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Washington, DC 20555-0001

BELL BEND NUCLEAR POWER PLANT
PARTIAL RESPONSE TO RAI No. 37
BNP-2009-330 Docket No. 52-039

References: 1) M. Canova (NRC) to R. Sgarro (PPL Bell Bend, LLC), Bell Bend COLA – Request for Information No. 37 (RAI No. 37) – SEB1 -2659, 2660, 2661, e-mail dated July 27, 2009

2) BNP-2009-244, R. R. Sgarro (PPL Bell Bend, LLC) to U.S. Nuclear Regulatory Commission, "Response to RAI No. 37 and Schedule Information," dated August 26, 2009

The purpose of this letter is to provide a partial response to the request for additional information (RAI) identified in the NRC correspondence to PPL Bell Bend, LLC (PPL) (Reference 1). This RAI addresses Seismic System Analysis, Seismic Subsystem Analysis, and Seismic Design Parameters as discussed in Chapter 2 of the Final Safety Analysis Report (FSAR) and submitted in Part 2 of the Bell Bend Nuclear Power Plant Combined License Application (COLA).

Response to portions of RAI No. 37, questions 03.07.01-3 and 03.07.03-1 were provided in the previous PPL Bell Bend correspondence to the NRC (Reference 2). Reference 2 also provided the schedule for submittal of the remainder of RAI 37 responses.

The enclosure provides our response to RAI No. 37 questions 03.07.01-2, 03.07.02-3 and the remainder of the portions of questions 03.07.01-3 and 03.07.03-1. This RAI response includes COLA text changes which will be incorporated into a future revision of the COLA.

The future COLA updates are the only new regulatory commitment.

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NRO

Should you have questions or need additional information, please contact the undersigned at 570.802.8102.

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

Executed on October 21, 2009

Respectfully,

Rocco R. Sgarro

RRS/kw

Enclosure: As stated

cc: (w/o Enclosures)

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Enclosure 1

Response to NRC Request for Additional Information Set No. 37
Bell Bend Nuclear Power Plant

BBNPP RAI No. 37

Question 03.07.01-2

In FSAR Section 3.7.1.1 (Design Ground Motion) on page 3-31 it states the BBNPP site specific reactor coolant system (RCS) seismic loads are confirmed to be within the U.S. EPR Design Certification RCS seismic loads envelope. The applicant is requested to provide the specific steps that were used to develop the loads for this comparison and provide the results of the comparison for the locations identified on page 3-31 of the FSAR. Indicate in your response whether the load comparison was done with the results of the simplified RCS model included in the NI common basemat structures model or if the load comparison was done with the detailed seismic model of the RCS. Also indicate if a load comparison was done between the BBNPP simplified RCS model results and the BBNPP detailed RCS model results and whether these results are comparable. Provide examples of this comparison in your response. If such a comparison was not done provide justification for not doing so.

Response

BBNPP site-specific seismic analysis for the detailed Reactor Coolant Loop model is performed using the specific steps described in U.S. EPR FSAR, Tier 2, Appendix 3C.

Best Estimate, Lower Bound, and Upper Bound acceleration time histories at the basemat are used to excite the model. The enveloped load components at each location for BBNPP site specific seismic analysis are extracted and compared with loads from the U.S. EPR Design Certification RCS seismic analysis.

The locations listed in the BBNPP FSAR, Page 3-31, are the RCS piping, and inlet and outlet nozzles for the Reactor Pressure Vessel (RPV), Steam Generator (SG), and Reactor Coolant Pump (RCP). The load comparison for RCS piping is addressed on the same page. The load comparisons for component nozzles are provided in the Tables 1 and 2 below. Although two of the BBNPP site-specific seismic loads (RPV Outlet Loops 1 and 3 Nozzles) are not bounded by the corresponding nozzles in the U.S. EPR design certification loads, these are enveloped (as shown in Table 2) by the U.S. EPR design certification maximum RPV Outlet Nozzle loads which are used to design the nozzle. The comparisons of these locations, provided in the tables below, along with other comparisons, lead to the conclusion that the BBNPP site-specific RCS seismic loads are bounded by those of the U.S. EPR Design Certification RCS seismic analysis.

