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U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

BELL BEND NUCLEAR POWER PLANT
RESPONSES TO RAIs 37, 74, 75, 79, AND 90
AND REVISED SCHEDULE INFORMATION
BNP-2012-160 Docket No. 52-039

References: 1) R. R. Sgarro, (PPL Bell Bend, LLC) to U.S. Nuclear Regulatory Commission (NRC), "Schedule Information for Responses to Requests for Additional Information for the Bell Bend FSAR," BNP-2012-072, dated March 14, 2012.

2) R. R. Sgarro, (PPL Bell Bend, LLC) to U.S. Nuclear Regulatory Commission (NRC), "Schedule Information for RAIs 37 and 107," BNP-2012-152, dated June 18, 2012.

The purpose of this letter is to respond to the subject Requests for Additional Information (RAI). In Table 1 of Reference 1, PPL Bell Bend, LLC (PPL) indicated that PPL would provide a response to the subject RAIs on or before June 30, 2012. The questions in RAI 37 address Seismic Design Parameters and Seismic System Analysis as discussed in Sections 3.7.1 and 3.7.2, respectively, of the Final Safety Analysis Report (FSAR), submitted as Part 2 of the Bell Bend Nuclear Power Plant (BBNPP) Combined License Application (COLA). The questions in RAI 74 address Concrete Containment as discussed in FSAR Section 3.8.1.3. The questions in RAI 75 address Concrete and Steel Internal Structures of Steel or Concrete Containments as discussed in FSAR Section 3.8.3.3. The questions in RAI 79 address Other Seismic Category 1 Structures as addressed in FSAR Section 3.8.4.1.8. The questions in RAI 90 address Foundations as discussed in FSAR Section 3.8.5.

Enclosure 1 provides our responses to the subject RAIs. Enclosure 2 provides a table summarizing the questions which will be answered by the response to U.S. NRC RAI No. 107, the schedule for which was provided in Reference 2.

PPL requires additional time to complete the analyses associated with the relocation of the site footprint and incorporate the revised EPRI/NRC/DOE Central and Eastern United States Seismic Source Model in order to answer RAI No. 79 Question 03.08.04-9 parts (a) and (b), and RAI No. 90, Questions 03.08.05-5 and 03.08.05-7. PPL will provide responses to RAI No. 79 Question 03.08.04-9 parts (a) and (b) and RAI No. 90, Questions 03.08.05-5 and 03.08.05-7 on, or before December 31, 2012.

The only new regulatory commitment is to provide responses to RAI No. 79 Question 03.08.04-9 parts (a) and (b) and RAI No. 90, Questions 03.08.05-5 and 03.08.05-7 on, or before December 31, 2012.

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NRO

Should you have questions, please contact the undersigned at 610.774.7552.

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

Executed on June 28, 2012.

Respectfully,

Rocco R. Sgarro

RRS/kw

Enclosures: As stated.

cc: (w/ Enclosure)

Mr. Michael Canova
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Enclosure 1

Responses to RAIs 37, 74, 75, 79, and 90

RAI 37
Question 03.07.01-5

In FSAR Section 3.7.1.1.1 (Design Ground Motion Response Spectra) on page 3-36 the results of the site-specific analysis for the NI Common Basemat Structures are discussed. It states that the BBNPP zero period accelerations (ZPAs) are within the corresponding U.S. EPR FSAR ZPAs except at one location of the Containment Building. At this location, which is not identified, it states that the horizontal (y-direction) ZPA of the BBNPP exceeds the ZPA of the U.S. EPR by less than 10 percent. However in FSAR Section 3.8.1.3, covering the concrete containment and in FSAR Section 3.8.3.3, covering the Reactor Containment Building Internal Structures, it states that the BBNPP site specific ZPA values are enveloped by the standard U.S. EPR design certification values. The statement that the exceedance is less than 10 percent of the U.S. EPR ZPA is not a basis for accepting the result without suitable technical justification, which needs to be included in the FSAR. In order for the staff to complete its review of whether seismic Category I standard plant structures can meet the requirements of GDC 2, provide the following information.

1) In FSAR Section 3.7.1.1.1, identify the location where the exceedance takes place.
2) Describe the technical justification for accepting the exceedance and include the numerical results that support this position.

Response

The BBNPP Ground Motion Response Spectra (GMRS) is being re-calculated using the 2012 Central and Eastern United States (CEUS) – Seismic Source Characterization (SSC) model.

Revised reconciliation results, including FSAR updates, if necessary, will be included in the response to RAI 107, Q03.07.02-23.

COLA Impact

No change to the BBNPP COLA is required as a result of this response.

RAI 37
Question 03.07.01-6

In FSAR Section 3.7.1.1.1 (Design Ground Motion Response Spectra) on page 3-36 the ZPA results of the site-specific analysis for the EPGB and ESWB structures are discussed. In Table 3.7-4, there are a number of locations where the zero period acceleration (ZPA) results from the site specific analysis exceed the ZPA of the U.S. EPR certified design. On page 3-181 of FSAR Section 3.8.4.3 it states that additional confirmatory evaluation for the site specific response spectra and soil profiles were performed and confirmed that the other Seismic Category I structures are acceptable for the BBNPP site. No details are provided as to what was done to perform this confirmatory evaluation, nor does it provide any numerical results. The statement that an exceedance is less than 10 percent of the U.S. EPR ZPA is not a basis for accepting the result without suitable technical justification. The applicant is requested to describe the reconciliation process and technical justification for each of the exceedances shown in Table 3.7-4. Include in the response the numerical results that support the basis for the acceptability of the exceedances identified.

Response

The BBNPP Ground Motion Response Spectra (GMRS) is being re-calculated using the 2012 Central and Eastern United States (CEUS) – Seismic Source Characterization (SSC) model.

Revised reconciliation results, including FSAR updates, if necessary, will be included in the response to RAI 107, Q03.07.02-23.

COLA Impact

No change to the BBNPP COLA is required as a result of this response.

