Progress Energy

Serial: NPD-NRC-2009-157
July 20, 2009

10 CFR 52.79

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

LEVY NUCLEAR PLANT, UNITS 1 AND 2
DOCKET NOS. 52-029 AND 52-030
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 040 RELATED TO PROBABLE MAXIMUM SURGE AND SEICHE FLOODING

Reference: Letter from Brian C. Anderson (NRC) to Garry Miller (PEF), dated May 19, 2009, "Request for Additional Information Letter No. 040 Related to SRP Section 2.4.5 for the Levy Nuclear Plant Units 1 and 2 Combined License Application"

Ladies and Gentlemen:

Progress Energy Florida, Inc. (PEF) hereby submits our response to the Nuclear Regulatory Commission's (NRC) request for additional information provided in the referenced letter.

A response to the NRC request is addressed in the enclosure. The enclosure also identifies changes that will be made in a future revision of the Levy Nuclear Plant Units 1 and 2 application.

If you have any further questions, or need additional information, please contact Bob Kitchen at (919) 546-6992, or me at (919) 546-6107.

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

Executed on July 20, 2009.

Sincerely,

Garry D. Miller
General Manager
Nuclear Plant Development

Enclosure

cc: U.S. NRC Region II, Regional Administrator
Mr. Brian Anderson, U.S. NRC Project Manager

Progress Energy Carolinas, Inc.
P.O. Box 1551
Raleigh, NC 27602

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NRO

Levy Nuclear Plant Units 1 and 2
Response to NRC Request for Additional Information Letter No. 040 Related to SRP Section 2.4.5 for the Combined License Application, dated May 19, 2009

NRC RAI #	Progress Energy RAI #	Progress Energy Response
02.04.05-01	L-0277	Response enclosed – see following pages
02.04.05-02	L-0278	Response enclosed – see following pages
02.04.05-03	L-0279	Response enclosed – see following pages
02.04.05-04	L-0280	Response enclosed – see following pages
02.04.05-05	L-0281	Response enclosed – see following pages
02.04.05-06	L-0282	Response enclosed – see following pages
02.04.05-07	L-0283	Response enclosed – see following pages
02.04.05-08	L-0284	Response enclosed – see following pages

NRC Letter No.: LNP-RAI-LTR-040

NRC Letter Date: May 19, 2009

NRC Review of Final Safety Analysis Report

NRC RAI NUMBER: 02.04.05-01

Text of NRC RAI:

To meet the requirements of GDC 2, 10 CFR 52.17, and 10 CFR Part 100, estimates of the probable maximum hurricane (PMH) and the probable maximum storm surge, are needed. The PMH, as defined by NOAA NWS Report 23, should be estimated for coastal locations that may be exposed to these events. In the FSAR text, it is stated that FSAR Table 2.4.5-201 contains a list of hurricanes that came within 50 mi of the LNP site during 1867-2004. The table contains a list of events that includes hurricanes, tropical storms, and tropical depressions. Please resolve this inconsistency.

PGN RAI ID #: L-0277

PGN Response to NRC RAI:

Estimates of the total water depth associated with a probable maximum hurricane (PMH) and the probable maximum storm surge for the LNP site are presented in LNP FSAR Subsection 2.4.5.3.2 and LNP FSAR Table 2.4.5-215.

LNP FSAR Subsection 2.4.5.1.1 presents LNP FSAR Table 2.4.5-201, which is described in the text as "A list of hurricanes that have impacted the areas within 80 km (50 mi.) of the LNP site from 1867 to 2004." However, Table 2.4.5-201 is entitled "Major Storms within 80.5 Km (50 Mi.) of the LNP Site, Levy County, Florida" and lists all recorded hurricanes, tropical storms, and tropical depressions that have impacted the areas within 50 mi. of the LNP from 1867 to 2004. LNP FSAR Table 2.4.5-201 will be revised to include only a listing of recorded hurricanes that have impacted the area of interest.

