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

July 27, 2010
U7-C-STP-NRC-100170

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
Response to Request for Additional Information

Attached is the STP Nuclear Operating Company (STPNOC) response to Request for Additional Information (RAI) question 02.04.05-10 in RAI letter number 334 related to COLA Part 2, Tier 2, Section 2.4S.5, "Probable Maximum Surge and Seiche Flooding." This letter provides the complete response to RAI letter number 334. The attachment provides the response to the following RAI:

02.04.05-10

No COLA changes are required as a result of this response.

There are no commitments in this letter.

If you have any questions, please contact Scott Head 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 7/27/10

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Mark McBurnett
Vice President, Oversight & Regulatory Affairs
South Texas Project Units 3 & 4

rhb

Attachment: RAI 02.04.05-10

D091
NRO

STI 32704607

cc: w/o attachments and enclosure except*
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02.04.05-10

QUESTION:

(1) The applicant's estimation of the effects of the Probable Maximum Storm Surge (PMSS) are based on the estimation of storm surge using two approaches: (i) use of the SURGE model to estimate storm surge in the Gulf of Mexico and applying the estimated storm surge as a boundary condition in HEC-RAS modeling software to predict water surface elevations near the STP site, and (ii) extrapolation from storm surge values obtained from the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model near the STP site for Category 1 through 5 hurricanes in the Gulf of Mexico to estimate the storm surge for probable maximum hurricane (PMH) conditions. The applicant-estimated PMSS water surface elevation at the STP site was produced by the second approach above (31.1 ft MSL) and did not reach the site grade (34 ft MSL).

Through independent confirmatory analysis, the staff determined that the PMSS water surface elevation of 31.1 ft MSL, obtained by the applicant using the extrapolation procedure described above may not be technically valid or conservative. Based on its independent estimation of PMSS water surface elevations, the staff determined that the outer face of the MCR north embankment may be subject to wave action from PMSS. Because the outer face of the MCR embankment is only grass-lined and not protected by reinforced soil-cement or riprap, the staff postulated that the MCR embankment could possibly fail during the PMSS event. If this scenario were to occur, the MCR breach flood would coincide with the PMSS event.

Please provide the following information: (a) an analysis of the PMSS event using a conservative approach such as those predicted by a storm surge model (e.g., SLOSH) with input from appropriate PMH models, (b) reasons why exposure of the outer face of the MCR embankment to the PMSS event would not lead to a breach, and (c) if an MCR breach is postulated under PMSS conditions, a revised estimate of the design-basis flood water surface elevation at the STP site.

(2) In case the design basis flood level is changed, provide proposed text changes for 2.4S.10 considering the followings: (a) describe how safety-related facilities are designed to withstand the combination of newly established flooding conditions and wind wave run-up; (b) for safety-related facilities, re-identify the doors and hatches that are affected by the new design flood level; and (c) describe how the watertight doors and hatches are designed to resist static and dynamic forces of flooding without water penetrations, or provide any design specifications that could be applicable to this case

RESPONSE:

General Design Criterion (GDC) 2 and the STP Probable Maximum Storm Surge:

10 CFR Part 50, Appendix A, General Design Criterion (GDC) 2, requires that STPNOC demonstrate that STP 3 & 4 structures, systems, and components (SSC) important to safety are designed to withstand the effects of the most severe natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated. GDC 2 would be satisfied for the probable maximum storm surge (PMSS) resulting from the probable maximum hurricane (PMH) by demonstrating that the predicted flood water level and wave effects resulting from the PMH are less than the STP 3 & 4 design basis flood (DBF) level. The STP 3 & 4 DBF level is 40.0 feet mean sea level (MSL), which is 6 feet above the nominal site grade elevation of 34 feet MSL, as described in FSAR Table 2.0-2. As stated in FSAR 2.4S.2.2, all power block safety-related structures have appropriate flood protection measures, such as water tight doors and components, that will prevent any flooding of the safety-related SSCs, below elevation 40.0 ft MSL. The Ultimate Heat Sink (UHS) and reactor service water (RSW) pump house are water tight below elevation 50 ft MSL.

FSAR 2.4S.5.2, "Surge and Seiche Water Levels," was developed to provide the descriptions and analyses that demonstrate that GDC 2 was met for the PMSS resulting from the PMH. At the time of the submittal (Letter ABR-AE-07000004, dated September 20, 2007), the descriptions and analyses in FSAR 2.4S.5.2 conformed to the Standard Review Plan 2.4.5, "Probable Maximum Surge and Seiche Flooding," recommendation that the storm surge induced by the PMH should be estimated "as recommended by Regulatory Guide (RG) 1.59, supplemented by current best practices."

