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**BELL BEND NUCLEAR POWER PLANT  
BBNPP PLOT PLAN CHANGE COLA  
SUPPLEMENT, PART 3 (ER); SECTION 7.3  
BNP-2010-277                      Docket No. 52-039**

- References: 1) BNP-2010-117, T. L. Harpster (PPL Bell Bend, LLC) to U.S. NRC, "May 2010 BBNPP Schedule Update", dated May 7, 2010
- 2) BNP-2010-246, R. R. Sgarro (PPL Bell Bend, LLC) to U.S. NRC, "BBNPP Plot Plan Change Supplement Schedule Update," dated September 28, 2010

In Reference 1, PPL Bell Bend, LLC (PPL) provided the NRC with schedule information related to the intended revision of the Bell Bend Nuclear Power Plant (BBNPP) footprint within the existing project boundary which has been characterized as the Plot Plan Change (PPC). As the NRC staff is aware, the plant footprint relocation will result in changes to the Combined License Application (COLA) and potentially to new and previously responded to Requests for Additional Information (RAIs). PPL declassified this docketed schedule information from regulatory commitment status in Reference 2, with an agreement to update the staff via weekly teleconferences as the project moves forward.

PPL has committed to provide the NRC with COLA supplements, consisting of revised COLA Sections and associated RAI responses/revisions, as they are developed. These COLA supplements will only include the changes related to that particular section of the COLA and will not include all conforming COLA changes. Conforming changes for each supplement necessary for other COLA sections will be integrated into the respective COLA supplements and provided in accordance with the schedule, unless the supplement has already been submitted. In the latter case, the COLA will be updated through the normal internal change process. The revised COLA supplements will also include all other approved changes since the submittal of Revision 2. All COLA supplements and other approved changes will ultimately be incorporated into the next full COLA revision.

*D102*  
*NRC*

Enclosure 1 provides the revised BBNPP COLA Supplement, Part 3 (Environmental Report), Section 7.3, Revision 2a. The revised BBNPP COLA section supersedes previously submitted information in its entirety. No departures and/or exemptions to this BBNPP COLA section have been revised as a result of the PPC. No new or revised RAI responses are included in this transmittal.

The only new regulatory commitment is to include the revised COLA section (Enclosure 1) in the next COLA revision.

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 October 28, 2010

Respectfully,



Rocco R. Sgarro

RRS/kw

Enclosure 1: Revised BBNPP COLA Part 3 (ER); Section 7.3, Revision 2a

cc: (w/o Enclosures)

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Enclosure 1

Revised BBNPP COLA Part 3 (ER); Section 7.3, Revision 2a

### 7.3 SEVERE ACCIDENT MITIGATION ALTERNATIVES

The purpose of the severe accident mitigation alternatives (SAMA) analysis is to review and evaluate both design and non-hardware (i.e., operation and maintenance programs) alternatives that could significantly reduce the radiological risk from a postulated severe accident by preventing core damage and significant releases from the containment. The U.S. EPR Design Certification Environmental Report (U.S. EPR DC ER) (AREVA, 2007a)2009 for the U.S. EPR design submitted by AREVA NP evaluated both design and non-hardware alternatives.

The primary focus of the U.S. EPR DC ER was the severe accident mitigation design alternatives (SAMDA). However, non-hardware alternatives were identified in the analysis and will be addressed when the plant design is finalized and processes and procedures are being developed for the U.S. EPR. The conclusions drawn in the U.S. EPR DC ER are applicable to BBNPP.

#### 7.3.1 SAMDA Analysis Methodology

The methodology used to develop a comprehensive list of U.S. EPR SAMDA candidates, define the screening criteria used to categorize the SAMDA candidates, and the cost-benefit evaluation is summarized in this section based on the U.S. EPR DC ER (AREVA, 2007a)2009 for the U.S. EPR.

