Nuclear Operating Company

South Texas Project Electric Generating Station 4000 Avenue F – Suite A Bay City, Texas 77414

July 24, 2008
ABR-AE-08000055

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
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Rockville MD 20852-2738

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

Attached are responses to NRC staff questions included in Request for Additional Information (RAI) letter numbers 33, 39, 40, 49, and 50 related to Combined License Application (COLA) Part 2, Tier 2 Sections 2.4S and 2.5S. This submittal includes responses to the following Questions:

02.04.04-2	02.04.12-6	02.04.13-3	02.05.01-1	02.05.02-8
	02.04.12-10			02.05.02-9
	02.04.12-16			
	02.04.12-24			
	02.04.12-26			

When a change to the COLA is indicated by a Question response, the change will be incorporated into the next routine revision of the COLA following NRC acceptance of the response.

Response to Question 02.05.02-9 refers to a current commitment to the NRC (COM 2.5S-1). There are no new commitments made in this letter.

If you have any questions regarding the attached responses, please contact me at (361) 972-7206, or Greg Gibson at (361)-972-4626.

D079
NRO

STI# 32339053

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

Executed on July 24, 2008

M A McBurnett
Mark A. McBurnett
Vice President, Oversight and Regulatory Affairs
South Texas Project, Units 3 & 4

ccc

Attachments:
1. Question 02.04.04-2
2. Question 02.04.12-6
3. Question 02.04.12-10
4. Question 02.04.12-16
5. Question 02.04.12-24
6. Question 02.04.12-26
7. Question 02.04.13-3
8. Question 02.05.01-1
9. Question 02.05.02-8
10. Question 02.05.02-9

cc: w/o attachment except*
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RAI 02.04.04-2:

QUESTION:

Provide a discussion supporting the validity and conservativeness of the hydrostatic and hydrodynamic pressure assumptions used in the postulated MCR Breach and Delft3D-FLOW application.

RESPONSE:

Delft3D-FLOW solves the governing flow equations based on shallow-water approximations whereby a hydrostatic pressure distribution is assumed. For rapidly varying flows, such as dam-break, flows over weirs, and hydraulic jumps, etc., a hydrostatic pressure assumption is typically not valid locally. To more accurately approximate rapidly varied flows, Delft3D-FLOW employs a numerical approximation technique (referred to as "Flooding" scheme in Delft3D-FLOW) that uses conservation properties, derived from physical balance principles in open channel hydraulics, with the shallow water equations. The numerical algorithm is an extension of the classical staggered grids with implicit integration schemes. The numerical approximation method, which is applicable to a wide range of Froude numbers, is based on the following principles (References 1 and 2):

1. Mass conservation combined with non-negative water depths to improve flooding characteristics
2. Momentum balance in flow expansions to ensure accurate representation of hydraulic jumps and bores
3. Energy head conservation in strong contractions.

The accuracy of this improved shallow water approximation method has been satisfactorily tested with analytical solutions on one-dimensional problems such as sudden contraction, sudden expansion, hydraulic jumps and dam break. Results from a 2-dimensional dam break laboratory experiment were found to be represented accurately by the numerical approximations (Reference 2).

As the flood wave travels further downstream from the MCR breach location into the far field shallow water flow regime where the safety-related facilities are located, hydrostatic pressure distribution, which is widely used and verified in practical applications, is a reasonable assumption for the flow simulation.

No COLA Revision is required as a result of this RAI response.

References:

1. WL|Delft Hydraulics (2004), Computer Program - Delft3D-FLOW for flooding computations (dam break simulation capability summary of Delft3D).

2. Stelling, G.S. and Duinmeijer, S.P.A. (2003), "A staggered conservative scheme for every Froude number in a rapidly varied shallow water flows," International Journal for Numerical Methods in Fluids, No. 43-2003, 1329–1354.

RAI 02.04.12-6:

QUESTION:

In FSAR Section 2.4S.12.2.2, Page 2.4S.12-10, the topic of relief wells and toe drain acting to reduce reservoir influence on the shallow aquifer is not sufficiently described. It is not clear that communication between the MCR and aquifer is potentially through the dike but primarily elsewhere, (e.g., perhaps through pits excavated in the bottom of the MCR). Also, the statement that there is an "absence of significant water ponding on the downgradient side of the MCR dike" fails to acknowledge the presence and role of the engineered drainage ditch that surrounds the MCR. Please clarify.

RESPONSE:

The purpose and operation of the main cooling reservoir (MCR) relief wells and drainage system are described in STP Units 1 & 2 UFSAR Sections 2.4.8.2.5, 2.4.13.3.2.2, 2.4.13.3.2.3, 2.5.6.6.1, 2.5.6.6.1.3, and 2.5.6.6.1.4 (Reference 1). A total of about 770 relief wells are located along the perimeter of the landward toe of the MCR embankment, at a maximum spacing of 200 feet, in those areas where piezometers installed in the Upper Shallow Aquifer indicate the need to reduce hydrostatic pressure. The relief wells are six inches in diameter and screened into the Upper Shallow Aquifer. Completion details for typical relief wells and piezometers are provided in Attachment 1 to RAI Question Response 02.04.12-13. In areas where sands of the Upper Shallow Aquifer are discontinuous beneath the embankment and relief wells would be less effective, a drainage system consisting of an interconnected sand chimney, sand drainage blanket and toe drain are installed at the base of the landward side of the embankment. Figure 2.4.8-3 from STP Units 1 & 2 UFSAR (Reference 1) shows a typical section through the embankment, including a sand chimney, sand drainage blanket and toe drain.

The relief wells are typically flowing water and comprise a passive drainage system designed to reduce the increased artesian pressure in the Upper Shallow Aquifer near the embankment induced by seepage through the bottom of the MCR. The interconnected sand chimney, sand drainage blanket and toe drain provide an alternative passive drainage system designed to intercept seepage that may be induced through the embankment in areas where the sands of the Upper Shallow Aquifer are discontinuous. Local variations in the permeability of the shallow soil underlying the unlined MCR allow increased seepage under the embankment in some areas. Seepage through the bottom of the MCR is induced by the water level in the MCR, which provides up to 20 feet of hydraulic head above the original land surface.

Control of seepage beneath and through the MCR embankment is necessary because the differential head placed on the embankment can cause excess hydrostatic pressures in pervious strata beneath the embankment that could result in heave or boiling of the overlying stratum. Subsurface soil conditions beneath the embankment are described in Section 2.5.6.2.1 of the STP Units 1 & 2 UFSAR (Reference 1). Surface soils over most of the length of the MCR embankment area primarily consist of Strata 1a and 1b (clay) underlain by a zone of granular material (Stratum 2). Stratum 2 generally occurs between 8 and 42 feet below the ground surface, which correlates to the sands of the Upper Shallow Aquifer.