STPNOC recognizes that "current best practices" are evolving rapidly due to the very high level of interest and active involvement of the Federal Emergency Management Agency (FEMA), the National Oceanic and Atmospheric Administration (NOAA), and the US Army Corps of Engineers (USACE) and the associated supporting research being conducted at several major universities. These ongoing efforts have resulted in improvements to the competing multidimensional computer models used to predict storm surge. Additionally, digital elevation maps based on Light Detection and Ranging (LiDAR) are now available for a wider area, including the STP site. The LiDAR based maps improve the accuracy and resolution of an important input to the computer models that predict storm surge.

Use of the ADCIRC Model for Predicting PMSS at STP:

Recent developments with the Advanced Circulation (ADCIRC) Model were of particular interest to STPNOC. The ADCIRC model, developed by a consortium of four universities in partnership with the USACE and the United States Naval Research Laboratory, is maintained by the USACE and has been certified by FEMA for use in performing storm surge analyses. The ADCIRC model is currently being used by the USACE for the design of flood and storm damage reduction projects and infrastructure all along in the Gulf Coast Area, including Matagorda Bay, which is located in close proximity to the STP site. ADCIRC is currently being used by FEMA for the development of Flood Insurance Rate Maps for the area around the STP site. High resolution digital elevation maps based on LiDAR were developed to support these efforts. STPNOC understands that the NRC is also actively engaged in updating RG 1.59, "Design Basis Floods for Nuclear Power Plants," to recognize these improvements in prediction capability, including the use of ADCIRC, and to evaluate adding probabilistic methods to the existing deterministic methods for assessing risk due to storm surge.

The STPNOC investigation of PMSS modeling software indicates that ADCIRC (i.e., Model 5) will provide the most reliable predictions of PMSS at the STP site. Model 5 predicted the PMSS at the STP site, including wave runup, is 26.5 feet MSL, which is less than the site grade. STPNOC conclusions regarding ADCIRC are based on the following:

- The ADCIRC model was designed to provide high resolution in areas of complex shoreline and bathymetry where it is needed to maximize simulation accuracy. The targeted areas for ADCIRC application include continental shelves, near-shore coastal areas, inlets, and estuaries. Therefore, ADCIRC is particularly well suited for use at STP. SLOSH is not well suited to the simulation of irregular shorelines, such as are found near STP.
- FEMA has certified ADCIRC for use in performing storm surge analyses, and is currently using ADCIRC for developing Flood Insurance Rate Maps (FIRMs) in the vicinity of the STP site. FEMA has not certified SLOSH for development of FIRMs anywhere in the coastal United States.
- ADCIRC digital elevation maps for the STP vicinity are based on LiDAR data that incorporate a much higher grid resolution (50 m x 50 m) than what is used in SLOSH (0.3 km to 4 km), thus enabling ADCIRC to better model surface friction.
- ADCIRC more accurately models topographic features that block or accelerate storm surge flooding (e.g. highways) than SLOSH. This feature of ADCIRC is particularly relevant to STP because the barrier islands along the Texas Coastline south of the STP site and the levee surrounding the City of Matagorda southeast of the STP site influence predicted storm surge levels at the STP site (see Figure 1 and Figure 2).
- Model validation for use in Texas in particular (including the STP vicinity), and in the Gulf of Mexico region in general, is more robust for ADCIRC than for SLOSH. As a result, ADCIRC is more widely used by both USACE and FEMA to obtain more detailed predictions of storm surge levels in these areas.

Confirmatory Analyses of STP PMSS Predictions:

This RAI requests that STPNOC confirm predictions of the PMSS already presented in FSAR 2.4S.5.2 by performing "an analysis of the PMSS event using a conservative approach such as those predicted by a storm surge model (e.g., SLOSH) with input from appropriate PMH models." To ensure that "current best practices" are reflected in the PMSS predictions for STP 3 & 4, STPNOC has completed additional modeling of the PMSS using the latest versions of both the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model and the Advanced Circulation Model (ADCIRC) and the latest available digital elevation maps generated using LiDAR. As a result, there are now six separate PMSS predictions, including the confirmatory analysis performed by the NRC mentioned in this RAI question. These six predictions of PMSS are based on at least three separate storm surge computer models (i.e., SURGE, various versions of SLOSH, and ADCIRC) that predict the PMSS at the STP site. Each of the models developed by STPNOC is based on initial conditions and assumptions intended to envelope the GDC 2 requirement to consider "the most severe natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated." A detailed discussion of the initial conditions and assumptions STPNOC used to ensure the requirements of GDC 2 are met is presented below. This is followed by a description and the results of each of the six models predicting PMSS at the STP site. The results and the specific assumptions for each model are also listed in Table 1.