RAI 37
Question 03.07.01-9

In FSAR Section 3.7.1.1.1 on page 3-36 it states that a comparison of the Bell Bend ISRS with the corresponding peak broadened U.S. EPR FSAR ISRS show that the certified design ISRS are exceeded by the Bell Bend ISRS by more than 10 percent at some of the key building locations including the NI Common Basemat structures, EPGB and ESWB. It also states that the exceedance of certified design ISRS is a departure from the U.S.EPR FSAR and is justified consistent with the seismic reconciliation guidelines contained in the U.S. EPR FSAR Section 2.5.2.6 as described in BBNPP FSAR Section 2.5.2.6. In the BBNPP FSAR Section 2.5.2.6, Step 9, it states: "These evaluations, summarized below, confirm that the safety-related structures, systems and components of the U.S. EPR are not affected." The staff, however, could not identify any such evaluations. The applicant is requested to provide an evaluation of each exceedance (not just those that are in excess of 10 percent) and to justify the use of the U.S. EPR certified design ISRS at the BBNPP site for all Seismic Category I Structures including the NI, EPGB, and ESWB. State whether the seismic models used for the BBNPP site are different from those used for the U.S. EPR certified design, and, if so, justify why a comparison of results from the two sets of models is valid.

Response

The BBNPP Ground Motion Response Spectra (GMRS) is being re-calculated using the 2012 Central and Eastern United States (CEUS) – Seismic Source Characterization (SSC) model.

Revised reconciliation results, including FSAR updates, if necessary, will be included in the response to RAI 107, Q03.07.02-23.

COLA Impact

No change to the BBNPP COLA is required as a result of this response.

RAI 37
Question 03.07.02-1

Bell Bend Nuclear Power Plant (BBNPP) combined license (COL) Final Safety Analysis Report (FSAR) Section 3.7.2, page 3-39, states that a COL applicant that references the U.S. EPR design certification will confirm that the site-specific seismic response is within the parameters of Section 3.7 of the U.S. EPR standard design. The FSAR addresses the COL item by stating, on page 3-40, that the site-specific Nuclear Island (NI) basemat response spectra, response spectra at the Emergency Power Generating Buildings' (EPGB) and Emergency Service Water Buildings' (ESWB) footprints, In-Structure Response Spectra (ISRS) and maximum accelerations represent a departure from the U.S. EPR FSAR, as described in Section 3.7.1.1.1 and augment the response spectra and maximum accelerations in the U.S. EPR FSAR. Please explain how NI basemat response spectra, response spectra at the EPGB and ESWB footprints, ISRS and maximum accelerations are used to augment the analysis that was done for the U.S. EPR Certified Design by providing specific examples of their application to the design of U.S. EPR structures, systems, and components (SSCs) at the BBNPP site.

Response

The BBNPP Ground Motion Response Spectra (GMRS) is being re-calculated using the 2012 Central and Eastern United States (CEUS) – Seismic Source Characterization (SSC) model.

Revised reconciliation results, including FSAR updates, if necessary, will be included in the response to RAI 107, Q03.07.02-23.

COLA Impact

No change to the BBNPP COLA is required as a result of this response.

RAI 37
Question 03.07.02-2

FSAR Section 3.7.2 (Seismic System Analysis) on page 3-39, provides a description of a dynamic finite element model (ANSYS) of the NI Common Basemat Structures, which is based on the detailed static finite element model. A compatibility check showing a comparison of results between the dynamic and static finite element model is provided in Figures 3.7-99 through 3.7-116.

(1) Describe the input that was used to provide the comparison of results, and provide the response spectra of the input motion used in the dynamic analysis.
(2) Describe why a separate dynamic model was necessary, and reconcile the exceedances of the static model results with the dynamic model results.
(3) Explain the legends at the bottom of each figure and explain why in many cases multiple results for both static and dynamic models are provided in Figures 3.7-99 through 3.7-116.
(4) Is the static model referred to in the BBNPP FSAR the same as the one used for the certified design of the U.S. EPR standard plant? If not, identify the differences and describe the impact these differences have on the U.S. EPR certified design.
(5) The static loads representing dead and live loads from the static finite element model are converted to masses for the dynamic finite element model.
    (a) What percentage of these loads is used to represent additional mass in the dynamic model?
    (b) Does the application of these additional masses meet SRP Acceptance Criteria 3.D of SRP Section 3.7.2? If not, provide justification.

Response

The BBNPP Ground Motion Response Spectra (GMRS) is being re-calculated using the 2012 Central and Eastern United States (CEUS) – Seismic Source Characterization (SSC) model. In addition, static and dynamic models have been revised since FSAR section 3.7.2 was prepared.

Revised reconciliation results, including FSAR updates, if necessary, will be included in the response to RAI 107, Q03.07.02-23.

COLA Impact

No change to the BBNPP COLA is required as a result of this response.

RAI 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

The BBNPP Ground Motion Response Spectra (GMRS) is being re-calculated using the 2012 Central and Eastern United States (CEUS) – Seismic Source Characterization (SSC) model. In addition, static and dynamic models have been revised since FSAR section 3.7.2 was prepared.

Revised reconciliation results, including FSAR updates, if necessary, will be included in the response to RAI 107, Q03.07.02-23.

COLA Impact

No change to the BBNPP COLA is required as a result of this response.

RAI 37
Question 03.07.02-4

FSAR Section 3.7.2 states on page 3-39 that section properties of the stick models for both the reactor building internal structure (RBIS) and reactor containment building (RCB) were modified to capture the response due to the high frequency content of the ground motion response spectra (GMRS).

(1) (a) As this site-specific modification represents a departure from the U.S. EPR design basis, describe how the RBIS and RCB models were modified; and
(b) Describe how these changes allow capture of the high frequency input contained in the GMRS.
(2) Provide comparisons of the new site-specific models to the EPR certified design models which illustrate the site-specific changes that were made.
(3) (a) If used in the U.S. EPR seismic analysis, would the revised RBIS and RCB stick models change the seismic results presented in the U.S. EPR FSAR?; and
(b) if so, describe the nature of the change and explain why the seismic results of the U.S. EPR certified design are still valid.
(4) The NRC Interim Staff Guidance (COL/DC-ISG-1, Interim Staff Guidance on Seismic Issues Associated with High Frequency Ground Motion in Design Certification and Combined License Applications, May 2008) indicates that structural models should have the capability to capture responses to at least 50 Hz. As the GMRS has a zero period acceleration (ZPA) greater than 50 Hz, explain how the change to a dynamic finite element model (FEM) for the NI common basemat structures captures frequencies of up to at least 50 Hz and identify the cutoff frequency used in the seismic analysis of this structure.