Table 1: Percent Change in RCS Nozzle Loads from U.S. EPR FSAR to Bell Bend

Location	Section	Node	Fx	Fy	Fz	Mx	My	Mz
RPV Inlet Loop 1 Nozzle	9336	9336	-34	-52	-50	-59	-69	-40
RPV Inlet Loop 2 Nozzle	9386	9386	-37	-57	-56	-53	-60	-40
RPV Inlet Loop 3 Nozzle	9376	9376	-26	-52	-57	-71	-62	-80
RPV Inlet Loop 4 Nozzle	9346	9346	-33	-52	-49	-50	-67	-63
RPV Outlet Loop 1 Nozzle	9326	9326	-62	-52	-33	-72	29	-62
RPV Outlet Loop 2 Nozzle	9396	9396	-57	-50	-55	-80	-39	-54
RPV Outlet Loop 3 Nozzle	9366	9366	-64	-54	-52	-65	1	-47
RPV Outlet Loop 4 Nozzle	9356	9356	-64	-56	-44	-84	-45	-44
SG Inlet Loop 1 Nozzle	6198	1380	-55	-56	-50	-43	-55	-60
SG Inlet Loop 2 Nozzle	6298	2380	-49	-49	-58	-65	-60	-52
SG Inlet Loop 3 Nozzle	230	3380	-57	-56	-37	-46	-51	-58
SG Inlet Loop 4 Nozzle	6498	4380	-57	-56	-61	-53	-66	-54
SG Outlet Loop 1 Nozzle	6199	1570	-44	-57	-39	-44	-38	-52
SG Outlet Loop 2 Nozzle	6299	2570	-47	-53	-40	-52	-36	-59
SG Outlet Loop 3 Nozzle	227	3570	-53	-51	-30	-46	-40	-56
SG Outlet Loop 4 Nozzle	6499	4570	-58	-71	-52	-46	-54	-68
RCP Inlet Nozzle Loop 1	7101	7115	-55	-43	-50	-49	-51	-43
RCP Inlet Nozzle Loop 2	7201	7215	-44	-36	-68	-50	-50	-43
RCP Inlet Nozzle Loop 3	533	15	-49	-44	-52	-49	-55	-45
RCP Inlet Nozzle Loop 4	7401	7415	-61	-53	-65	-53	-61	-54
RCP Outlet Nozzle Loop 1	7199	7160	-44	-47	-42	-52	-52	-59
RCP Outlet Nozzle Loop 2	7299	7260	-51	-45	-32	-44	-47	-56
RCP Outlet Nozzle Loop 3	534	60	-45	-50	-43	-50	-35	-48
RCP Outlet Nozzle Loop 4	7499	7460	-49	-59	-62	-62	-50	-63

Table 2: Reconciliation of Load Increases in Previous Table

Location	Section	Node	Force ~ kips			Moments ~ ft-kips		
Compare unbounded Bell Bend load components in heavy borders (from Table 1) with the corresponding maximum loop load from U.S. EPR FSAR.								
			Fx	Fy	Fz	Mx	My	Mz
RPV Outlet Maximum Nozzle Load (Design Certification)			1128.09	98.10	118.17	207.16	708.42	561.58
RPV Outlet Loop 1 Nozzle (BBNPP)	9326	9326	395.21	43.72	77.37	50.77	645.81	210.83
RPV Outlet Loop 3 Nozzle (BBNPP)	9366	9366	331.86	34.54	55.01	71.20	658.56	191.11
All RPV Bell Bend "My" loads are bounded by the maximum "My" load. Bell Bend loads are bounded.								

The load comparison was performed using the results from the detailed RCS model. There was satisfactory agreement between the two models, as stated in response to U.S. EPR FSAR, RAI No. 201, Question 03.07.02-35 (ML092260789), and there were no changes in the models that would affect the results of the comparison.