References:

None

Associated LNP COL Application Revisions:

Table 2.4.5-201 in LNP FSAR Rev. 0 will be replaced with the following table:

Table 2.4.5-201
Hurricanes within 80.5 Km (50 Mi.) of the LNP Site, Levy County, Florida

	Year	Month	Day	Name	Wind Speed (KTS)	Pressure (Mb)	Category
1	1867	10	6	NOT NAMED	70	NA	H1
2	1871	8	17	NOT NAMED	70	NA	H1
3	1871	8	18	NOT NAMED	70	NA	H1
4	1871	8	25	NOT NAMED	70	NA	H1
5	1871	9	6	NOT NAMED	70	NA	H1

Table 2.4.5-201
Hurricanes within 80.5 Km (50 Mi.) of the LNP Site, Levy County, Florida

	Year	Month	Day	Name	Wind Speed (KTS)	Pressure (Mb)	Category
6	1871	9	6	NOT NAMED	70	NA	H1
7	1874	9	28	NOT NAMED	70	NA	H1
8	1878	9	10	NOT NAMED	80	NA	H1
9	1878	9	10	NOT NAMED	90	NA	H2
10	1878	9	10	NOT NAMED	80	970	H1
11	1878	9	10	NOT NAMED	70	NA	H1
12	1880	8	30	NOT NAMED	70	NA	H1
13	1880	10	8	NOT NAMED	70	NA	H1
14	1880	10	8	NOT NAMED	70	NA	H1
15	1882	10	11	NOT NAMED	70	NA	H1
16	1886	7	18	NOT NAMED	70	NA	H1
17	1886	7	19	NOT NAMED	70	NA	H1
18	1888	10	10	NOT NAMED	95	NA	H2
19	1888	10	11	NOT NAMED	95	970	H2
20	1896	9	29	NOT NAMED	110	960	H3
21	1896	9	29	NOT NAMED	100	963	H3
22	1928	9	17	NOT NAMED	110	955	H3
23	1928	9	17	NOT NAMED	90	NA	H2
24	1935	9	4	NOT NAMED	85	NA	H2
25	1935	9	4	NOT NAMED	80	NA	H1
26	1944	10	19	NOT NAMED	65	968	H1
27	1945	6	24	NOT NAMED	80	NA	H1
28	1945	6	24	NOT NAMED	70	NA	H1
29	1946	10	8	NOT NAMED	65	NA	H1
30	1949	8	27	NOT NAMED	65	974	H1
31	1950	9	5	EASY	110	NA	H3
32	1950	9	5	EASY	105	958	H3
33	1950	9	5	EASY	105	NA	H3

Table 2.4.5-201
Hurricanes within 80.5 Km (50 Mi.) of the LNP Site, Levy County, Florida

	Year	Month	Day	Name	Wind Speed (KTS)	Pressure (Mb)	Category
34	1950	9	5	EASY	100	NA	H3
35	1950	9	6	EASY	85	NA	H2
36	1950	10	18	KING	65	NA	H1
37	1968	10	18	GLADYS	70	NA	H1
38	1968	10	19	GLADYS	70	977	H1
39	1968	10	19	GLADYS	70	978	H1
40	2000	9	17	GORDON	65	985	H1

Notes:
H1 = Category 1 hurricane
H2 = Category 2 hurricane
H3 = Category 3 hurricane
KTS = knots
Mb = millibar
NA = Not available
Source: Reference 2.4.5-202

Attachments/Enclosures:

None

NRC Letter No.: LNP-RAI-LTR-040

NRC Letter Date: May 19, 2009

NRC Review of Final Safety Analysis Report

NRC RAI NUMBER: 02.04.05-02

Text of NRC RAI:

To meet the requirements of GDC 2, 10 CFR 52.17, and 10 CFR Part 100, estimates of the probable maximum hurricane (PMH) and the probable maximum storm surge are needed. The storm surge induced by the PMH should be estimated as recommended by Regulatory Guide 1.59, supplemented by current best practices. Please clarify the use for Hsu's empirical equation for the estimation of PMH storm surge and justify why the estimated coastal storm surge elevations under PMH conditions would be conservative.

PGN RAI ID #: L-0278

PGN Response to NRC RAI:

Estimates of the probable maximum hurricane (PMH) and probable maximum storm surge for the LNP site are presented in LNP FSAR Subsection 2.4.5.

As described in LNP FSAR Subsection 2.4.5.2.4, Hsu's method was used to empirically estimate PMH storm surge. The origins of empirical models to forecast maximum storm-surge heights can be traced back to the mid-to-late 1950s. Since then many researchers have developed empirical equations for forecasting maximum storm surge heights in the Gulf of Mexico using expected extreme hurricane tides, pressure difference between a storm's minimum central pressure and the ambient pressure, mean speed of hurricane movement, shoaling factors, and other variables.