The comprehensive list of SAMDA candidates was developed for the U.S. EPR design by reviewing industry documents for generic PWR enhancements and considering plant-specific enhancements. The SAMDA candidates were defined as enhancements to the U.S. EPR plant that have the potential to prevent core damage and significant releases from the containment. The primary industry document supporting the development of U.S. EPR generic PWR SAMDA candidates was NEI 05-01 (NEI, 2005).

In addition to the generic SAMDA candidates, the results of the Level 1 and Level 2 PRA were reviewed to identify plant-specific modifications for inclusion in the comprehensive list of SAMDA Candidates.

The U.S. EPR top 100 U.S. EPR Level 1 PRA core damage frequency (CDF) cutsets were evaluated to identify plant-specific those modifications for inclusion that would reduce the likelihood of occurrence of the significant core damage sequences. As stated in the comprehensive list U.S. EPR FSAR Section 19.1.4.1.2.3 (Significant Cutsets and Sequences), ninety-five percent of SAMDA candidates. The the total CDF is represented by over 12,000 cutsets for the U.S. EPR design; however, the top 100 cutsets represent include all cutsets contributing >1 percent to the total CDF. For the U.S. EPR design, this equates to approximately 50 percent of the total core damage frequency (CDF) for CDF. In fact the U.S. EPR. The selection of the top 100 cutsets conservatively includes cutsets of low importance. For example, the percentage of the individual contribution to the total CDF for the cutsets 101<sup>st</sup> below the top 100 cutset was minimal. Therefore, these cutsets were not likely contributors for identification of cost beneficial enhancements for the U.S. EPR design. 0.10 percent.

The U.S. EPR top 100 large release frequency (LRF) cutsets were evaluated to identify those modifications that would reduce the likelihood of occurrence of the significant containment challenges. This population of cutsets specifically excluded the contribution to LRF of core damage sequences due to Main Steam Line Break (MSLB) inside containment with main feedwater unisolated, as this sequence of events was determined not to lead to core damage

or LRF. This exclusion ensures that the conservative treatment of an event does not artificially reduce the importance of other containment failure mechanisms. The top 100 LRF cutsets include all cutsets contributing greater than 1 percent to the total LRF. For the U.S. EPR design this equates to approximately 50 percent of the total LRF, and includes many low importance cutsets that individually contribute only 0.10 percent to the total LRF.

An extensive evaluation of the top 100 cutsets was completed in order to establish that all possible Consistent with current regulatory guidance and industry practice, the risk significant design alternatives for the U.S. EPR were addressed. design have been addressed by detailed evaluations of the top 100 CDF and LRF cutsets to identify plant-specific modifications for inclusion in the comprehensive list of U.S. EPR SAMDA candidates. Through evaluation of the evaluation, top 100 Level 1 PRA cutsets, numerous U.S. EPR specific operator actions and hardware-based SAMDA candidates were developed. When evaluating the top 100 LRF cutsets no additional SAMDA candidates were identified. The U.S. EPR DC ER (AREVA, 2007a) 2009) provides a detailed list of the SAMDA candidates for the U.S. EPR. EPR design. The SAMDA candidates identified in the U.S. EPR DC ER are applicable to BBNPP.

The SAMDA candidates developed for the U.S. EPR design were qualitatively screened using seven categories. The intent of the screening is to identify the candidates for further risk-benefit calculation. For each SAMDA candidate, a screening criteria and basis for screening was identified to justify the implementation or exclusion of the SAMDA candidate in the U.S. EPR. EPR design. The seven categories used during the screening process included:

