FPL

L-2011-427
10 CFR 52.3

October 11, 2011

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555-0001

Re: Florida Power & Light Company
Proposed Turkey Point Units 6 and 7
Docket Nos. 52-040 and 52-041
Response to NRC Request for Additional Information Letter No. 030
(eRAI 5818) Standard Review Plan Section 02.04.06
Probable Maximum Tsunami Flooding

Reference:

1. NRC Letter to FPL dated July 18, 2011, Request for Additional Information Letter No.030 Related to SRP Section 02.04.06 - Probable Maximum Tsunami Flooding for the Turkey Point Nuclear Plant Units 6 and 7 Combined License Application
2. FPL Letter to NRC dated August 17, 2011 Schedule for Response to NRC Request for Additional Information Letter No. 030 (eRAI 5818) - Standard Review Plan 02.04.06 - Probable Maximum Tsunami Flooding

Florida Power & Light Company (FPL) provides, as attachments to this letter, its responses to the Nuclear Regulatory Commission's (NRC) Request for Additional Information (RAI) 02.04.06-4 and 02.04.06-6 provided in Reference 1. FPL provided a schedule for the responses to RAI 02.04.06-4 and 02.04.06-6 in Reference 2. The attachment identifies changes that will be made in a future revision of the Turkey Point Units 6 and 7 Combined License Application (if applicable).

If you have any questions, or need additional information, please contact me at 561-691-7490.

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

Executed on October 11, 2011

Sincerely,

William Maher
Senior Licensing Director – New Nuclear Projects

WDM/RFB

D097
NRO

Attachment 1: FPL Response to NRC RAI No. 02.04.06-4 (eRAI 5818)

Attachment 2: FPL Response to NRC RAI No. 02.04.06-6 (eRAI 5818)

cc:
PTN 6 & 7 Project Manager, AP1000 Projects Branch 1, USNRC DNRL/NRO
Regional Administrator, Region II, USNRC
Senior Resident Inspector, USNRC, Turkey Point Plant 3 & 4

NRC RAI Letter No. PTN-RAI-LTR-030

SRP Section: 02.04.06 - Probable Maximum Tsunami Flooding

Question from Hydrologic Engineering Branch (RHEB)

NRC RAI Number: 02.04.06-4 (eRAI 5818)

Section C.I.2.4.6.3 of Regulatory Guide 1.206 (RG 1.206) provides specific guidance with respect to the source characteristics needed to determine the PMT. These characteristics include detailed geologic descriptions of the controlling tsunami generators, including location, source dimensions, and maximum displacement. In FPL's response to NRC RAI 2.04.06-1 (Question 18184), FPL acknowledges evidence of Miocene debris flows in the Florida Straits region. However, they justify omission of Florida Straits debris flows as potential tsunami sources for PMT determination on the basis of (1) absence of evidence for any correlated tsunami deposit along the southern Florida coast and (2) the unlikelihood of debris flows similar to those that occurred in the Miocene under present-day sea-level-rise conditions. With regard to the first point, Miocene tsunami deposits would probably not be preserved over such a long period and in areas that are near sea level now, given the changes in paleogeography since Miocene time. With regard to the second point, additional justification (e.g., past scientific studies) is needed to support this assertion. Provide justification for the assertion that debris flows in the Florida Straits region, similar to those observed in the Miocene from drill-hole records, would not occur under present-day sea-level conditions.

FPL RESPONSE:

The omission of Florida Straits debris flows as potential tsunami sources for the PMT determination is based on the following: (1) absence of evidence for any correlated tsunami deposit along the southern Florida coast and (2) unlikelihood of debris flows similar to those that occurred in the Miocene under present-day sea-level rise conditions. With regard to the first point, Miocene tsunami deposits would likely not be preserved over such a long period and in areas that are near sea level now, given the changes in paleogeography since Miocene time. In regards to the second point, additional information from past scientific studies is provided on the Miocene tectonic setting and ocean circulation, both of which influenced the current flow in the Straits of Florida during the Miocene to support the second assertion.

<u>Tectonic Processes affecting the Straits of Florida:</u>

The Greater Antilles Arc collision with the Bahama Platform that occurred during the Mesozoic had an enormous impact on the evolution of shallow-water carbonate platforms in the Florida-Bahamas region (FSAR Subsection 2.5.1.1.1.3.2). Loading of the North American plate propagated northward away from the collision zone and caused differential subsidence along the margins of the paleo-reentrant of the Santaren Channel. This resulted in the foundering of carbonate platforms beginning in the late Cretaceous and as late as the early Miocene. Structural features in the Santaren channel, such as thrust faults and other compressional features, constrain the extent and timing of deformation and foundering of shallow-water carbonate banks related to the Greater Antilles Arc collision with the Bahama Platform (Winston, 1991 and Bergman, 2005).