The purposes of the MCR seepage control structures, according to UFSAR Section 2.4.8.2.5, are specifically:

- "To minimize seepage through the embankment section and prevent detrimental surface manifestation on downstream slopes.
- To minimize underseepage beneath the embankment and control its exit in order to prevent detrimental uplift and surface manifestations at the downstream toe.
- To limit the maximum piezometric level at the relief well line to El. 27.0 MSL opposite the power block structures."

Relief well and toe drain discharge is collected in drainage ditches around the periphery of the MCR embankment, which discharge at various locations offsite. Groundwater flow that bypasses the relief wells and toe drains exits down-gradient from the site in the Upper Shallow Aquifer.

Reference:

1. STP Units 1 & 2 UFSAR, Revision 13.

The last paragraph of STP Units 3 & 4 FSAR Subsection 2.4S.12.2.2 will be revised as follows in order to clarify the role of the MCR relief wells.

> A specific concern with respect to the groundwater flow direction in the Shallow Aquifer is the impact of the MCR on the groundwater system. The 7000-acre MCR is unlined and in places acts as a local recharge source to the Shallow Aquifer at the site. The normal maximum operating level elevation is 49 ft above MSL, imposing a hydraulic head of up to 20 ft above ground surface. The MCR embankment and associated drainage features are designed to lower the hydraulic gradient across the embankment to the extent that the potentiometric level in the soil layers adjacent to the toe of the embankment stay below the ground surface. This objective is accomplished through the use of low permeability clay (compacted fill), relief wells, and an interconnected drainage system comprised of a sand chimney, sand drainage blanket and toe drain.
>
> Discharge to the environment from the MCR occurs from seepage through the reservoir floor and embankments to the groundwater in the Upper Shallow Aquifer. Seepage from the MCR at the location of the embankment is intercepted in part by the relief well system installed into the sands of the Upper Shallow Aquifer and the drainage system comprised of sand chimney, sand drainage blanket and toe drain installed at the base of some sections of the embankment. The collected seepage is discharged from the passive relief wells and toe drains into drainage ditches around the periphery of the MCR embankment and then discharged to surface water features at various locations.

Figure 2.4S.12-21 presents a conceptual hydrogeologic section extending from the MCR to the STP 3 & 4 area. This section suggests that the influence of the MCR is restricted to the area immediately down-gradient (outside) of the reservoir embankment ~~dike~~. The combined effects of the relief wells and the toe drain act to reduce the head applied by the reservoir to the embankment. Further evidence of the effectiveness of this drainage system is provided by hydrogeochemical data ~~the absence of significant water ponding on the downgradient side of the MCR dike~~. Standard groundwater hydrogeochemical characteristics are discussed in FSAR 2.4S.12.2.5 and ER Subsection 2.3. FSAR Table 2.4S.12-15 lists regional hydrogeochemical data while Table 2.4S.12-16 lists the hydrogeochemical data from selected observation wells within the STP Units 3 & 4 area. A trilinear diagram of the hydrogeochemical data is presented in FSAR Figure 2.4S.12-30. A comparison of FSAR Table 2.4S.12-16 and ER Table 2.3.3-3 (MCR water quality data) suggests no strong geochemical correlation between the MCR waters and groundwater in the Shallow Aquifer north of the MCR. In addition, the potentiometric maps presented in FSAR Figure 2.4S.12-19 indicate little, if any, evidence of groundwater mounding north of the MCR. These data indicate that the relief wells are effective in reducing the aquifer head and minimizing the amount of seepage from the MCR to groundwater north of the MCR.

RAI 02.04.12-10:

QUESTION:

See FSAR Section 2.4S.12.2.3, "Temporal Groundwater Trends". Safety related structures for the ABWR will be constructed on engineered backfill. The excavation will remove the overlying clay and silt deposit that confines or semi-confines the Upper Shallow Aquifer. Assuming the backfill could be more permeable than the original clay and silt deposit, the hydraulic head in the vicinity of safety related structures can be expected to be as high as 27 ft MSL simply based on the observed present-day maximum. This is 3 ft below the pre-construction grade of 30 ft MSL, and would be 5 ft below the planed finished plant grade for STP Unit 3 of 32 ft MSL. However, this more permeable material will also be more likely to allow infiltration from storm events. Will backfill material near and at the ground surface be designed to be less permeable? Thus, following storm runoff and infiltration events, would one expect a somewhat higher water table elevation local to safety related structures? Would water table elevations local to the facilities be monitored? Would the applicant be prepared to detect and ensure the ABWR DCD requirement of a maximum groundwater level of 2 ft below ground surface is not violated? Or, are engineered systems going to be in place to limit infiltration into the disturbed environment?

RESPONSE:

Most of the power block will be occupied by buildings and structures. Roof drains for the buildings and structures will be directed to storm drains. Storm water collected in these drains will be conveyed to surface water outfalls. Most of the remaining area within the power block will be covered with material of relatively low permeability (clay and/or asphalt) similar to STP Units 1 & 2. Grading within the power block will be designed to direct precipitation falling on the surfaces to storm drains, which will then convey the storm water to surface water outfalls. As a result, it is anticipated that very little precipitation will infiltrate into the ground beneath the power block and any increase in groundwater elevation due to infiltration of precipitation through the backfill will be negligible.

The experience at STP Units 1 & 2 provides an indication of how groundwater levels were affected by placement of relatively permeable engineered fill within the power block excavation. The 34-year period of record shows that groundwater levels in the power block area before and after construction of STP Units 1 & 2 do not differ significantly. Refer to the response to RAI 02.04.12-26 for a detailed discussion of the record of groundwater levels since 1973.

Groundwater levels will be monitored periodically during operation of the plant in selected groundwater monitoring wells located throughout the plant site to confirm expected conditions.

The last paragraph of FSAR Section 2.4S.12.5 will be revised as shown below based on this response.

In summary, based on the water level elevations collected to date, the groundwater depth in both power block areas is below the maximum groundwater level of 61 cm (2 ft) below ground surface as specified in DCD Table 2.0-1 for the ABWR. Based on this observation, a permanent dewatering system is not anticipated to be a design feature for the STP 3 & 4 facility. Most of the power block will be occupied by buildings and structures. Roof drains for the buildings and structures will be directed to storm drains. Storm water collected in these drains will be conveyed to surface water outfalls. Most of the remaining area within the power block will be covered by a relatively low permeability material. Grading within the power block will be designed to direct precipitation falling on the surfaces to storm drains, which will then convey the storm water to surface water outfalls, minimizing precipitation infiltrating into the backfill within the power block area. Post-construction groundwater conditions are anticipated to have some localized changes resulting from excavation and backfilling, however, based on observations of STP 1 & 2 post-construction groundwater conditions, the effects would be minimal and may include localized communication between the Upper and Lower Shallow Aquifers and an increased cone of depression in the Deep Aquifer resulting from increased groundwater use for STP 3 & 4. The groundwater supply wells to be installed for STP 3 & 4 are not a safety-related source of water because the UHS has a 30-day supply of water, which is sufficient for plant shutdown without a supplementary water source.