Initial Conditions and Assumptions for the STP PMSS Models:

Each of the models for predicting PMSS developed by STP is based on initial conditions and assumptions that are consistent with recommendations in SRP 2.4.5 and RG 1.59. Specific assumptions for each model are listed in Table 1. These assumptions include the following:

a) Probable Maximum Hurricane (PMH): PMH parameters for the Gulf of Mexico coast near the site are based on NOAA National Weather Service (NWS) Technical Report NWS 23, as recommended by SRP 2.4.5. The PMH defining parameters are described and listed in FSAR 2.4S.5.1 and FSAR Table 2.4S.5-2. Where PMH parameters are presented as ranges (i.e., forward speed and radius of maximum wind), multiple combinations were tested and the combination resulting in the highest predicted surge was used as the model input.

b) Storm Track Direction and Landfall Location: Each model considered numerous combinations of hurricane track directions and landfall locations. The results presented are based on the hurricane track and landfall location that resulted in the highest predicted surge.

c) 10% Exceedance High Tide: The peak of each PMH modeled was assumed to coincide with a 10% exceedance of the high spring tide, which is the predicted maximum monthly astronomical tide over a 21-year period plus 10%. For Models 1 and 2, the 10% exceedance high tide is based on values provided in RG 1.59. For Models 3, 4 and 5, the 10% exceedance high tide was computed using observed tide data per the definition given in RG 1.59, which resulted in a lower value. Specific assumptions for each model are listed in Table 1.

d) Initial Rise: The peak of each PMH modeled was assumed to coincide with either a tidal initial rise (also called forerunner or sea level anomaly), which is an anomalous departure of the tide level from the predicted astronomical tide, or observed tide data as recommended in RG 1.59.

e) Long Term Sea Level Rise: Each PMH modeled includes an adjustment for projected sea level rise. For Models 1 and 2, the long-term sea level rise is based on the averaged trend reported by NOAA in 2007 when these models were developed. In Models 3, 4, and 5, the long-term sea level rise is based on the slightly lower rate of sea level rise being predicted by NOAA in 2010.

f) Storm Decay: Hurricane strength typically decays as the storm approaches the coast. STP developed models assume that hurricane strength did not decay prior to landfall, except for Model 3. To evaluate the effect on storm surge of decay in hurricane strength as the storm approaches the coast, Model 3 assumes an increase in hurricane central pressure beginning 90 nautical miles from landfall.

The PMH, the starting point for all of the PMSS models, is described in NOAA Technical Report NWS 23 as the most severe hurricane possible in a particular geographic area. A PMH, an unlikely event, is even less likely to occur with the specific combination of parameters (i.e., storm track direction; landfall location; forward speed; and radius of maximum wind) that results in the highest possible storm surge at one particular location. Adding the assumptions that this specific PMH would not decay as it approached the coast and that the PMH landfall would occur concurrently with a 10% exceedance high tide, an initial rise or sea level anomaly, and with a long term sea level rise predicted for the end of plant life, makes the specific PMH being modeled a highly improbable event.

Description and Results of the STP PMSS Models:

The STP PMSS models and results, which are based on the initial conditions and assumptions described above, are as follows:

Model 1: The original SURGE model described in FSAR 2.4S.5.2 and the response to RAI 02.04.05-9 (STPNOC Letter U7-C-STP-NRC-090134, dated September 16, 2009) used SURGE to predict the PMSS at the Gulf Coast and used the HEC-RAS hydraulic model to extrapolate these results to the STP site. SURGE predicted the PMSS at the Gulf Coast is 20.04 feet MSL. The combined SURGE and HEC-RAS hydraulic model predicted the PMSS at the STP site is 24.29 feet MSL. Wave runup is not predicted because the predicted maximum surge level at STP is less than the site grade.

Model 2: The original SLOSH model described in FSAR 2.4S.5.2 and the response to RAI 02.04.05-9 used the April 2007 version of the SLOSH Display CD, which required estimating the PMSS for the PMH by extrapolating the predictions for Category 2 through 5 hurricanes to predict the results for the more severe PMH (FSAR 2.4S.5.2.4). This model predicted the PMSS at the Gulf Coast is 25.98 feet MSL. This model predicted the PMSS at the STP site is 31.1 feet MSL. Wave runup is not predicted because maximum surge at STP with this model is less than the site grade.

Model 3: This STP confirmatory analysis is based on the April 2010 version of SLOSH and assumed that hurricane <u>intensity decays</u> as the storm approaches the coast. This model predicted the PMSS at the STP site is 36.16 feet MSL. Including wave runup calculated using a supplemental USACE Coastal Engineering Manual formulation, this SLOSH model predicted a maximum surge at the STP site of 38.59 feet MSL.