By the early Cenozoic, the Greater Antilles Arc moved northwards making contact with the Bahama Platform and initiated an arc-continent collision. The rotation of the Caribbean Plate as it moved further northward was impeded and the direction of movement rotated to the east where less resistance was encountered. This occurred over 50 m.y (million years ago), from the Late Paleocene (60 Ma [Million years]) to early Miocene (20 Ma). Initiation of minor north-south convergence between North America and South America Plates began in the early Miocene, about 15 Ma (Tenbrink et al., 2009).

Ocean Circulation from Miocene to Present:

The warm climate during the late early Miocene to early middle Miocene caused current flow to intensify at about the same time the North Component Water (NCW, proto-North Atlantic Deep Water (NADW)) began to warm and intensify. This time of erosive current activity in the Straits of Florida and the North Atlantic was followed by the onset of sediment (drift) deposition. In the Florida-Bahamas seaways, gently mounded drifting and sediment wave (sediment waves are generated beneath currents flowing across the seabed, in the form of either downslope-flowing turbidity currents or along slope-flowing bottom currents) retreat occurred at the same time (about 15.1 Ma) as accumulation rates increased on drifts in the North Atlantic. Also during this time, the East Antarctic Ice Sheet expanded, became permanent, and the NCW might have cooled resulting in a decrease in strength (Bergman, 2005 and Wynn and Stow, 2002). Bergman (2005) concludes that beginning about 15.1 Ma, the primary currents flowing through the regions were dominated by northward flowing, relatively stable, currents.

During the middle Miocene at approximately 12.2 Ma, mounded drifts initiated and expanded in the region. Associated development of mounded drifting in the Santaren Channel and steep prograding drift clinoforms within the Straits of Florida indicate that a western boundary paleo-Florida Current had developed and the Straits of Florida had become the major pathway for the Florida-Gulf Stream surface current system by the middle Miocene (Bergman, 2005 and Anselmetti et al, 2000).

Also, during the Miocene from approximately 13 to 2.7 Ma, the Central American Seaway (CAS) (also known as the Isthmus of Panama) closed. The closing of the CAS is believed to have resulted in a strengthening of the Gulf Stream (increase in salinity and temperature) that caused the Caribbean to become a major pathway of flow for the northward flowing surface limb of the Atlantic meridional overturning circulation (MOC) and the entering of corrosive intermediate waters into the Caribbean (Bergman, 2005).

As a direct impact of the closure of the CAS, the Atlantic MOC began to influence the properties of the NADW. The Atlantic MOC became isolated, which increased the deepwater formation (combination of cold air temperatures and relatively high surface water salinity creates denser water, which causes the water to sink to the bottom) in the North Atlantic. This strengthened the geostropic flow (wind-driven surface circulation composed of lower density water masses) northward through the Caribbean and resulted in an increase in heat transport to the North Atlantic (Bergman, 2005, Droxler et al., 1998, Sigurdsson et al, 1997, Mutti et al., 2005, and Roth et al., 2000). The density contrast and resulting inversion (overturning of the NADW) led to a general increase in the North Atlantic MOC strength. The influx into the Caribbean Basins of Antarctic Intermediate Water (AAIW) would have been initiated at this time to replenish the waters sinking in the northern latitudes of the North Atlantic Ocean. This led to an increase in dissolution of sea floor sediments in the middle Miocene, about the time of initial shoaling of the seaway. Also, as a result of dissolution of sea floor sediments it has been postulated that the increase in the Atlantic MOC brought corrosive intermediate waters into the Caribbean (Bergman, 2005, Sigurdsson et al., 1997, Droxler et al., 1998, Roth et al., 2000).

The closure of the CAS affected the Straits of Florida region by increasing the velocity of the currents flowing through the Straits and resultant erosion and sedimentological processes forming turbidity currents, debris flows, and slumps that reworked the sea floor. These processes created submarine debris flows, turbidite deposits, slumping and submarine landslides features. Seismic reflection data and sedimentological study of five boreholes from ODP Leg 166 (Sites 1003-1007), drilled along a slope-basin transect off the western margin of Great Bahama Bank, indicate deposits that appear as shingled, mounded lobes from the upper slope of the toe-of-slope, which thin toward, and interfinger with, basinal deposits (Bergman, 2005 and Eberli et al., 1997).

Large-scale mass gravity flow deposits are documented from the middle Miocene throughout the Florida-Bahamas region that also includes the western Florida margin and the Blake-Bahama Basin. One such debris flow deposit that was shed from the Great Bahama Bank in the Central Straits of Florida is known as the “Abaco episode”. It is synchronous with the Unit II gravity flows that are interpreted as contourite deposits of the Gulf Stream (Brooks, 1979). In general, the contourite deposits formed in the lower velocity zones along margins or beneath the core of higher-energy currents, where flow velocities are low enough to induce deposition but yet high enough to contain a high suspended load that would not be present in the absence of the current. If there is a strong or concentrated nepheloid layer, (a layer of water above the ocean floor that contains significant amounts of suspended sediment (Bates and Jackson, 1980)), a rapid deposition of sediment will occur, forming a contourite/turbidity deposit (Bergman, 2005). Unit II sediments consist of large debris flows and turbidites that accumulated on top of the carbonate banks at a marine high stand which became unstable as sea level fell (ODP Shipboard Scientific Party, 1986).