Response

The BBNPP Ground Motion Response Spectra (GMRS) is being re-calculated using the 2012 Central and Eastern United States (CEUS) – Seismic Source Characterization (SSC) model. In addition, dynamic finite element models are now used in the soil structure interaction analyses rather than the stick models previously described in FSAR section 3.7.2.

Revised reconciliation results, including FSAR updates, if necessary, will be included in the response to RAI 107, Q03.07.02-23.

COLA Impact

No change to the BBNPP COLA is required as a result of this response.

RAI 37
Question 03.07.02-5

FSAR Section 3.7.2 states on page 3-40 that an input motion called G1.1 was used as a study motion to compare the ISRS at key locations of the RBIS and RCB between the concrete-only stick models, the static finite element models and, in the case of the RCB, the dynamic finite element model. The FSAR also states the G1.1 has frequency content similar to that of the BBNPP GMRS.

(1) Provide a comparison of the response spectrum of the G1.1 input motion with the GRMS base-lined to the same ZPA.
(2) Describe the development of the G1.1 input motion and how it meets SRP Acceptance Criteria 1.B of SRP Section 3.7.1.
(3) Explain why G1.1 was used for this study rather than the BBNPP GMRS.

Response

The BBNPP Ground Motion Response Spectra (GMRS) is being re-calculated using the 2012 Central and Eastern United States (CEUS) – Seismic Source Characterization (SSC) model. In addition, static and dynamic models have been revised since FSAR section 3.7.2 was prepared.

Revised reconciliation results, including FSAR updates, if necessary, will be included in the response to RAI 107, Q03.07.02-23.

COLA Impact

No change to the BBNPP COLA is required as a result of this response.

RAI 37
Question 03.07.02-6

FSAR Section 3.7.2 states on page 3-40 that the ESWB model has the same number of modes and elements as the original model, except for node re-sequencing and the reshaping of the elements.

(1) Please explain the reasons for renumbering the nodes and reshaping the elements, and explain what impact these changes have on the natural frequencies of the original model.

(2) Why is it valid to compare the ESWB seismic analysis results from the U.S. EPR certified design with those from the BBNPP site, when in each case different models were used for this structure?

Response

The BBNPP Ground Motion Response Spectra (GMRS) is being re-calculated using the 2012 Central and Eastern United States (CEUS) – Seismic Source Characterization (SSC) model. In addition, static and dynamic models have been revised since FSAR section 3.7.2 was prepared.

Revised reconciliation results, including FSAR updates, if necessary, will be included in the response to RAI 107, Q03.07.02-23.

COLA Impact

No change to the BBNPP COLA is required as a result of this response.

RAI 37
Question 03.07.02-7

FSAR Section 3.7.2 states on page 3-40 that for the EPGB, the soil structure interaction (SSI) model is a refined FEM and represents a departure from the U.S. EPR FSAR.

(1) Describe the site-specific changes to the model and why they were made.
(2) Will physical changes be made to the building (EPGB) described in the U.S. EPR FSAR? If so, explain the reasons for these changes and why they are necessary.
(3) Explain why a comparison of ISRS values and ZPA values in the BBNPP FSAR and the U.S. EPR FSAR remain valid, since in each case a different structure and seismic model was used.
(4)(a) Are the original design loads and critical sections presented in the U.S. EPR FSAR still valid for the BBNPP site?
(b) If not, describe the differences between the U.S. EPR EPGB and the BBNPP EPGB, and provide reasons why the BBNPP EPGB should not be considered as a site-specific structure.
(5) Provide the basis for the design loads and ISRS for the BBNPP EPGB.

Response

The BBNPP Ground Motion Response Spectra (GMRS) is being re-calculated using the 2012 Central and Eastern United States (CEUS) – Seismic Source Characterization (SSC) model. In addition, static and dynamic models have been revised since FSAR section 3.7.2 was prepared.

Revised reconciliation results, including FSAR updates, if necessary, will be included in the response to RAI 107, Q03.07.02-23.

COLA Impact

No change to the BBNPP COLA is required as a result of this response.

RAI 37
Question 03.07.02-8

FSAR Section 3.7.2 states on page 3-40 that the 26 Hz cutoff frequency is deemed sufficient for the BBNPP ESWB, as it is governed by low frequency input motion and there is no high frequency sensitive equipment currently identified for this structure. Since the GMRS has a ZPA that exceeds 50 Hz, provide the following information regarding this structure.

(1) How was this cutoff frequency determined?
(2) How was the NRC Interim Staff Guidance (COL/DC-ISG-1, May 2008) considered in determining the cutoff frequency?
(3) List and describe the equipment, including breakers and control modules, which will be located in the BBNPP ESWB, and identify the frequency range for which the equipment will need to be seismically qualified.
(4) For the BBNPP ESWB, provide a comparison of the difference(s) in the BBNPP ESWB response and ISRS between a 26 Hz cutoff frequency and 50 Hz cutoff frequency.
(5) Table 3.7.2-7 of the U.S. EPR FSAR identifies slabs with cutoff frequencies above 26 Hz.
  (a) What is the impact of higher frequencies on the design loads for these slabs?
  (b) Were these higher frequencies considered?
  (c) If not, provide justification for omitting this analysis.
(6) Since the BBNPP EPGB used a cutoff frequency of 50 Hz, please explain why the same cutoff frequency wasn't used for the BBNPP ESWB.

Response

The BBNPP Ground Motion Response Spectra (GMRS) is being re-calculated using the 2012 Central and Eastern United States (CEUS) – Seismic Source Characterization (SSC) model. In addition, static and dynamic models have been revised since FSAR section 3.7.2 was prepared.

Revised reconciliation results, including FSAR updates, if necessary, will be included in the response to RAI 107, Q03.07.02-23.

COLA Impact

No change to the BBNPP COLA is required as a result of this response.

