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UniStar
NUCLEAR ENERGY

10 CFR 50.4
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May 4, 2011

UN#11-149

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: UniStar Nuclear Energy, NRC Docket No. 52-016
Response to Request for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3, RAI 288, Low Water Considerations

References:
1) Surinder Arora (NRC) to Robert Poche (UniStar Nuclear Energy), "FINAL RAI 288 RHEB 5329" email dated January 07, 2011

2) UniStar Nuclear Energy Letter UN#11-138, from Greg Gibson to Document Control Desk, U.S. NRC, Response to Request for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3, RAI 288, Low Water Considerations, dated April 18, 2011.

The purpose of this letter is to respond to the request for additional information (RAI) identified in the NRC e-mail correspondence to UniStar Nuclear Energy, dated January 07, 2011 (Reference 1). This RAI addresses Low Water Considerations, as discussed in Section 2.4.11 of the Final Safety Analysis Report (FSAR), as submitted in Part 2 of the Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3 Combined License Application (COLA), Revision 7.

Reference 2 provided a May 17, 2011 date for the response to RAI No. 288, Question 02.04.11-1. The Enclosure provides our response to RAI No. 288, Question 02.04.11-1. A Licensing Basis Document Change Request has been initiated to incorporate these changes into a future revision of the COLA.

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NRO

Our response does not include any new regulatory commitments. This letter does not contain any sensitive or proprietary information.

If there are any questions regarding this transmittal, please contact me at (410) 470-4205, or Mr. Wayne A. Massie at (410) 470-5503.

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

Executed on May 4, 2011

for Greg Gibson

Enclosure: Response to Request for Additional Information, RAI No. 288, Question 02.04.11-1, Low Water Considerations, Calvert Cliffs Nuclear Power Plant Unit 3

cc: Surinder Arora, NRC Project Manager, U.S. EPR Projects Branch
Laura Quinn, NRC Environmental Project Manager, U.S. EPR COL Application
Getachew Tesfaye, NRC Project Manager, U.S. EPR DC Application (w/o enclosure)
Charles Casto, Deputy Regional Administrator, NRC Region II (w/o enclosure)
Silas Kennedy, U.S. NRC Resident Inspector, CCNPP, Units 1 and 2
U.S. NRC Region I Office

GTG/SJS/mdf

Enclosure

Response to Request for Additional Information
RAI No. 288, Question 02.04.11-1, Low Water Considerations
Calvert Cliffs Nuclear Power Plant Unit 3

RAI No 288

Question 02.04.11-1

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 (PMSS) are needed to address the effects of low water on the intake structure and pump design bases. In response to RAI 249 Question 02.04.05-6, the applicant performed SLOSH model simulations to estimate the PMSS in the Chesapeake Bay near the site. However, in FSAR Section 2.4.11, the applicant uses an empirical equation to predict low water conditions during a PMH event. Upon further review, the staff has determined that the methods for estimation of low water conditions in FSAR Section 2.4.11 should be consistent with those used for estimation of high water conditions in FSAR Section 2.4.5.

Provide an updated estimate of low water conditions during a PMSS event that (a) accounts for antecedent water levels appropriate for low water conditions, (2) uses a conservative approach such as a storm surge model (e.g., SLOSH) with input from appropriate PMH scenarios, and (3) accounts for any concurrent wind-wave activity.

Response

As requested by RAI 288, a conservative approach (SLOSH model) was used to estimate low water conditions at the Site.

Several model runs with a conservative combination of PMH parameters and storm tracks were performed. Utilizing SLOSH, the magnitude of the low water levels at the CCNPP Unit 3 site was estimated based on a combination of the following hypothetical PMH parameters: forward wind direction and speed, radius of maximum winds, pressure, and normal/high tide.

The initial Still Water Level (SWL) was incorporated directly in the SLOSH simulations and defined as the 10% Exceedance Low Tide. The 10- percent low tide probability of non-exceedance was computed statistically based on NOAA's 21- year synthetic tidal signal developed at the Solomons Island tide station. Log Pearson Type III provided the best representative distribution resulting in a 10-percent low tide probability of non-exceedance of -2.56 ft (-0.79 m) NGVD29.

Six PMH tracks that could cause drawdown conditions at the site were developed based on historical data obtained from NOAA and the National Hurricane Center (NHC).