- ◆ Not applicable. The SAMDA candidates were identified to determine which are definitely not applicable to the U.S. EPR. EPR design. Potential enhancements that are not considered applicable to the U.S. EPR design are those developed for systems specifically associated with boiling water reactors (BWR) or with specific PWR equipment that is not in the U.S. EPR design.
- ◆ Already implemented. The SAMDA candidates were reviewed to ensure that the U.S. EPR design does not already include features recommended by a particular SAMDA candidate. Also, the intent of a particular SAMDA candidate may have been fulfilled by another design feature or modification. In these cases the SAMDA candidates are already implemented in the U.S. EPR plant design. If a SAMDA candidate has already been implemented at the plant, it is not retained.
- ◆ Combined. If one SAMDA candidate is similar to another SAMDA candidate, and can be combined with that candidate to develop a more comprehensive or plant-specific SAMDA candidate, only the combined SAMDA candidate is retained for screening.
- ◆ Excessive implementation cost. If a SAMDA candidate requires extensive changes that will obviously exceed the maximum benefit, even without an implementation cost estimate and therefore incurs an excessive implementation cost, it is not retained.
- ◆ Very low benefit. If a SAMDA candidate is related to a non-risk significant system for which change in reliability is known to have negligible impact on the risk profile, it is deemed to have a very low benefit and is not retained.
- ◆ Not required for design certification. Evaluation of any potential procedural or surveillance action SAMDA candidates are not appropriate until the plant design is finalized and the plant procedures are being developed. Therefore, if a SAMDA candidate is related to any of these enhancements, it is not retained for this analysis.

- ◆ Considered for further evaluation. If a particular SAMDA candidate was not categorized by any of the preceding categories, then the SAMDA candidate is considered for further evaluation and subject to a cost-benefit analysis.

The screening categories were chosen based on guidance from NEI 05-01. The U.S. EPR DC ER contains a detailed description of each of the categories. The screening categories are applicable to BBNPP.

The SAMDA candidates categorized as "Not required for design certification" in the AREVA NP Environmental Report Standard Design Certification were re-evaluated for BBNPP. These SAMDA candidates were re-evaluated using the screening methodology in AREVA NP Environmental Report Standard Design Certification. An additional screening category called "Not a design alternative" was used to capture any SAMDA candidate not related to plant design. This category included SAMDA candidates related to procedure modifications, training, or surveillance. If a SAMDA candidate is related to any of these enhancements, it is not retained for this analysis.

After the screening process was completed, the SAMDA candidates that were placed in the Considered for Further Evaluation category would require a cost-benefit evaluation. The cost-benefit evaluation of each SAMDA candidate would determine the cost of implementing the specific SAMDA candidate with the maximum averted cost risk from the implementation of the specific SAMDA candidate. The maximum averted cost risk, typically referred to as the maximum benefit, equates to the cost obtained by the elimination of all severe accident risk.

### 7.3.2 Severe Accident Cost Impact and Maximum Benefit for BBNPP

The severe accident impact is determined by summing the occupational exposure cost, on-site cost, public exposure, and off-site property damage. The methodologies provided in NEI 05-01 (NEI, 2005) and NUREG/BR-0184 (NRC, 1997) were used as guidance. The principal inputs to the calculations were the CDF, 2,000 dollars per person-rem (NRC, 1997), licensing period of 60 years, 7% best estimate discount rate (NEI, 2005), and 3% upper bound discount rate (NEI, 2005). The maximum benefit calculation performed in the U.S. EPR DC ER used the whole body dose and economic impact from U.S. EPR Level 3 PRA analysis, which was based on population data from 2000. The maximum benefit calculation for BBNPP uses the economic impact and whole body dose for a 2050 population (Table 7.3-1). ~~The bestpoint estimate and upper bound mean value CDF with 2008 replacement power costs~~ severe accident impact cost for BBNPP is also shown in Table 7.3-1.

The total cost impact of a severe accident (maximum benefit) must account for the risk contribution from internal initiating events, internal flooding, fire, and seismic. The total core damage frequency (CDF) at power for the U.S. EPR design includes the contribution from internal initiating events (55%), internal flooding (12%), and fire (33%) (AREVA, 2007b). A seismic ~~margin~~ assessment instead of a seismic PRA was completed for the U.S. EPR design. The seismic ~~margin~~ analysis yields valuable information regarding the ruggedness of the seismic design with respect to the potential severe accident (AREVA, 2007b). However, it does not result in the estimation of seismic CDF which is used to determine the cost impact of a severe accident in the SAMDA analysis. In order to account for the seismic contribution, it was assumed that the seismic risk is equivalent to the fire risk since the fire risk in the U.S. EPR PRA analysis was evaluated to be the highest external event risk at 33% of the total CDF.