RAI 02.04.12-16:

QUESTION:

In FSAR Section 2.4S.12.2.5, Page 2.4S.12-15, make clear why connectivity between OW-332U and L, and OW-930U and L would not be significant to pathways used in analysis. This connectivity virtually parallels the shortest path projected in both the Upper Shallow Aquifer and the Lower Shallow Aquifer. Explain why a shortened pathway may be created by combining water movement in the Upper Shallow Aquifer with that in the Lower Shallow Aquifer or vice-versa not occur.

RESPONSE:

FSAR Section 2.4S.12.2.5 states that a possible downward vertical connection between the Upper and Lower Shallow Aquifers may be evident at these two locations based on available geochemical data. It was further reasoned in FSAR Section 2.4S.12.2.5 that the No. 4 aquifer test conducted in the Shallow Aquifer system at the southwest portion of STP supported the possibility of hydraulic connection between the two aquifers. The possible connectivity between the Upper and Lower Shallow Aquifer was also recognized in FSAR Section 2.4S.13.1.2 by the following statement "Site investigations indicate that this separation is not continuous and leakage between the two units is occurring."

A downward head gradient between the two aquifer zones is prevalent in the northern portion of the STP site as evident in FSAR Table 2.4S.12-8 and discussed in FSAR Section 2.4S.12.2.2. Considering the bulk movement of groundwater is horizontal within permeable strata of layered sedimentary deposits, zones where vertical connectivity and hydraulic gradients occur would increase leakage between strata, providing a pathway for vertical movement of groundwater. If leakage from the Upper Shallow Aquifer occurs to the Lower Shallow Aquifer due to such leakage, a minor component of groundwater movement between the two zones would likely occur. Consequently, in the vicinity of wells OW-332U and L, and OW-930U and L, contaminants that might be released to the Upper Shallow Aquifer could be transported downward into the Lower Shallow Aquifer. Once in the Lower Shallow Aquifer, bulk transport would be southeasterly with the prevailing potentiometric gradient shown in Figures 2.4S.12-17 and 2.4S.12-19. The length and transport time of this flow path would be bounded by the flow paths and travel time described in FSAR Section 2.4S.12.3 (Subsurface Pathways) for the Upper and Lower Shallow Aquifer, listed in Table 2.4S.12-17.

An upward vertical movement of groundwater from the Lower Shallow Aquifer to the Upper Shallow Aquifer due to thermal buoyancy is considered unlikely. Consequently, a pathway from the Lower Shallow Aquifer to the Upper Shallow Aquifer is not considered to be a likely scenario, nor is it considered to be a shorter or faster pathway than the pathway described for the Upper Shallow Aquifer in FSAR Section 2.4S.12.3 considering the more tortuous route of this pathway and the likely retardation of movement due to the natural downward vertical gradient.

No COLA revision is required as a result of this RAI response.

RAI 02.04.12-24:

QUESTION:

In FSAR Section 2.4S.12.4, "Monitoring or Safeguard Requirements", provide a description of the actual monitoring or safeguard requirements for the proposed STP Units 3 and 4. Describe current STP groundwater monitoring program, if the program for STP Units 3 and 4 will be patterned after them. Why isn't one of the declared purposes of groundwater level measurements in the vicinity of safety related structures to ensure that groundwater is more than 2 ft below the plant grade at all times?

RESPONSE:

The environmental monitoring approach for STP Units 3 & 4 is presented in the COL Environmental Report. A detailed groundwater monitoring plan for STP Units 3 & 4 will be developed based upon the groundwater monitoring program for STP Units 1 & 2 and the final design of STP Units 3 & 4. The environmental monitoring program for STP Units 1 & 2 is currently under revision to incorporate the industry guidelines recently published by the Electric Power Research Institute (EPRI) for identification and monitoring of groundwater contamination due to releases of plant-related radionuclides to the environment.

The EPRI guidelines that will form the basis for monitoring groundwater quality at the STP units include drilling monitoring wells at locations and depths indicated by the site conceptual model to be appropriate for identification and monitoring of groundwater impacts due to releases to the environment of plant-related radionuclides. The monitoring plan for STP Units 3 & 4 will incorporate selected wells drilled in the Shallow Aquifer during the 2006 - 2007 subsurface investigation and other observation wells, as appropriate. The monitoring plan will specify techniques for sampling groundwater from the monitoring wells, frequency of sampling, radionuclides to be analyzed for, methods and minimum detectable concentrations for sample analysis, methods of quality assurance for collection and analysis of samples, and remedial action levels for each radionuclide of concern.

Groundwater levels will be measured as part of the monitoring program for STP Units 3 & 4. The wells to be measured and frequency of measurements will be specified in the monitoring plan. The purpose of water-level measurements in the Deep Aquifer is to monitor changes in the piezometric surface related to groundwater withdrawals from the existing and future plant production wells. Monitoring these levels will provide an indication of the availability of the required groundwater supply and allow determination of the groundwater flow directions in the Deep Aquifer.

Similarly, the groundwater environmental monitoring plan for STP Units 3 & 4 will specify measuring water levels in selected Shallow Aquifer wells in the area of Units 3 & 4. These measurements will allow determination of the groundwater flow directions and potential contaminant pathways in both the Upper and Lower zones of the Shallow Aquifer. Groundwater levels will also be monitored during construction dewatering and rewetting activities in the power block area. At the completion of rewetting, an evaluation of the water levels will be conducted to determine if groundwater level observations can be discontinued or should be continued to ensure that groundwater is less than 2 feet below plant grade in the vicinity of safety-related structures.

The second bullet beneath the third paragraph of FSAR Section 2.4S.12.4 will be revised as shown below based on this response.

- Shallow Aquifer – Periodic water level measurements in the Upper and Lower zone observation wells and collection of geochemical samples and analysis will be performed in selected observation wells. The water level monitoring program objective is to detect changes in flow patterns in the Shallow Aquifer that might impact accident analysis and ~~would~~ to track temporal trends in groundwater levels that might impact structural stability in the vicinity of STP 3 & 4. The geochemical monitoring would detect changes in groundwater geochemistry that would be deleterious to plant structures and subsurface components.

