Nuclear Operating Company
South Texas Project Electric Generating Station P.O. Box 289 Wadsworth, Texas 77483

April 1, 2009
U7-C-STP-NRC-090025

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

South Texas Project
Units 3 and 4
Docket Nos. 52-012 and 52-013
Responses to Requests for Additional Information

Attached are responses to NRC staff questions included in Request for Additional Information (RAI) letter number 78, related to Combined License Application (COLA) Part 2, Tier 2, Sections 2.5S. This submittal forms a complete response to RAI letter number 78. Attachments 1 through 6 include responses to the following RAI questions:

02.05.04-16	02.05.04-18	02.05.04-20
02.05.04-17	02.05.04-19	02.05.04-21

There are no commitments in this letter.

If you have any questions regarding these responses, please contact me at (361) 972-7136, or Bill Mookhoek at (361) 972-7274.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on 4/1/09

Scott Head
Manager, Regulatory Affairs
South Texas Project Units 3 & 4

rhb

Attachments:
1. Question 02.05.04-16
2. Question 02.05.04-17
3. Question 02.05.04-18
4. Question 02.05.04-19
5. Question 02.05.04-20
6. Question 02.05.04-21

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NRO

STI 32450246

cc: w/o attachment except*
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RAI 02.05.04-16:

QUESTION:

The supplemental dewatering information indicates that the drawdown will be a minimum of 3 feet below side-slopes; however, the temporary excavation slope stability analyses indicate that acceptable factors of safety require drawing down the phreatic surface to a minimum of 5 feet below the slope surface. In order for the staff to review the adequacy of the dewatering plan, please coordinate these two supplements.

RESPONSE:

The supplemental dewatering information (*Dewatering Plan Rev. D, Section 2.1*) requires a clarification in the wording of the drawdown value as follows:

"*The water level will be maintained a minimum of 3 feet below the bottom of the excavation and 5 feet below the faces of slopes to achieve a **minimum** slope stability factor of safety of 1.3.*"

The second paragraph of FSAR Subsection 2.5S.4.5.4.1 "Dewatering Method" will be revised as follows:

> The dewatering system is designed to lower and maintain the free-water and hydrostatic pressures inside the construction and foundation area to a minimum of at least 3 feet below ~~earth slopes and excavation surfaces, inclusive of the interior slopes of any retaining structure embankments~~ the bottom of the excavation.

The sixth paragraph of FSAR Subsection 2.5S.4.5.4.1 "Dewatering Method" will be revised as follows:

> The dewatering plan, Figure 2.5S.4-50, shows the anticipated dewatering zones. Figures 2.5S.4-51 and 52 show typical sections and details for each type of dewatering system that may be utilized. Figure 2.5S.4-53 shows a typical section of the slurry wall and dewatering systems. Due to the magnitude of the excavation, it is anticipated that a series of deepwells, sand drains, eductors and/or wellpoints may also be required within the excavation to maintain the piezometric levels a minimum of 3 feet below ~~slopes and~~ the bottom of the excavations and 5 feet below the faces of the slopes to achieve a minimum slope stability factor of safety of 1.3. Multiple piezometers or monitoring wells are installed inside and outside the slurry wall to monitor the effect the dewatering system will have on the groundwater elevation. The monitoring system is established to measure and evaluate the effectiveness of the dewatering system and to assess the stability of the cut slopes. Instruments are monitored as necessary to provide data.

RAI 02.05.04-17

QUESTION:

The large strain elastic moduli for each of the clay layers were calculated using the average of values computed from Equation 2.5S.4-4, ($E = 600S_u$), and equation 2.5S.4-5, $E=2G(1+m)$. The results were averaged using a weighted formula that favored the shear wave velocity-derived value 2:1, as in the case for the sand layers. Equation 2.5S.4-4 was derived from a study performed on Beaumont Clays and therefore would seem to be valid for the Beaumont clays at the South Texas site. Please explain why the two methods generally provide significantly different results, and why the shear wave velocity-derived results are favored by 2:1 in computing an average value for use in predicting immediate settlements.

