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June 05, 2009

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

BELL BEND NUCLEAR POWER PLANT
RESPONSE TO RAI SET NO. 4
BNP-2009-098 Docket No. 52-039

References: 1) M. Canova (NRC) to R. Sgarro (PPL Bell Bend, LLC), Bell Bend COLA – Request for Information No. 4 (RAI No. 4) – SPLA-1878, email dated May 7, 2009

The purpose of this letter is to respond to the request for additional information (RAI) identified in the referenced NRC correspondence to PPL Bell Bend, LLC. This RAI addresses Probabilistic Risk Assessment and Severe Accident Evaluation, as discussed in Section 19.1 of the Final Safety Analysis Report (FSAR), as submitted in Part 2 of the Bell Bend Nuclear Power Plant Combined License Application (COLA).

The enclosure provides our response to RAI No. 4, Questions 19-1, 19-2, 19-3, 19-4, 19-5, 19-6, and 19-7, which includes revised COLA content. A Licensing Basis Document Change Request has been initiated to incorporate this change in a future revision of the COLA. This future revision of the COLA is the only new regulatory commitment.

If you have any questions, please contact the undersigned at 570-802-8102.

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

Executed on June 05, 2009

Respectfully,

Rocco R. Sgarro

Rocco R. Sgarro

Enclosure: As stated

D079
NRO

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Enclosure 1

Response to NRC Request for Additional Information Set No. 4
Bell Bend Nuclear Power Plant

RAI Set No. 4

Question 19-1:

The probabilistic risk assessment (PRA) guidance (Chapter 19) in section C.III of Regulatory Guide (RG) 1.206 states that "[i]n cases where it can be shown that assumptions in the certified design PRA (1) bound certain site-specific and plant-specific parameters, and (2) do not have a significant impact on the PRA results and insights, no change to the design certification PRA is necessary." The discussion of losses of offsite power (LOOP) on page 19-8 of the Bell Bend Nuclear Power Plant (BBNPP) Final Safety Analysis Report (FSAR) states that "[t]he U.S. EPR PRA Loss of Offsite Power recovery probabilities bound BBNPP site-specific values." Please revise the FSAR to include site-specific values (both at power and during shutdown) that support this statement, as well as the source for the values.

Response:

For a LOOP initiating event, the U.S. EPR one-hour and two-hour LOOP nonrecovery probabilities are provided in Table 19-1-1. These are taken from NUREG/CR-6890 Table ES-3 and are frequency-weighted averages of the four LOOP category industry-average nonrecovery probabilities. Using this same method and substituting the Susquehanna Unit 1 or Unit 2 LOOP category frequencies from NUREG/CR-6890 Table D-1 provides the BBNPP LOOP nonrecovery probabilities, also summarized in Table 19-1-1.

Recovery from a LOOP that occurs during the 24-hour mission time is incorporated into the basic event LOOP24+REC, provided in Table 19-1-1. The unavailability value for this basic event is calculated by taking the generic at-power LOOP yearly frequency from NUREG/CR-6890 Table ES-1, removing the contribution of consequential LOOPs (consequential LOOPs are handled separately), dividing it by the number of days in a year and applying a one-hour nonrecovery probability. Using this same method and substituting the Susquehanna Unit 1 or Unit 2 LOOP category frequencies from NUREG/CR-6890 page D-8 results in the BBNPP value provided in Table 19-1-1.

Similarly, the U.S. EPR shutdown LOOP24+REC, provided in Table 19-1-1, is calculated by taking the generic shutdown LOOP yearly frequency from NUREG/CR-6890 Table ES-1, dividing it by the number of days in a year, and applying a one-hour nonrecovery probability. Shutdown LOOP recovery value is 0.413 and is based on generic data taken from NUREG/CR-6890 Table 4-1. The value is generic and applicable to BBNPP. This basic event, multiplied by a duration of the specific power operating state, is also used to model LOOP initiators and recoveries in the shutdown states.