Hsu's method is one method that has been validated using data obtained from recent hurricanes Katrina and Rita. Hsu's method and its application to the PMH storm are described in LNP FSAR Subsection 2.4.5.2.4. Equation 2.4.5-1 in LNP FSAR Subsection 2.4.5.2.4 indicates that there are three parameters that must be known in order to apply Hsu's method: (1) minimum sea level pressure, (2) shoaling factor, and (3) the correction factor for storm motion. This equation is a generalized equation that is used to predict maximum storm surge and can be applied to any category of storm in the Gulf of Mexico, including the PMH.

As discussed in LNP FSAR Subsection 2.4.5.2.1, three different approaches were used to estimate the storm surge at the LNP site. In order to demonstrate that the predicted PMH storm surge elevations based on Hsu's method were conservative, a comparison was made between the estimated coastal storm surge elevations obtained from Regulatory Guide 1.59 and Hsu's method. A comparison could not be made between the estimated coastal storm surge elevations obtained from the Sea, Lake, and Overland Surge from Hurricanes (SLOSH) model and Hsu's method because the SLOSH model results corresponding to the PMH conditions (the considered hypothetical PMH event is larger than the Category 5 hurricane) were not available. As stated in LNP FSAR Subsection 2.4.5.2.1, the SLOSH model results were used to obtain

estimates of Category 1 – 5 storm event surge elevations at several locations, including Yankeetown, Inglis, and near the LNP site.

As described in LNP FSAR Subsection 2.4.5.2.2, the storm surge based on the Regulatory Guide 1.59 approach is 34.10 feet (ft.) mean low water (MLW). This storm surge includes the 10 percent exceedance high tide of 4.3 ft. MLW. The equivalent 10 percent exceedance high tide in National Geodetic Vertical Datum of 1929 (NGVD29) is 2.01 ft. Therefore, the storm surge in NGVD29 = 34.10 - 4.3 + 2.01= 32.71 ft. NGVD29.

As described in LNP FSAR Table 2.4.5-212, the maximum coastal storm surge obtained using Hsu's method is 30.76 ft. Adding the 10 percent exceedance high tide storm surge of 2.9 ft. mean sea level (msl), the storm surge becomes 30.76 ft. + 2.9 ft. MSL = 33.66 ft. msl. The equivalent storm surge in NGVD29 is 30.76 + 2.01 ft. NGVD29 = 32.77 ft. NGVD29, which is higher than the storm surge of 32.71 ft. NGVD29 obtained from the Regulatory Guide 1.59. Therefore, the maximum coastal storm surge under the PMH conditions obtained using Hsu's method is conservative.

The maximum coastal surge heights were converted into NGVD29 datum to be consistent with the other approaches reported elevations. The elevation of the NOAA gauge Cedar Key, FL, is 4.06 North American Vertical Datum of 1988 (NAVD88). Using the VERTCON tool (http://www.ngs.noaa.gov/cgi-bin/VERTCON/vert_con.prl), latitude, longitude, and orthographic height in NAVD88, the corresponding elevation of the NOAA gauge Cedar Key, FL, was 4.73 ft. NGVD29. Therefore, the equivalent maximum coastal storm surge using Hsu's method and Regulatory Guide 1.59 is 32.10 ft. NAVD88 and 32.04 ft. NAVD88, respectively.

References:

None

Associated LNP COL Application Revisions:

None

Attachments/Enclosures:

None

NRC Letter No.: LNP-RAI-LTR-040

NRC Letter Date: May 19, 2009

NRC Review of Final Safety Analysis Report

NRC RAI NUMBER: 02.04.05-03

Text of NRC RAI:

To meet the requirements of GDC 2, 10 CFR 52.17, and 10 CFR Part 100, estimates of the probable maximum hurricane (PMH) and the probable maximum storm surge are needed. The storm surge induced by the PMH should be estimated as recommended by Regulatory Guide 1.59, supplemented by current best practices. Please clarify the details of how the conversion from MSL to NGVD29 was made and provide details of how the Hsu method storm surge heights in FSAR Table 2.4.5-213 were obtained. Please clarify why the table is titled "PMH Analysis for the LNP Site," since it appears that the values reported in this table are for storm surges for hurricanes of categories 1 through 5 and not for the PMH.

PGN RAI ID #: L-0279

PGN Response to NRC RAI:

Estimates of the probable maximum hurricane (PMH) and the probable maximum storm surge are presented in LNP FSAR Subsection 2.4.5.