RESPONSE:

The following changes were proposed in the COLA mark-up submitted in conjunction with RAI response 02.05.04-13, Supplement 1 on February 23, 2009, under letter number U7-C-STP-NRC-090012. The following paragraphs were proposed additions to Section 2.5S.4.2.1.1, second and third paragraphs after Equation 2.5S.4-7:

> Note that the empirically-based modulus values to accompany the velocity-based modulus values are computed for clay layers using Equations 2.5S.4-4A and 2.5S.4-4B. For sand layers, the empirically-based modulus values come from Equation 2.5S.4-13. The empirically-based modulus values and the velocity-based modulus values are summarized in Table 2.5S.4-14. The values in Table 2.5S.4-14 indicate the empirically-based modulus values are compatible with the velocity-based values.
>
> The small strain modulus (Equations 2.5S.4-5 and -6) determined from the measurement of wave velocities in-situ is the highest achievable stiffness. Because it is measured in-situ at non-destructive strains it is considered to be a "benchmark". Because of these factors, the velocity-derived results for modulus are assigned a weighting of (2:1) compared to the modulus estimate from undrained shear strength (S_u) or SPT values (N).

No additional COLA revisions are required as a result of this RAI response.

RAI 02.05.04-18

QUESTION:

The large strain elastic modulus for each of the sand layers were calculated using the average of values computed from Equation 2.5S.4-13, (E = 36N), and equation 2.5S.4-5, E=2G (1+m). The results were averaged using a weighted formula that favored the shear wave velocity-derived value 2:1, as in the case for the clay layers. Equation 2.5S.4-5 was derived from a study performed on New England sands and gravels and the results agreed with other relationships reported in the literature. Please explain why the two methods generally provide significantly different results, and why the shear wave velocity-derived results are favored by 2:1 in computing an average value for use in predicting immediate settlements.

RESPONSE:

The following changes were proposed in the COLA mark-up submitted in conjunction with RAI response 02.05.04-13, Supplement 1 on February 23, 2009, under letter number U7-C-STP-NRC-090012. The following paragraphs were proposed additions to Section 2.5S.4.2.1.1, second and third paragraphs after Equation 2.5S.4-7:

> Note that the empirically-based modulus values to accompany the velocity-based modulus values are computed for clay layers using Equations 2.5S.4-4A and 2.5S.4-4B. For sand layers, the empirically-based modulus values come from Equation 2.5S.4-13. The empirically-based modulus values and the velocity-based modulus values are summarized in Table 2.5S.4-14. The values in Table 2.5S.4-14 indicate the empirically-based modulus values are compatible with the velocity-based values.
>
> The small strain modulus (Equations 2.5S.4-5 and -6) determined from the measurement of wave velocities in-situ is the highest achievable stiffness. Because it is measured in-situ at non-destructive strains it is considered to be a "benchmark". Because of these factors, the velocity-derived results for modulus are assigned a weighting of (2:1) compared to the modulus estimate from undrained shear strength (S_u) or SPT values (N).

No additional COLA revisions are required as a result of this RAI response.

RAI 02.05.04-19

QUESTION:

The elastic modulus, E, for clay soils and coarse grained soils, was evaluated using relationships found in Reference 2.5S.4-9, "Settlement of Two Tall Chimney Foundations". The reference states that heavily over-consolidated clays are assumed to behave in an elastic or pseudo-elastic manner when loaded at a level well below their pre-consolidation pressure. The reference says that same is true for sands. The derivation of the relationship for the clay was based on a loading of approximately half the pre-consolidation pressure. It is assumed that for this relationship to be valid for South Texas site, the same ration of gross stress to pre-consolidation pressure in each clay layer to the imposed stresses down to the maximum depth of interest. If the loading is greater than one-half the pre-consolidation pressure, please indicate why this relationship is still valid for computing immediate settlements at the South Texas Project.

RESPONSE:

The following changes were proposed in the COLA mark-up submitted in conjunction with RAI response 02.05.04-13, Supplement 1 on February 23, 2009, under letter number U7-C-STP-NRC-090012. The following paragraph was a proposed addition to Section 2.5S.4.2.1.1, second paragraph after Equation 2.5S.4-3B:

> The elastic modulus of the various soil layers is used herein to represent the soil compressibility for purposes of settlement estimates. This is justified because the soils behave as overconsolidated. Settlement estimates later herein are based on the dewatered condition where the water table is kept artificially lowered to 5 ft below the bottom of the excavation throughout the process of loading the foundation areas. Even with this dewatered condition, the effective stresses in the soil layers do not exceed the preconsolidation pressures except the small amounts in limited locations described later. (The compression of the soil layers in these limited locations is modeled using the consolidation test data as described in Equation 2.5S.4-29). When construction dewatering ends and the water table rises, buoyancy will reduce the effective stresses in all soil layers below the final water table and thus the final effective stresses will be less and will not exceed the preconsolidation stress. This supports the use of the elastic modulus to model the soil for settlement purposes.