The analysis confirmed that the storm track of a PMH that moves tangentially to the eastern boundary of the Chesapeake Bay is critical. Using SLOSH, the maximum negative surge (including the initial SWL antecedent conditions) at the CCNPP Unit 3 is -6.5 ft (-1.98 m) NGVD29, compared to -5.03 ft (-1.53 m) computed empirically. The difference is attributed to the use of mean lower low water (MLLW) instead of the 10% exceedance low tide probability and that SLOSH provides a more conservative approach. The SLOSH analysis uses the 10% exceedance low tide probability as recommended by ANSI/ANS 2.8 (1992).

Technical Report NWS 48 (Jelesnianski, C.P., et al., SLOSH: Sea, Lake, and Overland Surges from Hurricanes, Technical Report NWS 48, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, April 1992) suggests a 20% margin be applied to the SLOSH model to account for uncertainties. Combining the antecedent water level, SLOSH results and 20% uncertainty results in a negative surge between -7.29 ft (-2.22 m) and -5.71 ft (-1.74 m) as shown in Table 1.

TABLE 1: Comparison of Negative Surge Results

Scenario	Antecedent Water Level (NGVD29)	SLOSH Primary Surge (NGVD29)	20% on SLOSH Primary Surge (NGVD29)*	Total PMSS (NGVD29)
SLOSH results	-2.56 ft (-0.78 m)	-6.50 ft (-1.98 m)	0.0 ft (0.0 m)	-6.50 ft (-1.98 m)
Addition of -20% Uncertainty	-2.56 ft (-0.78 m)	-6.50 ft (-1.98 m)	-0.79 ft (-0.24 m)	-7.29 ft (-2.22 m)
Addition of +20% Uncertainty	-2.56 ft (-0.78 m)	-6.50 ft (-1.98 m)	0.79 ft (0.24 m)	-5.71 ft (-1.74 m)

* Twenty percent of the net surge. i.e., (20% * [6.50 – 2.56])

The potential of wind wave induced run-down in the Intake Forebay, based on the Probable Maximum Hurricane (PMH) critical track, was also analyzed.

A summary of the maximum negative surge if the additional set-down is added to the maximum negative surge is shown in Table 2. The run-down in the Intake Forebay is negligible, due to the geometry and water depth in the Forebay as well as its location.

TABLE 2: Summary of Run-Down Results

Scenario	Total PMSS (NGVD29)	Total Including Run-Down (NGVD29)
SLOSH results	-6.50 ft (-1.98 m)	-6.9 ft (-2.10 m)
Addition of -20% Uncertainty	-7.29 ft (-2.22 m)	-7.7 ft (-2.34)
Addition of +20% Uncertainty	-5.71 ft (-1.74 m)	-6.1 ft (-1.86 m)

When the additional set-down is added to the maximum negative surge, the total negative surge is -7.7 ft (-2.34 m) in the Intake Forebay.

COLA Impact

COLA FSAR Section 2.4.11.2.1 will be updated as shown below:

2.4.11.2.1 Storm Surge Effect

<u>**Empirical Analysis**</u>

Surge studies for the Chesapeake Bay reveal that the negative storm surge could be obtained based on the historical hurricane studies (Pore, 1960) (USWB, 1963). The extreme negative surges would occur at the Chesapeake Bay when hurricanes travel close and parallel to the coastline as shown in Figure 2.4-50 (MDGIS, 2007). This is the most critical path because if a hurricane travels over land its strength is reduced. The historical negative surge data for several hurricanes near the site are summarized in Table 2.4-30 (Pore, 1960) (USWB, 1963). Two additional hurricanes with similar tracks have occurred since 1960, Hurricane Gloria (September of 1985) and Hurricane Emily (August of 1993). The annual minimum water levels recorded at Annapolis and Solomons Island Stations, shown in Table 2.4-32 (NOAA, 2006b) and Table 2.4-33 (NOAA, 2006c), are not associated with these two hurricanes. Therefore, Hurricane Donna has been selected as a typical hurricane to estimate the negative surge in the Chesapeake Bay area considering the data availability, because the wind data near the site area (at Cove Point and Lookout Point) during Hurricane Donna is available. Moreover, Hurricane Donna is one of the all-time great hurricanes and its path was such that it created a negative surge in the Chesapeake Bay (NOAA, 2006a).

Based on the available data, the maximum sustained wind speed at the Cove Point and Lookout Point was observed as 57 mph (50 knots) (88.5 km/hr) during Hurricane Donna (USWB, 1960). The Cove Point and Lookout Point are located about 6 miles (9.7 km) and 27 miles (43.5 km) south of the site, respectively, as shown in Figure 2.4-51 (MDGIS, 2007). Because the wind moves in a counter-clockwise direction, the wind direction changes from NE to N as the hurricane travels past the Chesapeake Bay. It can be inferred that the northerly wind would drive the water towards the south in the Chesapeake Bay and, therefore, the water level at Baltimore is lowest in the Chesapeake Bay area due to the wind setdown.