COLA Impact

The COLA will not be revised as a result of this response.

BBNPP RAI No. 37

Question 03.07.01-3

FSAR Section 3.7.1.1.1 (Design Ground Motion Response Spectra), starting on page 3-35, describes the site specific analysis for the NI Common Basemat Structures. However, details relating to the development of seismic design parameters were not provided. With regard to this analysis, the applicant is requested to provide the following information:

1. A description of the development of the ground motion input time histories that were used in the analysis and how they meet SRP Acceptance Criteria 1.B of SRP Section 3.7.1.
2. A comparison of the response spectra of the input time histories to the GMRS. Demonstrate how the response spectra of the input time histories meet Approach 1 or Approach 2 of NUREG -0800, Standard Review Plan (SRP) Acceptance Criteria 1.B of SRP Section 3.7.1.
3. A description of how the strain-compatible soil profiles were generated including information on (a) the computer code used to develop the results, (b) the assumed material degradation models used in the calculations for each soil layer of the base-case profile, (c) how randomized parameters were selected for each soil layer, (d) the correlation model used between layers and its appropriateness for application to the Bell Bend site, and (e) plots of low strain velocities for each of the soil profiles used in the site response analyses.
4. A description of the SSI analyses performed including a description of the computer codes, seismic models, how embedment effects were considered, modeling assumptions, and properties of the backfill incorporated into the analyses.
5. FSAR 3.7.1, Page 3-30, states that Tables 3.7-1 and 3.7-2 presents the seismic input ground motion utilized in the seismic design of the seismic Category I structural components. These two tables appear to provide the best estimate (BE) and lower bound (LB) soil modeling characteristics. The statement needs to be corrected and the appropriate tables added to the FSAR.

Response

The responses to question parts 1 through 3 were provided in PPL Bell Bend, LLC correspondence BNP-2009-244 dated August 26, 2009.

4. The Soil-Structure Interaction (SSI) analysis methodology that was used for Design Certification of the NI Common Basemat Structures is used for the current site-specific SSI analyses with some modifications as the Ground Motion Response Spectra (GMRS) for BBNPP are not bounded by the Certified Seismic Design Response Spectra (CSDRS) at all frequencies. Details of the changes are discussed in Section 3.7.2 of BBNPP FSAR.

   The analytical process used and computer codes employed are as follows:

   - An ANSYS dynamic finite element model (FEM) of the NI Common Basemat structures is developed based on the detailed static finite element model as discussed in Section 3.7.2 of BBNPP FSAR.
   - The stick model of the NI Common Basemat structures for the U.S. EPR is used for computing the 6-degrees-of-freedom (6-DOF) NI basemat motions from the SSI analysis using SASSI.
   - An ANSYS modal superposition time history analysis of the fixed-base dynamic FEM of the NI Common Basemat structures for BBNPP is performed using the 6-DOF NI

basemat motions from SASSI as the input motions as discussed in Section 3.7.2 of BBNPP FSAR.

- In-structure response spectra (ISRS) and floor zero period accelerations (ZPAs) are developed from the modal superposition time history analysis of the dynamic finite element model using ANSYS to compare with the U.S. EPR ISRS for acceptability.

AREVA computer code SASSI version 4.2PC was used for SSI analysis. ANSYS version 10.0 SP1 was used for analysis of the finite element model. AREVA computer code RESPEC version 1.2PC and ANSYS version 10.0 SP1 were used for computing the response spectra.