Increasing the severe accident impact by 33 percent includes the contribution from seismic risk and is the maximum benefit for BBNPP. The maximum benefit for BBNPP is ~~\$52,064 (best estimate) and \$87,530 (upper bound)~~, based on the point estimate CDF with 2008 replacement power costs is \$72,388.

The percentage contributions of each hazards group are slightly different for the mean value CDF. Therefore, seismic risk based on the mean value CDF is assumed to be 28 percent of total mean value CDF. The resulting maximum benefit on the mean value CDF would be \$92,677.

### 7.3.3 Sensitivity Studies

Sensitivity cases were performed to investigate the sensitivity of certain parameters in the Bell Bend SAMDA analysis. A total of five sensitivity benefit calculations were performed for both the point estimate and mean value CDF with 2008 replacement power costs. Below is a brief description of the sensitivity cases.

- ◆ The first case investigated the sensitivity of the base case to the discount rate by assuming a lower discount rate of three percent. The method to calculate the present value of replacement power for a single event is discussed in U.S. EPR DC ER (AREVA 2009).
- ◆ The second case investigated the sensitivity of the base case to the discount rate by assuming a lower discount rate of five percent.
- ◆ The third case investigated the sensitivity of the base case to the on-site dose estimates. For the base case analysis, an immediate and long-term on-site dose to plant personnel following a severe accident is 3,300 rem and 20,000 rem, respectively. Therefore, this sensitivity case used the recommended high estimate dose values of 14,000 rem and 30,000 rem for immediate and long term dose on-site respectively, as suggested in (NRC, 1997).
- ◆ The fourth case investigated the sensitivity of the base case to the total on-site cleanup cost. For the base case analysis, the total on-site cleanup cost following a severe accident is taken to be \$1,500,000. Therefore, this analysis assumed a high estimated on-site cleanup cost of \$2,000,000 as suggested in (NRC, 1997).
- ◆ The fifth case also investigated the sensitivity of the increase in the replacement power cost for the U.S. EPR design. This sensitivity case projected that the cost of replacement power would double between 2008 and 2015. This would result in electricity cost of 24 cents/kw-h in 2015 based upon the assumption that the cost of electricity in 2008 is 12 cents/kw-h. The inflation rate for this sensitivity case was calculated using the the method outlined in (AREVA, 2009).

Table 7.3-2 and Table 7.3-3 provide the calculated benefit for the point estimate and mean value CDF with 2008 replacement power cost sensitivity cases discussed above.

### 7.3.4 Results and Summary

A total of 167 SAMDA candidates developed from industry and U.S. EPR documents were evaluated in the U.S. EPR DC ER completed by AREVA NP. The basis for screening is provided in detail for each SAMDA candidate in the U.S. EPR DC ER. Below is a summary of the results of the SAMDA analysis performed for the U.S. EPR and is applicable to BBNPP.

- ◆ Twenty-five SAMDA candidates were not applicable to the U.S. EPR design.

- ◆ ~~Seventy~~Sixty-nine SAMDA candidates were already implemented into the U.S. EPR design either as suggested in the SAMDA or an equivalent replacement that fulfilled the intent of the SAMDA. These SAMDA candidates are summarized in Table 7.3-4.
- ◆ Four SAMDA candidates were combined with another SAMDA because they had the same intent.
- ◆ ~~Forty-five~~Forty-three SAMDA candidates were categorized as not a design alternative because they were related to procedure modifications, training, or surveillance.
- ◆ One SAMDA candidate was categorized as very low benefit.
- ◆ ~~Twenty-three~~Twenty-five SAMDA candidates were categorized as excessive implementation cost.
- ◆ None of the SAMDA candidates were categorized as consider for further evaluation.

