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UniStar
NUCLEAR ENERGY

10 CFR 50.4
10 CFR 52.79

July 26, 2013

UN#13-091

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 308, Foundations

References:

1) Surinder Arora (NRC) to Robert Poche (UniStar Nuclear Energy), "FINAL RAI No. 308 SEB2 5748" email dated May 23, 2011

2) UniStar Nuclear Energy Letter UN#13-006, from Mark T. Finley to Document Control Desk, U.S. NRC, Updated RAI Closure Plan, dated January 30, 2013

3) UniStar Nuclear Energy Letter UN#12-036, from Mark T. Finley to Document Control Desk, U.S. NRC, Response to Request for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3, RAI 308, Foundations, dated April 18, 2012

4) UniStar Nuclear Energy Letter UN#12-010, from Mark T. Finley to Document Control Desk, U.S. NRC, Response to Request for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3, RAI 308, Foundations, dated February 1, 2012

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5) UniStar Nuclear Energy Letter UN#13-019, from Mark T. Finley to Document Control Desk, U.S. NRC, Response to Request for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3, RAI 369, Foundations, dated March 21, 2013

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 May 23, 2011 (Reference 1). This RAI addresses Foundations, as discussed in Section 03.08.05 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 9.

Reference 2 indicated that a response to RAI 308, Question 03.08.05-9, related to the foundation of the Essential Service Water Building (ESWB), would be provided to the NRC by July 31, 2013.

Enclosure 1 provides our response to RAI 308, Question 03.08.05-9, related to the foundation of the ESWB, and includes revised COLA content. Enclosure 2 provides the COLA impact of this response to RAI 308, Question 03.08.05-9. A Licensing Basis Document Change Request has been initiated to incorporate these changes into a future revision of the COLA. Reference 3 provided the UniStar response to RAI 308, Question 03.08.05-9, related to the foundation of the Emergency Power Generation Building (EPGB). Reference 4 provided the response to RAI 308, Question 03.08.05-8, and indicated that changes to FSAR Section 2.5.4.10.2 would be later supplemented with the response to RAI 308, Question 03.08.05-9, once the foundation analysis of the ESWBs was finalized (this response). Reference 5 (Followup RAI for RAI 308, Question 03.08.05-9) provided a response concerning the foundation for the Common Basemat Intake Structure (CBIS).

The submittal of this response, related to the foundation of the ESWB, in combination with References 3, 4, and 5, completes the UniStar response to RAI 308, Questions 03.08.05-8 and 03.08.05-9 for the CCNPP Unit 3 applicable structures.

Enclosure 3 provides a table of changes to the CCNPP Unit 3 COLA associated with this RAI 308, Question 03.08.05-9 response.

Our response does not include any new regulatory commitments. This letter, and its enclosures, do not contain any sensitive or proprietary information.

If there are any questions regarding this transmittal, please contact me at (410) 369-1907 or Mr. Wayne A. Massie at (410) 369-1910.

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

Executed on July 26, 2013

Mark T. Finley

Enclosures:

1) Response to NRC Request for Additional Information RAI 308, Question 03.08.05-9, related to the foundation of the ESWB, Foundations, Calvert Cliffs Nuclear Power Plant, Unit 3

2) Changes to CCNPP Unit 3 COLA Associated with the Response to RAI 308, Question 03.08.05-9, related to the foundation of the ESWB, Calvert Cliffs Nuclear Power Plant, Unit 3

3) Table of Changes to CCNPP Unit 3 COLA Associated with the Response to RAI 308, Question 03.08.05-9, related to the foundation of the ESWB, Calvert Cliffs Nuclear Power Plant, Unit 3

cc: Surinder Arora, NRC Project Manager, U.S. EPR Projects Branch
Laura Quinn-Willingham, NRC Environmental Project Manager, U.S. EPR COL Application
Tomeka Terry, NRC Environmental Project Manager, U.S. EPR COL Application
Amy Snyder, NRC Project Manager, U.S. EPR DC Application, (w/o enclosures)
Patricia Holahan, Acting Deputy Regional Administrator, NRC Region II, (w/o enclosures)
Silas Kennedy, U.S. NRC Resident Inspector, CCNPP, Units 1 and 2,
David Lew, Deputy Regional Administrator, NRC Region I (w/o enclosures)

Enclosure 1

Response to NRC Request for Additional Information
RAI 308, Question 03.08.05-9,
related to the foundation of the ESWB, Foundations,
Calvert Cliffs Nuclear Power Plant, Unit 3

RAI No. 308

Question 03.08.05-9

SRP Acceptance Criteria 3.8.5.II.4 discusses information on the design and analysis procedures for Seismic Category I foundations, including the consideration of settlement. In RAI number 03.08.05-4. The staff requested that the applicant quantify and explain some differences obtained from the U.S. EPR structural analysis results due to site-specific settlements and groundwater conditions for the Nuclear Island (NI) common basemat structure, the Emergency Power Generating Buildings (EPGBs), and the Essential Service Water Buildings (ESWBs).