RAI 02.04.12-26:

QUESTION:

In FSAR Section 2.4S.12.5, "Site Characteristics for Subsurface Hydrostatic Loading", Figure 2.4S.12-32 presents a graph of maximum allowed hydrostatic pressure, and the hydrostatic pressure associated with the maximum observed hydraulic head. What guarantees that the past maximum observed groundwater level will not be exceeded after construction of the new units? Given the substantial changes to be made to topography and land surface (type, vegetation, etc.), how good a predictor of future water level is the past measured hydraulic head? Will the water table elevation be monitored and a program be in place to ensure that the water table is always below the 2 ft below grade requirement?

RESPONSE:

The experience at STP Units 1 & 2 provides an indication of how well future groundwater levels can be predicted based upon past measured hydraulic heads. Figure 2.4.13-18 from the STP Units 1 & 2 UFSAR (Reference 1) provides a hydrograph for Piezometer 601, completed in the Upper Shallow Aquifer. The hydrograph shows groundwater levels in the well during the period of July 1973 through January 1974, before construction of Units 1 & 2 began. Piezometer 601 is located approximately 1.0 mile northeast of the Unit 1 containment building. This location is generally cross-gradient from the Unit 1 & 2 power block; therefore, water levels in Piezometer 601 are generally the same as those in the Upper Shallow Aquifer in the Unit 1 & 2 power block. The hydrograph in Figure 2.4.13-18 shows that groundwater levels varied between about 22.8 and 25.6 feet MSL during the seven-month period.

Figure 2.4.13-19 from the STP Unit 1 & 2 UFSAR (Reference 1) is a contour map showing groundwater elevations in the Upper Shallow Aquifer on March 14, 1974. This map shows that groundwater elevations in the power block ranged between about 25.5 feet in the northwest to about 24 feet in the southeast.

Groundwater elevations in the Upper Shallow Aquifer in June 1986 are shown on Figure 2.4.13-19A in the STP Unit 1 & 2 UFSAR (Reference 1). At that time water levels in the power block ranged between 20 and 22 feet MSL. These levels may have been lower than they normally would have been because of the effect of dewatering the power block excavation.

Figure 2.4S.12-17 from the FSAR for STP Units 3 & 4 shows contours of the potentiometric surface in the Upper Shallow Aquifer on two dates. The data set is limited but based on the interpretation of the data; the groundwater elevation in the Unit 1 & 2 power block was about 23 feet MSL on November 1, 2005 and about 22 feet MSL on May 1, 2006. These dates were after construction of Units 1 & 2 was complete, and water levels measured then were no higher than had been measured in 1973 and 1974, before construction began.

Similar groundwater levels in the Upper Shallow Aquifer are shown in the power block area of Units 1 & 2 on Figure 2.4S.12-19 of the FSAR for STP Units 3 & 4. This figure shows water levels to be between about 23 and 24 feet MSL on February 22, 2007, and between about 23 and 24.5 feet MSL on April 27, 2007.

Finally, Figure 2.4S.12-23 from the FSAR for STP Units 3 & 4 includes a hydrograph showing water levels in Piezometer 601 during the period 1995 through 2006. Water levels in this well ranged between approximately 17.8 and 26.8 feet MSL during this period, with an average elevation of about 23 feet MSL. These levels are comparable to those that were measured in Piezometer 601 in 1973. Figure 2.4S.12-23 also includes a hydrograph showing water levels in Piezometer 602A during the period 1995 through 2006. Water levels in this well are below 26 feet MSL during this period. This Upper Shallow Aquifer zone piezometer is located just to the north of the STP Units 3 & 4 power block area.

The 34-year period of record provides groundwater levels in the power block area before, during and after construction of STP Units 1 & 2. The experience at Units 1 & 2 indicates that groundwater levels measured in the Upper Shallow Aquifer before construction began are a good predictor of future water levels after site modifications made during plant construction are complete. Therefore, the groundwater levels at STP Units 3 & 4 are not expected to exceed the 2 foot below grade requirement for safety related features (planned plant ground floor elevation is 35 feet MSL).

A detailed groundwater environmental monitoring plan for STP Units 3 & 4 will be developed based upon the groundwater environmental monitoring program for Units 1 & 2 and the final design of STP Units 3 & 4. The monitoring program for Units 1 & 2 is currently under revision. The monitoring program will incorporate the industry guidelines recently published by the Electric Power Research Institute for identification and monitoring of groundwater contamination due to releases of plant-related radionuclides to the environment.

Groundwater levels will be measured in selected wells in both the Upper and Lower zones of the Shallow Aquifer as part of the environmental monitoring program for STP Units 3 & 4. The wells to be measured and frequency of measurements will be specified in the monitoring plan. These measurements will allow determination of the groundwater flow directions and potential contaminant pathways in both the Upper and Lower zones of the Shallow Aquifer.

Groundwater levels will also be monitored during construction dewatering and rewetting activities in the power block area. At the completion of rewetting, an evaluation of the water levels will be conducted to determine if groundwater level observations can be discontinued or should be continued to ensure that groundwater is less than two feet below plant grade in the vicinity of safety-related structures.

References:

1) STP 1 & 2 UFSAR, Revision 13.

No COLA revision is required as a result of this RAI response.

RAI 02.04.13-3:

QUESTION:

In FSAR Section 2.4S.13.1.2, Conceptual Model, the applicant's statement toward the end of the section that "Other pathways that were considered and then rejected…," needs to be coordinated with the discussion of pathways in FSAR Section 2.4S.12. The discussion of alternative pathways in FSAR Section 2.4S.13 should parallel that in FSAR Section 2.4S.12. Please clarify.

RESPONSE:

Information presented in FSAR Section 2.4S.13.1.2 (Conceptual Model) will be incorporated in FSAR Section 2.4S.12.3.1 (Exposure Point and Pathway Evaluation) for section reviewer consistency with respect to the alternative groundwater pathways associated with STP Units 3 & 4.

FSAR Section 2.4S.12.3.1 will be revised as shown:

The site groundwater system consists of two aquifers; the Shallow Aquifer and the Deep Aquifer. The Shallow Aquifer extends from near ground surface and is approximately 100 ft to 150 ft thick. The Shallow Aquifer is separated from the Deep Aquifer by a 100 ft to 150 ft thick sequence of clay and silt. Potentiometric surface maps created from onsite groundwater level measurements indicate that flow in the Deep Aquifer is towards the onsite groundwater production wells located on the east and west sides of the STP site. The Deep Aquifer is greater than 500 ft thick and is the principal groundwater production interval in the site area.

