Greg Gibson
Vice President, Regulatory Affairs

750 East Pratt Street, Suite 1600
Baltimore, Maryland 21202

UniStar
NUCLEAR ENERGY

10 CFR 50.4
10 CFR 52.79

June 15, 2009

UN#09-287

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 No. 99, Probable Maximum Tsunami Flooding

Reference:

1) John Rycyna (NRC) to Robert Poche (UniStar Nuclear Energy), "RAI No 99 RHEB 2090.doc (PUBLIC)" email dated April 16, 2009

2) UniStar Nuclear Energy Letter UN#09-272, from Greg Gibson to Document Control Desk, U.S. NRC, Response Schedule to Request for Additional Information for RAI No. 99, Probable Maximum Tsunami Flooding; RAI No.101, Groundwater; RAI No. 103, Probable Maximum Surge and Seiche Flooding, dated June 2, 2009

The purpose of this letter is to respond to a request for additional information (RAI) identified in the NRC e-mail correspondence to UniStar Nuclear Energy, dated April 16, 2009 (Reference 1). This RAI addresses Probable Maximum Tsunami Flooding, as discussed in Section 2.4.6 of the Final Safety Analysis Report (FSAR), as submitted in Part 2 of the Combined License Application (COLA), Revision 4.

Reference 1 requested UniStar Nuclear Energy to respond to the RAI within 30 days. Reference 2 stated that responses to Questions 02.04.06-6, 02.04.06-7 and 02.04.06-8 would be provided by June 19, 2009.

The enclosure provides our responses to RAI No. 99, Questions 02.04.06-6, 02.04.06-7 and 02.04.06-8 and includes revised COLA content. A Licensing Basis Document Change Request has been initiated to incorporate these changes into a future revision of the COLA.

D096
NRO

Our responses to RAI No. 99, Questions 02.04.06-6, 02.04.06-7 and 02.04.06-8 do not include any new regulatory commitments.

If there are any questions regarding this transmittal, please contact me at (410) 470-4205, or Mr. Michael J. Yox at (410) 495-2436.

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

Executed on June 15, 2009

Christian Clement
for greg gibson

Greg Gibson

Enclosure: Response for Request for Additional Information RAI No. 99, Probable Maximum Tsunami Flooding, Questions 02.04.06-6, 02.04.06-7 and 02.04.06-8, Calvert Cliffs Nuclear Power Plant Unit 3

cc: John Rycyna, NRC Project Manager, U.S. EPR COL Application
Laura Quinn, NRC Project Manager, Environmental Projects Branch 2
Getachew Tesfaye, NRC Project Manager, U.S. EPR DC Application (w/o enclosure)
Loren Plisco, 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

Enclosure

Response for Request for Additional Information RAI No. 99,
Probable Maximum Tsunami Flooding,
Questions 02.04.06-6, 02.04.06-7 and 02.04.06-8,
Calvert Cliffs Nuclear Power Plant Unit 3

RAI No. 99

Question 02.04.06-6

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 Probable Maximum Tsunami Flooding. These characteristics include detailed geo-seismic descriptions of the controlling local tsunami generators, including location, source dimensions, and maximum displacement. Provide a discussion in the updated FSAR of the literature search conducted that was used to determine the tsunami source parameters for the Norfolk Canyon landslide scenario.

Response

The tsunami source parameters for the hypothetical Norfolk Canyon landslide scenario described in Revision 4 of FSAR Subsection 2.4.6.3.1 are adopted from the studies of Ward[a] and Driscoll[b] et al. With the use of GLORIA side scan sonar, Driscoll et al. discovered a 40-km long system of en echelon cracks along the edge of the outer continental shelf off southern Virginia that suggests past submarine slope failures. The new crack system is located just north of a known submarine landslide[2] (Albemarle-Currituck) dated from the Pleistocene, which was estimated to have released a total sediment volume of about 150 km^3, based on GLORIA and bathymetric data. Driscoll et al. went on to evaluate the tsunami hazard that might be posed by a major submarine landslide, similar to the late Pleistocene Albemarle-Currituck slide, if it nucleated on the discovered crack system. In an attempt to characterize the landslide parameters, Ward assumed that the extent of the Norfolk Canyon landslide would be the same as the mapped debris field of the Albemarle-Currituck landslide. Ward suggested that the mapped 130-km long and 30-km wide Albemarle-Currituck landslide scar that occupied an area of 3700 km^2 would result from a 40-km long headwall sliding out to a distance of about 90 km. Using the slide volume of 150 km^3 estimated for the Albemarle-Currituck landslide, Ward proposed a slide scenario of 136 m thick slab occupying an area of 1100 km^2 sliding down-slope into a fan 58 m thick and 2600 km^2 in area. Assuming the slide front would advance at 35 m/s, same as that of the Storegga landslide in the northern Atlantic Ocean, Ward estimated a slide speed of 15 m/s at the back of the sliding block for the Norfolk Canyon landslide and concluded that at these velocities, mass motions would continue for 55 minutes.