As discussed in LNP FSAR Subsection 2.4.5.2.1, the Cedar Key tidal datum was used for the coastal line storm surge conversion from mean sea level (msl) to other data, such as NGVD29 and NAVD88. LNP FSAR Table 2.4.5-204 presents elevation information for the Cedar Key tidal datum as provided by the National Ocean and Atmospheric Association (NOAA) (LNP FSAR Reference 2.4.5-209); an equivalent elevation in NGVD29 was not provided. Using the NOAA VERTCON tool (LNP FSAR Reference 2.4.2-202) and inputs of latitude, longitude, and orthographic height in NAVD88, the corresponding elevation of the Cedar Key NOAA gauge site was found to be 1.443 meters (m) (4.733 feet [ft.]) NGVD29. Using this information, an elevation with an msl datum can be converted into an elevation with a NGVD29 datum.

For example, at the Cedar Key gauge site, an msl datum can be converted into an NGVD29 datum using the following expression:

X ft. msl = gauge height – msl datum (3.84 ft) (1)

gauge height = X ft. msl + msl datum (3.84 ft) (2)

Elev. in NGVD29 = gauge height – NGVD29 datum (4.733 ft.) (3)

Substituting the value of gauge height from (2) into (3), one gets:

Elev. in NGVD29 = X ft. msl + msl datum (3.84 ft) – NGVD29 datum (4.733 ft.) (4)

= (X ft. msl + 3.84 -4.733) = (X ft. msl - 0.893) ft.

The Hsu method storm surge heights in LNP FSAR Table 2.4.5-213 were obtained by using LNP FSAR Equation 2.4.5-1 along with the hurricane parameters given in LNP FSAR Table 2.4.5-205. Where ranges of atmospheric pressure in the hurricane eye were given in LNP FSAR Table 2.4.5-205, the average value was used. For example, for a Category 2 hurricane, the atmospheric pressure ranges from 965 millibars to 979 millibars. In order to apply Hsu's method, the average pressure (965 + 979)/ 2 = 972 millibars was used.

LNP FSAR Table 2.4.5-213 will be revised to clarify that the table consists of coastline storm surges for hurricanes of Categories 1 through 5 and not for the PMH. The purpose of this table is to show the following: (1) the general agreement between the coastline storm surges calculated using Hsu's method and the SLOSH model, (2) the fact that coastline storm surges obtained using Hsu's method are conservative, and (3) the basis of the relationship between the storm surge values obtained using Hsu's method and the SLOSH model, which is represented by LNP FSAR Equation 2.4.5-2.

LNP FSAR Equation 2.4.5-2 is used to determine the PMH surge at the LNP site. LNP FSAR Table 2.4.5-213 is one step in the process of determining the PMH elevation at the LNP site; therefore, the subtitle "PMH Analysis for the LNP Site" was used in LNP FSAR Table 2.4.5-213. For clarity, the title of LNP FSAR Table 2.4.5-213 and the titles of other tables stating "PMH Analysis for the LNP Site" will be revised.

References:

None

Associated LNP COL Application Revisions:

LNP FSAR Table 2.4.5-213 will be revised to clarify that the table consists of coastline storm surges for Categories 1 through 5 Hurricanes and not for the PMH. The titles of all other tables in FSAR Subsection 2.4.5 with the subtitle "PMH Analysis for the LNP Site" will be updated in a future revision of the LNP FSAR for clarity.

Revisions to the tables include:

1) In the title, remove the line, "PMH Analysis from the LNP Site", from LNP FSAR Tables 2.4.5-203, 2.4.5-205, 2.4.5-210, 2.4.5-211, 2.4.5-212, 2.4.5-213, 2.4.5-214, and 2.4.5-215.
2) Add the following text as a note to LNP FSAR Table 2.4.5-213: "Note: Storm surge heights pertain to hurricanes of Categories 1 through 5."

Attachments/Enclosures:

None

NRC Letter No.: LNP-RAI-LTR-040

NRC Letter Date: May 19, 2009

NRC Review of Final Safety Analysis Report

NRC RAI NUMBER: 02.04.05-04

Text of NRC RAI:

To meet the requirements of GDC 2, 10 CFR 52.17, and10 CFR Part 100, an estimate of wind-induced wave runup under PMH winds is needed. The controlling flood water surface elevations are estimated based on the combination of appropriate ambient water surface elevations, critical storm surge or seiche water surface elevations, and coincident wind-wave action as described in ANSI/ANS-2.8-1992.

(1) The applicant stated in FSAR Revision 0, Section 2.4.5.2.3, page 2.4-37: "Since the datum used in the SLOSH model is NGVD, formerly known as the Sea Level Datum of 1929, an astronomical tide level above NGVD29 would add additional height to the values computed by the SLOSH model. Thus, the SLOSH model accounts for astronomical tides." Jelesnianski et al. (1992) clearly state that astronomical tide is ignored by the SLOSH model except for its superposition onto the computed surge. The applicant's statement conveys a broader interpretation of the capabilities of the SLOSH model in how it incorporates the effect of astronomical tide in surge computations.