The staff reviewed the RAI response to Question 03.08.05-4 provided in two parts: Part one in UniStar letter UN#10-193 dated July 23, 2010 (ML102100480) and Part two in UniStar letter UN#11-085 dated February 22, 2011 (ML110560307). The RAI response addressed most of the staff's original questions. However, the staff notes that the issue of differential settlements of Seismic Category I structures is still under discussion in the U.S. EPR Design Certification (DC) review, and the most recent draft EPR RAI response submittal for Question 03.08.05-22 by AREVA provides updated information on settlement evaluations of Seismic Category I structures. Therefore, the staff requests that the applicant, after the official publication of the new COL items proposed by the AREVA draft submittal, explain how the new and updated COL Items regarding settlements of the EPGBs and the ESWBs will be addressed, for example, whether the same U.S. EPR models, methodology and procedures will be used, what site-specific conditions will be considered, and how the site-specific soil case is compared to the soil cases considered in U.S. EPR's settlement evaluation of the EPGBs and the ESWBs. If not the same, explain the difference(s) and quantify the differences in structural results. The staff also notes that the new Common Basemat Intake Structure (CBIS) foundation is comparable in size with the foundations of the EPGBs and the ESWBs. In light of the new and updated COL items for Seismic Category I structures, explain whether the methodology and procedures used for the settlement evaluation of the CBIS foundation will be comparable to those used for the EPGB and the ESWB foundations. If not, explain the difference(s) and provide the technical basis for the difference(s). The staff needs the information in order to be able to conclude in the SER that there is reasonable assurance that the foundation design of the Seismic Category I structures is consistent with SRP Acceptance Criteria 3.8.5.II.4, and has been adequately addressed in the CCNPP Unit 3 FSAR.

Response:

EPGB

A site-specific assessment and soil properties of the basemat of the EPGB was provided in the previous response to RAI 308, Question 03.08.05-9[1].

ESWB

A site-specific assessment and comparison of the angular distortion across the basemat of the ESWB is required by U.S. EPR FSAR Tier 2, Table 1.8-2, COL item 3.8-20. The site-specific angular distortion of the ESWB was compared to the angular distortion in the total differential settlement contours in U.S. EPR FSAR Tier 2, Figure 3.8-136 as supplemented by AREVA in response to U.S. EPR FSAR RAI 354, Question 03.08.05-22, Supplement 37.

The ESWB uses the same models, methodology and procedures in U.S. EPR FSAR Tier 2, Section 3.8.5.4.4 to evaluate the predicted settlement and angular distortion.

The ESWB Calvert Cliffs Unit 3 site-specific angular distortion values were compared to the angular distortion in the total differential settlement contours in U.S. EPR FSAR Tier 2, Figure 3.8-136, using methods described in U.S. Army Engineering Manual 1110-1-1904. The basemat area is partitioned into separate slab design areas in both the east-west and north-south directions. The maximum CCNPP Unit 3 ESWB foundation angular distortion is less than the maximum angular distortion in every slab design area for the softest soil case in U.S. EPR FSAR Table 3.7.1-8; thus, the U.S. EPR design envelops the site.

Site-specific considerations account for short and long term effects of settlement, including the effects of dewatering, excavation and foundation material preparation. No construction sequence is specified for the ESWB in the U.S. EPR FSAR. These considerations conform to the requirements specified in U.S. EPR Tier 2, Table 1.8-2, COL item 2.5-12 and Section 2.5.4.10.2.

CCNPP Unit 3 FSAR Section 3.8.5.4.4 states that no departures or supplements are made from the U.S. EPR FSAR.

Common Basemat Intake Structure (CBIS)

A site-specific assessment and soil properties of the basemat of the CBIS was provided in the response to RAI 369, Question 03.08.05-11[2].

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[1]UniStar Nuclear Energy Letter UN#12-036, from Mark T. Finley to Document Control Desk, U.S. NRC, Response to Request for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3, RAI 308, Foundations, dated April 18, 2012.

[2]UniStar Nuclear Energy Letter UN#13-019, from Mark T. Finley to Document Control Desk, U.S. NRC, Response to Request for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3, RAI 369, Foundations, dated March 21, 2013.

COLA Impact

Enclosure 2 provides the COLA impact of the response to RAI 308, Question 03.08.05-9, related to the foundation of the ESWB.