The lowest water level due to wind effects will take place during the passage of the Probable Maximum Hurricane (PMH) because the wind field due to the PMH is the strongest. The track of the PMH causing the lowest water level at the site location is indicated in Figure 2.4-50. The characteristics of the PMH for calculating the negative surge as detailed in EM 1110-2-1412, Storm Surge Analysis and Design Water Level Determinations (USACE, 1986) are as follows:

From Figure C-10 (USACE, 1986), the K factor for the PMH, Latitude N37o (location of site) and for units of mph is K = 78.7. The Coriolis parameter is estimated to be f = 0.315/hr.

From Figure C-4 (USACE, 1986), the upper and lower limits of radius to the maximum winds for the PMH are:

Rlower = 10 nautical miles or Rlower = 11.51 mi (18.53 km)

Rupper = 26.2 nautical miles or Rupper = 30.15 mi (48.52 km)

The lowest sea-level pressure po (in inches Hg) at the hurricane center is determined from Figure C-2 (USACE, 1986) for the PMH at Chesapeake Bay:

po = 26.56 in Hg (67.46 cm Hg)

Finally, the peripheral pressure pn, the sea level pressure at the outskirts of the PMH hurricane is taken as

pn = 30.12 in Hg (76.50 cm Hg)

Using the PMH characteristics at the site and following the procedure described in EM 1110-2-1412 (USACE, 1986), the maximum sustained wind speed at the site area is estimated as 102.9 mph (165.6 kmph) when the eye of the PMH passes along the coastline as indicated in Figure 2.4-50.

The negative surge at the site due to Hurricane Donna is estimated to be -1.2 ft (-0.37 m) based on the data of Table 2.4-30 and by interpolating between the Annapolis and Solomons Island Stations. The storm surge is generally proportional to the square of the wind speed (USACE, 1959). Therefore the negative surge due to the PMH can be calculated on the basis of the law of proportionality as follows:

$$\frac{(\text{wind speed due to Hurricane Donna})^2}{(\text{Negative surge at site})} = \frac{(\text{wind speed due to PMH})^2}{(\text{Negative surge at site})} \Rightarrow \frac{57^2}{-1.2} = \frac{102.9^2}{\text{surge at site}} \quad \text{Eq. 2.4.11-1}$$

Therefore, the negative surge due to the PMH is estimated as -3.9 ft (-1.2 m). Moreover, considering the westerly cross wind effects, the additional water level drop has to be added to the negative surge due to the PMH. Assuming that the additional setdown is equal to the setup due to the PMH given in Section 2.4.5 for an easterly wind, the additional setdown is 1.13 ft (0.34 m). Therefore, the total setdown, computed empirically, due to the PMH is -5.03 ft (-1.53 m).

SLOSH Analysis

To be consistent with methodology presented in FSAR Section 2.4.5 and as a conservative approach, the estimation of low water conditions is also determined using a SLOSH model.

Several model runs with a conservative combination of PMH parameters and storm tracks were performed. Utilizing SLOSH, the magnitude of the low water levels at the CCNPP Unit 3 site is estimated based on the PMH track causing the lowest water level at the site location as indicated in Figure 2.4-50 and PMH characteristics reported in the empirical analysis.

The initial Still Water Level (SWL) is incorporated directly in the SLOSH simulations and defined as the 10% Exceedance Low Tide. The 10-percent low tide probability of non-exceedance is computed statistically based on NOAA's 21-year synthetic tidal signal developed at the Solomons Island tide station. Log Pearson Type III provides the best representative distribution resulting in a 10-percent low tide probability of non-exceedance of -2.56 ft (-0.79 m) NGVD29.

Using SLOSH, the maximum negative surge (including the low water antecedent conditions) at the CCNPP Unit 3 site is -6.5 ft (-1.98 m) NGVD29, compared to -5.03 ft (-1.53 m) computed empirically. The difference is attributed to the use of MLLW instead of the 10% exceedance low tide probability and that SLOSH provides a more conservative approach. This surge height was then adjusted to take into account the 20% margin (SLOSH model uncertainties) suggested in Technical Report NWS 48 (Jelesnianski, 1992). The final elevation thus obtained is -7.2 ft (-2.22 m) NGVD29.