(2) The applicant stated in FSAR Revision 0, Section 2.4.5.2.3, page 2.4-37: "Generally, waves do not add significantly to the total area flooded by storm surge and can usually be ignored." The applicant also stated in FSAR Revision 0, Section 2.4.5.3.1, page 2.4-41: "As mentioned in FSAR Subsection 2.4.5.2.3, the SLOSH model does not include the additional heights generated by wind-driven waves on top of the stillwater storm surge. Therefore, wind-driven wave height needs to be determined." While the first statement may be true inasmuch as the area of inundation is concerned, it gives an impression that wind waves on top of storm surge stillwater elevation may be ignored, which is not the case, as stated by the second quote.

Please resolve these inconsistencies, or explain why your statements are sufficient.

PGN RAI ID #: L-0280

PGN Response to NRC RAI:

An estimate of wind-induced wave runup under probable maximum hurricane (PMH) winds is presented in LNP FSAR Subsection 2.4.5. Additional elements of this RAI are discussed below.

1. The SLOSH model accounts for tides by specifying the initial tide level. The SLOSH output combines the tide level and the storm surge, giving the total increase in water level due to a given storm . The SLOSH model incorporated a mean tide elevation of 2.5 feet (ft.) NGVD29 into the model output presented in LNP FSAR Tables 2.4.5-206 through 2.4.5-209. However, the 10 percent exceedance high tide for Cedar Key is 4.3 ft. mean low water (MLW) (2.01 ft. NGVD29). Therefore, the PMH analysis presented in LNP FSAR

Subsection 2.4.5 was based on mean tide elevation 0.49 ft. higher than the site-specific 10 percent exceedance high tide. To be specific to site conditions, the PMH analysis was revised to incorporate the 10 percent exceedance high tide at Cedar Key. This revised analysis is presented in LNP calculation package LNG-0000-X7C-010, Rev. 1 - "Probable Maximum Hurricane (LNP Site)," which is available in the Progress Energy-provided Reading Room.

2. The statement "generally, waves do not add significantly to the total area flooded by storm surge and can usually be ignored" is a generalized statement and is true in the case of smaller storm events rather than extreme events like the PMH. LNP FSAR Subsection 2.4.5.3.1 discusses wave contributions due to PMH winds. LNP FSAR Subsection 2.4.5.3.2 presents total water depth due to PMH surge and wave contributions. For clarity and to be more specific to site conditions, the statement "generally, waves do not add significantly to the total area flooded by storm surge and can usually be ignored" will be deleted from the LNP FSAR.

References:

None

Associated LNP COL Application Revisions:

LNP FSAR Subsection 2.4.5, Rev. 0 will be revised to incorporate the revised PMH analysis and text presented in LNP calculation package LNG-000-X7C-010, Rev. 1.

As part of these revisions and for clarity, the fourth bullet of LNP FSAR Subsection 2.4.5.2.3 will be revised from:

"Adjustments to Astronomical Tide: Since the datum used in the SLOSH model is NGVD, formerly known as the Sea Level Datum of 1929, an astronomical tide level above NGVD29 would add additional height to the values computed by the SLOSH model. Thus, the SLOSH model accounts for astronomical tides."

to:

"The SLOSH model accounts for tides by specifying the initial tide level. The SLOSH output combines the tide level and the storm surge giving the total increase in water level due to a given storm."

For clarity the statement "generally, waves do not add significantly to the total area flooded by storm surge and can usually be ignored" will be deleted from LNP FSAR Subsection 2.4.5.2.3.

Attachments/Enclosures:

None

NRC Letter No.: LNP-RAI-LTR-040

NRC Letter Date: May 19, 2009

NRC Review of Final Safety Analysis Report

NRC RAI NUMBER: 02.04.05-05

Text of NRC RAI:

To meet the requirements of GDC 2, 10 CFR 52.17, and 10 CFR Part 100, estimates of the probable maximum hurricane (PMH) and the probable maximum storm surge are needed. The storm surge induced by the PMH should be estimated as recommended by Regulatory Guide 1.59, supplemented by current best practices. Please clarify and justify the hydrodynamic basis for the extrapolation equation, FSAR Revision 0 Equation 2.4.5-5, used for estimation of storm surge at the LNP site.