In conclusion, the use of U.S. EPR data for LOOP recovery bounds BBNPP site-specific values and the difference does not have a significant impact on the PRA results.

Table 19-1-1: At-Power LOOP Recovery Basic Events

ID	Description	U.S. EPR Value	Equivalent BBNPP Value
REC OSP 1HR	Failure to Recover Offsite Power Within 1 Hour	5.30E-01	5.16E-01
REC OSP 2HR	Failure to Recover Offsite Power Within 2 Hours	3.18E-01	3.07E-01
LOOP24+REC **(at-power)**	Loss of Offsite Power During Mission Time and Failure of Recovery Within 1 Hour	4.80E-05	3.95E-05
LOOP24+REC **(at-shutdown)**	Loss of Offsite Power During Mission Time and Failure of Recovery Within 1 Hour	2.2E-04	2.2E-04

For consequential LOOP (not applicable in shutdown), there are four related basic events, which are provided in Table 19-1-2. The consequential LOOP values (the first column) are taken from NUREG/CR-6890 (page 51), and adjusted for different events. Recovery values (the second column) are taken from the same source (Table A-5). No recovery is credited for a consequential LOOP after a LOCA event. The consequential LOOP values and recoveries are not site-related, they are related to plant events. The values are generic and applicable to BBNPP. Note that these consequential LOOP values and recoveries are also provided in the response to U.S. EPR RAI Set No. 66, Question 19.01-46.

Table 19-1-2: At-Power Consequential LOOP Recovery Basic Events

ID	Description	Consequential LOOP Value	Non-Recovery Value	Total Value
LOOPCON+REC	Consequential LOOP and Failure of Recovery within 1 Hour for IEs Leading to Auto Scram	5.3E-03	0.33	1.80E-03
LOOPCSD+REC	Consequential LOOP and Failure of Recovery within 1 Hour for IEs Leading to a Controlled Shutdown	5.3E-04	0.33	1.80E-04
LOOPFCSD+REC	Consequential LOOP and Failure of Recovery within 1 Hour for Fire IEs Leading to a Controlled Shutdown	1.1E-03	0.33	3.60E-04
LOOPCONL+REC	Consequential LOOP for LOCA IEs	5.3E-03	1.0	5.30E-03

COLA Impact:

The FSAR will be revised to summarize the response to this question. The changes are shown below:

From FSAR Section 19.1.4.1

Loss of Offsite Power

LOOP frequencies used in the U.S. EPR PRA model are consistent with NUREG/CR-6890 guidelines (NRC, 2005). The LOOP frequency value used in the U.S. EPR PRA model is 1.9E-02/yr, based on the generic USA LOOP frequency value of 3.6E-02/yr from NUREG/CR-6890, modified by crediting U.S. EPR full load rejection capability for grid-related events and by excluding consequential LOOP events (consequential LOOP is treated separately in the PRA model).

The base value for LOOP frequency at the ~~SSES Units 1 and 2~~ BBNPP site from NUREG/CR-6890 is approximately 2.9E-02/yr. A composite LOOP frequency is calculated by using the U.S. EPR FSAR

PRA-generated frequency values for plant- and switchyard-centered LOOP events, and site-specific values for weather- and grid-centered LOOP events. This results in a LOOP event frequency (adjusted for consequential LOOP and full load rejection) of approximately 1.7E-02/yr for BBNPP. This LOOP event frequency is smaller than the value used in the U.S. EPR PRA model (1.9E-02/yr); therefore the U.S. EPR PRA model is conservative for LOOP event frequency at BBNPP. In general, given that the generic LOOP frequency for the USA is used in the U.S. EPR PRA, this frequency is likely to be conservative for advanced plants because better plant and switchyard performances are expected. Generic U.S. data is also considered applicable for LOOP recovery values, consequential LOOP values and shutdown LOOP frequency.