Today the Gulf Stream is a strong, western boundary surface current that flows northward along the western side of the North Atlantic Ocean basin, and is characterized by warm temperature and high salinity. Approximately 90 percent of the

Gulf Stream originates as the Florida Current that exits the Caribbean through the Straits of Florida. The Florida Current is composed of waters that enter the Caribbean through seaways of the Greater and Lesser Antilles, and which flow northwest across the Caribbean Sea and into the Caribbean Current. These currents then flow north through the Yucatan Channel and into the Gulf of Mexico as the Loop Current, where it loops into the Gulf in a clockwise direction before entering the Straits of Florida. As the Florida Current exits the Straits of Florida, it flows north of the Little Bahama Bank and joins the smaller Antilles Current to become the Gulf Stream (Bergman, 2005).

<u>The Role of Current Interaction in the Straits of Florida Region during the Miocene:</u>

Ocean currents and debris flows during the Miocene influenced the current-controlled drift deposits in the area of the Straits of Florida that formed as currents funneled through the seaways between Florida, Cuba, Cay Sal Bank and Great Bahama Bank. These currents formed sediment drift deposits, also known as contourite drifts. Sediment drifts are recognizable in seismic reflection data (seismic lines from ODP Leg 166). In general, the external morphology is often mounded and underlain by a laterally continuous, discontinuity that is the result of erosion, the onset of bottom current flow, or a compositional change accompanying current regime change. Internal morphology is generally lenticular in shape containing convex upward reflections that are not parallel to underlying reflections and migrate or prograde toward the current axis (Bergman, 2005 and Eberli et al., 1997).

The seismic facies (that appears as stacked discontinuities) in the Straits of Florida indicates that the early Miocene paleo-Florida shelf slope was a region of little sediment deposition (Bergman, 2005, Anselmetti et al., 2000 and Eberli et al., 1997). The internal reflections have high amplitudes, which infer periodic breaks in the sediments. In addition, the overlying current channeling facies show high amplitudes and little divergence. According to Bergman (2005), the configurations of early Miocene seismic drift reflections and periplatform sediments were influenced by currents that resulted in erosive channels and discontinuous accumulations of sediment.

Seismic reflection data and drill core sediments indicate the presence of paleo-erosive channels on the Florida shelf. The Florida shelf middle Miocene periplatform sediments are steeply dipping, and contain erosive channels. Near the Miami Terrace, the slope surface remains thinly veneered by sediment. According to Mullins and Neumann (1979), the Miami Terrace surface is a hardground that was developed by the Florida Current during low sea level.

An example of discontinuous accumulations of sediment is seen in the Santaren Channel. The Santaren Channel on the west side's sediment body is characterized by discontinuous wavy reflections distinct from continuous sediment waves that developed around 15.9 Ma. In the north, the sediment body is overlain by continuous reflections beginning at 15.1 Ma. In the south, the sediment body is overlain by an erosive reflection at 10.7 Ma. This sediment wave body is approximately the same age as calciturbidite shedding along the slope of the Great Bahama Bank from 15.9 to 10.7 Ma. The implication is that the sediment body in the Santaren Channel may also have resulted from an episode of downslope sediment transport (Bergman, 2005).

Conclusion:

The Straits of Florida influences global climate because it is the location of the northward flowing limb of North Atlantic meridional overturning circulation (MOC) that is responsible for transporting heat and high salinity waters from low to high latitudes and thus an important contributor to deep-water formation in the North Atlantic. These currents have varied in strength through time due to tectonics, both regionally and locally, and the gradual shoaling and closure of the Central American Seaway (Bergman, 2005).

The seaway in the Straits of Florida has evolved from a constricted middle Cretaceous shallow-water carbonate bank environment to a current-swept seaway during the Miocene and to the present deep-water channel that acts as the primary conduit for northward flow of the Florida Current-Gulf Stream western boundary current system (Bergman, 2005).

The relatively strong Miocene current deposited debris flows and eroded submarine landforms were marked by a fall in sea level. The present current regime is different from that in the Miocene, with sea level rising since the end of the Wisconsinan glacial stage (Potter and Lambeck, 2003 and Otvos, 2004). Therefore, the debris flows that occurred in the Miocene are unlikely to occur in the present day with its rising sea level.

This response is PLANT SPECIFIC.

References:

Anselmetti, F., Eberli, G., and Ding, Z., "From the Great Bahama Bank into the Straits of Florida: A Margin Architecture Controlled by Sea-Level Fluctuations and Ocean Currents," *GSA Bulletin*, v. 112, no. 6, pp. 829-844, Geological Society of America, 2000.

Bates, L., and Jackson, J. (eds), *Glossary of Geology*, 2nd edition, American Geological Institute, Virginia, 1980.