Similar to the empirical analysis, consideration is given to wind wave effects from the westerly cross wind. The potential of wind wave induced run-down in the Intake Forebay, based on the Probable Maximum Hurricane (PMH) critical track, is analyzed using empirical equations from the Coastal Engineering Manual (USACE, 2008).

When the additional set-down is added to the maximum negative surge, the total negative surge is -7.7 ft (-2.34 m) in the Intake Forebay.

COLA FSAR Section 2.4.11.2.3 will be updated as shown below:

2.4.11.2.3 Low Water Level Due to Surge and Tsunami

The combined low water levels for the cases of the negative storm surge and the tsunami are assumed to occur coincident with the occurrence of Mean Lower Low Water (MLLW) at the site. The MLLW, at the site is estimated by using the tide datum relationship at the Cove Point station. At Cove Point Station the MSL and MLLW are 3.13 ft (0.95 m) and 2.50 ft (0.76 m) above station datum, respectively. The datum at Cove Point is -0.01 ft (-0.003 m) MLLW. This value is adopted for the site and the respective low water levels at the site for the empirically calculated negative surge and tsunami are:

- MLLW + Negative Surge: 0.01 ft (0.003 m) -5.03 ft (-1.53 m) = -5.02 ft (-1.53 m)

Eq. 2.4.11-2

- MLLW + Negative Tsunami: 0.01 ft (0.003 m) -1.64 ft (-0.50 m) = -1.63 ft (-0.50 m)

Eq. 2.4.11-3

Therefore, the lowest water level in the Forebay is due to negative storm surge predicted using SLOSH and is estimated as -7.7 ft (-2.34 m) ~~and was estimated to be -5.02 ft (-1.53 m), which is a combination of surge due to PMH and MLLW~~. The minimum ~~operating~~ water level for the safety-related Ultimate Heat Sink (UHS) makeup intake is discussed in Section 2.4.11.5. ~~conservatively set at -6.0 ft (-1.83 m) at the pipe inlet at the bay shore.~~

COLA FSAR Section 2.4.11.5 will be updated as shown below:

2.4.11.5 Plant Requirements

In terms of plant requirements, the Essential Service Water System (ESWS) provides flow for normal operating conditions, for shutdown/cooldown and for Design Basis Accident (DBA) conditions. The ESWS pump in each train obtains water from the ESWS cooling tower basin of that train and circulates the water through the ESWS. Heated cooling water returns to the ESWS cooling tower to dissipate its heat load to the environment. Makeup water is required to compensate for ESWS cooling tower water inventory losses due to evaporation, drift, and blowdown associated with cooling tower operation. Makeup water to the ESWS cooling tower basins under normal operating and shutdown/cooldown conditions is provided by the plant Raw Water Supply System. Water is stored in the ESWS cooling tower basin, which provides at least 72 hours of makeup water for the ESWS cooling tower following a DBA. After 72 hours have elapsed under DBA conditions, emergency makeup water to the tower basins is provided by the safety-related UHS emergency makeup water pumps housed in the UHS makeup intake structure.

Under normal plant operating conditions, the makeup water for the CWS will be taken from the Chesapeake Bay by pumps at a maximum rate of approximately 44,320 gpm (167,769 lpm) for the unit. Under normal plant operating conditions, UHS gets its makeup from fresh water (desalination plant output).

Under DBA conditions, the CWS is lost, since it is non-safety-related. The ESWS makeup water under DBA conditions will be provided at a maximum flow rate of approximately 942 gpm (3,566 lpm) to accommodate the maximum evaporation rate (approximately 61 gpm (231 lpm)) and drift loss and seepage (approximately 19.5 gpm (74 lpm) for the unit) for two UHS cooling towers. Maximum ESWS blowdown and makeup rates are based on maintaining ten cycles of concentration and evaporation at 82°F (27.8°C) wet-bulb temperature and 20% relative humidity.