RAI 74
Question 03.08.01-1

For COL information item COL 3.8(1) in the BBNPP COL FSAR, Subsection 3.8.1.3,"Loads and Load Combinations" (SRP Section 3.8.1), the applicant states in the third paragraph (Page 3-164) "Site specific Reactor Containment Building (RCB) design loads are confirmed to lie within the standard U.S. EPR design certification envelope with the exception of design loads resulting from the BBNPP site specific seismic response spectra and soil profiles described in 3.7.1. Additional confirmatory evaluations for the site specific seismic response spectra were performed to confirm that the RCB is acceptable for the BBNPP site.
These evaluations confirmed:

- BBNPP site specific Nuclear Island (NI) Common Base Mat Structure foundation soil spring values are enveloped by the standard U.S. EPR design certification soil spring values.
- BBNPP site specific NSSS support loads are enveloped by the standard U.S. EPR design certification NSSS support loads.
- The BBNPP site specific zero period acceleration (ZPA) values for the RCB are enveloped by the standard U.S. EPR design certification ZPA values for the RCB."

Also, in BBNPP COL FSAR, Subsection 3.7.1,"Seismic Design Parameters", the third paragraph states "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)."

The applicant is requested to provide the following information:

1. In BBNPP COL FSAR, Subsection 3.7.1, the applicant states that the Ground Motion Response Spectra (GMRS) for BBNPP are not bounded by the Certified Seismic Design Response Spectra (CSDRS) at all frequencies (Page 3-30).
   Provide the technical basis for why the three additional evaluations (shown as the three bullets in the first paragraph above) demonstrate that the seismic response of the RCB for BBNPP is enveloped by that of U.S. EPR.
2. The elevation of the water table is about 30 ft. above the elevation of the bottom of the NI foundation basemat. The SSI analysis performed in the US-EPR FSAR did not consider the effect of this high water table.
   Provide the technical basis that supports the conclusion that the effect of high water table is negligible, and that the results of US-EPR are applicable to BBNPP RCB.
3. (c) 10CFR Part 50, Appendix S states that "The Safe Shutdown Earthquake Ground Motion must be characterized by free-field ground motion response spectra at the free ground surface". The grade elevation for BBNPP is at 674.5 ft. However, in the second paragraph quoted above, the SSE for BBNPP is defined at the elevation of 640 ft.

Provide justification for the use of the GMRS at the 640 ft elevation for the SSE.

Response

The BBNPP Ground Motion Response Spectra (GMRS) is being re-calculated using the 2012 Central and Eastern United States (CEUS) – Seismic Source Characterization (SSC) model. Static and dynamic models have been revised since FSAR section 3.7.2 was prepared. In addition, the new grade elevation for BBNPP is 719 feet. The elevations discussed in Part 2 of the RAI question no longer apply.

Revised reconciliation results, including FSAR updates, if necessary, will be included in the response to RAI 107, Q03.07.02-23.

COLA Impact

No change to the BBNPP COLA is required as a result of this response.

RAI 75

Question 03.08.03-1

For COL information item COL 3.8(2) in the BBNPP COL FSAR, Subsection 3.8.3.3, "Loads and Load Combinations" (SRP Section 3.8.3), the applicant states in the third paragraph (Page 3-177) that "Site specific RCB [Reactor Containment Building] internal structures design loads have been confirmed to lie within the standard U.S. EPR design certification envelope with the exception of design loads resulting from the BBNPP site specific seismic response spectra and soil profiles described in Section 3.7.1. Additional confirmatory evaluations for the site specific seismic response spectra have been performed as noted below and confirm that the RCB internal structures are acceptable for the BBNPP site:

- BBNPP site specific NI Common Base Mat Structure foundation soil spring values are enveloped by the standard U.S. EPR design certification soil spring values.
- BBNPP site specific NSSS support loads are enveloped by the standard U.S. EPR design certification NSSS support loads.
- The BBNPP site specific ZPA values for the RCB internal structures are enveloped by the standard U.S. EPR design certification ZPA values for the RCB internal structures."

Also, in BBNPP COL FSAR, Subsection 3.7.1.1.1, "Design Ground Motion Response Spectra", the first paragraph (Page 3-33) states "A comparison of the BBNPP GMRS versus the CSDRS for five percent damping anchored at 0.30g is shown in Figure 3.7-1 and Figure 3.7-2. As shown, the CSDRS [Certified Seismic Design Response Spectra] are exceeded by the BBNPP GMRS in both the horizontal and vertical directions."

The applicant is requested to provide the following information:

1. Provide the technical basis that supports the conclusion that the three additional evaluations listed in the first paragraph quoted above (the three bullets) demonstrate that the response of the RCB internal structures for BBNPP is enveloped by that of U.S. EPR.
2. The elevation of the water table is about 30 ft. above the elevation of the bottom of the NI foundation basemat. The SSI analysis performed in US-EPR does not appear to have considered the effect of this high water table.
   Provide the technical basis that supports the conclusion that the effect of high water table is negligible, and that the results of US-EPR are applicable to BBNPP RCB internal structures.
3. Are there equipment items that are sensitive to high frequency excitations? If so, describe these and describe how they are designed to accommodate the seismic loads.
4. In BBNPP COL FSAR, Subsection 3.7.1.1 under the title of "Reactor Coolant System" (first paragraph in Page 3-31), the applicant states that "BBNPP site-specific time history analyses are performed to approximately 40 seconds using input at 0.005 second intervals. Sensitivity evaluation confirms the integration time step used, 0.0005 seconds, is adequate." Explain how the time histories used in these analyses were generated? Provide damping values assumed for the structures in these analyses.
5. In BBNPP COL FSAR, Subsection 3.7.1.1 under the title of "RPV Internals" (Page 3-31), the applicant states that "Site-specific time histories are developed from the site specific GMRS/FIRS and the site-specific best estimate, lower bound, and upper bound soil profiles."

   Provide information for these site-specific time histories, their duration, time steps, and the target response spectra to which they are matched.

Response to Question 03.08.03-1, Parts 1, 4 and 5

The BBNPP Ground Motion Response Spectra (GMRS) is being re-calculated using the 2012 Central and Eastern United States (CEUS) – Seismic Source Characterization (SSC) model. In addition, static and dynamic models have been revised since FSAR section 3.7.2 was prepared.

Revised reconciliation results, including FSAR updates, if necessary, will be included in the response to RAI 107, Q03.07.02-23.

Response to Question 03.08.03-1 Part 2

Due to the relocation of the plant footprint to minimize the impact on wetlands, the new grade elevation for BBNPP is at EL 719 ft. As a result of this move, the water table is considerably lower at the new plant location; therefore this RAI is no longer applicable.