Bergman, K.L., *Seismic Analysis of Paleocurrent Features in the Florida Straits: Insights into the Paleo-Florida Current, Upstream Tectonics, and the Atlantic-Caribbean Connection*, University of Miami, Coral Gables, Florida, p. 238, 2005.

Brooks, I., "Fluctuations in the Transport of the Florida Current at Periods between Tidal and Two Weeks," *Journal of Physical Oceanography*, v. 9, pp. 1048-1053, 1979.

Droxler, A., Burke, K., Cunningham, A., Hine, A., Rosencrantz, E., Duncan, D., Hallock, P. and Robinson, E., "Caribbean Constraints on Circulation between Atlantic and Pacific Oceans Over the Past 40 Million Years," *Oxford Monographs on Geology and Geophysics, no. 39, Tectonic Boundary Conditions for Climate Reconstructions*, Crowley, T. and Burke, K. (eds.), New York, Oxford University Press, 1998.

Eberli, G.P., Swart, P.K., Malone, M.J., et al., 1997 Proceedings Ocean Drilling Program, Initial Reports, 166 [Online]. Available from World Wide Web: http://www-odp.tamu.edu/publications/166IR/166TOC.HTM . Accessed August 1, 2011.

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Otvos, E., Holocene Gulf Levels: Recognition Issues and an Updated Sea-Level Curve, *Journal of Coastal Research*, V. 20(3), pp. 680-699, 2004.

Potter, E., and Lambeck, K., "Reconciliation of Sea-Level Observations in the Western North Atlantic during the Last Glacial Cycle", *Earth and Planetary Science Letters*, V. 217, pp. 171-181, 2004.

Roth, J., Droxler, A., and Kameo, K., "Chapter 17: The Caribbean Carbonate Crash at the Middle to Late Miocene Transition-Linkage to the Establishment of the Modern Global Ocean Conveyer," *Proceedings of the Ocean Drilling Program, Scientific Results*, v. 165, Leckie, R., Sigurdsson, H., Acton, G, and Draper, G. (eds.), pp. 249-273, 2000.

Sigurdsson, H., Leckie, R., and Acton, G., "Caribbean Ocean History and the Cretaceous/Tertiary Boundary Event," *Proceedings of the Ocean Drilling Program, Preliminary Reports*, v. 165, 1997.

Tenbrink, U., Marshak, S., and Granja Bruna, J., "Bivergent Thrust Wedges Surrounding Oceanic Island Arcs: Insight from Observations and Sandbox Models of the Northeastern Caribbean Plate," *Geological Society of America Bulletin*, v. 121, pp. 1522-1536, 2009.

Winston, G., *Atlas of Structural Evolution and Facies Development on the Florida-Bahamas Platform Triassic through Paleocene*, Miami Geological Society, p. 38, 1991.

Wynn, R., and Stow, D., "Classification and Characterization of Deep-Water Sediment Waves", *Marine Geology*, V. 192, pp. 7-22, 2002.

ASSOCIATED COLA REVISIONS:

The twentieth paragraph (second paragraph under subheading-Potential Bahama Platform and Straits of Florida Tsunami Sources) in Subsection 2.5.1.1.5 will be updated in a future revision as indicated below:

Units I and III are interpreted as contourite deposits of the Gulf Stream, which sweeps the drill site with bottom velocities of 20 to 40 centimeters/second (8 to 16 inches/second) (Reference 741). **In general, the contourite deposits formed in the lower velocity zones along margins or beneath the core of higher-energy currents, where flow velocities are low enough to induce deposition but yet high enough to contain a high suspended load that would not be present in the absence of the current. If there is a strong or concentrated nepheloid layer, (a layer of water above the ocean floor that contains significant amounts of suspended sediment (Reference 905)), a rapid deposition of sediment will occur, forming a contourite/turbidity deposit (Reference 906).** Unit II interrupts the contourite record in an impressive way. During a four million year interval in the middle Miocene, debris flows and turbidites were emplaced too rapidly to be reworked by the bottom currents. ODP scientists reviewing the stratigraphic relationships hypothesize that the large debris flow and turbidites of Unit II represent material that had accumulated ~~atop~~ **on top of** the carbonate banks at a marine high stand and that the material became unstable as sea level fell (Reference 740). ~~A~~ **Debris** flow**s** and associated turbidites, ~~of~~ the size of Unit II, might not be expected to occur in today's environment of rising sea levels. **The present current regime is different from that in the Miocene because sea level has been generally rising since the end of the Wisconsinan glacial stage (References 907 and 908).**

References 905 through 908 will be added to FSAR Subsection 2.5.1 in a future update of the FSAR.

905. Bates, L., and Jackson, J. (eds), *Glossary of Geology*, 2nd edition, American Geological Institute, Virginia, 1980.

906. Bergman, K.L., *Seismic Analysis of Paleocurrent Features in the Florida Straits: Insights into the Paleo-Florida Current, Upstream Tectonics, and the Atlantic-Caribbean Connection*, University of Miami, Coral Gables, Florida, pp. 238, 2005.