The Shallow Aquifer is divided into the Upper Shallow Aquifer and Lower Shallow Aquifer that are separated by a clay and silt layer. Both zones are considered to be semi-confined to confined with a downward hydraulic gradient between the zones. The Upper Shallow aquifer is comprised of interbedded sand layers to depths of approximately 50 ft below ground surface. The Lower Shallow Aquifer consists of interbedded sand layers approximately 50 ft to 150 ft below ground surface. Site investigations indicate that this separation is not continuous and leakage between the two aquifer zones is occurring. The groundwater flow direction in both the Upper and Lower zones of the Shallow Aquifer is to the east-southeast, toward the Colorado River, with a minor flow component toward the southwest in the western portion of the site. The Shallow Aquifer has limited production capability and is used for livestock watering and occasional domestic supply within Matagorda County.

Collector tanks inside the Radwaste Building are assumed to be the source of a hypothetical release to groundwater (FSAR 2.4S.13). The Radwaste Building basement floor is at a depth of approximately 45 ft below plant grade and the Radwaste Building foundation is at a depth of approximately 53 ft below plant grade. The excavation for the adjacent Reactor Building extends to a depth of approximately 90 ft below plant grade, which would involve placement of structural fill beneath the Radwaste Building as part of backfilling around the Reactor Building. The Radwaste Building includes several levels of protection such as an alarmed tank level monitoring system and steel-lined compartments surrounding the radwaste tanks (FSAR 2.4S.13).

The excavation required for the construction of STP 3 & 4 penetrates into both the Upper and Lower Shallow Aquifer zones, but is above the thick sequence of clay and silt that separates the Shallow Aquifer from the more productive Deep Aquifer. Because there is a downward, vertical hydraulic gradient between the Upper and Lower Shallow Aquifer zones, and the backfilled excavation encounters both aquifer zones, the most likely groundwater pathway for an accidental release is the Lower Shallow Aquifer.

Figure 2.4S.12-31 presents the Blessing SE U.S. Geological Survey 7.5 minute quadrangle map of the site area (Reference 2.4S.12-21). This map shows onsite and offsite surface features considered in the evaluation. Review of regional groundwater use data presented in Subsection 2.4S.12.2.1 indicates that there is a credible existing Shallow Aquifer groundwater user exposure point in the vicinity of the STP site at Well 2004120846. This would be the most likely exposure point for the Shallow Aquifer groundwater. A second exposure pathway is via surface water, where the Shallow Aquifer discharges to local creeks or the Colorado River. The most likely exposure point for the Deep Aquifer would be the onsite groundwater production wells.

Off-site migration pathways were evaluated for the following hydrogeologic units:

- Upper Shallow Aquifer
- Lower Shallow Aquifer
- Deep Aquifer

The Upper Shallow Aquifer is the most likely hydrogeologic unit to be impacted by an accidental liquid effluent release onsite. Due to the shallow depth of this unit, a conservative release scenario would be a direct injection of liquid effluent into the Upper and Lower Shallow Aquifer. The Upper Shallow Aquifer has a flow direction toward the southeast, as discussed in Subsection 2.4S.12.2.2. Examination of Figure 2.4S.12-31 indicates that a potential Upper Shallow Aquifer groundwater discharge area would be the unnamed tributary, located to the east of the STP 1 & 2 Essential Cooling Pond (ECP), which flows into Kelly Lake, approximately 7300 ft from STP 3. A second possible discharge area for both the Upper and Lower Shallow Aquifer is at existing Well 2004120846, which is an 80 ft deep livestock well, located east of the site boundary approximately 9000 ft from STP 3. This pathway assumes the well discharges to stock watering containers and that the groundwater is consumed by livestock, which would be an indirect human exposure pathway. Information from Appendix 2.4S.12-A3 indicates this well is estimated to produce 200,000 gallons per year or approximately 0.4 gpm. A third possible discharge area for both Shallow Aquifer units would be the Colorado River, approximately 17,800 ft from STP 3.

Groundwater potentiometric surface maps (Figures 2.4S.12-17, 2.4S.12-19, and 2.4S.12-21) indicate the Shallow Aquifer groundwater flow is from, rather than towards, the MCR in the vicinity of the MCR toe drain and relief wells. The MCR was formed by constructing an approximately 45-foot high embankment on top of the existing ground surface. The water level in the MCR is up to 20 feet above the original grade level. Because the MCR is unlined, this hydrostatic head induces seepage through its bottom, causing potentiometric levels in the underlying Upper Shallow Aquifer near the perimeter of the MCR to be higher than those farther outside the perimeter.

During the construction of the MCR, sets of piezometers were installed at locations along the MCR embankment to monitor the hydraulic head of the underflow through and beneath the MCR embankment structure. These sets of piezometers generally consist of three or more piezometers, aligned perpendicular from the top of the MCR embankment to the toe of the embankment. The piezometer sets are installed at various locations throughout the MCR embankment structure (Reference 2.4S.12-9).

Historical groundwater levels measured in these piezometers indicate that the hydraulic heads in the Upper Shallow Aquifer beneath the entire length of the MCR embankment decreases in the landward direction, inducing groundwater flow outward from the MCR and toward the relief wells in the Upper Shallow Aquifer. The relief wells are "flowing" wells because the hydraulic head imposed by the water level in the MCR induces potentiometric levels in the relief wells that are higher than the nearby ground surface elevation. The relief wells discharge to the toe ditches/streams near the embankment toe. The relief well system was design to capture at least 50% of the seepage outwards from the MCR with the remaining seepage moving through the Upper Shallow Aquifer, beyond the relief wells system (Reference 2.4S.12-9). This condition causes groundwater flow in the Upper Shallow Aquifer from areas up-gradient in the power block of Units 3 & 4 to be diverted and flow around the MCR.

The Lower Shallow Aquifer is isolated over much of the site by the Lower Shallow Aquifer Confining Layer. However, aquifer pumping test data (Subsection 2.4S.12.2.4.1) and hydrogeochemical data (Subsection 2.4S.12.2.5) suggest that leakage through the less permeable confining layer is occurring. Additionally, excavations for the foundations of some of the deeper structures are projected to enter the Lower Shallow Aquifer. Subsection 2.4S.12.2.2 indicates that a consistent downward vertical hydraulic gradient exists between the Upper and Lower Shallow Aquifer, which would provide the driving force for movement of groundwater from the Upper to the Lower Shallow Aquifer in the ~~leakage~~ STP 3 & 4 site areas, and therefore, ~~A conservative effluent release scenario would be~~ a direct effluent release into the Lower Shallow Aquifer. Subsection 2.4S.12.2.2 indicates the Lower Shallow Aquifer has an east to southeast flow direction. Due to the depth to the top of the aquifer and the downward vertical hydraulic gradient in the Lower Shallow Aquifer, it is unlikely that discharge would occur into the unnamed tributary to the east of the STP 1 & 2 ECP. Likely existing discharge points are Well 2004120846, as discussed above, or the Colorado River alluvium, where the river channel has incised into the Lower Shallow Aquifer, approximately 17,800 ft from STP 3 & 4. A future discharge point would be a well installed into the Shallow Aquifer at the site boundary, down-gradient of STP Unit 3, approximately 7300 feet southeast of the unit.