Enclosure 2

Changes to CCNPP Unit 3 COLA Associated with the Response to RAI 308, Question 03.08.05-9, related to the foundation of the ESWB, Calvert Cliffs Nuclear Power Plant, Unit 3

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Table 1.8-2— FSAR Sections that Address COL Items
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Item No.	Description	Section
-5	A COL applicant that references the U.S. EPR design certification will investigate site-specific surface and subsurface geologic, seismic, geophysical, and geotechnical aspects within 25 miles around the site and evaluate any impact to the design. The COL applicant will demonstrate that no capable faults exist at the site in accordance with the requirements of 10 CFR 100.23 and of 10 CFR 50, Appendix S. If non-capable surface faulting is present under foundations for safety-related structures, the COL applicant will demonstrate that the faults have no significant impact on the structural integrity of safety-related structures, systems, or components.	2.5.3
2.5-6	A COL applicant that references the U.S. EPR design certification will present site-specific information about the properties and stability of soils and rocks that may affect the nuclear power plant facilities under both static and dynamic conditions, including the vibratory ground motions associated with the CSDRS and the site specific SSE.	2.5.4
2.5-7	A COL applicant that references the U.S. EPR design certification will verify that the predicted tilt settlement value of ½ in per 50 ft in any direction across the foundation basemat of a Seismic Category I structure is not exceeded. Settlement values larger than this may be demonstrated acceptable by performing additional site-specific evaluations.	2.5.4.10.2
2.5-8	A COL applicant that references the U.S. EPR design certification will evaluate site-specific information concerning the stability of earth and rock slopes, both natural and manmade (e.g., cuts, fill, embankments, dams, etc.), of which failure could adversely affect the safety of the plant.	2.5.5
2.5-9	A COL applicant that references the U.S. EPR design certification will reconcile the site specific soil and backfill properties with those used for design of U.S. EPR Seismic Category I structures and foundations described in Section 3.8.	2.5.4.2
2.5-10	A COL applicant that references the U.S. EPR design certification will investigate and determine the uniformity of the soil layer(s) underlying the foundation basemats of Seismic Category I structures.	2.5.4.10.3
2.5-11	Deleted	Deleted
2.5-12	A COL applicant that references the U.S. EPR design certification will provide an assessment of predicted settlement values across the basemat of Seismic Category I structures during and post construction. The assessment will address both short term (elastic) and long term (heave and consolidation) settlement effects with the site-specific soil parameters, including the soil loading effects from adjacent structures.	2.5.4.10.2
3.1-1	A COL applicant that references the U.S. EPR design certification will identify the site-specific QA Program Plan that demonstrates compliance with GDC-1.	3.1.1.1.1
3.2-1	A COL applicant that references the U.S. EPR design certification will identify the seismic classification of applicable site-specific SSCs that are not identified in Table 3.2.2-1.	3.2.1
3.2-2	A COL applicant that references the U.S. EPR design certification will identify the quality group classification of site-specific pressure-retaining components that are not identified in Table 3.2.2-1.	3.2.2
3.3-1	A COL applicant that references the U.S. EPR design certification will determine site-specific wind and tornado characteristics and compare these to the standard plant criteria. If the site-specific wind and tornado charactistics are not bounded by the site parameters, postulated for the certified design, then the COL applicant will evaluate the design for site-specific wind and tornado events and demonstrate that these loadings will not adversely affect the ability of safety-related structures to perform their safety functions during or after such events.	3.3
3.3-2	A COL applicant that references the U.S. EPR design certification will demonstrate that failure of site-specific structures or components not included in the U.S. EPR standard plant design, and not designed for wind loads, will not affect the ability of other structures to perform their intended safety functions.	3.3.1
3.3-3	A COL applicant that references the U.S. EPR design certification will demonstrate that failure of site-specific structures or components not included in the U.S. EPR standard plant design, and not designed for tornado loads, will not affect the ability of other structures to perform their intended safety functions.	3.3.2