Response to Question 03.08.03-1 Part 3

PPL provided the response to Question 03.08.03-1 Part 3 in PPL Letter BNP-2010-086 "Bell Bend Nuclear Power Plant Partial Response to RAI No. 75 and Request for Extension," Dated April 7, 2010 from R.R. Sgarro to U.S. Nuclear Regulatory Commission Document Control Desk.

COLA Impact

No change to the BBNPP COLA is required as a result of these responses.

RAI 79
Question 03.08.04-8

For COL information item COL 3.8(7) in the BBNPP COL FSAR, Subsection 3.8.4.3, "Loads and Load Combinations" (SRP Section 3.8.4), the applicant states in the last sentence of the third paragraph (BBNPP FSAR page 3-181) that "Additional confirmatory evaluation for the site-specific response spectra and soil profiles were performed and confirmed that the other Seismic Category I Structures are acceptable for the BBNPP site."

The applicant is requested to provide the following information:

(a) Describe the "additional confirmatory evaluation" mentioned in the above quoted sentence.

(b) The water table at the BBNPP is high (30 ft above the elevation of the bottom of the NI foundation basemat). Is the effect of high water table included in the calculation of site-specific response spectra? If not, provide the technical basis for not including this effect.

(c) The Ground Motion Response Spectra for BBNPP were generated by making use of the SHAKE computer program (see BBNPP COL FSAR Section 2.5.2). The SHAKE program is based on the elastic wave theory which does not consider the effect of water. The governing equations for wave propagation in porous media are different from those of the wave propagation in elastic media.

    Provide the technical basis to support the use of site-specific response spectra based on the elastic wave theory.

(d) The Figure 3.7-38 through Figure 3.7-73 of BBNPP COL FSAR shows that the site-specific response spectra of BBNPP exceed those of the US-EPR FSAR.

    Provide the technical basis for stating that the other Seismic Category I Structures of BBNPP are acceptable.

Response to Question 03.08.04-8 parts (a) and (d)

The BBNPP Ground Motion Response Spectra (GMRS) is being re-calculated using the 2012 Central and Eastern United States (CEUS) – Seismic Source Characterization (SSC) model. In addition, static and dynamic models have been revised since FSAR section 3.7.2 was prepared.

Revised reconciliation results, including FSAR updates, if necessary, will be included in the response to RAI 107, Q03.07.02-23.

Response to Question 03.08.04-8 parts (b) and (c)

Due to the relocation of the plant footprint to minimize the impact on wetlands, the new grade elevation for BBNPP is at EL 719 ft. As a result of this move, the water table is considerably lower at the new plant location; therefore parts (b) and (c) of this RAI are no longer applicable.

COLA Impact

No change to the BBNPP COLA is required as a result of this response.

RAI 79
Question 03.08.04-9

For COL information item COL 3.8(7) in the BBNPP COL FSAR, Subsection 3.8.4.3.1,"Design Loads" (SRP Section 3.8.4), the applicant lists (Pages 181 and 182) the design loads for Essential Service Water Emergency Makeup System (ESWEMS) Pumphouse and the Retention Pond.

The applicant is requested to provide the following information:

(a) Is the hydrodynamic load included in the Safe-Shutdown Earthquake load for the Retention Pond? This load should be explicitly covered in the BBNPP COL FSAR. The applicant is requested to confirm that hydrodynamic loads are included in the SSE analysis, and to describe how the hydrodynamic load is calculated.

(b) In BBNPP COL FSAR, Subsection 3.7.1.1.2, "Design Ground Motion Time History" (Page 3-38) (SRP Section 3.7.1), the applicant states that "A set of three synthetic ground motion time histories, two horizontal and one vertical, has been developed for use in the ESWEMS Pumphouse seismic analysis. Figure 3.7-135 through Figure 3.7-137 present the comparison of the spectra computed from the time histories to the respective design spectra The time histories have a total duration of 24 seconds"

1) In Figure 3.7-135 through 3.7-137, what is the damping value assumed? Do the time histories also match target response spectra at other damping values?
2) According to NUREG 1-208, Power Spectral Density (PSD) functions need to be calculated to show that the time histories have adequate power at all important frequency ranges. Provide PSD plots for the three time histories used in the seismic analysis.
3) Provide the rationale as to why each of these time histories has a duration of 24 seconds, whereas, the time histories mentioned in BBNPP COL FSAR, Subsection 3.7.1.1 have durations of 40 seconds.

What is the time step for these three time histories?

Response to Question 03.08.04-9 part (a)

As a result of the plant footprint move to minimize the impact on wetlands and the update to the 2012 Central Eastern United States (CEUS)-Seismic Source Characterization (SSC) model, the seismic analysis including the definition of the Safe Shutdown Earthquake (SSE) is being updated. A response to this question will be provided once the analysis is complete. PPL will provide an answer to this RAI by December 31, 2012.

Response to Question 03.08.04-9 part (b)

As a result of the footprint move to minimize the impact on wetlands and the update to the 2012 Central Eastern United States (CEUS)-Seismic Source Characterization (SSC) model, seismic analyses are being redone and Final Safety Analysis Report (FSAR) Section 3.8 is being updated accordingly, including Figures 3.7-135 through 3.7-137 and the ground motion time histories. A response to this question will be provided once the analysis is complete. PPL will provide an answer to this RAI by December 31, 2012.

COLA Impact

No change to the BBNPP COLA is required as a result of this response.

RAI 79
Question 03.08.04-13

For COL information items COL 3.8(8) through 3.8(10) in the BBNPP COL FSAR, Subsection 3.8.4.4.5, "Buried Conduit and Duct Banks, and Buried Pipe Ducts" (SRP Section 3.8.4), the fourth paragraph (BBNPP COL FSAR Page 3-184) states that "Soil overburden pressures on buried duct banks typically do not induce significant bending or shear effects, because the soil cover and elastic support below the duct bank are considered effective and uniform over the entire length of the buried duct bank. When this is not the case, vertical soil overburden pressure is determined by the Boussinesq method."