The site-specific LOOP non-recovery probabilities are as follows:

- 1-Hour LOOP non-recovery probability of 0.516 compared with a U.S. EPR value of 0.530
- 2-Hour LOOP non-recovery probability of 0.307 compared with a U.S. EPR value of 0.318
- 24-Hour LOOP and non-recovery probability of 3.95E-05 compared with a U.S. EPR value of 4.8E-05.

The use of U.S. EPR data for LOOP recovery bounds BBNPP site-specific values and the difference does not have a significant impact on the PRA results.

For consequential LOOP, there is limited industry data. The U.S. EPR FSAR used generic data from NUREG/CR-6890. This data is applicable to BBNPP.

The U.S. EPR shutdown LOOP recovery value is 0.413 and is generic data taken from NUREG/CR-6890. The value is applicable to BBNPP.

A summary of LOOP related conclusions is given below:

- The U.S. EPR PRA Loss of Offsite Power frequency bounds the BBNPP site-specific frequency.

- The U.S. EPR PRA Loss of Offsite Power recovery probabilities bound BBNPP site-specific values.

- The U.S. EPR PRA consequential LOOP probabilities do not need to be changed for BBNPP because they are not site dependent (they are initiating event dependent)

- The U.S. EPR PRA shutdown LOOP frequency and recovery probabilities are based on generic values and do not need to be changed for BBNPP.

Question 19-2:

Please provide enough detailed information regarding the circulating water system (CWS) (see page 19-7 of the FSAR) to support the conclusion that the U.S. EPR PRA bounds the plant-specific CWS design. Revise the FSAR to include a quantitative discussion of how the failure probability of the plant-specific CWS and normal heat sink (NHS) is bounded by the NHS undeveloped event modeled in the U.S. EPR PRA, as well as how assumptions related to the NHS model have been confirmed for the BBNPP site.

Response:

The NHS undeveloped event modeled in the U.S. EPR PRA is "SUP UHS NS". The scope of this undeveloped event, in addition to the NHS, includes the circulating water system ability to provide cooling to the Main Condenser and to supply cooling water to the Auxiliary Cooling Water System (ACWS). This undeveloped event has an estimated failure frequency of 1.0E-02 per year as part of the Loss of Balance of Plant (LBOP) initiating event and a corresponding failure probability of 2.8E-05 in a 24-hour mission time as a part of the Main Feedwater (MFW) and Startup Shutdown System (SSS) functional event.

The "SUP UHS NS" undeveloped event failure numbers are based on generic industry data from NUREG/CR-6928 and NUREG/CR-5750. NUREG/CR-6928 provides a Loss of Condenser Heat Sink initiating event frequency of 8.11E-02. NUREG/CR-5750 provides more detailed initiating event data and states that 46% of the Total Loss of Condenser Heat Sink contribution in PWRs is from Loss of Condenser Vacuum. It also states that 36% of the Loss of Condenser Vacuum contribution is from "problems related to the circulating water system: Loss of Non-Safety-Related Cooling Water." These values combine to result in a frequency of failure of 1.3E-02 per year. The use of a lesser value of 1.0E-02 per year is considered reasonable because

- The value of 1.3E-02 per year includes events such as screen plugging, not likely to occur in a closed system. BBNPP uses a closed-loop CWS.
- Failures of the CWS and NHS are multiple-counted in the U.S. EPR PRA model: They are implicitly included in the generic initiating event frequency for Loss of Main Feedwater (LOMFW) and Loss of Condenser and they are also explicitly included in the ACWS fault tree used in determining the LBOP initiating event frequency.

The values used for the NHS undeveloped event and described above are generic and applicable to BBNPP.

The Fussell-Vesely importance measure of the "SUP UHS NS" undeveloped event is 1.6E-05: it contributes less than 0.002% to the total CDF.

COLA Impact:

The FSAR will be revised to summarize the response to this question. The changes are shown below.