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Table 1.8-2— FSAR Sections that Address COL Items
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Item No.	Description	Section
3.8-8	A COL applicant that references the U.S. EPR design certification will address site-specific Seismic Category I structures that are not described in this section.	3.8.4.1
3.8-9	A COL applicant that references the U.S. EPR design certification will describe site-specific foundations for Seismic Category I structures that are not described in this section.	3.8.5.1
	A COL applicant that references the U.S. EPR design certification will evaluate site-specific methods for shear transfer between the foundation basemats and underlying soil for site-specific soil characteristics that are not within the envelope of the soil parameters specified in Section 2.5.4.2.	3.8.5.5
3.8-11	A COL applicant that references the U.S. EPR design certification will evaluate the use of epoxy coated rebar for foundations subjected to aggressive environments, as defined in ACI 349-01, Chapter 4. In addition, waterproofing and dampproofing system of Seismic Category I foundations subjected to aggressive environments will be evaluated for use in aggressive environments. Also, the concrete of Seismic Category I foundations subjected to aggressive environments will meet the durability requirements of ACI 349-01, Chapter 4 or ASME, Section III, Division 2, Article CC-2231.7, as applicable.	3.8.5.6.1
3.8-12	A COL applicant that references the U.S. EPR design certification will describe the program to examine inaccessible portions of below-grade concrete structures for degradation and monitoring of groundwater chemistry.	3.8.5.7
3.8-13	A COL applicant that references the U.S. EPR design certification will identify site-specific settlement monitoring requirements for Seismic Category I foundations based on site-specific soil conditions.	3.8.5.7
3.8-14	A COL applicant that references the U.S. EPR design certification will describe the design and analysis procedures used for buried conduit and duct banks, and buried pipe and pipe ducts.	3.8.4.4.5
3.8-15	A COL applicant that references the U.S. EPR design certification will use results from site specific investigations to determine the routing of buried pipe and pipe ducts.	3.8.4.4.5
3.8-16	A COL applicant that references the U.S. EPR design certification will perform geotechnical engineering analyses to determine if the surface load will cause lateral and/or vertical displacement of bearing soil for the buried pipe and pipe ducts and consider the effect of wide or extra heavy loads.	3.8.4.4.5
3.8-17	A COL applicant that references the U.S. EPR design certification will address examination of buried safety-related piping in accordance with ASME Section XI, IWA-5244, "Buried Components."	3.8.4.7
3.8-18	A COL applicant that references the U.S. EPR design certification will compare the NI common basemat site-specific predicted angular distortion to the angular distortion in the relative differential settlement contours in U.S. EPR FSAR Figure 3.8-124 through Figure 3.8-134, using methods described in U.S. Army Engineering Manual 1110-1-1904. The comparison is made throughout the basemat in both the east-west and north-south directions. If the predicted angular distortion of the NI common basemat structure is less than the angular distortion shown for each of the construction steps, the site is considered acceptable. Otherwise, further analysis will be required to demonstrate that the structural design is adequate.	3.8.5.5.1
3.8-19	A COL applicant that references the U.S. EPR design certification will compare the EPGB site-specific predicted angular distortion to the angular distortion in the total differential settlement contours in Figure 3.8-135, using methods described in U.S. Army Engineering Manual 1110-1-1904. The comparison is made throughout the basemat in both the east-west and north-south directions. If the predicted angular distortion of the basemat of EPGB structures is less than the angular distortion shown, the site is considered acceptable. Otherwise, further analysis will be required to demonstrate that the structural design is adequate.	3.8.5.5.2
3.8-20	A COL applicant that references the U.S. EPR design certification will compare the ESWB site-specific predicted angular distortion to the angular distortion in the total differential settlement contours in Figure 3.8-136, using methods described in U.S. Army Engineering Manual 1110-1-1904. The comparison is made throughout the basemat in both the east-west and north-south directions. If the predicted angular distortion of the basemat of ESWB structures is less than the angular distortion shown, the site is considered acceptable. Otherwise, further analysis will be required to demonstrate that the structural design is adequate.	3.8.5.5.3
3.9-1	A COL applicant that references the U.S. EPR design certification will submit the results from the vibration assessment program for the U.S. EPR RPV internals, in accordance with RG 1.20.	3.9.2.4

Table 2.0-1— {U.S. EPR Site Design Envelope Comparison}
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	U.S. EPR FSAR Design Parameter Value	CCNPP Unit 3 Site Characteristic Value
Minimum Dynamic Bearing Capacity	Maximum dynamic bearing demand is 35,000 lbs/ft^2 at the toe of the Seismic Category I structure basemats.	35.2 ksf across the NI basemat with a factor of safety (FOS) of 2.0.
	The ultimate dynamic bearing capacity divided by 2.0 is greater than or equal to the maximum dynamic bearing demand.	51,100 lbs/ft^2 across the EPGB basemat with a factor of safety (FOS) of 2.0.
		59,000 lbs/ft^2 across the ESWB basemat with a factor of safety (FOS) of 2.0. (See Section 2.5.4, Table 2.5-65)
Minimum Shear Wave Velocity (Low strain best estimate average value at bottom of basemat)	1000 fps	Shear wave velocity profile values of structural fill material for the CCNPP Unit 3 Seismic Category I and II structures, and the FP Building and FP Tanks, are greater than or equal to 1000 fps at depths of 41.5 ft or greater, greater than or equal to 845 fps at depths greater than or equal to 22 ft and less than 41.5 ft, greater than or equal to 720 fps for depths greater than or equal to 6 ft and less than 22 ft, and greater than or equal to 650 fps for depths greater than or equal to 0 ft and less than 6 ft. See note h for departure information.
Liquefaction	None	None (See section 2.5.4)
Slope Failure Potential	No slope failure potential is considered in the design of safety-related SSCs for U.S. EPR design certification.	No slope failure potential that would adversely affect the safety of the proposed CCNPP Unit 3 (See Section 2.5.5)
Maximum Settlement (across the basemat)		
1. Differential Settlement	Figure 3.8-124 through Figure 3.8-136	See section 3.8.5.5.1 for NI, ~~and~~ Section 3.8.5.5.2 for the EPGB, and Section 3.8.5.5.3 for ESWB
2. Tilt Settlement	½ inch in 50 feet in any direction	Less than ½ inch in 50 feet in any direction of NI Common Basemat. See Section 2.5.4.10.2
Angle of Internal Friction (in situ and backfill)	26.6 degrees (minimum) 30 degrees (maximum)	TBD
Soil Density (γ) (in situ and backfill)	110 lb/ft^3 $\leq \gamma \leq$ 134 lb/ft^3	TBD
Maximum Ground Water	3.3 ft below grade	Approximately 30 feet below grade (See Section 2.4.12.5)