Consistent with the SSI analysis methodology presented in U.S. EPR FSAR, the embedment of the Nuclear Island is ignored and the SSI analysis is performed using a surface-founded SSI model. Since the analysis is conducted for a surface-founded model, backfill materials were not included in the analysis. BBNPP Nuclear Island is founded on stiff soil. Including the embedment effects on a hard soil is expected to increase the fundamental frequency of the Nuclear Island. Since the site-specific input motion has high frequency content, it is expected that including the embedment effects would increase the response of the Balance of NI structures (BONI) as the input motion spectrum is increasing in the range of NI modes with major mass participation. [BONI is defined as all buildings on the NI basemat except Reactor Containment Building (RCB) and Reactor Building Internal Structures (RBIS)]. However, this increase in response of the BONI is expected to be minor as the peak of the input motion occurs at around 25 Hz and most major horizontal modes occur at frequencies lower than 10 Hz. Moreover, the CSDRS has a considerable margin over the BBNPP FIRS at frequencies less than 10 Hz. As the RBIS and RCB are structurally decoupled and connected to the BONI only via NI common basemat, their responses are not expected to change due to embedment effects for a stiff soil site. Since embedment effects (including backfill) are not significant the effect of backfill materials does not alter the responses significantly.

For more detailed discussion of the models used refer to the following:

Dynamic Finite Element Model

See BBNPP FSAR Section 3.7.2.

Stick Model

See BBNPP FSAR Section 3.7.2.

Modal Superposition Time History Analysis

Using the 6-DOF response acceleration time histories for the center of the Nuclear Island Common Basemat output from SASSI as input motions, a modal superposition time history analysis of the fixed-base dynamic finite element model of the Nuclear Island Common Basemat structures using ANSYS is performed. The key analysis steps are as follows:

- Use material damping values as specified in Regulatory Guide (RG) 1.61.
- Calculate dynamic properties, including mode shapes, frequencies, mass participation and composite modal damping (using the MP, DAMP ANSYS command.)
- Input modal damping in modal superposition analysis using MDAMP ANSYS command.

- Perform modal superposition time history analysis using the 6-directional (3 translations and 3 rotations) acceleration time histories from the SASSI analysis as the input motions.

5. The statement in FSAR 3.7.1 will be corrected to refer to Figures 3.7-1 and 3.7-2 instead of Tables 3.7-1 and 3.7-2.

COLA Impact

BBNPP COLA FSAR Section 3.7.1 will be revised as follows in a future revision of the COLA:

> The SSE at BBNPP is defined as the maximum GMRS on top of the Mahantango formation, at approximate Elevation 640.0 ft msl (194.8 m). Section 2.5.2 describes the development of the GMRS based on geologic and seismic information. Figures ~~Table~~ 3.7-1 and ~~through Table~~ 3.7-2 present ~~presents~~ the seismic input ground motion utilized in the seismic design of the Seismic Category I structural components. Soil liquefaction is not considered a risk factor because the ESWEMS Pumphouse base-mat and its pumpwell base are situated on concrete backfill overlying the Mahantango formation

RAI No. 37

Question 03.07.02-3

FSAR Section 3.7.2 on page 3-39 describes a number of site-specific changes that have been made to the seismic models described in the U.S. EPR FSAR. To assist the staff in its review of FSAR Section 3.7.2, provide in a table format:

1. The structure being modeled;
2. The type of model (stick or FEM):
3. The computer code used;
4. The purpose of the analysis;
5. Whether the model proposed for use at BBNPP is identical to the model used for the U.S. EPR certified design; and
6. If site-specific changes have been made to the U.S. EPR design certification model for the BBNPP, identify the changes and provide supporting reasons for the changes.

