-9

Sections 2.5.4.1.5 and 2.5.4.5.1 of the FSAR indicate that the power block structures are set back from the top of the reservoir slopes about 150' to 200', and that no evidence of previous landsliding has been found. Please clarify whether there are any assessments for the adequacy of this standoff distance to provide sufficient support for soil-structural interaction and lateral sliding. Also, please provide the specific evaluations performed to indicate that this standoff distance has been taken into account, and identify whether there have been any impacts to the stability evaluation for facilities of the plan area of the power blocks.

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RAI 2.5.4-10

FSAR Figure 2.5.4-217 shows a general conceptual excavation cross-section. Please describe the procedure that will be followed during site excavation and construction activity to ensure that appropriate strata for proposed foundation locations, as described in the FSAR, are confirmed through objective measures and the exposed foundation laying surface is uniform. Any part of the contact surface of foundation that is shale and not Glen Rose limestone, should be removed and the remedial measures should be described in the FSAR. Please provide vertical and horizontal extent of all seismic categories I excavations, fills, and slopes, including the locations and limits of excavations, fills, and backfills on plot plans and geologic sections and profiles.

RAI 2.5.4-11

- Subsection 2.5.4.5.1.2 in the FSAR proposes that concrete fill will be used for foundation preparing, and further states that the fill concrete has a design compressive strength of 3,000 psi to meet the strength requirement. Please address the concrete durability, as described in American Concrete Institute (ACI) 201.2R, for fill concrete.
- Erosion of porous concrete sub-foundation, as described in NRC Information Notice (IN) 97-11, and leaching of calcium hydroxide could be potential problems, since the assumed water ground table (EL. 780 ft) is very close to proposed approximate excavation bottom (about EL. 782 ft), and even could be higher than some localized excavation areas, which need to be deepened below EL. 782 ft to remove disturbed or unstable material. In addition, ground water and perched water seeping down along the sides of the structures could cause potential impact on porous concrete fill. Please explain how the differential settlement due to erosion, and loss of concrete strength due to leaching, will be addressed, and provide justification for the manner in which these potential issues will be addressed.

RAI 2.5.4-12

By letter dated April 2, 2009, Luminant provided a revision to FSAR Subsection 2.5.4.5.4.1.2 "Fill Concrete." In its revision, Luminant proposed using the American Society for Testing and Material (ASTM) C94/C94M-07 "Standard Specification for Ready-Mixed Concrete," for use of ready mixed concrete for backfill purposes. The bulk of the ASTM C94/C94M standard is a performance, or end-result, specification. ASTM C94/C94M does not prescribe a method of achieving these requirements and results, such as how to achieve the slump, the air content, the temperature, or minimum strengths. Please indicate why the ASTM C94/C94M standard, and not the standard in American Concrete Institute 349, will be used.

RAI 2.5.4-13

Although the backfill material sources have been identified as excavated limestone in FSAR Section 2.5.4.5.4, please discuss the steps that will be taken to avoid inclusion of shale, or other undesirable material, which is unsuitable for structural backfill.

RAI 2.5.4-14

Table 4 of TXUT-001-PR-007, "Dynamic Profile," provides dynamic properties of subsurface rock materials. Please clarify the following:

a. **Table 4 refers to Curve 1, 2, 3, 4, 5, Figures 1 or 2 for the relationship describing the variation in shear modulus and damping to strain. Please include these figures in the document.**
b. **Table 4 indicates that the Cv used for upper bound (UB) and lower bound (LB) are not the same for some layers, which would indicate that some distribution other than lognormal is used for the shear moduli. What is the basis for use of the non-log normal distribution for soil/rock properties?**
c. **Note 11 of Table 4 refers to Figure 2b for damping. Please include this figure in the document.**
d. **Subnotes C and D of Table 4 indicate that the damping has been adjusted downward for use in development of the ground motion response spectra (GMRS). Please reflect this change in the text.**

RAI 2.5.4-15

FSAR Section 2.5.4.8 states "Thus, the engineered compacted fill does not meet the conditions stated in RG 1.206 or RG 1.198 that would cause suspicion of a potential for liquefaction, and no liquefaction analysis is necessary. Even in the unlikely event that the engineered compacted fill became completely saturated, the soil density is too high and the site PGA range is too low to suspect a potential for liquefaction". Please provide a quantitative comparison to validate the statement, given that some fill material will be granular. Also, please provide an analysis to verify the effect of potential liquefaction of duct banks and buried safety related piping and tunnels.