Table 2.0-1 compares CCNPP Unit 3 site Characteristic Values with U.S. EPR FSAR design Parameters. The static and dynamic bearing capacity exceed the requirements established for the NI, EPGB and ESWB as shown in Table 2.0-1.

For static and dynamic loading conditions, and based on a factor of safety of 3.0 (static) and 2.0 (dynamic), the site provides adequate allowable bearing capacity.}

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2.5.4.10.2 Settlement

The U.S. EPR FSAR includes the following COL Items in Section 2.5.4.10.2:

> A COL applicant that references the U.S. EPR design certification will provide an assessment of predicted settlement values across the basemat of Seismic Category I structures during and post construction. The assessment will address both short term (elastic) and long term (heave and consolidation) settlement effects with the site specific soil parameters, including the soil loading effects from adjacent structures.
>
> A COL applicant that references the U.S. EPR design certification will verify that the predicted tilt settlement value of ½ inch per 50 ft in any direction across the foundation basemat of a Seismic Category I structure is not exceeded. Settlement values larger than this may be demonstrated acceptable by performing additional site specific evaluations.

These COL Items are addressed as follows:

{The surface topography and subsurface conditions of the CCNPP Unit 3 Powerblock Area make the estimation of settlement and building tilt complex. The objective of the settlement analysis of the CCNPP Powerblock Area is to provide an estimate of the time dependant settlement and heave distribution throughout the footprint of the Powerblock Area, including maximum settlement and tilt estimated for each of the facilities.

The settlement analysis of the CCNPP Powerblock Area was carried out under the following premises:

- Develop a three-dimensional model capable of capturing irregular subsurface conditions, realistic foundation footprint shapes, and asymmetric building loads;
- Perform a time-dependant simulation, that provides settlement and tilt estimates as a function of time through and after construction;
- Incorporate a construction sequence and examine the behavior of settlement and tilt as buildings are erected;
- Account for asymmetric topography, by recognizing that reloading time to original consolidation pressure after excavation will be variable throughout the foundation footprint;
- Perform the settlement analysis simultaneously for the NI and adjacent facilities, including the detached safety related structures (EPBG and ESWB);

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Section 2.5.4.10.2.2

- The differential settlement between the NI and TB is provided after each loading step. Since both facilities are founded on different basemats, a discontinuity shows the magnitude of the differential settlement. The same condition applies between the NI and the NAB. The differential settlement between the NI and these two adjacent facilities is estimated to be in the order of one to two inches. Tilt between NAB and RB occurs in opposite directions, and both facilities tilt towards each other. This condition needs to be accounted for in the final design and construction.

- Groundwater is below foundation grade during construction. After construction, groundwater is expected to rise to El. 55. The settlement estimates are not sensitive to variations in the groundwater rebound level, if such variations are in the order of plus or minus ten feet.

The U.S. EPR FSAR Section 2.5.4.10.2 identifies tilt settlement as a required parameter to be enveloped, defined as "½ inch per 50 ft in any direction across the foundation basemat of a Seismic Category I structure" and that "values larger than this may be demonstrated acceptable by performing additional site specific evaluations."

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The estimated tilt settlements for ESWB 1 and ESWB 2 do not meet the U.S. EPR FSAR requirement of ½ inch per 50 ft (or 1/1,200) and EPGB 1 is at ½ inch per 50 ft (see Table 2.5-~~69~~); however, additional site specific evaluations will be performed to demonstrate their acceptability, as follows.

To verify that foundations perform according to estimates, and to provide an ability to make corrections, if needed, major structure foundations are monitored for rate of movement during and after construction.