The applicant is requested to provide the following information:

a) At the BBNPP site, are there any locations of buried utilities such that the vertical soil overburden pressure needs to be computed by the Boussinesq method? Describe what level of non-uniformity of the soil support makes use of the Boussinesq analysis necessary.
b) Describe how the Boussinesq method is applied to the soil conditions for the BBNPP.

Explain the meaning of "effective and uniform" in "the soil cover and elastic support below the duct bank are considered effective and uniform over the entire length of the buried bank." How is it determined that the soil cover and elastic support are "effective and uniform"?

Response

a) A buried duct bank is placed in a trench before backfill with soil cover. The soil below the duct bank acts as an elastic foundation, which provides continual supports for the duct bank. An electrical duct bank is relatively wide and shallow in dimensions. As a result, the soil cover and soil below the duct bank are considered uniform and effective over the entire width and length of the duct bank. This assumption facilitates the evaluation of vertical soil overburden pressure acting on the buried duct bank. The pressure is determined in accordance with Section 3.10.1.3 of the AREVA Topical Report ANP-10264NP.

b) At the Bell Bend Nuclear Power Plant, Seismic Category I buried duct banks require Seismic Category I Granular Backfill. They are buried less than 20 feet within the Glacial Overburden 1 (Ref. FSAR Table 2.5-51). Therefore, different layers of soil do not need to be accounted for, using the Boussinesq method.

COLA Impact

No change to the BBNPP COLA is required as a result of this response.

RAI 79
Question 03.08.04-15

For COL information items COL 3.8(8) through 3.8 (10) in the BBNPP COL FSAR, Subsection 3.8.4.4.5,"Buried Conduit and Duct Banks, and Buried Pipe and Pipe Ducts" (SRP Section 3.8.4) , the 2nd paragraph (Page 3-183), states: "The design of Seismic Category I, buried electrical duct banks and buried Essential Service Water pipes (hereafter in this section referred to as buried duct banks and buried pipe) has been confirmed to meet the requirements specified in Section 3.8.4.4.5 and the AREVA NP Topical Report ANP-10264(NP) and demonstrates sufficient strength to accommodate:

- Strains imposed by seismic ground motion.

- Static surface surcharge loads due to vehicular loads (AASHTO HS-20 (AASHTO, 2002)) truck loading, minimum, or other vehicular loads, (including during construction) on designated haul routes.

- Static surface surcharge loads during construction activities, e.g., for equipment laydown or material laydown.

- Tornado missiles and, within their zone of influence, turbine generated missiles.

- Ground water effects."

The applicant is requested to provide a description of the analyses and evaluations performed to support the conclusion that the design of the BBNNP buried utilities meets AREVA Topical Report ANP-10264NP and demonstrates sufficient strength to accommodate the loads and other effects listed above. Include in this discussion the values of loads, strains, and other effects considered in the analyses. The discussion should also describe measures taken to mitigate potential damaging effects of ground water entering the buried utility enclosures.

Response

For FSAR Section 3.8.4.4.5, the reference to buried Essential Service Water pipes was changed to "buried safety-related pipes," in Revision 3 of the BBNPP COLA.

- Strains Imposed by Seismic Ground Motion:

  Axial strains on buried duct banks are estimated by ASCE4-98, Equation 3.5-1 or 3.5-2, whichever is less per Commentary C.5.2.1 in the code.

  Axial strain on buried pipe is addressed in AREVA Topical Report ANP-10264NP. The equation is consistent with ASCE4-98 Equation 3.5-1.

- Static Surface Surcharges:

  Section 3.10.1.4, "Surface Loads" in the AREVA Topical Report ANP-10264NP provides the method for evaluating pressure transmitted to the buried pipe under live loads, such as those imposed by trucks or rail. Table 3-6 lists values of surface loads transmitted to the pipe due to vehicular loads (AASHTO HS-20 (AASHTO, 2002)) and Railway (E80), including impact factors based on Table

3.5. The tabulated values are applied to construction equipment or other construction conditions, as appropriate.

- Tornado Missiles and, within their zone of influence, Turbine Generated Missiles.

  In accordance with Section 6.3.6, "Tornado (W_T) Loads", of the AREVA Topical Report ANP-10264NP, the W_T load only applies to an exposed piping. In accordance with the U.S. EPR FSAR Section 3.5.2 safety-related buried utilities are protected from external generated missiles. It states: "*Safety-related pipes and cables routed outside of missile-protected structures are buried a* sufficient *depth to provide protection for these items from missile impact.*" The externally generated missiles for which the U.S. EPR is designed are addressed in the U.S. EPR FSAR Section 3.5.1. The depth of missile penetration through soil is evaluated, using formulas in the U.S. EPR FSAR Section 3.5.3.1.1. Alternatively, its evaluation may be based on Young's Method per "Young W.C., Depth Prediction for Earth- Penetrating Projectiles", by ASCE Journal of Solid Mechanics and Foundations Division, May 1969. The design soil cover to preclude missile impact on buried structures is conservatively determined for exceeding the predicted penetrating soil depth by a minimum of 20 percent.

- Ground Water Effects:

  For utilities buried below groundwater table, vertical force due to buoyancy is evaluated in accordance with Section 3.10.1.5, "Buoyancy Force" of the AREVA Topical Report ANP- 10264NP. Since safety-related utilities are buried with sufficient soil protection from the design external generated missiles, such deep cover mitigates flotation effect. As delineated in "Buried Pipe Design" by A.P. Moser, McGraw-Hill, Third Edition, the buoyant force of the utility cannot exceed its weight and the effective weight of the soil wedge, or anchorages would be designed to resist the flotation. The minimum required Factor of Safety (FS) against flotation is taken at 1.5 for normal loading conditions, 1.3 under severe environmental conditions, and 1.1 under construction. Potential intrusion of ground water into duct banks is mitigated using a waterproofing system and sloping the duct bank toward manholes.

  Values Used in Analysis:

  Essential values, used to assign axial strains, axial stresses, and bending stresses of the buried utilities due to Safe Shutdown Earthquake (SSE) loadings, are listed below. Unless noted otherwise, these values are described in the Response to RAI 03.08.04-6[1].