From FSAR Section 19.1.4.1

Site-Specific Balance of Plant Systems

Site-specific balance of plant (BOP) systems that are evaluated for potential site specific deviations are the Circulating Water System (CWS), the Closed Cooling Water System (CLCWS), the Auxiliary Cooling Water System (ACWS) and the Normal Heat Sink (NHS).

These site-specific systems were evaluated for differences between the U.S. EPR PRA assumptions and the BBNPP site-specific design. It was concluded that the U.S. EPR PRA inputs for the NHS, CWS, CLCWS, and ACWS provide a reasonable and conservative representation of these systems for BBNPP. This conclusion is based on the following.

- "Loss of Balance of Plant" initiating event is modeled by the fault tree for the BOP support systems. For "Loss of Condenser" and "Loss of Main Feedwater" initiating events the generic initiating event frequencies are used, based on current industry experience. The advanced plants are expected to perform better. Also, the modeling of both loss of main feedwater (generic data) and loss of balance of plant (fault tree) initiating events is conservative since the loss of main feedwater contribution is double-counted (due to a loss of the BOP supporting systems).
- The NHS and the CWS are modeled in the U.S. EPR PRA as one undeveloped event, with scope that includes failures of:
    - The NHS
    - The CWS ability to provide cooling to the Main Condenser and to the ACWS system

  This undeveloped event has a failure frequency of 1.0E-02 per year and a failure probability of 2.8E-05 in a 24-hour mission time. These numbers are based on generic industry data from NUREG/CR-6928 (NRC, 2007e) and NUREG/CR-5750 (NRC, 1999). These NUREGs give a frequency of failure of 1.3E-02 per year. The use of 1.0E-02 per year is considered reasonable for the following reasons:

    - The value of 1.3E-02 per year included events such as screen plugging, not likely in a closed system, as is used in BBNPP
    - Loss of Auxiliary Cooling Water events, to which failures of the CWS and NHS contribute, are also included within the Loss of Main Feedwater initiating event and the Loss of Condenser initiating event, multiple-counting some events

  The values used and system characteristics used for the NHS and CWS are generic and/or applicable to BBNPP.

- In addition, the U.S. EPR PRA~~,~~ unavailability of the NHS is estimated based on the unavailability of the safety UHS that requires operation of one of two cooling fans. This unavailability is expected to bound the unavailability for the BBNPP NHS that uses natural draft cooling towers.

- ~~The CWS is not explicitly modeled in the U.S. EPR PRA. Failures of the CWS are assumed to be enveloped by the failure probability of the NHS.~~ The U.S. EPR PRA model also does not credit the CWS pumps to cool ACWS loads. BBNPP has the ability to utilize either the CWS pumps or the ACWS pumps to supply auxiliary cooling water flow to turbine building equipment. Therefore, the ACWS unavailability in the U.S. EPR PRA is expected to bound the unavailability for the BBNPP ACWS.

- The Fussell-Vesely importance measures for the evaluated BOP SSCs are low (<0.01%). Based on these importance measures, the applicable U.S. EPR PRA inputs and assumptions would not have a significant impact on the BBNPP PRA results and insights.

From FSAR Section 19.1.9

NRC, 1991. Procedural and Submittal Guidance for the Individual Plant Examination of External Events, NUREG-1407, U. S. Nuclear Regulatory Commission, May 1991.

NRC, 1999. Rates of Initiating Events at U.S. Nuclear Power Plants, NUREG/CR-5750, Nuclear Regulatory Commission, February 1999.

NRC, 2001. Regulatory Guide 1.78, Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release, Revision 1, U.S. Nuclear Regulatory Commission, November 2001.

NRC, 2005. Reevaluation of Station Blackout Risk at Nuclear Power Plants, NUREG/CR-6980, U.S. Nuclear Regulatory Commission, November 2005.

NRC, 2007a. An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities, Regulatory Guide 1.200, U. S. Nuclear Regulatory Commission, January 2007.

NRC, 2007b. Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, NUREG-0800, U. S. Nuclear Regulatory Commission, January 2007.