PGN RAI ID #: L-0281

PGN Response to NRC RAI:

Estimates of the probable maximum hurricane (PMH) and the resulting storm surge are presented in LNP FSAR Subsection 2.4.5.
Hydrodynamic condition in the coastal area at any instant in time can be viewed as a function of sea state. A sea state is comprised of the state of the waves, water levels, tides, winds, etc. A sea state is inherently variable in nature. It is even more variable during a PMH event. Storm surge modeling is a complex mathematical process that involves several complex components such as nearshore wave interactions, complex wind fields, and inland wave propagation. As mentioned in FSAR Subsection 2.4.5.2.1, three different approaches (Regulatory Guide 1.59 based approach, SLOSH model, and Hsu's empirical method) were used to estimate storm surge at the coastline. However, the mechanism of propagation of waves and consequent flooding to inland locations is based on the results obtained from the SLOSH numerical model corresponding to hurricanes of Categories 1 through 5. Therefore, the hydrodynamic basis for the extrapolation equation (LNP FSAR Rev. 0 Equation 2.4.5-5) that was used to determine the magnitude of the probable maximum storm surge at the LNP site is the SLOSH model. The SLOSH model solves complex hydrodynamic equations while considering the local bathymetric and topographic data. In order to further clarify the basis of the extrapolation equation (LNP FSAR Rev. 0 Equation 2.4.5-5), some of its main features are described as follows:

- The considered hypothetical PMH event is larger than the Category 5 hurricane; therefore, an extrapolation of SLOSH modeling results from Categories 1 through 5 was used, as SLOSH modeling results were available only for Category 1 through 5 hurricanes.

- LNP FSAR Rev. 0 Equation 2.4.5-5 is based on the MOM (Maximum of Maximum Envelope of Water) SLOSH output corresponding to hurricanes of Categories 1 through 5. Therefore, this equation captures the maximum surge elevation or worst case flooding impact at a given inland location in the coastal region using the SLOSH modeling results rather any other state of surge elevation. The accuracy of the predicted surge elevation based on the extrapolation equation reduces as the distance from the base locations used in the

extrapolation increases. For example, the accuracy of LNP FSAR Rev. 0 Equation 2.4.5-5 reduces as one goes farther away from the town of Inglis, as it is one of the base locations.

- In most situations, LNP FSAR Rev. 0 Equation 2.4.5-5 will overestimate the predicted water elevation at a given inland location. The magnitude of over-prediction increases with distance of the impact location away from the base location. Therefore, application of LNP FSAR Rev. 0 Equation 2.4.5-5 to locations farther from the town of Inglis is conservative. This feature of the extrapolation is clarified further in the following example.

Example

As described above, the application of LNP FSAR Rev. 0 Equation 2.4.5-5 to locations farther from the town of Inglis is conservative. Thus, its application is justified. In order to show why its application is justified, an example is considered in which a known quantity--the water elevation due to storm surge from a Category 5 hurricane in the town of Inglis--is determined using the SLOSH model results corresponding to hurricanes smaller than Category 5. LNP FSAR Rev. 0 Equation 2.4.5-5 is given as follows:

$$WE_{LNP} = WE_{Yankee} + \frac{(WE_{Inglis} - WE_{Yankee})}{(CD_{Inglis} - CD_{Yankee})}(CD_{LNP} - CD_{Yankee})$$

where,

- WE_{LNP} and CD_{LNP} are the water elevation (ft. NGVD29) and distance (mi.) of the LNP site from the coastline
- WE_{Yankee} and CD_{Yankee} are the water elevation (ft. NGVD29) and distance (mi.) of Yankeetown from the coastline
- WE_{Inglis} and CD_{Inglis} are the water elevation (ft. NGVD29) and distance (mi.) of Inglis from the coastline.

In the above equation, Yankeetown and Inglis are the base locations that are used in the extrapolation process to predict the water elevation at the LNP site. In the present example, however, water level prediction is made in Inglis. Therefore, coastline and Yankeetown will be used as the base locations. It should be noted that LNP FSAR Rev. 0 Equation 2.4.5-5 consists of two steps of extrapolation, as follows:

1. **Determine water elevations corresponding to Category 5 storms at Yankeetown.** Using the data of coastline storm surge from FSAR Table 2.4.5-213 for hurricanes Category 1 through 4, the storm surge relationship between coastline surge and inland surge at Yankeetown was developed. Attachment 02.04.05-5A (Figure 1) shows the developed relationship. Using this relationship, storm surge corresponding to Category 5 hurricanes was determined and compared with Yankeetown, as presented in Table 1. As shown in Table 1, the predicted maximum storm surge in Yankeetown corresponding to a Category 5 hurricane is 0.5 foot (ft.) higher than that obtained from the SLOSH model. Further, if the same methodology is used to determine the predicted PMH storm surge at Yankeetown, the predicted PMH storm surge at Yankeetown will be 0.8 ft. higher than that obtained from the SLOSH model. This result indicates that the extrapolation error, or in other terms the magnitude of conservatism, increases as one deviates from the base.