Response

Structure Modeled	Model Type	Computer Code	Purpose of Analysis	Identical to U.S. EPR Model?	Site-Specific Changes
NI Common Basemat Structures	FEM	ANSYS v.10.0 SP1	Perform a modal superposition time history analysis of the fixed-base dynamic FEM of the U.S. EPR NI structures in order to compute response spectra and zero period accelerations (ZPA) when subjected to acceleration time histories.	No	A dynamic finite element model (FEM) was developed in order to capture the effects of site-specific high frequency input motions.
NI Common Basemat Structures	Stick	SASSI v4.2PC GT STRUDL v.28	Compute the 6 degrees of freedom NI basemat motions from SSI analysis to be used as input motions to the modal superposition time history analysis of the fixed-base dynamic FEM of the NI.	No	Stick models for the RBIS and the RCB have been revised to be sufficient when subjected to high frequency input motions associated with the GMRS for BBNPP.
ESWB	FEM	SASSI 2000, Version 3.1 GT STRUDL v.27	Develop an SSI FEM and perform SSI analysis in order to define equivalent static seismic loads for the subject building. Evaluate the structure for overturning and sliding effects based on the SSI dynamic analysis. Output maximum element stresses for structural design of basemat and generate in-structure response spectra	No	The ESWB has the same number of nodes and elements as the original model used for the U.S. EPR except for the node re-sequencing and the reshaping of elements in order to output basemat element force results. A detailed explanation will be provided in the response to RAI 37, Question 03.07.02-6.
EPGB	FEM	SASSI 2000, Version 3.1 GT STRUDL v.27	Develop an SSI FEM and perform SSI analysis in order to define equivalent static seismic loads for the subject building. Evaluate the structure for overturning and sliding effects based on the SSI dynamic analysis. Output maximum element stresses for structural design of basemat and generate in-structure response spectra	No	The SSI finite element model was refined to account for site specific soil profiles.

COLA Impact

The COLA will not be revised as a result of this response.

RAI No. 37

Question 03.07.03-1

FSAR Section 3.7.3.12 starting on page 3-50 describes the analysis for buried Seismic Category I piping, conduits and tunnels and indicates that the analyses will be done in accordance with American Society of Civil Engineers (ASCE)4-98 (Note: reference to ASCE 4-86 appears to be incorrect). For the analysis of these buried utilities, provide the following information:

1. Provide the basis for the foundation input response spectra (FIRS) shown in Figures 3.7-151 and 3.7-152.
2. Describe any computer codes used and their application to the analysis and design of buried utilities.
3. Provide the soil properties used in the analysis and how differences in soil properties are accommodated in the analysis.
4. Identify the design codes and acceptance criteria for each category of buried utilities.
5. Describe the missile protection provided for safety-related buried utilities.
6. Describe how ground water effects are considered in the analysis.
7. For utility runs that are both above and below ground, describe how above ground inertial effects are combined with below ground seismic wave effects.
8. Describe how the wave velocities are determined for calculating the maximum axial strain.
9. Provide the basis for determining the maximum friction force per unit length of pipe.
10. Describe how displacement time histories were generated for structures from the SASSI analyses.
11. Describe how the building anchor point displacements are determined and how these are combined with seismic wave effects and soil loads. Include in the description how out-of-phase displacements between the free field and building response are addressed.

Response

The responses to question parts 1 through 9 were provided in PPL Bell Bend, LLC correspondence BNP-2009-244 dated August 26, 2009.

10. The methodology for calculation of relative displacement is described in U.S. EPR FSAR, Tier 2, Section 3.7.2.4.6 (1) third paragraph which states the following:

    > The time history of the displacement at the NI Common Basemat relative to the input ground motion is determined by double integrating the acceleration response time history at the basemat Node 417, applying a linear baseline correction, and subtracting from it the displacement time history of the free field ground motion for each SSI analysis case. Table 3.7.2-26—Maximum NI Common Basemat Displacement Relative to Free Field Input Motion lists the peak relative displacement at Node 417 for all twelve SSI analysis cases. The maximum relative displacement at a given structural location in the NI Common Basemat Structures with respect to the basemat is conservatively taken from the equivalent static analysis of the FEM of the NI Common Basemat Structures described in Section 3.8.4.

11. The building anchor movements are determined using the methodology described in "U.S. EPR Piping Analysis and Pipe Support Design Topical Report" (AREVA Document ANP-10264NP-A, Revision 0, November 2008) (ML083170748) Section 3.10 – Seismic Category I Buried Pipe. The seismic response of buried pipes due to seismic wave effects and soil loads are provided in Section 3.10.3 – Seismic Loads. The out-of-phase displacements between the free field and building response are described in Section 3.10.3.1 – Axial and bending Strains Due to Propagation of Seismic Waves.

COLA Impact

The COLA will not be revised as a result of this response.