NRC, 2007c. Design Basis Tornado and Tornado Missiles for Nuclear Power Plants, Regulatory Guide 1.76, Revision 1, U. S. Nuclear Regulatory Commission, March 2007.

NRC, 2007d. Tornado Climatology of the Contiguous United States, NUREG/CR-4461, Revision 2, U. S. Nuclear Regulatory Commission, February 2007.

NRC, 2007e. Industry Average Performance for Components and Initiating Events at U.S. Commercial Nuclear Power Plants, NUREG/CR-6928, U.S.Nuclear Regulatory Commission, February 2007.

RAI No. 19-3:
The application identifies the use of CWS pumps to cool turbine building equipment, as stated in the FSAR, as a plant-specific change to the design modeled in the PRA developed for the U.S. EPR design certification. Please identify all additional plant-specific changes to the design of the closed cooling water system (CLCWS) or auxiliary cooling water system (ACWS) as modeled in the U.S. EPR PRA. These systems are described in the AREVA NP response to Question 19-07 (RAI 2; May 30, 2008) on the U.S. EPR design certification application.

Response:

Regarding the Closed Cooling Water System (CCWS), the U.S. EPR PRA models this system as 3-50% capacity pumps and 3-50% capacity heat exchangers. This is consistent with the BBNPP CCWS design.

The U.S. EPR model of the Auxiliary Cooling Water System (ACWS) differs from the BBNPP system. The U.S. EPR PRA models the ACWS as a 1-out-of-2 trains system that takes suction from the Circulating Water System (CWS) with one pump normally running and one in standby. The BBNPP ACWS has a similar arrangement with the addition of a bypass around both pumps that allows the CWS to provide the water supply and motive force for the ACWS. This is the normal mode of operation with both pumps in standby and flow provided by the CWS. The use of U.S. EPR ACWS model bounds BBNPP specific system design and the difference does not have a significant impact on the PRA results.

As described in the BBNPP FSAR (19.1.4.1):

- The CWS is not explicitly modeled in the U.S. EPR PRA. Failures of the CWS are assumed to be enveloped by the failure probability of the NHS. The U.S. EPR PRA model also does not credit the CWS pumps to cool ACWS loads. BBNPP has the ability to utilize either the CWS pumps or the ACWS pumps to supply auxiliary cooling water flow to turbine building equipment. Therefore, the ACWS unavailability in the U.S. EPR PRA is expected to bound the unavailability for the BBNPP ACWS.

COLA Impact:

The BBNPP COLA will not be changed as a result of this question.

Question RAI No. 19-4:

Describe how the plant-specific ultimate heat sink (UHS) support systems (identified in section 9.2.5.2 of the BBNPP FSAR) are modeled in the BBNPP PRA. If the support systems are not modeled, demonstrate that the assumptions in the U.S. EPR PRA bound the plant-specific parameters for these support systems and that there is no significant impact on the PRA results and insights.

Response:

Ultimate Heat Sink (UHS) failures are part of the PRA modeling of the Component Cooling Water (CCW) / Essential Service Water (ESW) systems. They are also included in the evaluation of initiating events related to losses of one or two CCW common headers. These CCW common headers are supplied by one of two CCW trains, which are cooled by the ESW trains. The PRA model for the ESW trains and corresponding UHS supply does not include failures of the UHS support systems described in the BBNPP FSAR Section 9.2.5.2. These support systems are:

- Normal ESW Makeup, supplied from the Raw Water Supply System (RWSS)
- Blowdown from the ESW System Cooling Tower Basins
- ESW Emergency Makeup System
- ESW Makeup Water Chemical Treatment.

The water inventory in two ESW cooling tower basins is sufficient to support the plant operation for 72 hours after a plant trip. Therefore, these support systems have no impact on the ability of the ESW system to perform its function as a mitigating system for the 24-hour mission time following an initiating event.