The westward flow component in the Shallow Aquifer may represent a pathway from the Unit 4 Radwaste Building. However the site potentiometric maps (Figure 2.4S.12-17) indicate that flow is southward along the west side of the MCR and then turns back toward the southeast, on the south side of the MCR. This results in a much longer flow path distance to reach the Colorado River. Little Robbins Slough is not considered to be a discharge point for the Shallow Aquifer based on the potentiometric surface maps.

The Deep Aquifer is the least likely hydrogeologic unit to be impacted by an accidental liquid effluent release. The Deep Aquifer is separated from the Shallow Aquifer by a 100 ft to 150 ft thick clay and silt layer. Recent potentiometric surface maps for the Deep Aquifer (Subsection 2.4S.12.2.2) indicate that groundwater flow in the plant area is moving toward the production wells at the site, thus precluding the potential for offsite migration should the effluent pass through the clay layer. The additional groundwater needs for operation of STP 3 & 4 will further depress the potentiometric surface in the Deep Aquifer. The combined effects of horizontal flushing by flow in the Shallow Aquifer, radionuclide sorption as the effluent passes through the 100+ ft thick clay layer, and groundwater capture by the site production wells suggest that there is no credible offsite release pathway for the Deep Aquifer.

RAI 02.05.01-1:

QUESTION:

Based on Blum and Aslan (SSAR Reference 2.5S.1-38) and dozens of papers during the past 15 years, the present concept of the "Beaumont Formation" in terms of both the origin and age of its sediments and the landforms associated with it is quite different than described in Section 2.5S.1.1.4.1.3. Please provide an up-to-date summary of the Pleistocene and Holocene sediments (age, origin, process, landform morphology) and their relation to the tectonic history of the region. In particular, address why Pleistocene surfaces of increasing age in this area are tilted at increasingly high angles as described in several of the references cited and whether the tilting is related to fault movement.

RESPONSE:

There are two issues identified within this RAI question, which can be summarized as:

1. Please provide an up-to-date summary of the Pleistocene and Holocene sediments (age, origin, process, landform morphology) and their relation to the tectonic history of the region.

2. Address why Pleistocene surfaces of increasing age in this area are tilted at increasingly high angles as described in several of the references cited and whether the tilting is related to fault movement.

Each of these issues will be addressed individually.

Issue 1

As described in Subsection 2.5S.1.1.4.1.3, the Texas coastal plain during the Late Cenozoic period was characterized by subsidence from crustal loading caused by sediment deposition in the Gulf of Mexico Basin. This subsidence has caused progressive gulfward migration of the shoreline and the deposition of sedimentary units, which decrease in age towards the gulf. The long-term gulfward migration of the shoreline has been overprinted during the late Cenozoic period with relatively minor marine regressions and transgressions associated with sea-level changes during glacial and interglacial periods. These glacial cycles are recorded in the deposition of the Beaumont and Lissie Formations, the major Pleistocene formations in the site vicinity. Both formations were deposited during interglacial transgressions as facies of alluvial fan-delta systems (References 3 and 4).

The closest mapped exposure of Lissie Formation is approximately 68 km north of the site (Reference 2). In general, the formation is characterized by low-energy sedimentary deposits including levee deposits, distributary sands, and flood-basin muds (Reference 2). The Lissie Formation has a surface morphology characterized by rounded shallow depressions, pimple mounds, and subdued drainage channels (Reference 2). The Lissie Formation also has a relatively uniform surface gradient with a gulfward dip of approximately 1 m per km (0.06°) that is distinct from younger units (e.g., Beaumont Formation) (Reference 6). The depositional age of the formation is between approximately 1.4 million and 400,000 years ago as constrained by downdip projections of strata to biostratigraphic markers identified in the offshore, as well as the magnetic polarity stratigraphy of these deposits (Reference 4).

In contrast to the Lissie Formation, the younger Beaumont Formation within the greater site vicinity is very heterogeneous and composed of multiple non-contiguous soil types deposited within transgressive, aggradational, and progradational environments as facies of alluvial fan-delta systems within the Colorado and Brazos fluvial systems (References 4 and 6). The Beaumont Formation is characterized by coalescing low-gradient alluvial fans, inset fluvial terraces, incised river paleochannels, point bars, natural levees, backswamp deposits, and relict barrier islands and dunes (References 2 and 6).

Historically the Beaumont Formation has been interpreted as being deposited between 150,000 and 100,000 years ago (References 2, 5 and 6). However, some researchers have noted the existence of three distinct Beaumont Formation valley fills that reflect unique depositional periods occurring over a longer time span (References 1, 3 and 4) (Figure 2.5S.1-14). The valley fills, from youngest to oldest, are the Bay City, El Campo, and Lolita valley fills (Reference 4). Thermoluminescence dating indicates that the oldest valley fill (Lolita) was deposited approximately 350,000 years ago during the interglacial period associated with marine Oxygen Isotope Stage (OIS) 9 (Reference 3). Thermoluminescence ages constrain deposition of the youngest valley fill (Bay City) to have occurred during OIS 6 to 5, approximately 150,000 to 100,000 years ago (References 3 and 4).

Falling sea levels associated with the ending of the Sangamon interglacial highstand led to a period of non-deposition between roughly 100,000-80,000 years ago (Reference 4). The falling base level caused rivers to incise into the Beaumont Formation and deposit the sequence of Deweyville fluvial terraces found along river systems throughout the gulf coastal plain (References 2 and 4). The Deweyville unit is comprised of a series of terraces that represent former floodplains of their host river systems (Reference 4). There have been very few depositional ages determined from Deweyville units, but those that have been show a wide range in age from the early Holocene to Late Pleistocene (References 2 and 4). There are no Deweyville exposures within the site vicinity because more recent depositional episodes along the Colorado river have buried Deweyville deposits (Reference 2 and 4).