In addition to the above, STP will revise Section 2.5S.4.2.1 to include the following:

> The stress-based equation for the modulus ratio does not associate with the criterion of one-half of the pre-consolidation pressure. The stress-based equation gives essentially the same modulus ratio as the equation being discussed. Therefore, it is reasonable to use either equation in spite of the fact that the loading exceeds one-half of the pre-consolidation pressure at times during the loading. When the site is re-watered, the stresses become less than the pre-consolidation pressure due to buoyancy.

RAI 02.05.04-20

QUESTION:

The elastic modulus computed using equation 2.5S.4-5, E=2G(1+m), assumes strain in the range of 0.25% to 0.50%. Please indicate the level of strain in the sands and clays for which this relationship was used.

RESPONSE:

The following changes were proposed in the COLA mark-up submitted in conjunction with RAI response 02.05.04-13, Supplement 1 on February 23, 2009, under letter number U7-C-STP-NRC-090012. The following paragraph was a proposed addition to Section 2.5S.4.2.1.1, first paragraph after Equation 2.5S.4-7:

> Equation 2.5S.4-7 is a "strain-based" approach to determining the large strain static modulus from the modulus at small strains. Equation 2.5S.4-7 gives modulus ratios (large strain to small strain) of 0.28 to 0.34 for the clay layers, which have PI values between 35 and 50. Note that later herein a "stress-based" approach (Equation 2.5S.4-14) that incorporates the factor of safety with respect to the ultimate stress is applied to the sand layers. If Equation 2.5S.4-14 were applied to the clay layers in lieu of strain-based Equation 2.5S.4-7, the modulus ratio would be 0.30. The velocity-based modulus thus determined for the clay layers would be about the same value. Thus it is determined that velocity-based modulus values for the clay layers could be determined using either Equation 2.5S.4-7 or Equation 2.5S.4-14. Because of the agreement with Equation 2.5S.4-14, it is not considered necessary to correlate Equation 2.5S.4-7 with the actual strain computed in each clay layer. Note that for the layers N Sand and N Clay and deeper, the incremental stress levels applied from the construction are lower, the factor of safety is higher, and a modulus ratio equal to 0.5 is considered appropriate.

No additional COLA revisions are required as a result of this RAI response.

RAI 02.05.04-21

QUESTION:

STPNOC letter dated December 20, 2007, ABR-AE-07000014, Appendix A states in response to Issue 9(f), "STPNOC is aware of the potential for settlement and differential settlement at this site based on lessons learned during the construction of STP 1 & 2. STPNOC will develop a program to manage settlement and differential settlement, and will share the program with the NRC."

Because of the uncertainties in calculating settlement and the magnitude of the predicted settlements, please describe the acceptance criteria and method(s) you will use to ensure that essentially all the settlement is complete prior to fuel load. Please also describe how you will ensure that no excessive stresses will result in any structures, systems or components of the Category 1 structures as a result of the settlements and differential settlements within and/or between safety-related structures.

RESPONSE:

The following changes were proposed in the COLA mark-up submitted in conjunction with RAI response 02.05.04-13, Supplement 1 on February 23, 2009, under letter number U7-C-STP-NRC-090012. The following paragraphs were proposed additions to Section 2.5S.4.10.4, last paragraph:

> Construction sequencing will be necessary to address the time-rate of settlement for the Category 1 structures. The structural and mechanical considerations (addressed during design) will influence differential settlement tolerances between structures. Experience during settlement monitoring of STP Units 1 & 2 (Reference 2.5S.4-3) will be used to assist with the time-rate of settlement projections.

In addition to the above, STP will revise Section 2.5S.4.10.4 to include the following sentence at the end of the above paragraph:

> The acceptance criteria for settlement of Category 1 structures will be developed during design of these structures and will be consistent with the DCD.