It is possible that, during plant operation, failures of these support systems could disable one or multiple ESW trains, and lead to an initiating event. However, these events are not likely to have significant impact on the plant risk based on the following insights:

- Even if a failure of the RWSS disabled the normal ESW makeup, there would be extensive time available for the operators to recover the function using the emergency ESW Emergency Makeup System.
- In the unlikely event where the ESW Emergency Makeup System would also fail, a safe shutdown of the plant could still be successfully supported by the ESW cooling tower basin volume.

The above discussion shows that failures of the UHS support systems would be unlikely to trigger an initiating event and can be screened out as negligible contributors to the PRA results and insights.

COLA Impact:

The BBNPP COLA will not be changed as a result of this question.

Question 19-5:

Describe how the UHS makeup water intake structure ventilation system and UHS electrical building ventilation system are modeled in the BBNPP PRA. If failures of ventilation components are not modeled, provide a quantitative justification for exclusion of these ventilation failures from the model, with reference to failure probabilities, room heat-up assumptions, and operator actions that are possible. (Note that the AREVA NP responses to Questions 19-62 (RAI 7; June 16, 2008) and 19-169 (RAI 26; August 15, 2008) on the U.S. EPR design certification application address design-specific ventilation dependencies.)

Response:

The UHS makeup water intake structure ventilation system and the UHS electrical building ventilation system described in the question are included in the Emergency Service Water Emergency Makeup System (ESWEMS) Pumphouse Ventilation System described in the FSAR Section 9.4.15. The ESWEMS Pumphouse Ventilation System was not explicitly modeled in the BBNPP PRA.

The ESWEMS Pumphouse Ventilation System consists of four trains, one for each train of the ESWEMS. Failure of a component in the ESWEMS Pumphouse Ventilation System train could eventually result in a failure of the associated ESWEMS train. Combined with an independent failure of the Raw Water Supply System (RWSS), this could lead to the failure of a train of Essential Service Water (ESW), as discussed above in the response to Question 19-4. As discussed in that response, these events are not likely to have significant impact on the plant risk and failures of the UHS support systems can be screened out as negligible contributors to the PRA results and insights.

COLA Impact:

The BBNPP COLA will not be changed as a result of this question.

Question 19-6:

The AREVA NP response to Question 19-166 on the U.S. EPR FSAR (RAI 26; October 31, 2008) includes a draft version of Table 19.1-109, which lists assumptions from the PRA. Footnote 2 to the table states that these assumptions will be reevaluated as part of the PRA maintenance and upgrade process and that combined license (COL) item 19.1-9 is provided to confirm that assumptions used in the PRA remain valid during operation. Neither the proposed license condition related to COL item 19.1-9 nor the description of the maintenance and upgrade process in Section 19.1.2.4.1 of the BBNPP FSAR refers to this table in the U.S. EPR FSAR. Explain how this table would be used to ensure that the BBNPP PRA continues to reflect the plant as it is constructed and operated. (Note that the PRA maintenance and upgrade process is addressed in Title 10 of the Code of Federal Regulations (10 CFR) 50.71(h)(2).) Revise the FSAR and license condition as appropriate.

Response:

The description of how COL item 19.1-9 is addressed in the BBNPP FSAR Section 19.1.2.2 and in the Part 10 proposed license conditions, will be revised to include a reference to the design certification assumptions found in U.S. EPR FSAR Table 19.1-109.

COLA Impact:

The FSAR will be revised to summarize the response to this question. The changes are shown below.

19.1.2.2 PRA Level of Detail

The U.S. EPR FSAR includes the following COL Item in Section 19.1.2.2:
A COL applicant that references the U.S. EPR design certification will review as-designed and as-built information and conduct walk-downs as necessary to confirm that the assumptions used in the PRA, including PRA inputs to RAP and severe accident mitigation design alternatives (SAMDA), remain valid with respect to internal events, internal flooding and fire events (routings and locations of pipe, cable and conduit), and human reliability analyses (HRA) (i.e., development of operating procedures, emergency operating procedures and severe accident management guidelines and training), external events including PRA-based seismic margins, high confidence, low probability of failure (HCLPF) fragilities, and low power shutdown (LPSD) procedures.