Model 4: This STP confirmatory analysis is based on the April 2010 version of SLOSH and assumed that hurricane <u>intensity does not decay</u> as the storm approaches the coast. This model predicted the PMSS at the STP site is 38.46 feet MSL. Including wave runup calculated using a supplemental USACE Coastal Engineering Manual formulation, this SLOSH model predicted a maximum surge at the STP site of 41.76 feet MSL.

Model 5: This STP confirmatory analysis is based on ADCIRC Version 49 and Texas Grid Version 13 and assumed that PMH intensity started to decay only after landfall. This model predicted the PMSS at the Gulf Coast is 21.5 feet MSL. This model predicted the PMSS at the STP site, including wave runup, is 26.5 feet MSL. The predicted maximum surge at STP is less than the site grade (Figures 1 and 2).

Model 6: The NRC confirmatory analysis mentioned in the second paragraph of this RAI was based on a 2009 version of SLOSH. As reported to STPNOC by the NRC during a teleconference on May 12, 2010, this model predicted the PMSS at the STP site is between 37 and 38 feet MSL. Assuming the wave runup of 2.0 feet reported during the teleconference, this model predicted the maximum surge at the STP site is between 39 and 40 feet MSL.

Note that all six models described above, including Model 6, the NRC confirmatory analysis, predict that the PMSS is less than the STP 3 & 4 design basis flood level of 40 feet MSL. When wave runup is included, five of the six models, including the NRC confirmatory analysis, predict the PMSS, including wave runup, is less than the STP 3 & 4 DBF level of 40 feet MSL. Only the STP confirmatory analysis (Model 4), which is based on the April 2010 version of SLOSH and assumes, very conservatively, that hurricane <u>intensity does not decay</u> as the storm approaches the coast, predicted that wave runup associated with the PMSS could exceed 40 feet MSL.

Main Cooling Reservoir (MCR) Embankment Failure resulting from PMSS:

STPNOC evaluated the potential that a PMSS could cause a breach of the north face of the MCR embankment based on the PMSS and wave runup predicted by Model 4, which resulted in the highest prediction for PMSS, 38.46 feet MSL still water level, and 41.76 feet MSL with wave runup.

The north face of the MCR embankment, the section of the embankment immediately adjacent to the safety-related structures, was evaluated because of the proximity to safety-related structures and because a breach at this location results in the highest flood levels near the power block when the MCR breach is considered separately. An MCR breach at locations other than the north face would have little or no impact on safety-related structures.

The surge level time history predicted by Model 4 indicates that surge levels during the PMH, excluding wave action, will be as follows: i) at or above 34 feet MSL (i.e., site grade) for approximately 80 minutes; ii) at or above 36 feet MSL for approximately 50 minutes; and, iii) at or above 38 feet MSL for approximately 25 minutes. As discussed earlier, storm surge predictions are sensitive to the storm track and proximity. These worst-case surge levels are contingent upon a storm moving inland to the west of the site. In such a storm, winds are initially from the east (wind blowing in the direction of 264 degrees) at the time the surge is sufficiently high to bring water on to the site at the northern side of the MCR levee. As the eye of the storm moves further inland and the surge increases, the wind direction clocks to the SE (blowing in the direction of 314 degrees) and then to the south (blowing towards the north or 000 degrees). As the storm moves further inland, the surge elevation drops below the site elevation.

The analysis concluded that beyond a wind direction from the southeast, the MCR would act to block waves or limit the fetch during the PMH to the extent that significant wave generation would not occur near the north MCR embankment. A similar situation exists with regard to the potential for waves associated with the PMSS to damage the northern part of the MCR embankment. As the surge elevation rises above ground level, waves would be generated by the strong hurricane winds. With winds from the east when water first reaches the site, waves would affect the eastern side of the MCR but there would be no direct wave impact on the northern portion of the levee. As the wind direction shifts from east to southeast and then south, the surge rises and then falls to below the site elevation. At no time during the PMSS passage do winds have a northerly component that could produce waves that would strike the northern side of the embankment. Absent waves on the northern face of the embankment, a wave attack damaging the northern face of the embankment would not be possible.

While the postulated PMSS would not have winds or waves from the north, it would be possible to have a hurricane that did include winds from the north. For example, if a storm were to pass to the east of the facility it would produce northerly winds. However, such a storm would entail surge elevations much lower than the PMH. The PMH must pass to the west of the site to generate surge levels predicted by Model 4.