907. Otvos, E., Holocene Gulf Levels: Recognition Issues and an Updated Sea-Level Curve, *Journal of Coastal Research*, V. 20(3), pp. 680-699, 2004.

908. Potter, E., and Lambeck, K., "Reconciliation of Sea-Level Observations in the Western North Atlantic during the Last Glacial Cycle", *Earth and Planetary Science Letters*, V. 217, pp. 171-181, 2004.

ASSOCIATED ENCLOSURES:

None

NRC RAI Letter No.: PTN-RAI-LTR-030 Dated July 18, 2011

SRP Section: 02.04.06 – Probable Maximum Tsunami Flooding

Question from Hydrologic Engineering Branch

NRC RAI Number: 02.04.06-6 (e-RAI 5818)

Section C.I.2.4.6.3 of Regulatory Guide 1.206 (RG 1.206) provides specific guidance with respect to the historical tsunami record, including paleo-tsunami evidence, source characteristics needed to determine the PMT, and orientation of the site relative to the generating mechanism, shape of the coastline, offshore land areas, and hydrography.

1) The assertion in FPL's response to NRC RAI 2.04.06-3 (Question 18186) that the site is sheltered by the Bahamas Islands from landslide-generated tsunamis north of Puerto Rico depends on FPL's response to NRC RAI 2.04.06-2 (Question 18185). In response to NRC RAI 2.04.06-2 (Question 18185), FPL did not specifically model tsunamis from landslides north of Puerto Rico. Further evidence is needed to verify this assertion.

2) The assertion in FPL's response to NRC RAI 2.04.06-3 (Question 18186) that the impact of a submarine landslide to the north (offshore of the Carolinas) would be considerably reduced depends on FPL's response to NRC RAI 2.04.06-2 (Question 18185). In FPL's response to NRC RAI 2.4.6-2 (Question 18185), FPL did not specifically model tsunamis from landslides offshore of the Carolinas. Further evidence is needed to verify this assertion.

Subsection 2.4.1.1.5 does not exist in the FSAR. Justify the assertion that the Bahamas Islands shelter the site from landslide-generated tsunamis north of Puerto Rico. Justify the assertion that tsunami water levels from submarine landslides to the north (offshore of the Carolinas) would be negligible at the site.

FPL RESPONSE:

The RAI is addressed below in three parts.

1. The Sheltering of Units 6 & 7 Site from Landslide Tsunamis North of Puerto Rico

Literature review indicates that no tsunami simulation was performed for landslide sources north of Puerto Rico, i.e., the Puerto Rico Trench. However, the sheltering effect of the Bahamas Islands on the Units 6 & 7 site from landslides generated north of Puerto Rico can be demonstrated based on the results of a tsunami model simulation caused by an earthquake in the Puerto Rico Trench (North Puerto Rico/Lesser Antilles subduction zone). Figure 2.4.6-228 (see the attached associated COLA revision), taken from Reference 1, shows contours of tsunami amplitudes and the associated regional tsunami propagation pattern due to an earthquake at the Puerto Rico Trench. As indicated in the figure, the southeast Florida coast is sheltered by the Bahamas from tsunami waves generated in the area north of Puerto Rico. Although the mechanism of tsunami generation by earthquakes and landslides is different, the regional tsunami propagation pattern between the two is expected to be similar for the Puerto Rico Trench area. As Figure 2.4.6-228 indicates, the apparent earthquake tsunami beaming is along an azimuth perpendicular to the strike, i.e., in the north direction. For a landslide tsunami that may originate in the Puerto Rico Trench, the direction of the seaward tsunami propagation would also be in the north direction, and the tsunami amplitude would be relatively lower at far-field. This is because landslide tsunamis are greatly attenuated at far-field due to non-linear and dispersive effects compared to earthquake tsunamis (Reference 1). Therefore, a landslide in the carbonate platform north of Puerto Rico is not considered a PMT source for the Units 6 & 7 site.

2. Impact of a Submarine Landslide Offshore of the Carolinas (Cape Fear Slide)

As discussed in the FSAR Subsection 2.4.6.1.1, the largest submarine landslide area near Units 6 & 7 is identified in an area south of Cape Hatteras, off the Carolina Trough. This area includes the Cape Fear and Cape Lookout Slides. Between the two landslides, the Cape Fear Slide (CFS) complex is the larger and closer to the Units 6 & 7 site. Therefore, the CFS complex is expected to have greater impact. Literature review indicates that there was no far-field tsunami analysis performed for the landslide complex. However, Hornbach et al. (Reference 2) performed a localized tsunami simulation for the largest landside from the CFS complex and obtained an estimate of maximum tsunami wave height at 100 meters water depth. The model results include contours of tsunami amplitudes 30 minutes after initiation of the landslide (see Figure 2.4.6-227 in the attached associated COLA revision). The major tsunami waves propagate along the axis of the landslide, both toward the coast and seaward. Geometrical spreading of the tsunami wave is prominent along the direction perpendicular to the axis of slide and toward the Straits of Florida. Based on the model results, the tsunami wave amplitude 30 minutes after slide initiation and about 200 kilometers (124 miles) along the Units 6 & 7 direction is approximately 1.5 meters (4.9 feet). In contrast, the tsunami amplitude off Miami, Florida, at a water depth of 783 meters (2569 feet) for the 1755 Lisbon Earthquake tsunami (which corresponds to the probable maximum tsunami) is 2.0 meters (6.6 feet) (Reference 3). The distance between the CFS complex and off-Miami site at water depth of 783 meters (2569 feet) is more than 800 kilometers (497 miles). Therefore, the tsunami maximum water level at Units 6 & 7 site due to the CFS complex landslide would be lower than that from the 1755 Lisbon Earthquake tsunami.