This COL Item is addressed as follows:

As-designed and as-built information will be reviewed, and walk-downs will be performed, as necessary, to confirm that the assumptions used in the PRA, including design certification related PRA assumptions found in U.S. EPR FSAR Table 19.1-109 and PRA inputs to RAP and SAMDA, remain valid with respect to internal events, internal flooding and fire events (routings and locations of pipe, cable and conduit), and HRA (i.e., development of operating procedures, emergency operating procedures and severe accident management guidelines and training), external events including PRA-based seismic margins, HCLPF fragilities, and LPSD procedures. This shall be performed prior to fuel load.

Part 10 Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) and ITAAC Closure
Appendix A - Proposed Combined Licensing Conditions
2. COL Items:

Proposed Conditions:

COL Item 19.1-9 in Section 19.1.2.2

As-designed and as-built information shall be reviewed, and walk-downs shall be performed, as necessary, to confirm that the assumptions used in the Probabilistic Risk Assessment (PRA), including design certification related PRA assumptions found in U.S. EPR FSAR Table 19.1-109 and PRA inputs to the Reliability Assurance Program and Severe Accident Mitigation Design Alternatives, remain valid with respect to internal events, internal flooding and fire events (routings and locations of pipe, cable and conduit), and Human Reliability Assurance (i.e., development of operating procedures, emergency operating procedures and severe accident management guidelines and training), external events including PRA-based seismic margins, high confidence, low probability of failure fragilities, and low power shutdown procedures. These activities shall be performed prior to initial fuel load.

Question 19-7:

Clarify whether the risk metrics resulting from the quantitative screening of external events described in Section 19.1.5 of the BBNPP FSAR are outputs of the at-power PRA or the PRA considering all modes of operation. If the at-power PRA was used, revise the FSAR to expand the description of the screening process and its numerical results to all modes of operation. The staff needs this information to evaluate the significance, if any, of external events occurring during low power and shutdown.

Response:

The risk metrics resulting from the quantitative screening of external hazards are based on the at-power PRA, and are judged to be bounding for all modes of operation, because:

- External hazards generally affect non-safety structures which are not designed to withstand the same challenges as safety structures. Non-safety systems modeled in the PRA are mostly related to balance of plant systems, which are more important for power operation than during shutdown.
- The U.S. EPR at-power PRA model conservatively assumes a full year (365 days) of operation.

As requested, an evaluation of the risk impact of external hazards occurring during shutdown is provided to demonstrate that the risk metrics shown in Section 19.1.5 of the BBNPP Plant FSAR are indeed bounding for all modes of operation.

In the BBNPP FSAR detailed quantitative modeling has been performed for two external hazards: tornadoes (bounds high winds), and aircraft hazard. These were screening calculations and were based on the U.S. EPR at-power PRA model which conservatively assumes a full year (365 days) of operation. A detailed quantitative analysis based on the U.S. EPR shutdown PRA model is provided below to show that the core damage frequency (CDF) obtained from the at-power screening calculations bounds the CDF from all modes of operation.

Quantitative screening was also performed for the external flooding hazard. The external flooding risk comes from a potential loss of balance of plant initiating event. This initiating event does not apply outside of at-power operations, therefore the assumption of a full year of operation bounds the CDF from all modes of operation.

The remaining external hazards are screened based on not having an adverse impact on the plant, or based on the frequency of the hazard alone. Therefore, their screening is applicable to all modes of operation.

An evaluation of the bounding tornado and aircraft crash scenarios is performed with the Low Power and Shutdown (LPSD) U.S. EPR PRA model to confirm that the existing screening calculations are bounding for all modes of operation. The following three scenarios are examined:

1. Tornado strike disabling all structures, systems and components (SSC) not designed to withstand tornadoes. This would result in an unrecoverable loss of offsite power (LOOP), as well as the loss of all electrical equipment located in the switchgear building (SWGRB): SBO diesel generators, non safety 2-hour and 12-hour batteries.
2. Aircraft crash into the turbine building and the switchyard. The consequences of this scenario are similar to those of the tornado, with LOOP and failure of Switchgear Building (SWGRB) SSC.