Table 1
Prediction of Surge for Cat 5 Storm in Yankeetown Using Developed Surge Relationship

Storm	Coastline Surge (ft. NGVD29)	Yankeetown Surge based on SLOSH Model (ft. NGVD29)	Calculated Yankeetown Surge (ft. NGVD29)	Difference (ft. NGVD29)
Cat 5	27.78	29.21	29.70	0.5
PMH	35.87	37.60	38.45	0.8

2. **Determine Category 5 storm surge at Inglis using coastline and Yankeetown storm surges**. Using the predicted Category 5 storm surge at Yankeetown (see Step 1), the water elevation at Inglis corresponding to the Category 5 storm was determined using the extrapolation equation results, as presented in Table 2. The same extrapolation equation can be used to determine the Category 5 storm surge at the LNP site, as presented in Table 2. Further, if the same methodology is used in the PMH storm surge calculation, the predicted PMH storm surge at the LNP site will be as tabulated in Table 2.

Table 2
Prediction of Surge for Cat 5 Storm in Inglis Town Using Extrapolation Equation

Location	Distance from coastline (mi.)	Predicted Cat 5 Storm Surge (ft. NGVD29)	Predicted PMH Storm Surge (ft. NGVD29)
Coastline	0	27.78	35.87
Yankeetown	2.4	29.70	38.45
Inglis Town	5.97	32.56	42.28
Plant Site	8.5	34.59	44.99

A summary of predicted errors or the expected magnitude of conservatism involved in the extrapolation process is presented in Table 3. The calculated errors presented in Table 3 confirm the following statements:

- The magnitude of storm surge over prediction increases with distance to the impact location from the base location.
- The extrapolation error, or in other terms the magnitude of conservatism, increases with distance from the base location.

Table 3
Summary of Predicted Errors

Location	Distance from Sea (mi.)	Cat 5 Storm (ft. NGVD29)	PMH Storm (ft. NGVD29)
Coastline	0	NA	NA

Yankeetown	2.4	0.50	0.84
Inglis Town	5.97	2.06	2.93
Plant Site	8.5	3.16	4.41

The data in Tables 1 through 3 were extracted from LNP calculation package LNG-0000-X7C-010, Rev. 1 – "Probable Maximum Hurricane (LNP Site)," which is available in the Progress Energy-provided Reading Room.

References:

None

Associated LNP COL Application Revisions:

None

Attachments/Enclosures:

None

NRC Letter No.: LNP-RAI-LTR-040

NRC Letter Date: May 19, 2009

NRC Review of Final Safety Analysis Report

NRC RAI NUMBER: 02.04.05-06

Text of NRC RAI:

To meet the requirements of GDC 2, 10 CFR 52.17, and 10 CFR Part 100, estimates of seiche and resonance in water bodies induced by meteorological causes, tsunamis, and seismic causes are needed. Please address the possibility of seiches of meteorological and seismic origin in Lake Rousseau; including, the possibility of resonance in Lake Rousseau that may amplify any potential seiche activity.

PGN RAI ID #: L-0282

PGN Response to NRC RAI:

As discussed in LNP FSAR Subsection 2.4.1.1, Lake Rousseau is located approximately 4.8 kilometers (km) (3 miles [mi.]) south of the LNP site. Also, as described in LNP FSAR Subsection 2.4.1.2.6, the operating pool elevation of Lake Rousseau is maintained between 24 and 28 feet (ft.) National Geodetic Vertical Datum of 1929 (NGVD29) (approximately equivalent to 23 to 27 ft. North American Vertical Datum of 1988 [NAVD88] near the LNP site), which is more than 20 ft. below the proposed nominal plant grade floor elevation for safety-related structures at the LNP site (51 ft. NAVD88).

The possibility of seiches of meteorological origin in Lake Rousseau, including the possibility of resonance in Lake Rousseau, is discussed in LNP FSAR Subsections 2.4.5.2.6 and 2.4.5.4. As discussed in these subsections, the possibility of a meteorologically induced seiche with a magnitude large enough to affect the LNP site is considered insignificant. In addition, due to the narrow and irregular shape of Lake Rousseau, the fetch distance from Lake Rousseau would be too small to generate a significant wave.