Foundations are designed to safely tolerate the anticipated total and differential settlements. Additionally, engineering measures are incorporated into design for control of differential movements between adjacent structures, piping, and appurtenances sensitive to movement, consistent with settlement estimates. This includes the development and implementation of a monitoring plan that supplies and requires evaluation of information throughout construction and post-construction on ground heave, settlement, pore water pressure, foundation pressure, building tilt, and other necessary data. This information provides a basis for comparison with design conditions and for projections of future performance.

The estimated differential settlements represent departures from the U.S. EPR FSAR requirements. Additional discussion of the acceptability of these estimated differential settlements is provided in Section 3.8.5.

2.5.4.10.2.3 Settlement in the Intake Area

The settlement model in the Intake Area is developed in a similar form. The model is much simpler and the influence of neighboring structures is negligible. The size of the foundation is very small compared to the variability in layer thickness throughout the footprint. Soil layers, as shown in Figure 2.5-154 are horizontal. There is no additional complication introduced by asymmetric topography. The loading sequence for the Intake Area facilities is applied in a single step. Figure 2.5-184 provides the FEM model for the UHS MWIS.

The total settlement at the end of construction for the facilities in the Intake Area is provided in Table 2.5-72. The maximum total settlement is 3.6 in and the maximum estimated tilt is 0.4 in/50 ft.}

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3.8.5.5.2 Emergency Power Generating Buildings Foundation Basemats

The U.S. EPR FSAR includes the following COL Item in Section 3.8.5.5.2:

> A COL applicant that references the U.S. EPR design certification will compare the EPGB site-specific predicted angular distortion to the angular distortion in the total differential settlement contours in Figure 3.8-135, using methods described in U.S. Engineering Manual 1110-1-1904. The comparison is made throughout the basemat in both the east-west and north-south directions. If the predicted angular distortion of the basemat of EPGB structures is less than the angular distortion shown, the site is considered acceptable. Otherwise, further analysis will be required to demonstrate that the structural design is adequate.

The COL Item is addressed as follows:

> {The Calvert Cliffs Unit 3 site-specific angular distortion values were compared to the angular distortion in the total differential settlement contours in U.S. EPR™ FSAR Tier 2, Figure 3.8-135, using methods described in U.S. Army Engineering Manual 1110-1-1904. The same models, methodologies and procedures are used as with the U.S. EPR™ Standard Plant design. The basemat area is partitioned into separate slab design areas in both the east-west and north-south directions. The maximum CCNPP Unit 3 angular distortion is less than the maximum angular distortion in every slab design area for the softest soil case in U.S. EPR™ FSAR Table 3.7.1-8; thus, the U.S. EPR™ design envelops the site.}

{The following departure is taken from U.S. EPR FSAR Section 3.8.5.5.2.

Section 2.5.4.10.2 of the U.S. EPR FSAR states that:

> "The design of Seismic Category I foundations for the U.S. EPR is based on a maximum differential settlement of ½ inch per 50 ft in any direction across the basemat."

The U.S. EPR FSAR maximum allowable differential settlement of ½ inch per 50 ft may also be expressed as a fraction, i.e., 1/1200.

According to Section 2.5.4.10.2, the estimated site-specific differential settlement is 1/1166, which is about 3% higher than the allowable value described in the U.S. EPR FSAR.

A finite element analysis of the entire EPGB structure, including CCNPP Unit 3 site-specific soil springs, indicates the maximum differential settlement within the confines of the EPGB basemat is 1/2714, or substantially less than the allowable value of the U.S. EPR FSAR. The variation of the finite element analysis differential settlement (1/2714) with the estimated differential settlement value of 1/1166 is attributed to the conventional geotechnical treatment of the foundation as a flexible plate, a condition much more conservative than the actual 6 ft thick reinforced concrete basemat.

To verify the finite element analysis results, a manual calculation is performed for a selected beam strip (1 ft (0.3 m) wide by 6 ft (1.8 m) deep) of the EPGB basemat, plan view of which is shown in U.S. EPR FSAR Figure 3E.2-3. The beam strip is located at the centerline of the basemat and is perpendicular to the center reinforced concrete bearing wall. The selected two-span beam strip is 96 ft (29.3 m) long, with the aforementioned center wall and two parallel primary reinforced concrete bearing walls serving as pinned supports. Soil bearing pressures are applied to the beam strip and beam deflection is calculated. The calculation results confirm similar findings as the finite element analysis results, i.e., the maximum differential settlement of the EPGB basemat is substantially less than 1/1200.