While the north portion of the embankment would not be exposed to wind-generated waves during the PMSS, it could experience strong currents along the outside of the levee, as a large quantity of water is moved past the site in a short period. The current velocities associated with the PMSS could damage the MCR embankment. However, the MCR levee is designed to contain water above ground level and the external side of the levee is a grass and maintained slope that is similar to levees designed specifically for protection from both hurricane surge and flooding rivers. A grass surface works well for short-term exposure because plant roots act to keep particles of soil together, creating a flexible system that can deform without tearing. Waves and currents of short duration (i.e., less than several hours) on a well-vegetated cohesive material embankment would not be expected to lead to erosion related concerns. Model 4, the worst case, predicts the surge level is at or above 36 feet MSL for approximately 50 minutes.

Most of the models predicting a PMSS, including those based on "current best practices," predict a maximum storm surge water level that is less than site grade elevation. Even the worst-case prediction for the PMSS poses little danger to the MCR embankment because the surge elevation only rises to the lowest portion of the levee and then only for a very short period. Even in the worst-case prediction for the PMSS, the surge level and associated wave action never approach the levee crest where a breach might be initiated. Any erosion at the base of the levee that might occur with less than an hour of exposure to the current would not threaten the levee.

Conclusion Regarding Conformance to GDC 2 for Probable Maximum Storm Surge:

Collectively, the PMSS predictions described above provide a very high degree of assurance that 10 CFR Part 50, Appendix A, GDC 2, is met for a storm surge by the design basis flood level of 40.0 feet MSL.

As discussed earlier, the initial conditions and assumptions used as the starting point for PMSS predictions by STP very conservatively encompass "the most severe natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated." A PMH in the vicinity of the STP site is an improbable event. A PMH coincident with all of the conditions required to generate the PMSS at the STP site is highly improbable. As discussed earlier, all six models, including Model 6, the NRC confirmatory analysis, predict that the PMSS maximum still water level is less than the STP 3 & 4 design basis flood level of 40 feet MSL. In addition, five of the six models, including the NRC confirmatory analysis, predict the PMSS, including wave runup, is less than the STP 3 & 4 DBF level of 40 feet MSL. Only

Model 4 predicted that wave runup associated with the PMSS could exceed 40 feet MSL and then, only for a very short period.

As discussed earlier, both the SURGE and ADCIRC models predict that the PMSS does not exceed site grade. Even with the most conservative predictions of storm surge and wave runup, surge levels and wave action do not create a significant risk for a breach of the MCR embankment because the northern face of the embankment would not be impacted by significant wave action, the duration of the surge is very short, and only the lower portion of the embankment is affected by the surge and wave action.

PMSS Levels as presented in FSAR 2.4S.5.2, "Surge and Seiche Water Levels:"

FSAR 2.4S.5.2, Revision 3, specifies that the PMSS at the STP site of 31.1 feet MSL is based on Model 2, the April 2007 version of SLOSH Display CD. RAI 02.04.05-9 was issued to challenge use of the polynomial curve fit used in Model 2 to extrapolate the predictions for Category 2 through 5 hurricanes to predict the results for the PMH. In this RAI, the NRC postulates, based on its confirmatory analysis, that the PMSS prediction of 31.1 feet MSL used in FSAR 2.4S.5.2 may be too low because "the extrapolation procedure described above may not be technically valid or conservative."

STPNOC responded to the NRC concern about the extrapolation method used in Model 2 in the response to RAI 02.04.05-9 (Letter U7-C-STP-NRC-090134, dated September 16, 2009) by showing that: a) the extrapolation method was more conservative (i.e., predicted a higher storm surge) than the level predicted using SURGE (Model 1); and, b) NUREG-0933, "A Prioritization of Generic Safety Issues - Item C-14: Storm Surge Model for Coastal Sites (Rev. 1)," dated 2007, indicated that "The staff believes that the existing bathystrophic model (SURGE) is adequate for calculating design basis water levels at future nuclear plant sites" and that "This model is very conservative and is still used by the CERC." During a teleconference with the NRC in April 2010, the staff concurred that SURGE was adequate for predicting PMSS at the Gulf Coast; however, it stated that the HEC-RAS hydraulic model used to extrapolate the SURGE results at the coast to the STP site is not a dynamic model and, therefore, not acceptable to either predict the PMSS at the STP site or to confirm that the extrapolation method used in Model 2 was valid.

STPNOC believes that the PMSS predictions generated by ADCIRC (Model 5) for both the Gulf Coast and the STP site and the PMSS predictions generated by SURGE (Model 1) for the Gulf Coast are adequate to confirm that the polynomial extrapolation method used with the 2007 version of the SLOSH Display CD (Model 2) and presented in FSAR 2.4S.5.2, Revision 3, is both technically valid and conservative. The ADCIRC and SURGE results also support a conclusion that the PMSS predictions generated by the April 2010 version of SLOSH (Models 3 and 4) are overly conservative for the Gulf Coast in the vicinity of the STP site.