The possibility of a seismically induced seiche with a magnitude large enough to affect the LNP site is considered insignificant. The earthquakes examined as part of the probable maximum tsunami (PMT) analysis presented in LNP FSAR Subsection 2.4.6 and RAI 02.04.06-8 are considered to be worst-case plausible tsunami generators in the Gulf of Mexico. The maximum runup and run-in resulting from these worst-case tsunami generating earthquakes is 5.67 meters (m) (18.6 ft.) and 0.55 mi., respectively. Because the LNP site is located significantly more than 0.55 mi. north of and more than 18.6 ft. above Lake Rousseau, the potential for flooding at the site due to a seismically induced seiche, including the possibility of resonance in Lake Rousseau, is considered insignificant.

References:

None

Associated LNP COL Application Revisions:

None

Attachments/Enclosures:

None

NRC Letter No.: LNP-RAI-LTR-040

NRC Letter Date: May 19, 2009

NRC Review of Final Safety Analysis Report

NRC RAI NUMBER: 02.04.05-07

Text of NRC RAI:

To meet the requirements of GDC 2, 10 CFR 52.17, and10 CFR Part 100, an estimate of wind-induced wave runup under PMH winds is needed. Criteria and methods of the USACE, as generally summarized in USACE Coastal Engineering Manual, are used as a standard to evaluate the PEF's estimate of coincident wind-generated wave action and runup. These criteria are also used to evaluate flooding, including the static and dynamic effects of broken, breaking, and nonbreaking waves. Please add a reference in the FSAR for the methodology used to estimate wave action in Lake Rousseau, or explain why such a reference is not needed.

PGN RAI ID #: L-0283

PGN Response to NRC RAI:

Progress Energy believes that the estimation of coincident wind-generated wave action and runup is not needed, given that the LNP site is located approximately 4.8 kilometers (km) (3 miles [mi.]) north of Lake Rousseau. Therefore, wind-wave action due to probable maximum hurricane (PMH) winds was not considered to be a potential flood-causing event at the LNP site. Additionally, due to the narrow and irregular shape of Lake Rousseau, the fetch distance from Lake Rousseau will be too short to generate a wave that can reach the site.

References:

None

Associated LNP COL Application Revisions:

None

Attachments/Enclosures:

None

NRC Letter No.: LNP-RAI-LTR-040

NRC Letter Date: May 19, 2009

NRC Review of Final Safety Analysis Report

NRC RAI NUMBER: 02.04.05-08

Text of NRC RAI:

To meet the requirements of GDC 2, 10 CFR 52.17, and10 CFR Part 100, an estimate of wind-induced wave runup under PMH winds is needed. The applicant added the estimated wave setup to the estimated stillwater PMH storm surge to obtain total water depth at the LNP site during the PMH conditions. Please provide an estimate of wave runup during the PMH storm surge at the LNP site.

PGN RAI ID #: L-0284

PGN Response to NRC RAI:

Wave runup was determined using the step-by-step approach given in Chapter 4 of the Coastal Engineering Manual (LNP FSAR Reference 2.4.5-219). Table 1 presents an estimate of the maximum wave runup under the probable maximum hurricane (PMH) winds to obtain total water depth at the LNP site during the PMH conditions. The data in Table 1 were extracted from LNP calculation package LNG-0000-X7C-010, Rev. 1 – "Probable Maximum Hurricane (LNP Site)," which is available in the Progress Energy-provided Reading Room.

Table 1
Maximum Wave Runup Under PMH Conditions

Item	Value	Unit
Site elevation	50	ft. NAVD88
Sea level elevation under normal conditions	4.06	ft. NAVD88
Site distance from shoreline	7.9	mi.
PMH surge height	40.00	ft.
Ground elevation	20.00	ft. NAVD88
Still-water depth, deep water wave height, H_0	20	ft.
Wave period	10	sec
Deep water wavelength, L_0	512.5	ft.
Beach slope, β	0.0011	Radian
Similarity parameter, ξ_0	0.0056	NA
Max. wave runup, R_{max}	0.85	ft.

References:

None

Associated LNP COL Application Revisions:

LNP FSAR Subsection 2.4.5, Rev. 0 will be revised to incorporate the revised PMH analysis and text presented in LNP calculation package LNG-000-X7C-010, Rev. 1. Results of the wave runup analysis presented above will be included in this revision.

Attachments/Enclosures:

None