The tenth paragraph in FSAR Section 2.5S.1.1.4.1.3 will be replaced with the following text:

~~The long-term southward migration of the Gulf shoreline continued into late Quaternary time with widespread deposition of alluvial fan-delta deposits of the Beaumont Formation during the period of high sea level associated with the late Pleistocene Sangamon interglacial (about 120 ka) (References 2.5S.1-38 and 2.5S.1-73). Subsequent retreat of Gulf shoreline during the Wisconsinan glaciation to its present location exposed the Beaumont Formation deposits at the STP 3 & 4 site to subaerial weathering and modest erosion (Reference 2.5S.1-38).~~

The long-term southward migration of the Gulf shoreline continued into the late Quaternary but has been overprinted with relatively minor marine regressions and transgressions associated with sea-level changes during glacial and interglacial periods. Within the greater site vicinity, some of these glacial cycles are recorded in the deposition of the Beaumont and Lissie Formations, the major Pleistocene formations within the site vicinity. Both of these formations were originally deposited as alluvial fan-delta deposits (Reference 2.5S.1-38) (Figure 2.5S1-19). The Lissie Formation is the older of the two with a depositional age between 1.4 million and 400,000 years ago (Reference 2.5S.1-38). The closest Lissie Formation outcrop to the site is approximately 42 miles (68 km) north of the site (Reference 2.5S.1-30). The Beaumont Formation underlies the site (Figure 2.5S.1-11 and Figure 2.5S.1-27) and varies in age between approximately 350,000 and 100,000 based on thermoluminescence ages from three distinct valley fills identified in the Colorado river basin (Figure 2.5S.1-14) (Reference 2.5S.1-38). The site lies on the youngest valley fill, the Bay City fill, which was deposited between 100,000 to 150,000 years ago. Subsequent to the deposition of the Beaumont Formation, falling sea levels resulted in the incision of coastal plain rivers (e.g., Colorado) into the Beaumont Formation.

Issue 2

In their description of Pleistocene deposits of the Texas coastal plain, Blum and Aslan (Reference 4) note previous researchers have identified that, "older surfaces have steeper slopes and are onlapped by younger surfaces farther downdip," (page 183). However, they do not indicate the source of this observation or describe it further in their paper. The apparent source of this observation is the work of Winker (Reference 6) where he documents the contrast in surface gradient between the Lissie (Early Pleistocene), Beaumont (Late Pleistocene), and undifferentiated Holocene surfaces along modern day rivers of the Texas coastal plain. For the Colorado River, the most proximal river to the site, Winker (Reference 6) reports gradients of these formations as:

- Lissie, approximately 1m/km with no reported range;
- Beaumont, approximately 0.55 m/km with a range of approximately 0.6 and 0.4 m/km; and
- Holocene, approximately 0.48 m/km with a range of approximately 0.5 to 0.3 m/km.

Winker (Reference 6) attributes this increasing surface slope with age to seaward tilting of the coastal plain as a response to loading of the coastal plain and Gulf of Mexico Basin by fluvial sedimentation.

As discussed in Subsection 2.5S.1.1.4.1.3, since the cessation of extension and rifting in the Gulf of Mexico during the Jurassic period, large volumes of sediments have been deposited within the Gulf of Mexico basin and Coastal Plain that have caused these regions to subside following a flexural-isostatic response. With continuous deposition since the Late Jurassic period, the cumulative amount of subsidence and associated flexural tilting has increased, causing older depositional Coastal Plain units to dip more steeply toward the Gulf than younger units. Through the Pleistocene period and modern times, rivers draining into the Gulf of Mexico have continued to load the Gulf of Mexico crust and the coastal plain, provoking a flexural-isostatic response to which Winker (Reference 6) attributes the contrast in Pleistocene surface dips. This conclusion is supported by Blum and Price (Reference 3) because they attribute the same observation to "subsidence and stratal downwarping," (Reference 3, page 32). Therefore, the observed tilting is part of a long-wavelength flexural process that affects much of the Gulf Coastal Plain and offshore regions, and is not related to local growth fault activity.

No COLA revision is required as a result of Issue 2 of this RAI response.

References:

1. Aslan, A., and Blum, D., 1999, Contrasting styles of Holocene avulsion, Texas Gulf Coastal Plain, USA: Special Publications of the International Association of Sedimentologists, v. 28, p. 193-209.
2. Barnes, V.E., 1987, Geologic Atlas of Texas Beeville-Bay City Sheet: Austin, TX, Bureau of Economic Geology.
3. Blum, M., and Price, D.M., 1998, Quaternary alluvial plain construction in response to glacio-eustatic and climatic controls, Texas Gulf coastal plain, Relative Role of Eustacy, Climate, and Tectonism in Continental Rocks, Society for Sedimentary Geology, Special Publication 59, p. 31-48.
4. Blum, M.D., and Aslan, A., 2006, Signatures of climate vs. sea-level change within incised valley-fill successions: Quaternary examples from the Texas Gulf Coast: Sedimentary Geology, v. 190, p. 177-211.
5. Dubar, J.R., Ewing, T., Lundelius, E.L., Otvos, E.G., and Winker, C.D., 1991, Quaternary Geology of the Gulf of Mexico Coastal Plain, in Morrison, R.B., ed., Quaternary Nonglacial Geology: Conterminous U.S., Volume K-2: Boulder, CA, Geological Society of America, Geology of North America, p. 583-610.
6. Winker, C.D., 1979, Late Pleistocene Fluvial-Deltaic Deposition: Texas Coastal Plain and Shelf [MA thesis]: Austin, TX, University of Texas at Austin.

RAI 02.05.02-8:

QUESTION:

The caption for Figure 2.5S.2-7 cites Reference 2.5S.2-3 as the source for the southern boundary of the EPRI incompleteness regions. Judged by its shape, however, the boundary plotted in Figure 7 appears different than the boundary plotted in Figure 4.4 of the cited reference. Please reconcile the apparent differences in the plotted boundaries.

RESPONSE:

The reference cited in the caption for Figure 2.5S.2-7 should have read "Table 5-1 of Reference 2.5S.2-16," not "Reference 2.5S.2-3."

The southern boundary of the EPRI incompleteness regions presented in Figure 4-4 of Reference 2.5S.2-3 is different in at least two ways from that presented by Table 5-1 of Reference 2.5S.2-16, the basis for Figure 2.5S.2-7 of the FSAR. First, upon inspection of Figure 4-4, it is apparent that there is a problem in this figure with the longitude markings – they are shifted towards the east – e.g., the middle of Florida should be centered about 82°W. Figure 5-2 from Reference 2.5S.2-16 is similar to Figure 4-4 of Reference 2.5S.2-3, but does not appear to have the problem with the shifted longitude markings.