FSAR Section 2.4.6.1 provides a discussion on the selection of cited reference literature.

COLA Impact

FSAR Section 2.4.6.3.1 will be updated as follows in a future COLA revision:

2.4.6.3.1 Norfolk Canyon Submarine Landslide, Virginia

- Source: Submarine landslide of continental shelf off the coast of southern Virginia and North Carolina (Driscoll, 2000) (Ward, 2001a)

---

[a] Landslide Tsunami, Journal of Geophysical Research, Volume 106, Number 6, S. Ward, 2001.

[b] Potential for Large-scale Submarine Slope Failure and Tsunami Generation along the U.S. mid-Atlantic Coast, Geology, Volume 28, Number 5, Driscoll, N.W., J.K. Weissel and J.A. Goff, May 2000.

- Sliding Scenario: 36 ~~mi3~~mi^3 (150 ~~km3~~km^3) of material running out at a speed of 49 to 115 ft/s (15 to 35 m/s) for 55 minutes (Ward, 2001a) (Driscoll, 2000).

- Tsunami Parameters: Maximum tsunami amplitude of 13 ft (4 m) at the Chesapeake Bay entrance with a period of 3,600 seconds.

It is suggested (Driscoll, 2000) that the presence of a system of en echelon cracks along the edge of the continental shelf, just north of the Pleistocene Albemarle-Currituck landslide, likely indicates an initial stage of a large scale slope failure. Because large magnitude earthquakes do not occur in the east coast of the U.S. or in the vicinity of the Norfolk Canyon, gas hydrate release and interglacial changes are possible triggering mechanisms for the landslide (Driscoll, 2000). Ward (Ward, 2001a) estimated the landslide parameters of the Norfolk Canyon landslide based on assumptions that the size and volume of a potential landslide would be the same as the mapped debris field of the Pleistocene Albemarle-Currituck landslide. The slide front would advance at the same speed as that of the Storegga landslide in the northern Atlantic Ocean. Ward (Ward, 2001a) used ~~These~~ these landslide parameters ~~were used~~ to perform ~~(Ward, 2001a)~~ model simulation for the submarine landslide-induced tsunami. While tsunami amplitude at the entrance of the Chesapeake Bay is selected from the model simulation results of Ward (Ward, 2001a), the tsunami period is estimated based on recorded tsunami periods along the east coast of the U.S. The longest wave period recorded from the 1929 Grand Banks submarine landslide-generated tsunami was 40 min, recorded at Halifax, Nova Scotia, Canada (NOAA, 2006a). Considering the proximity of the Chesapeake Bay entrance to the tsunami source location, similar to that of Halifax to the Burin Peninsula, a tsunami wave period of similar time span could be approximated. However, because the shallow and wide continental shelf would likely cause the short-period component waves to disperse before reaching the Chesapeake Bay entrance, the tsunami wave period at the entrance of the Chesapeake Bay was conservatively selected to be 60 min (3,600 sec).

Question 02.04.06-7

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 Probable Maximum Tsunami Flooding. These characteristics include detailed geo-seismic descriptions of the controlling distant tsunami generators, including location, source dimensions, and maximum displacement. Provide a discussion in the updated FSAR of the literature search conducted that was used to determine the tsunami source parameters for the La Palma landslide scenario.

Response

The tsunami source parameters for the La Palma landslide scenario described in Revision 4 of FSAR Subsection 2.4.6.3.2 are adopted from Ward and Day[a].

Based on geological evidence, Ward and Day estimated that a collapse of Cumbre Vieja volcanic flank would result in a slide block of 15-20 km wide and 15-25 km long, producing a rock fall volume in the range of 150 km^3 to 500 km^3 with a mean thickness in the range of 1-2 km. The worst-case scenario postulated (in terms of slide volume) is a 500 km^3 block, 25 km long, 15 km wide, and 1400 m thick, that would break away and spill into the deep ocean. Based on the shape of the previous La Palma slide and past collapses of similar volume elsewhere in the Canaries, Ward and Day proposed that the material in a 375 km^2 excavation would cascade down the steep offshore slope for about 60 km until it reaches the flat ocean floor at 4000 m depth. Ward and Day envisioned that the rundown of the accelerating block would quickly reach a peak velocity of 100 m/s before it disintegrates into a run-out.