  Final Safety Analysis Report (FSAR) Figure 3.7-132 through Figure 3.7-134 present the velocity time histories in the horizontal and vertical directions. Assuming the Peak Ground Acceleration (PGA), presented in FSAR Figures 3.7-151 and 3.7-152 occurs at a frequency near the Peak Ground Velocity (PGV) in Figures 3.7-132 through 3.7-134, a PGV at 10 Hz is assumed. This frequency is considered a reasonable estimate in light of enveloped curves presented in Figures 3.7-151 and 3.7-152 are used. A lower frequency also results in a conservative wavelength. Moreover, PGV values are tabulated below. The PGV = 0.67 feet per second (fps) is the square root of the sum of the square (SRSS) maximum among all three directional PGV and Peak Ground Horizontal (PGH) values.

[1] PPL Letter BNP-2010-094, from Rocco R. Sgarro to Document Control Desk, Bell Bend Nuclear Power Plant Response to RAI No. 79, dated April 15, 2010.

Facility	PGV H 1 (fps)	PGV H 2 (fps)	PGV V (fps)
NI	0.32	0.39	0.23
3URB	0.35	0.37	0.23
4URB	0.41	0.46	0.22
3UBP and 4 UBP (34UBP(S))	0.43	0.45	0.22
1URB and 2URB (12URB(N))	0.29	0.31	0.19
1UBP and 2UBP (12UBP-CONC(N))	0.37	0.30	0.21
PH El. 669	0.28	0.30	0.18

Apparent maximum P-wave velocity: 5250 fps.
Apparent maximum S-wave velocity: 3000 fps
Density of backfill: 140 pounds per cubic foot (pcf) (Ref. FSAR Section 2.5.4.10.2.1.1)
Maximum ground acceleration = 0.55g as SRSS peak three-directional ground accelerations from FSAR Figures 3.7-151 and 3.7-152.
Maximum apparent wavelength, λ_w = c/f. = 3000 /10 = 300 feet.

Other values, not listed, are dependent on material and sectional properties of the buried utilities and/or their buried depth.

In summary, for safety-related, seismic category I buried utilities, it is required that seismic loadings, which induce additional strains and stresses on the utilities, are evaluated in accordance with acceptance criteria from ASCE 4-98 and/or the AREVA Topical Report ANP-10264NP, as applicable to a long and straight section:

Maximum axial strain ignoring friction - Refer to ASCE 4-98, Part 3.5.2.1.1
Maximum axial strain considering friction - Refer to ASCE 4-98, Part 3.5.2.1.2
Maximum curvature - Refer to ASCE 4-98, Part 3.5.2.1.3
Maximum joint displacement and rotation in segmented structures - Refer to Part ASCE 4-98, 3.5.2.1.4.

Additionally, forces on bends, intersections, and anchor points are evaluated in accordance with ASCE 4-98, Part 3.5.2.2. For anchor point movement, the evaluation is in accordance with ASCE 4-98, Part 3.5.2.3.

COLA Impact

No change to the BBNPP COLA is required as a result of this response.

RAI 79
Question 03.08.04-20

For supplemental information item SUP 3.8(2) in the BBNPP COL FSAR, Subsection 3.8.4.4.7, "ESWEMS Pumphouse and ESWEMS Retention Pond" (SRP Section 3.8.4), the applicant states in the 9th paragraph (Page 3-185) that "The safety analysis for the ESWAEMS Retention Pond includes a slope stability evaluation that includes horizontal seismic loads. The pond slopes are a permanent design feature and were evaluated using GSTABL7. Factor of safety for various sections is presented in Section 2.5.5."

The applicant is requested to provide the following:

How were sloshing effects evaluated, and what were the results of that analysis? Where in the FSAR is the GSTBL7 code described? If it is not referenced, provide a description of the code, and a discussion of significant results from its use in the slope stability evaluation.

Response

Sloshing effects were not accounted for in the analysis. Instead, an analysis highlighting the effect, with seismic forces, of flooding waves and their complete retreat has been provided. These are the absolute worst case scenario conditions where the waves move back and forth nearly emptying and then flooding the Essential Service Water Emergency Makeup System (ESWEMS) retention pond. Although the retreat, known as rapid drawdown, has a lower factor of safety (FOS) than the original results the factor of safety is still well above any minimum requirement and can be considered to have a safe factor of safety. The table below shows the original factors of safety as well as those for the sensitivity analysis done with drawdown and rapid flood conditions.

TABLE 1: Factor of Safety Comparisons

PROFILE	ORIGINAL FOS	DRAWDOWN FOS	RAPID FLOOD FOS
1	2.9	2.4	3.2
2	2.4	2.2	2.8
3	2.2	1.9	2.4
4	2.1	1.8	2.4

The description of the program and its specifications is not included in the FSAR. The following is a brief synopsis of the program:

The slope stability analysis is performed using the latest version of Computer Program GSTABL7 with STEDwin. This program was originally developed by Purdue University for the Indiana State Highway Commission in 1986 and later revised and marketed by Geotechnical Engineering Software Company. The program calculates the factor of safety against slope failure utilizing a two-dimensional limit equilibrium method. The calculation of the factor of safety against slope instability is performed using the Simplified Bishop method of slices, which is applicable to circular shaped failure surfaces. Other methods available include the Simplified Janbu method of slices, which is applicable to failure surfaces of a general shape, and Spencer's method of slices which is applicable to surfaces having a circular or general shape. Dynamic analysis of the slopes can be performed using a pseudo- static approach, which represents the effects of seismic shaking by accelerations that create inertial forces. These forces act in the horizontal direction at the centroid of each slice.

The methods by which GSTABL7 solves for the critical failure surface involves solving for multiple trial slip surfaces within a range preset by the user. The number of trials can range from a couple of dozen to over a thousand, depending on the level of accuracy demanded by the cross section.

The Bishop Method builds on the Method of Slices which starts with a circular arc, with a radios R and center O. The part of the arc that cuts through the actual slope is considered to be the trial failure surface. The body of soil above the trial failure surface is cut up into slices using vertical planes. The base of each slice is assumed to have a straight line base. The slices are analyzed separately to determine the forces acting on each slice.

COLA Impact

No change to the BBNPP COLA is required as a result of this response.