3. Aircraft crash into Safeguard Building (SB) 1 or 4. This is assumed to result in a pipe break in the running residual heat removal (RHR) train. All SSC located in the affected SB are assumed to be disabled.

The first two scenarios described above would not result directly in an initiating event (that is defined in shutdown as a departure from heat balance conditions). However, the loss of offsite power increases the likelihood of a loss of RHR, because RHR pump operation then requires support by the emergency diesel generators (EDG). Therefore these two scenarios are analyzed for a possible consequential loss of RHR, in which case they are transferred to the loss of RHR event tree.

The third scenario, modeled as an aircraft crash into SB1, results in an interfacing system LOCA (ISLOCA). Since all SSC located inside the affected SB (e.g., SB1) are inoperable, the ISLOCA must be isolated by one of the two RHR isolation valves in series located inside containment. One of the two valves is powered from Division 1 which is also assumed inoperable due to the loss of SB1. Therefore the other isolation valve (powered from Division 2) must close to isolate the ISLOCA. Only automatic isolation is credited. Failure to isolate is assumed to result in core damage. Successful isolation results in a safe state.

The three scenarios defined above are quantified using the LPSD PRA model. The quantification results are shown below in Table 19-7-1. The LPSD tornado CDF is 3.0E-10/yr. The total LPSD aircraft crash CDF is 4.2E-10/yr.

Table 19-7-1 compares the LPSD CDF for these scenarios with the at-power CDF obtained from the quantitative analyses described in BBNPP FSAR (Section 19.1.5.4.1 for tornado and 19.1.5.4.4 for aircraft crash), and with the LPSD CDF for internal events (5.8E-8/yr, U.S. EPR FSAR, Section 19.1.6.2.1). This comparison shows that the CDF resulting from external hazards at shutdown is negligible (0.4%) compared with the current CDF for these same external hazards. It is also negligible compared with the current LPSD internal event CDF (0.7% for aircraft crash, 0.5% for tornado).

For each external hazard, the calculated LPSD risk is approximately 0.4 % of the at-power risk. The assumed total duration of shutdown in the U.S. EPR PRA is 21 days, which is approximately 6% of the year. This shows that the average daily risk in shutdown due to these external events is much lower than the at-power risk. Therefore, the existing analysis, which assumes 365 days of at-power operation, is bounding.

Based on the presented results, two conclusions can be drawn:

- For both analyzed external hazards, the CDF obtained by explicitly modeling external hazards occurring during shutdown is negligible compared to the CDF presented in FSAR Section 19.
- The current risk metrics resulting from the quantitative screening of external events described in Section 19.1.5 bound the risk metrics from all modes of operation.

Table 19-7-1: Calculation of Tornado and Aircraft Crash CDF for BBNPP for LPSD Operation

External Hazard Scenario	Scenario Frequency (1/year)	Scenario at-power CDF (from BBNPP FSAR) (1/year)	Scenario LPSD CDF (calculated in this sensitivity run) (1/year)	Ratio of Scenario LPSD CDF to Total Scenario CDF	Ratio of Scenario LPSD CDF to Internal Event LPSD CDF
Tornado	**8.7E-05**	**7.7E-08**	**3.0E-10**	**0.4%**	**0.5%**
Aircraft Crash into SB1 or 4	1.6E-06	9.4E-08	4.0E-10	0.4%	0.7%
Aircraft Crash into TB	6.2E-06	5.4E-09	2.1E-11	0.4%	0.04%
Total Aircraft Crash		**9.9E-08**	**4.2E-10**	**0.4%**	**0.7%**

COLA Impact:

The BBNPP COLA will not be changed as a result of this question.