To further evaluate the effects of the higher site-specific differential settlement, a finite element analysis of the entire EPGB is performed to evaluate the effect of a more conservative overall building tilt of L/550, where L is the least basemat dimension. For this analysis:

- Spring stiffnesses are adjusted until a tilt of L/550 is achieved.
- The elliptical distribution of soil springs is maintained.
- Soil spring stiffnesses along the centerline of the basemat (perpendicular to the direction of tilt) are retained.
- Adjustment is made to all other springs as a function of the distance from the basemat centerline.

The finite element analysis results show that increase in EPGB basemat design moment based on the more conservative differential settlement value of 1/550 (based on the overall tilt) is less than 3% of the U.S. EPR FSAR maximum design moment. Therefore, EPGB basemat is structurally adequate to resist the increased moments.}

3.8.5.5.3 Essential Service Water Buildings Foundation Basemats

The U.S. EPR FSAR includes the following COL Item in Section 3.8.5.5.3:

> A COL applicant that references the U.S. EPR design certification will compare the ESWB site-specific predicted angular distortion to the angular distortion in the total differential settlement contours in U.S. EPR FSAR Tier 2, Figure 3.8-136, using methods described in U.S. Army Engineering Manual 1110-1- 1904. The comparison is made throughout the basemat in both the east-west and north-south directions. If the predicted angular distortion of the basemat of ESWB structures is less than the angular distortion shown, the site is considered acceptable. Otherwise, further analysis will be required to demonstrate that the structural design is adequate.

The COL Item is addressed as follows:

INSERT

{ ~~TBD~~ }

{The following departure is taken from U.S. EPR FSAR Section 3.8.5.5.3.

U.S. EPR FSAR Section 2.5.4.10.2 states that:

> "The design of Seismic Category I foundations for the U.S. EPR is based on a maximum differential settlement of ½ inch per 50 ft in any direction across the basemat."

The U.S. EPR FSAR maximum allowable differential settlement of ½ inch per 50 ft may also be expressed as a fraction, i.e., 1/1200.

INSERT

The site-specific angular distortion values were compared to the angular distortion in the total differential settlement contours in U.S. EPR FSAR Tier 2, Figure 3.8-136, using methods described in U.S. Army Engineering Manual 1110-1-1904 (USACE, 1990). The same models, methodologies and procedures are used as with the U.S. EPR Standard Plant design. The basemat area is partitioned into separate slab design areas based on maximum angular distortion. The maximum angular distortion is less than the maximum angular distortion in every slab design area for the softest soil case in U.S. EPR FSAR Table 3.7.1-8; thus, the U.S. EPR design envelops the site.

Maximum soil bearing pressures under the CBIS foundations are provided in Table 3.8-3. The calculated maximum bearing pressures are smaller than the bearing capacities presented in Table 2.5-67 under both static and dynamic conditions.

Differential settlement across the CBIS is within the U.S. EPR FSAR differential settlement criterion of 1/1200.}

3.8.5.6 Materials, Quality Control, and Special Construction Techniques

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No departures or supplements.

3.8.5.6.1 Materials

The U.S. EPR FSAR includes the following COL Item in Section 3.8.5.6.1:

> A COL applicant that references the U.S. EPR design certification will evaluate the use of epoxy coated rebar for foundations subjected to aggressive environments, as defined in ACI 349-01, Chapter 4. In addition, waterproofing and dampproofing system of Seismic Category I foundations subjected to aggressive environments will be evaluated for use in aggressive environments. Also, the concrete of Seismic Category I foundations subjected to aggressive environments will meet the durability requirements of ACI 349-01, Chapter 4 or ASME, Section III, Division 2, Article CC-2231.7, as applicable.

This COL Item is addressed as follows:

{As described in Section 3.8.4.6.1, Seismic Category I structures other than NI common basemat structures and the ESWBs are not exposed to low-pH groundwater and, therefore, do not require protection to perform their safety function. However, in line with good construction practices and to fulfill defense in depth requirements, waterproofing and dampproofing systems are applied in accordance with Sections 1805.2 and 1805.3 of the IBC 2009 (IBC, 2009) to Seismic Category I foundations. For NI common basemat structures and the ESWBs, a waterproofing membrane is used to eliminate the prolonged exposure of below grade concrete from the low pH groundwater of Surficial aquifer, as described in Section 3.8.4.6.1. Since groundwater in the intake area is considered non-aggressive, and as the Seismic Category I Forebay and UHS Makeup Water Intake Structure contact water both inside and outside, these structures will not be waterproofed or dampproofed. Discussion of concrete mix design for improved resistance to sulfate attack and chloride ion penetration is also presented in Section 3.8.4.6.1. Epoxy coated rebar is not used.}

3.8.5.6.2 Quality Control

No departures or supplements.