3. Subsection 2.5.1.1.5

It is assumed that "Subsection 2.4.1.1.5" in the RAI is meant to be "Subsection 2.5.1.1.5". Subsection 2.5.1.1.5 exists in Revision 2 of the FSAR.

This response is PLANT SPECIFIC.

References:

1. Atlantic and Gulf of Mexico Tsunami Hazard Assessment Group, *Evaluation of Tsunami Sources with the Potential to Impact the U.S. Atlantic and Gulf Coasts — An Updated Report to the Nuclear Regulatory Commission*, U.S. Geological Survey, Administrative Report, August 2008.

2. Hornbach, M., Lavier, L., and Ruppel, C., "Triggering mechanism and tsunamogenic potential of the Cape Fear Slide complex, U.S. Atlantic coastal margin," *Geochemistry, Geophysics, and Geosystems*, Volume 8, No. 10, 2007.

3. Mader, C.M., "Modeling the 1755 Lisbon Tsunami," *Science of Tsunami Hazards*, Volume 19, No. 2, pp. 93–98, 2001.

ASSOCIATED COLA REVISIONS:

The second paragraph in Subsection 2.4.6.1.1 will be updated in a future revision as indicated below:

> AGMTHAG mapped a total of 48 landslide affected areas based on data compiled from bathymetry, GLORIA (Geological Long-Range Inclined Asdic) sidescan sonar imagery, seismic reflection profiles, and sediment core data (Reference 202). The general characteristics of the mapped landslides are summarized in Table 2.4.6-201. The distribution of landslide locations identified along the U.S. Atlantic margin from the Georges Bank to the Carolina Trough is shown in Figure 2.4.6-202. The largest submarine landslide area near Units 6 & 7 is **the Cape Fear Slide (CFS) complex,** identified in an area south of Cape Hatteras, off the Carolina Trough. The largest landslide in this area exceeds 15,241 square kilometers (5885 square miles) with a volume in excess of 150 cubic kilometers (36 cubic miles). Tectonic activities of the salt domes have been suggested as the triggering mechanism for the landslides in this area along with suggestions that decomposition of gas hydrates due to sea level change and small shallow earthquakes may also have contributed to the formation of these landslides (Reference 202).

The third paragraph in Subsection 2.4.6.1.1 will be updated in a future revision as indicated below:

> Units 6 & 7 are located approximately 400 miles (640 kilometers) southwest of Blake Spur with a wide and shallow continental slope and shelf in between (Figure 2.4.6-201). Details of the Atlantic continental shelf near the site are described in Subsection 2.5.1.1.1.1. Additionally, the landslide zones are oriented in a manner that Units 6 & 7 would be away from the main axis of submarine landslide-generated tsunamis. ~~Consequently, the~~**The** impact of any submarine landslide-generated tsunami on the continental slope and shelf north of Blake Spur would be considerably reduced before reaching Units 6 & 7. **For example, Hornbach et al. (Reference 223) simulated a tsunami generated by the largest landside from the CFS complex. The model results include contours of tsunami amplitudes 30 minutes after initiation of the landslide (see Figure 2.4.6-227). The major tsunami waves propagate along the axis of the landslide, both toward the**

> **coast and seaward. Geometrical spreading of the tsunami wave is prominent along the direction perpendicular to the axis of slide and toward the Straits of Florida. Based on the model results, the tsunami wave amplitude 30 minutes after slide initiation and about 200 kilometers (124 miles) along the Units 6 & 7 direction is approximately 1.5 meters (4.9 feet). In contrast, the tsunami amplitude off Miami, Florida, at a water depth of 783 meters (2569 feet) for the 1755 Lisbon Earthquake tsunami (which corresponds to the PMT) is 2.0 meters (6.6 feet) (Reference 209). The distance between the CFS complex and the off-Miami site at water depth of 783 meters (2569 feet) is more than 800 kilometers (497 miles). Therefore, the tsunami maximum water level at the Units 6 & 7 site due to the CFS complex landslide would be lower than that from the 1755 Lisbon Earthquake tsunami.**

The last sentence of the first paragraph in Subsection 2.4.6.1.5 will be updated in a future revision as indicated below:

> The relatively small tsunami amplitude near Units 6 & 7 is primarily a result of the presence of the Bahama platform to the east, as shown in Figure 2.4.6-208 **and Figure 2.4.6-228**.