As indicated in Table 1, ADCIRC (Model 5) predicts that the PMSS, including wave runup, at the STP site is 26.5 feet MSL (i.e., less than site grade). SLOSH (Model 2), using the polynomial extrapolation challenged by the NRC, predicts the PMSS at the STP site is 31.1 feet MSL. Models 3 and 4, based on the 2010 version of SLOSH, predict the PMSS at the STP site is 36.16 feet MSL and 38.46 feet MSL, respectively. When compared to the ADCIRC results, Model 2 is a very conservative prediction of PMSS at the STP site and Models 3 and 4 appear to provide an overly conservative prediction of PMSS at the STP site. For reasons discussed earlier in this response, STPNOC believes that ADCIRC provides the most reliable predictions for PMSS in the vicinity of the STP site and that ADCIRC verifies that the extrapolation method used in Model 2 is both technically correct and conservative.

In addition, as indicated in Table 1, SURGE (Model 1) and ADCIRC (Model 5) predict that the PMSS at the Gulf Coast is 20.04 feet MSL and 21.5 feet MSL, respectively. These surge level predictions for the Gulf Coast are considerable lower than the PMSS at the Gulf Coast of 25.98 feet MSL predicted in Model 2 using SLOSH and a linear extrapolation (see Table 1, footnotes (f) and (g)) of the Category 2 through 5 results to include the PMH. This very high prediction for PMSS at the Gulf Coast generated by Model 2 (when compared to Models 1 and 5) provides additional support that use of the polynomial extrapolation was appropriate and conservative for the Model 2 prediction of surge levels at the STP site.

CONCLUSION:

Collectively, the PMSS predictions described in this response provide a very high degree of assurance that 10 CFR Part 50, Appendix A, GDC 2, is met for the probable maximum storm surge because STP 3 & 4 SSC important to safety are designed for a design basis flood level of 40.0 feet MSL. In addition, as indicated by the comparison of the ADCIRC based prediction of PMSS at the STP site (i.e., 26.5 feet MSL) with the SLOSH based prediction of PMSS at the STP site in FSAR 2.4S.5.2, Revision 3, (i.e., 31.1 feet), FSAR 2.4S.5.2 presents a very conservative prediction of PMSS at the site and does not need to be modified.

There are no COLA changes required as a result of this response.

Table 1, PMSS and Wave Runup Analysis Assumptions and Results

Model	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6 [a]
Assumptions and Results	SURGE + HEC-RAS Model (FSAR 2.4S.5.2.3)	Extrapolation using SLOSH Display CDI (Version 2007) (FSAR 2.4S.5.2.4)	SLOSH Model (Version April 2010) PMH with Decaying Intensity	SLOSH Model (Version April 2010) PMH with Steady Intensity	ADCIRC Model (Version 49 with Texas Grid Version 13) PMH with Decaying Intensity Inland	SLOSH Model (Version 2009) (NRC Confirmatory Analysis)
PMH Parameters	From NWS 23 (FSAR Table 2.4S.5-2)	From NWS 23 (FSAR Table 2.4S.5-2)	From NWS 23 (FSAR Table 2.4S.5-2)	From NWS 23 (FSAR Table 2.4S.5-2)	From NWS 23 (FSAR Table 2.4S.5-2)	Not Discussed
Hurricane Decay	None	None	Central pressure increased 15 mb over the 90 nautical miles prior to landfall	None	Steady State PMH to landfall, followed by inland decay.	Not Discussed
10% Exceedance High Tide and Initial rise [b]	3.92 feet NGVD 29[c] at Freeport, TX (FSAR 2.4S.5.2)	3.92 feet NGVD 29[c] at Freeport, TX (FSAR 2.4S.5.2)	3.6 feet NGVD 29[c] at Freeport, TX	3.6 feet NGVD 29[c] at Freeport, TX	3.5 feet NAVD 88	Not Discussed
Long Term Sea Level Rise [d]	1.93 feet Freeport, TX[e]	1.93 feet Freeport, TX[e]	1.4 feet Freeport, TX[e]	1.4 feet Freeport, TX [e]	1.4 feet Freeport, TX[e]	Not Discussed
Predicted Maximum Surge (Gulf Coast)	20.04 feet MSL	25.98 feet MSL[f]	Not evaluated	Not Evaluated	21.5 feet MSL	Not Discussed
Predicted Maximum Surge (STP Site or vicinity)	**24.29 feet MSL**	**31.1 feet MSL[g]**	**36.16 feet MSL (overly conservative) [j]**	**38.46 feet MSL (overly conservative) [j]**	**26.5 feet MSL[i]**	**Approximately 37 to 38 feet MSL[a]**
Wave Runup at the Safety-Related Structures of Power Block	Not applicable	Not applicable	2.43 feet Following CEM[h] Formulations	3.30 feet Following CEM[h] Formulations	Not applicable	Approximately 2 feet[a]
PMH Maximum Flood Level including Wave Runup	**Less than site grade.**	**Less than site grade.**	**38.59 feet MSL (overly conservative) [j]**	**41.76 feet MSL (overly conservative)[j]**	**Less than site grade.**	**Approximately 39 feet to 40 feet MSL[a]**