3.8.5.6.3 Special Construction Techniques

{Special construction techniques are not expected to be used for the Emergency Power Generating Buildings, Essential Service Water Buildings, Forebay and UHS Makeup Water Intake Structure.}

3.8.5.7 Testing and Inservice Inspection Requirements

The U.S. EPR FSAR includes the following COL Items in Section 3.8.5.7:

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A COL applicant that references the U.S. EPR design certification will identify site-specific settlement monitoring requirements for Seismic Category I foundations based on site-specific soil conditions.

A COL applicant that references the U.S. EPR design certification will describe the program to examine inaccessible portions of below-grade concrete structures for degradation and monitoring of groundwater chemistry.

These COL Items are addressed as follows:

{The settlement monitoring program shall employ conventional monitoring methods using standard surveying equipment and concrete embedded survey markers. Survey markers are embedded in the concrete structures during construction and located in conspicuous locations above grade for measurement purposes throughout the service life of the plant as necessary. Actual field settlement is determined by measuring the elevation of the marker relative to a reference elevation datum. The reference datum selected is located away from areas susceptible to vertical ground movement and loads. If field measured settlements are found to be trending greater than expected values, an evaluation will be conducted to ensure compliance with design basis requirements.

The settlement monitoring program shall satisfy the requirements for monitoring the effectiveness of maintenance specified in 10 CFR 50.65 (CFR, 2008) and Regulatory Guide 1.160 (NRC, 1997), as applicable to structures.

The CCNPP Unit 3 below-grade concrete degradation monitoring program is described in Section 3.8.4.7. This program calls for:

- Examination of exposed portions of below-grade concrete, including buried utilities, for signs of degradation when excavated for any reason; and
- Periodic monitoring of risers and drain sumps for the NI common basemat structures to ensure that the groundwater leaking through the geomembrane envelope, if any, is being effectively removed and is not ponding against the concrete structure.

As stated in Section 3.8.4.7, groundwater levels throughout the powerblock area will be monitored. The CCNPP Unit 3 geochemical groundwater monitoring program is established on the following bases:

- Recorded baseline pH values and groundwater geochemistry concentrations prior to start of excavation.
- Recorded pH values and groundwater geochemistry concentrations after backfill is completed and at six month intervals thereafter.
- One-year after backfill is completed:
    - If no negative trend is identified, inspection intervals can be increased to once per year.
    - If a negative trend is identified, need for dewatering provisions will be evaluated for other below-grade concrete structures and utilities.}

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3.8.6 References

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Enclosure 3

Table of Changes to CCNPP Unit 3 COLA
Associated with the Response to
RAI 308, Question 03.08.05-9, related to the foundation of the ESWB,
Calvert Cliffs Nuclear Power Plant, Unit 3

Table of Changes to CCNPP Unit 3 COLA

Associated with the Response to RAI No. 308

Change ID #	Subsection	Type of Change	Description of Change
Part 2 – FSAR			
CC3-12-0039	Table 2.0-1	Incorporated COLA markups associated with the response to RAI 308, Question 03.08.05-8[3].	FSAR Table 2.0-1 was revised to add a line item for Maxium Settlement (across the basemat), including a reference to Section 3.8.5.5.1 for the NI for Differential Settlement associated with the RAI 308, Question 03.08.05-8 response.
CC3-12-0092	Table 2.0-1	Incorporated COLA markups associated with the response to RAI 308, Question 03.08.05-9[2].	FSAR Table 2.0-1 was revised to add a reference to Section 3.8.5.5.2 for the EPGB for Differential Settlement associated with the RAI 308, Question 03.08.05-9 response.
CC3-13-0115	Table 2.0-1	Incorporated COLA markups associated with the response to RAI 308, Question 03.08.05-9 (this response).	FSAR Table 2.0-1 was revised to add a reference to Section 3.8.5.5.3 for the ESWB for Differential Settlement associated with the RAI 308, Question 03.08.05-9 response.
CC3-13-0115	2.5.4.10.2.2	Incorporated COLA markups associated with the response to RAI 308, Question 03.08.05-9 (this response).	Modified a reference to Table 2.5-69 to 2.5-71 for estimated tilt settlements for ESWB 1 and ESWB 2 in FSAR Section 2.5.4.10.2.2 as part of the RAI 308, Question 03.08.05-9 response.
CC3-13-0115	3.8.5.5.3	Incorporated COLA markups associated with the response to RAI 308, Question 03.08.05-9 (this response).	A supplemental paragraph was added to FSAR Section 3.8.5.5.3 to address angular distortion values for the ESWB as part of the RAI 308, Question 03.08.05-9 response.

[3]UniStar Nuclear Energy Letter UN#12-010, from Mark T. Finley to Document Control Desk, U.S. NRC, Response to Request for Additional Information for the Calvert Cliffs Nuclear Power Plant, Unit 3, RAI 308, Foundations, dated February 1, 2012.