The fourth paragraph in Subsection 2.4.6.1.6 will be updated in a future revision as indicated below:

> Although the north Caribbean subduction zone is noted for several seismically generated tsunamis in recent times, as described in Subsection 2.4.6.1.5, potential submarine landslides of the carbonate platform edge north of Puerto Rico are capable of producing large tsunamis locally (see Subsections 2.4.6.2 and 2.5.1.1.5 for detailed discussions). However, because the Units 6 & 7 site is sheltered by the Bahamas Islands, such landslide-generated tsunamis are not expected to affect the site. **This sheltering effect can be seen from the results of a tsunami model simulation caused by an earthquake in the Puerto Rico Trench (North Puerto Rico/Lesser Antilles subduction zone). Figure 2.4.6-228, taken from Reference 202, shows contours of tsunami amplitudes and the associated regional tsunami propagation pattern due to an earthquake at the Puerto Rico Trench. As indicated in the figure, the southeast Florida coast is sheltered by the Bahamas from tsunami waves generated in the area north of Puerto Rico. Although the mechanism of tsunami generation by earthquakes and landslides is different, the regional tsunami propagation pattern between the two is expected to be similar for the Puerto Rico Trench area. As Figure 2.4.6-228 indicates, the apparent earthquake tsunami beaming is along an azimuth perpendicular to the strike, i.e., in the north direction. For a landslide tsunami that may originate in the Puerto Rico Trench, the direction of the seaward tsunami propagation would also be in the north direction, and the tsunami amplitude would be relatively lower at far-field. This is because landslide tsunamis are greatly attenuated at far-field due to non-linear and dispersive effects compared to earthquake**

tsunamis (Reference 202). Therefore, a landslide in the carbonate platform north of Puerto Rico is not considered as a PMT source for the Units 6 & 7 site.

Subsection 2.4.6.8 (References) will be updated in a future revision as indicated below:

223. Hornbach, M., Lavier, L., and Ruppel, C., "Triggering mechanism and tsunamogenic potential of the Cape Fear Slide complex, U.S. Atlantic coastal margin," ***Geochemistry, Geophysics, and Geosystems,*** **Volume 8, No. 10, 2007.**

Figure 2.4.6-227 Tsunami Wave Amplitude Results for 5, 15, and 30 Min. After Slide Initiation of the Largest Landslide Within CFS Complex (Source: Reference 223)