RAI 90
Question 03.08.05-4

For COL information item COL 3.8 (13) in the BBNPP COL FSAR Subsection 3.8.5.5.1,"Nuclear Island Common Base Mat Structure Foundation Base Mat" (SRP Section 3.8.5), the applicant states in the second paragraph that "The amount of sliding of the BBNPP [Nuclear Island] NI, when subjected to a load combination with seismic loading, was evaluated and determined to be negligible. Additionally, a nonlinear time history analysis of the NI under seismic loads determined that the possible amount of uplift for the BBNPP site-specific parameters is negligible and is enveloped by the U.S. EPR design."

The NRC Staff requests that the applicant provide the following information:

(1)(a) Where is the study of sliding and uplifting of the NI presented in the BBNPP COL FSAR?

(b) Is the effect of high water table on the sliding considered in the analysis?

(c) Provide the input motions used in the nonlinear time history analysis for the uplifting and explain how they are calculated.

(d) BBNPP COL FSAR Subsection 3.8.5.6.1 states that the NI foundation is submerged 30 ft. in water. The site-specific seismic motions developed in BBNPP Section 2.5 and 3.7 are based on the elastic wave theory, in which the effect of water is neglected. Provide the technical basis which shows that the same conclusions stated in the above quoted paragraph would be valid if the effect of the high water table is considered.

(2) In the BBNPP COL FSAR, Subsection 3.7.2, the applicant states that "The existing stick model of the NI Common Base Mat structures is used in the SASSI analysis to determine only the 6-DOF [degrees of freedom] SSI [soil-structure interaction] response motions at the NI base mat. The 6-DOF base mat motions from the SSI analysis of the NI are used as input motions to the modal superposition time history analysis of the fixed-base dynamic finite element model of the NI."

(a) Referring to the first sentence of the above quoted paragraph, does the SSI analysis using SASSI include only the stick model of the NI Common Base Mat structure? If so, provide justification for not including the superstructure model in this analysis, and provide data to show that the stick model is a good representation of its 3D counterpart.

(b) What is the maximum size of soil elements in the SSI analysis?

(c) BBNPP COL FSAR Table 2.5-51shows that the shear wave velocity for the top soil layer is 1150 ft/sec for the low-strain condition. What is the corresponding value for the high-strain condition during the safe-shutdown earthquake (SSE) event?

(d) Do the 6-DOF SSI response motions represent the motion at the mass center of the base mat, or at the bottom of the mat?

(e) Is the base mat in the fixed-base finite element model treated as a rigid body? If the base mat in the fixed-base finite element model is not treated as a rigid body, provide the method for using the 6-DOF SSI response motions from the SASSI analysis for the whole mat and explain the rationale for using that method.

(f) In the fixed-base finite element model, where are the 6-DOF SSI response motions applied?

Response

The BBNPP Ground Motion Response Spectra (GMRS) is being re-calculated using the 2012 Central and Eastern United States (CEUS) – Seismic Source Characterization (SSC) model. In addition, static and dynamic models have been revised since FSAR section 3.7.2 was prepared.

Revised reconciliation results, including FSAR updates, if necessary, will be included in the response to RAI 107, Q03.07.02-23.

COLA Impact

No change to the BBNPP COLA is required as a result of this response.

RAI 90
Question 03.08.05-5

For COL information item COL 3.8 (13) in the BBNPP COL FSAR, Subsection 3.8.5.5.2, "Emergency Power Generating Buildings Foundation Base Mats" (SRP Section 3.8.5), Page 3-190,the applicant states, in part: "The maximum bearing pressures under sliding and overturning for the EPGB [Emergency Power Generating Building] foundation mat were determined to be acceptable for the BBNPP site, and the applicable acceptance criteria are met."

The NRC Staff requests that the applicant provide the following information:

(1) Provide the actual value for the maximum bearing pressures under the EPGB foundation mat and a comparison of that value with the bearing capacity of the soil beneath the mat at the site.
(2) Provide the frictional force at the bottom of the EPGB foundation mat and a comparison of that value with the maximum shear forces in both N-S and E-W directions resulting from the SSE.

Response

As a result of the footprint move to minimize the impact on wetlands, the bearing capacity of the soil under the Emergency Power Generating Buildings (EPGB) has changed and, therefore, Final Safety Analysis Report (FSAR) Section 3.8 will be updated to reflect this new location. A response to this question will be provided once the analysis is complete. PPL will provide an answer to this RAI by December 31, 2012.

COLA Impact

No change to the BBNPP COLA is required as a result of this response.

RAI 90
Question 03.08.05-7

For COL information item COL 3.8 (13) in the BBNPP COL FSAR, Subsection 3.8.5.5.3,"Essential Service Water Buildings Foundation Base Mats," Page 3-190 (SRP Section 3.8.5), the applicant states in the last sentence of the paragraph that "The allowable bearing capacity for the ESWB foundation base mat is enveloped by the U.S. EPR design."

Provide a table listing the bearing pressure requirements for various BBNPP structures and the corresponding allowable bearing capacity. Also, state how the allowable bearing capacity is established.

Response

As a result of the footprint move to minimize the impact on wetlands, the bearing capacity of the soil under the Essential Service Water Buildings (ESWB) has changed and, therefore, Final Safety Analysis Report (FSAR) Section 3.8 will be updated to reflect this new location. A response to this question will be provided once the analysis is complete. PPL will provide an answer to this RAI by December 31, 2012.

COLA Impact

No change to the BBNPP COLA is required as a result of this response.

Enclosure 2

RAI Questions Deferred to the Response to RAI No. 107, Question 03.07.02-23

RAI Questions Answered by the Response to RAI No. 107, Question 03.07.02-23		
RAI	**Question Number**	**FSAR Section**
37	03.07.01-5	3.7.1
	03.07.01-6	3.7.1
	03.07.01-9	3.7.1
	03.07.02-1	3.7.2
	03.07.02-2	3.7.2
	03.07.02-3	3.7.2
	03.07.02-4	3.7.2
	03.07.02-5	3.7.2
	03.07.02-6	3.7.2
	03.07.02-7	3.7.2
	03.07.02-8	3.7.2
74	03.08.01-1 subparts 1, 3 (subpart 2 is no longer applicable)	3.8.1
75	03.08.03-1 subparts 1,4,5 (subpart 2 is no longer applicable)	3.8.3
79	03.08.04-8 subparts a, d (subparts b, c are no longer applicable)	3.8.4
90	03.08.05-4	3.8.5