RAI 2.5.4-16

Please provide a reference to the appropriate section in Chapter 19 where seismic margins analysis for site specific soil liquefaction and bearing capacity with respect to an earthquake of 1.67 times the Safe Shutdown Earthquake are demonstrated.

RAI 2.5.4-17

Section 2.5.4.10.1 of the FSAR indicates values of ultimate bearing capacity. Calculation No. TXUT-001-FSAR-2.5-CALC-009, "Settlement and Bearing Capacity," indicates that these were determined from standard formulae associated with static load conditions. The statement is made (FSAR page 189) that the ultimate bearing capacity of the Glen Rose Formation is 146 ksf. Please provide information on how dynamic effects were included in the assessment of ultimate bearing capacity, compare the ultimate bearing capacity with dynamic bearing demand, and assess safety factors under dynamic loads.

RAI 2.5.4-18

Section 2.5.4.10.5 of the FSAR indicates that resistance to lateral loads can be achieved by both passive soil pressure as well as friction below the base. Please provide information on how safety against sliding was computed incorporating consistent displacement estimates for both friction under the basemat and passive pressure estimates. Please provide information on how ultimate friction coefficients were computed between basemat and fill materials potentially located under the basemat.

RAI 2.5.4-19

FSAR Section 2.5.4.10.4 "Lateral Earth Pressure" reference FSAR Figure 2.5.4-242-2.5.4.-243 which provides calculation of the lateral active and at-rest pressures for selected granular backfill. Please provide sample calculations considering effects of the seismic lateral earth pressure on the retaining structures.

Comanche Peak Units 3 & 4

RAI 2.5.4-20

Calculation No. TXUT-001-FSAR-2.5-CALC-009, "Settlement and Bearing Capacity," indicates that the 50th percentile ultimate strength of the shale material is approximately 10 to 15 tsf, while the dynamic demand under the reactor building (static plus seismic loads) is over 30 tsf. The dynamic demands under the other facilities are also high, relative to this ultimate material strength. Please provide information to indicate that the shale material, as well as other such low-strength materials, will not be found under the power block facilities, and the program that will be used for confirmation.

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Comanche Peak Units 3 & 4

RAI 2.5.4-21

FSAR section 2.5.4.10.2, "Settlement," states that "settlement estimates are based on interpreted compressibility characteristics and elastic modulus properties of Glen Rose Formation limestone and shale materials, as discussed in Subsection 2.5.4.2." Please provide the settlement monitoring program that will be used during and after construction.

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RAI 2.5.5-1

FSAR Section 2.5.5.2.5. states that a pseudo-static method was used for the slope stability analysis at the site. The guidance described in SRP 2.5.5.2 specifies that both vertical and horizontal motions be considered in the evaluation of slope stability. Demonstrate how the vertical motion was considered in the slope stability analyses.

RAI 2.5.5-2

FSAR Figure 2.5.5-210 presents the static stability analysis for Cross Section E-E'. The slope stability failure surface indicated in this Figure appears to be pushed up above the retaining wall. Indicate whether the Factor of Safety is dependent upon the capacity of the wall. Please provide a description of the design of this wall.

RAI 2.5.5-3

FSAR Subsections 2.5.4.1.5 and 2.5.5.1.2 indicate that localized surficial erosion and raveling have occurred in undocumented fill and/or native colluvial soils on the reservoir slopes, and conclude that this is a surficial condition that does not present a significant slope stability hazard to the CPNPP Units 3 and 4 plant sites. Please provide information including (1) to what extent the "localized surficial erosion and raveling" has happened, (2) the technical basis of the applicant's conclusion that there is no significant slope stability hazard, and (3) what, if anything, the applicant intends to do to ensure the maintenance and protection the slope for CPNPP Units 3 and 4. In addition, please explain whether this local erosion and raveling is considered as a factor in the slope stability analyses presented in Subsection 2.5.5.3.