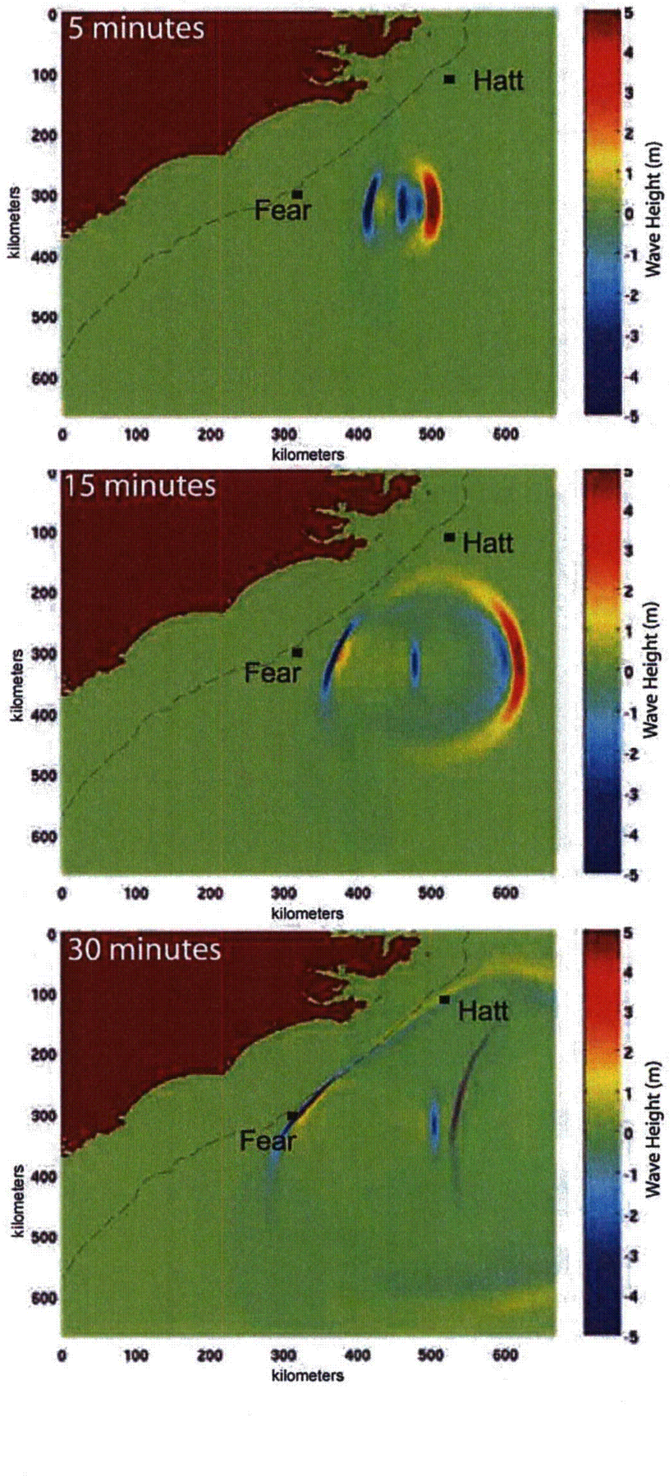
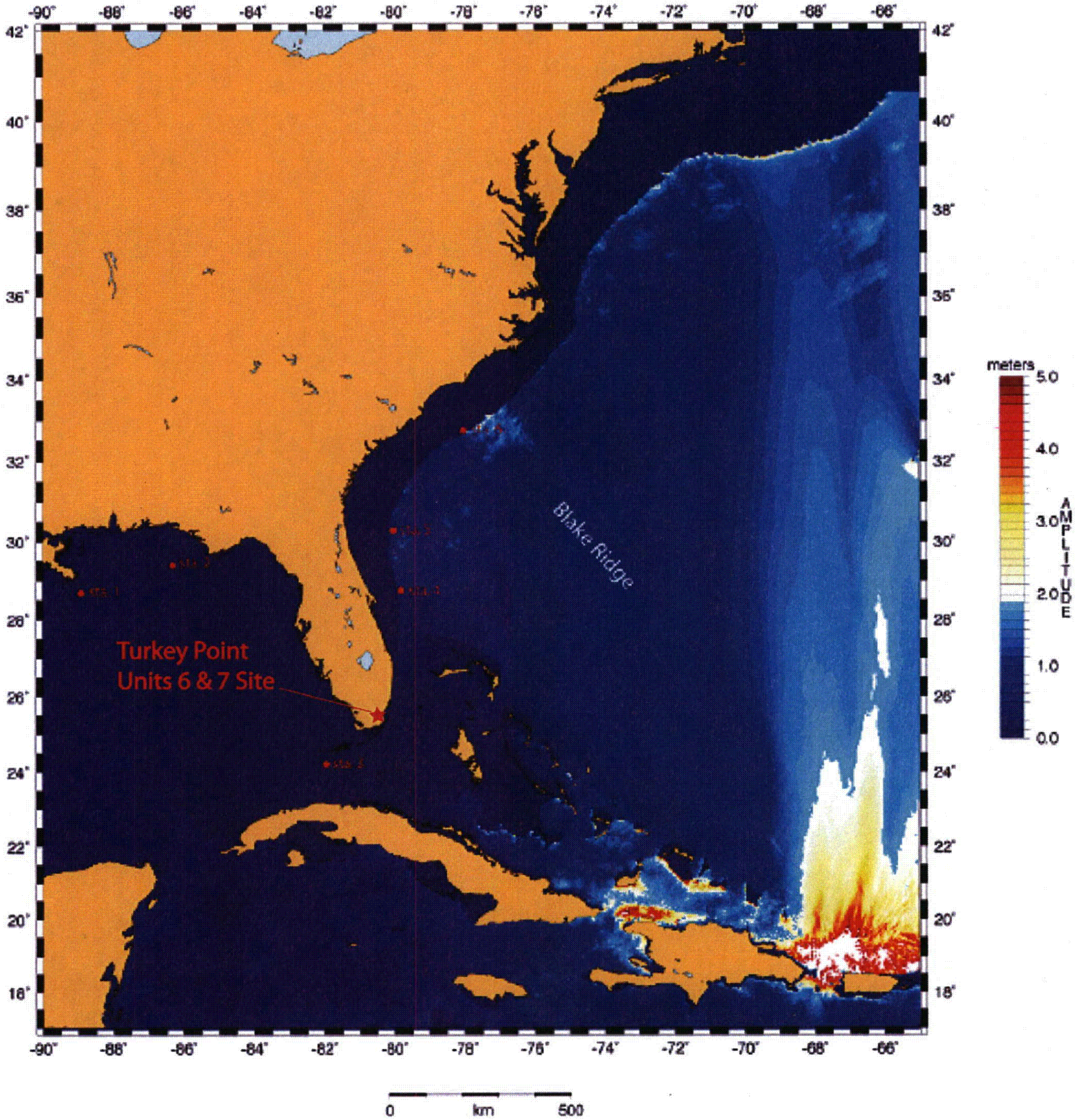


Figure 2.4.6-228 A Simulation Result of Maximum Open-Ocean Tsunami Amplitude Over 4.4 Hours of Propagation Time for North Puerto Rico/Lesser Antilles Subduction Zone (Source: Reference 202)



ASSOCIATED ENCLOSURES:

None