(a) NRC confirmatory analysis results, based on NRC input to STP during a NRC/STP/Bechtel teleconference on 5/12/2010.
(b) Following RG 1.59 (Ref. 5, Appendix C.3).
(c) National Geodetic Vertical Datum ("NGVD") of 1929, considered to be the same as Mean Sea Level (MSL) for this table.
(d) Following RG 1.59 (Ref. 5, Section C.3).
(e) Long-term sea level rise based on a 100 year prediction (an existing trend projected to 100 years).
(f) Based on Cat 1 through Cat 5 hurricane results with a linear extrapolation to the PMH results.
(g) Based on Cat 1 through Cat 5 hurricane results with a polynomial extrapolation to the PMH results.
(h) US Army Corps of Engineers, Coastal Engineering Manual, EM 1110-2-1100, 2006.
(i) Includes wave runup.
(j) As explained in the response to RAI 02.04.05-10, results generated by SLOSH, Version April 2010, are overly conservative for the STP site.

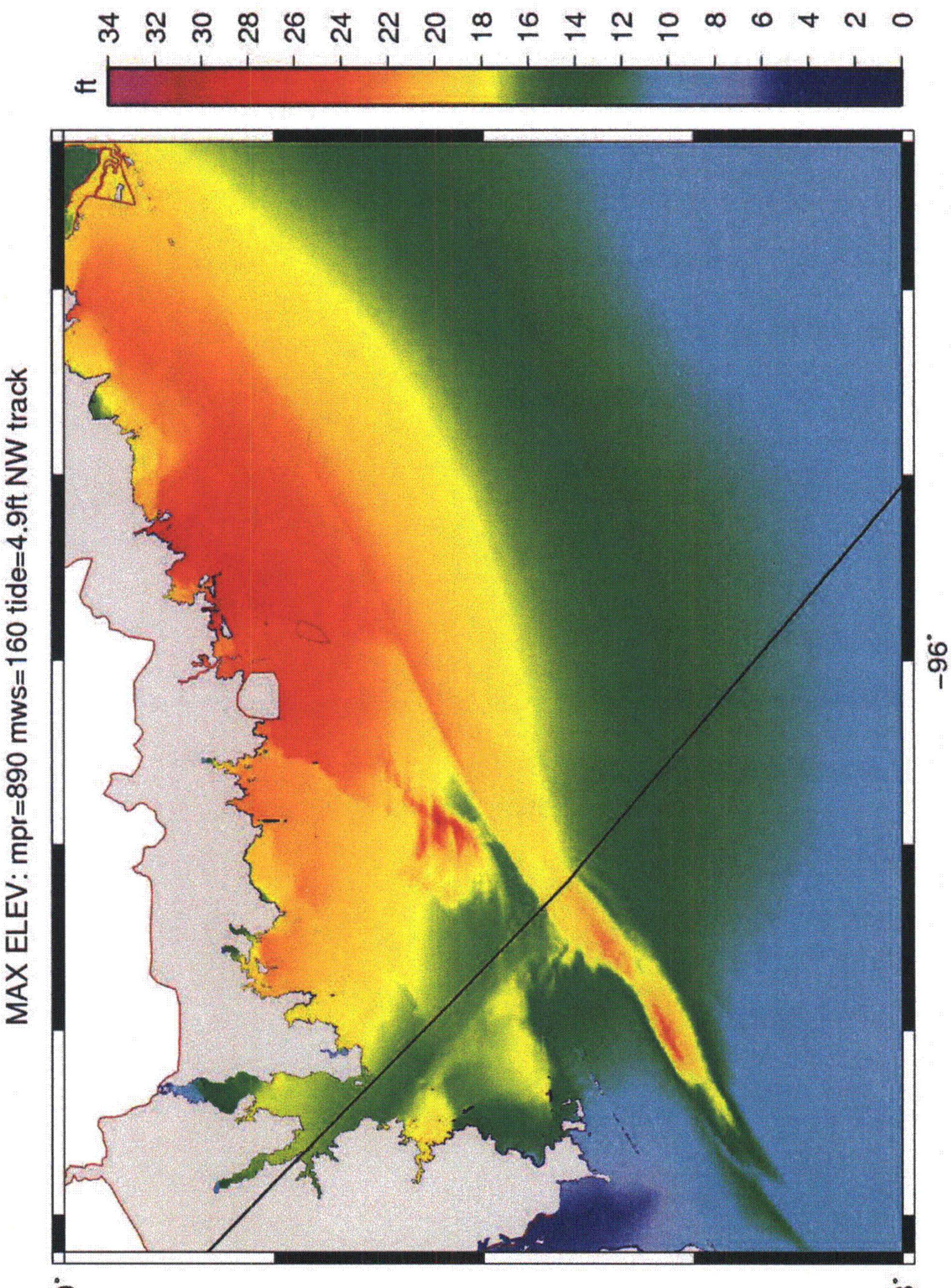

Figure 1, ADCIRC Results for the PMH with a Northwest Track passing West of the STP Site

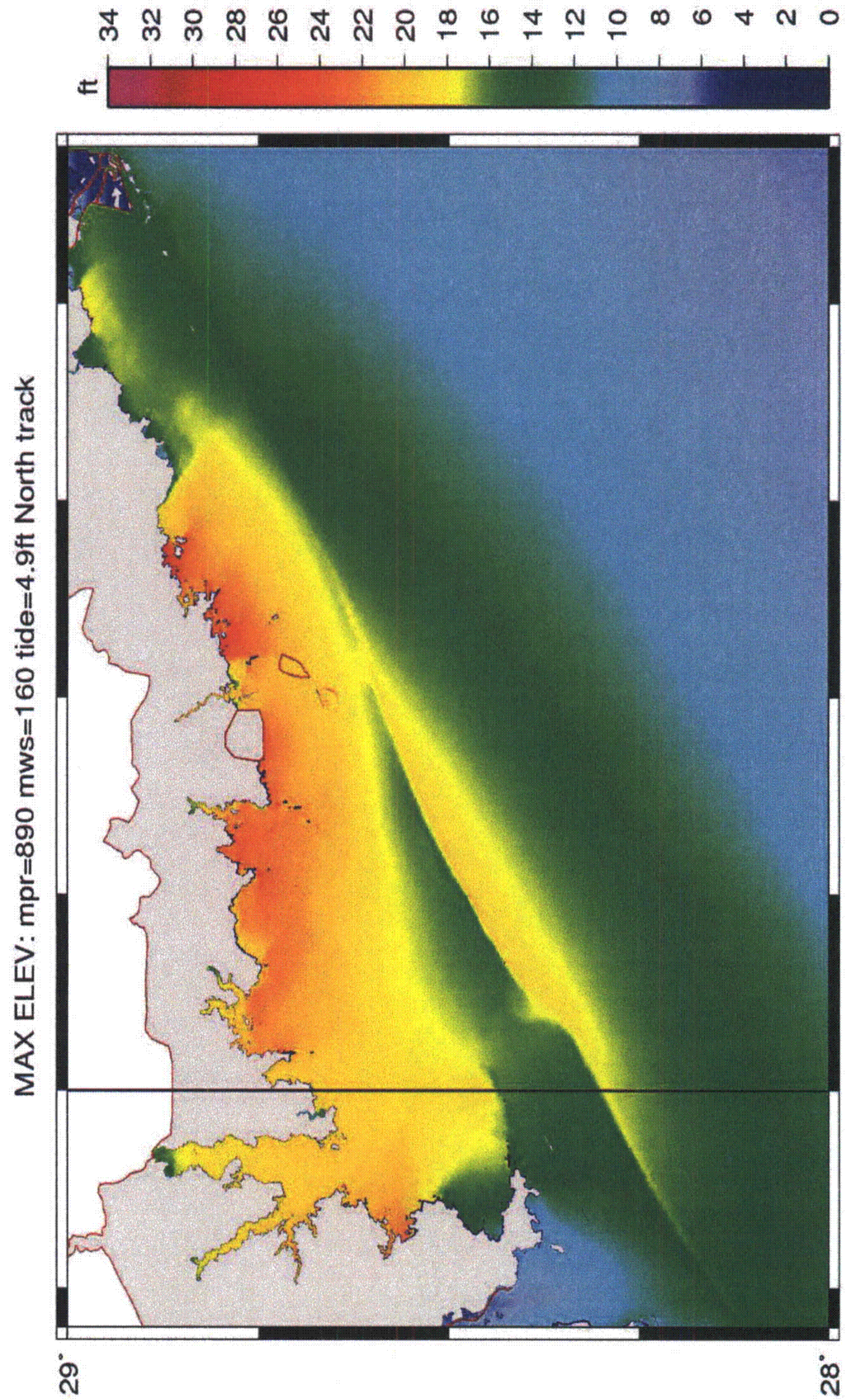

Figure 2, ADCIRC Results for the PMH with a North Track passing West of the STP Site