As discussed in Section 2.4.7.3, both the nonsafety-related circulating water system (CWS) makeup water intake structure and safety-related UHS makeup water intake structure for CCNPP Unit 3 are located approximately 500 ft (152.4 m) southeast of the CCNPP Units 1 and 2 intake structure. Makeup water to the common forebay for the Unit 3 intakes is conveyed via two buried pipes from an area adjacent to the Units 1 and 2 intake forebay formed between the existing baffle wall (acting as a skimmer wall) and a sheet pile wall extending from shore to the baffle wall. The <u>two 60 in (1.5 m) diameter intake pipes are buried with a centerline depth at approximately -17 ft (-5.2 m). These</u> buried pipes are safety-related structures. Four 100% capacity, vertical turbine, wet-pit UHS emergency makeup water pumps are provided to supply makeup water to the four-independent UHS cooling tower basins, one per train, with a capacity per pump of approximately 750 gpm (2835 lpm). The ~~common~~ <u>F</u>~~f~~orebay invert elevation is approximately at -22.5 ft (-6.9 m). The minimum design ~~operating~~ water level in the common <u>F</u>~~f~~orebay and for the UHS makeup water pumps is set at -8 ft (-2.4 m). The available water depth of 14.5 ft (4.42 m) under the minimum design water level is sufficient to satisfy the pump submergence and Net Positive Suction Head (NPSH) requirements taking into account the pump intake head loss through screens even when the four UHS emergency makeup pumps are operating concurrently at 750 gpm (2,835 lpm).

~~The discharge flow from CCNPP Unit 3 is from a retention basin, which collects all site non-radioactive wastewater and cooling tower blowdown to the Chesapeake Bay. Details of the outfall structure are provided in Section 10.4.5.~~

Since the minimum design ~~operating~~ water level in the ~~bay upstream of the two new intake pipes~~ Forebay is set at -8 ft (-2.4 m) ~~-6.0 ft (-1.83 m)~~ for the safety-related UHS makeup intake, the UHS makeup pumps supply sufficient water during the lowest water level due to negative surge from the PMH or tsunami (estimated at -7.7 ft (-2.34 m) ~~-5.02 ft (-1.53 m)~~). With a centerline elevation of the intake pipes at -17 ft (-5.2 m), there is no risk of vortices and air entrainment in the intake pipe.

Also, since the minimum design operating level in the bay for the non-safety-related CWS makeup intake is set at -4.0 ft (-1.22 m), the CWS makeup pumps also supply sufficient water during the 100-year low water level (estimated at -3.9 ft (-1.19 m) in the bay. The amount of water withdrawn from the Chesapeake Bay will be subject to the state water withdrawal permit limits.

The Chesapeake Bay withdrawal permit for the cooling water of the CCNPP Unit 3 will be subject to the provisions of Title 5 of the Environment Article, Annotated Code of Maryland (MD, 2007). The EPA declared the Chesapeake Bay as an impaired water body in 1998 based on the Federal Water Pollution Control Act (USC, 2007) because of excess nutrients and sediments (CBP, 2003). Both the safety-related and non-safety-related makeup intakes comply with the Section 316(b) requirements for existing power plants of the Federal Water Pollution Control Act (USC, 2007).

The discharge flow from CCNPP Unit 3 is from a retention basin, which collects site non-radioactive wastewater and cooling tower blowdown to the Chesapeake Bay. Details of the outfall structure are provided in Section 10.4.5.

A new reference will be added to COLA FSAR Section 2.4.11.7 as shown below:

2.4.11.7 References

USACE, 2008, Coastal Engineering Manual, EM 1110-2-1100, U.S. Army Corps of Engineers, 2008.

COLA FSAR Section 9.2.5.2.3 will be updated as shown below:

9.2.5.2.3 UHS Makeup Water System

Emergency makeup water for the ESWS is provided by the site-specific, safety-related UHS Makeup Water System that draws water from the Chesapeake Bay. The common forebay is shared between the CWS makeup water system and UHS makeup water system. Two buried 60" safety-related pipes provide a flow path for Chesapeake Bay water to enter the common forebay. Both pipes are designed to account for head losses in the pipe and provide sufficient flow for the CWS makeup and UHS makeup. Both pipes are normally in operation, however, either pipe can be isolated for maintenance as the other pipe is capable of providing 100% flow for CWS makeup and UHS makeup.

Due to the head loss through the pipes, the design low water level at the common forebay for the UHS makeup intake is at EL. -8 ft NGVD29, which is ~~2 feet~~ slightly lower than the ~~design~~ predicted minimum low water level in the Chesapeake Bay of -7.7 ft ~~-6 ft~~ NGVD29. The common forebay invert elevation is at -22.5 ft NGVD29, which provides ample additional margin in pump submergence during UHS operation with one or two intake pipes. The UHS Makeup Water Intake Structure houses four bar screens and four dual-flow traveling screens that remove large debris and trash that may be entrained in the flow. Each traveling screen is located in a separate enclosure and provides the required flow to the associated UHS Makeup Water Pump. Each traveling screen is equipped with a screen wash system which provides a high pressure spray to remove debris from the traveling screens.