Mader[b] cited similar landslide parameters, 500 km^3 of material running out 60 km at a mean speed of 100 m/s, for the lateral collapse of the flank of the Cumbre Vieja Volcano.
FSAR Section 2.4.6.1 in the current version of the COLA provides a discussion on the selection of cited reference literature.

FSAR Section 2.4.6.1 provides a discussion on the selection of cited reference literature.

COLA Impact

FSAR Section 2.4.6.3.2 will be updated as follows in a future COLA revision:

2.4.6.3.2 La Palma in Canary Islands

- Source: Lateral collapse of flank of Cumbre Vieja Volcano on La Palma in Canary Islands (Pararas-Carayannis, 2002) (Mader, 2001a) (Ward, 2001b)

- Sliding Scenario: 120 mi^3 (500 km^3) of material running out 37.3 mi (60 km) at a mean speed of 328 ft/s (100 m/s) (Ward, 2001b)

---

[a] Cumbre Vieja Volcano – Potential Collapse and Tsunami at La Palma, Canary Islands, American Geophysical Union, S. Ward and S. Day, 2001.

[b] Modeling the La Palma Landslide Tsunami, Science of Tsunami Hazards, Volume 19, pages 150 through 170, C. Mader, 2001.

- Tsunami Parameters: Maximum tsunami amplitude of 10 ft (3 m) at the Chesapeake Bay entrance with a period of 3,600 seconds

Ward (Ward, 2001b) postulated the sliding scenario and the tsunami source parameters of the Cumbre Vieja volcanic flank failure based on geological evidence of the area, shape of the previous La Palma slide, and past collapses of similar volume elsewhere in the Canaries.

Although Mader and Ward used the same source and sliding scenarios for the Cumbre Vieja volcano flank failure, they obtained vastly different tsunami amplitude distribution along the east coast of the U.S. While Mader suggests wave amplitude of 10 ft (3 m) along the east coast of the U.S., Ward suggests a maximum tsunami amplitude of between 10 ft (3 m) and 25 ft (7.6 m). Pararas-Carayannis indicated that parameters for initial tsunami generation from the postulated landslide and the initial wave properties are incorrectly addressed in Ward, thereby greatly exaggerating the tsunami amplitude along the U.S. coast.

Question 02.04.06-8

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 Probable Maximum Tsunami Flooding. These characteristics include detailed geo-seismic descriptions of the controlling distant tsunami generators, including location, source dimensions, fault orientation, and maximum displacement. Provide a discussion in the updated FSAR of the numerical model used to determine the 0.9 m maximum amplitude at the Chesapeake Bay entrance for the Haiti (Greater Antilles) earthquake scenario.

Response

NRC[a] adopted the linearized long-wave equations in the simulation of tsunami propagation of the Haiti (Greater Antilles) earthquake scenario. The simulated tsunami amplitude of about 0.9 m at the entrance of the Chesapeake Bay, obtained from Figure B-13 in NUREG/CR-1106, is used to represent the incident tsunami wave at the boundary of the model developed to predict tsunami amplitudes and draw downs at the CCNPP Unit 3 site, as described in Section 2.4.6.3.2 of FSAR Revision 4.

COLA Impact

FSAR Section 2.4.6.3.3 will be updated as follows in a future COLA revision:

2.4.6.3.3 Haiti in Caribbean Islands

- Source: Earthquake induced fault displacement (NRC, 1979)
- Displacement Scale: Length of 662 mi (1066 km), width of 298 mi (480 km), and peak displacement of 30 ft (9.2 m)
- Tsunami Parameters: Maximum tsunami amplitude of about 3.1 ft (0.9 m) at the Chesapeake Bay entrance with a period of 5,200 seconds obtained from the simulated tsunami hydrograph near Newport News VA as presented in Figure B-13 of NUREG/CR-1106 (NRC, 1979). The wave period was estimated as the period of the first wave cycle (peak to peak). NRC (1979) used a linear shallow water wave model for the simulation of this tsunami.

---

[a] Tsunami Atlas for the Coasts of the Unites States, NUREG/CR-1106, U.S. Nuclear Regulatory Commission, 1979.