The second difference between Figure 4-4 of Reference 2.5S.2-3 and Table 5-1 from Reference 2.5S.2-16 is apparent when comparing Figure 5-2 from Reference 2.5S.2-16 and Table 5-1 from Reference 2.5S.2-16. The southern boundaries of Figure 5-2 and the Table 5-1 differ only by the rectangular geographic box bounded by 95°W to 98°W, 28°N to 30°N. Specifically, Table 5-1 suggests that incompleteness regions are defined within this small geographic box, while Figure 5-2 would suggest they are not defined. The EPRI-SOG data files for source zones in this region do have a- and b-values – defining magnitude frequency recurrence rates – given for geographic source cells within this specific rectangular geographic box. These parameters could not be defined without the definition of detection probability matrices indicated by the incompleteness regions. Therefore, the representation of the southern boundary of the EPRI incompleteness regions presented in Figure 5-2 from Reference 2.5S.2-16 – as well as Figure 4-4 of Reference 2.5S.2-3 – is not correct. The boundary presented by Table 5-1 from Reference 2.5S.2-16, the basis for Figure 2.5S.2-7 of the FSAR, is consistent with the EPRI-SOG source zone data files.

The caption for Figure 2.5S.2-7 will be changed as follows:

> Figure 2.5S.2-7 Southern Boundary of EPRI Incompleteness Regions ~~(Reference 2.5S.2-3)~~(Table 5-1 of Reference 2.5S.2-16) and Gulf of Mexico Seismicity Recurrence Area (Re-Focus Zone)

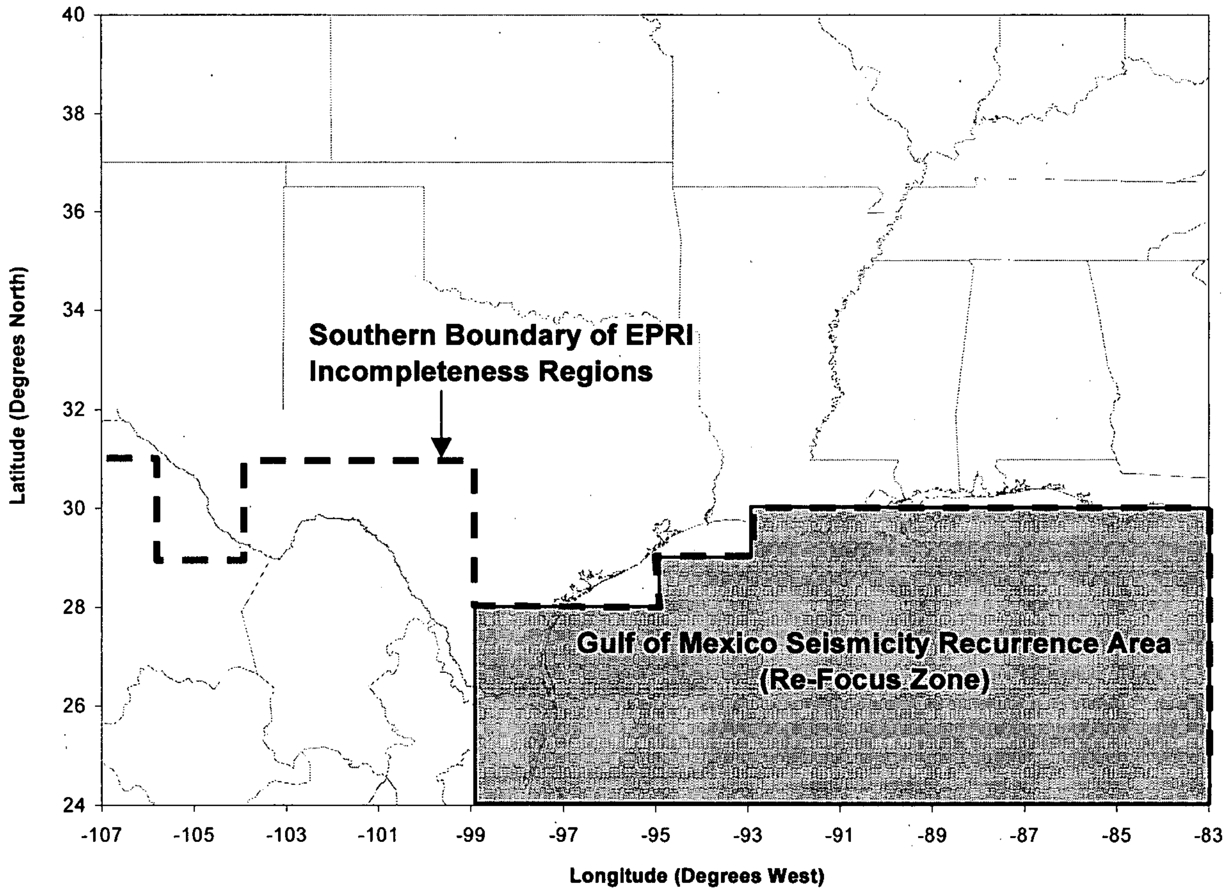

Figure 2.5S.2-7 Southern Boundary of EPRI Incompleteness Regions ~~(Reference 2.5S.2-3)~~ (Table 5-1 of Reference 2.5S.2-16) and Gulf of Mexico Seismicity Recurrence Area (Re-Focus Zone)

RAI 02.05.02-9:

QUESTION:

Section 2.5S.2.1.5.1 describes the mild ground motion effects observed in Texas from the 1985, Mw 8.0 Michoacan earthquake, and states that this has been the largest event in a century along this part of the Pacific plate boundary. This earthquake was roughly the same distance from the site as the New Madrid seismic zone. Please describe the potential for larger and/or closer Pacific plate-boundary earthquakes and the expected ground motion effects at the site, and how these remote sources will affect the site-specific GMRS.

RESPONSE:

A sensitivity study is in progress addressing this question. The study incorporates a simplified source model of the Middle America Trench (MAT) including the source of the Michoacan earthquake. Because it is anticipated that any contribution to earthquake hazard at the site from earthquakes on the MAT relative to sources included in the current FSAR site-specific GMRS will be greatest for longer period ground motions, 1 Hz ground motion is analyzed in particular.

The MAT source model reviews and synthesizes the characterizations of the Middle America Trench subduction zone as presented within peer-reviewed scientific literature and develops a seismic source model of the MAT that represents the range of legitimate and technically supportable characterizations of MAT subduction as related to interplate earthquakes. The source model includes a scenario for rupture of individual segments of the MAT only, such as occurred during the Mw 8.0 Michoacan earthquake, and an alternative scenario representing the possibility of rupturing multiple segments during a single event.

The 1 Hz attenuation model is based on a review of published attenuation ground motion models for large subduction zone interface earthquakes for large distances (that is, on the order of 1,000 km and more). Based on the comparison and limitation of specific models, a single attenuation model has been adopted.

There is a current NRC commitment (COM 2.5S-1) to update FSAR Section 2.5S, which will include the results of this sensitivity study following its completion.