The low probability of core damage events in the U.S. EPR coupled with reliable severe accident mitigation features provide significant protection to the public and the environment. Specific severe accident mitigation design alternatives from previous industry studies, and from U.S. EPR probabilistic risk assessment (PRA) insights, were measured against broad acceptance criteria in the U.S. EPR DC ER (AREVA, ~~2007a~~, 2009). Since none of the SAMDA candidates were categorized as considered for further evaluation, a cost-benefit analysis (i.e., risk reduction, value impact ratios) was not required for the U.S. EPR SAMDA analysis. The overall conclusion of the U.S. EPR SAMDA analysis is that no additional plant modifications are cost beneficial to implement due to the robust design of the U.S. EPR with respect to prevention and mitigation of severe accidents. The maximum benefit from the U.S. EPR DC ER was reevaluated for BBNPP. The detailed analysis and conclusions in the U.S. EPR DC ER remain applicable for BBNPP.

### 7.3.5 References

**AREVA, ~~2007a~~, 2009.** AREVA NP Environmental Report Standard Design Certification, ANP-10290, Revision ~~0~~, 1, AREVA NP, ~~November 2007~~, September 2009.

**AREVA, 2007b.** AREVA NP U.S. EPR Final Safety Analysis Report, Revision 0, AREVA NP, December 2007.

**NEI, 2005.** Severe Accident Mitigation Alternatives (SAMA) Analysis, Guidance Document, NEI 05-01, Revision A, Nuclear Energy Institute November 2005.

**NRC, 1997.** Regulatory Analysis Technical Evaluation Handbook, NUREG/BR-0184, Nuclear Regulatory Commission, January 1997.

**Table 7.3-1— Severe Accident Cost Impact**

	<b>Best-Point Estimate CDF (7% Discount Rate)Rate and 2008 Replacement Power Costs)</b>	<b>Upper-Bound Mean Value CDF (3% (7% Discount Rate)Rate and 2008 Replacement Power Costs)</b>
Averted Occupational Exposure (AREVA, 2007a)	\$264	\$607\$369
Averted Onsite Costs (AREVA, 2007a)	\$29,680\$45,102	\$47,011\$62,974
Averted Public Exposure	\$6,332\$6,247	\$12,519\$6,247
Averted Offsite Property Damage Costs	\$2,870\$2,814	\$5,675\$2,814
Severe Accident Cost Impact <sup>(a)</sup> Internal Events, Internal Flooding, Fire	\$39,146\$54,427	\$65,812\$72,404
Maximum Benefit <sup>(b)</sup> Internal Events, Internal Flooding, Fire, Seismic	\$52,064\$72,388	\$87,530\$92,677
Notes: (a) Severe Accident Cost Impact is the sum of the Averted Occupational Exposure, Averted Onsite Cost, Averted Public Exposure and Averted Offsite Property Damage Cost. (b) Maximum Benefit is calculated by increasing the Severe Accident Cost Impact by 33%.		

**Table 7.3-2— Maximum Benefit for Sensitivity Cases (Point Estimate CDF with 2008 Replacement Power Costs)**

<b>Case</b>	<b>Sensitivity Case 1: Discount Rate 3%</b>	<b>Sensitivity Case 2: Discount Rate - 5%</b>	<b>Sensitivity Case 3: High Estimated Dose (On-Site)</b>	<b>Sensitivity Case 4: High On-site Cleanup Costs</b>	<b>Sensitivity Case 5: Increase Replacement Power Cost via Inflation for 2015 Dollars</b>
Immediate Dose Savings (On-site)	\$97	\$66	\$209	\$49	\$49
Long Term Dose Savings (On-site)	\$510	\$317	\$322	\$215	\$215
Total Accident Related Occupational Exposure (AOE)	\$607	\$384	\$531	\$264	\$264
Cleanup/ Decontamination Savings (On-site)	\$19,110	\$13,053	\$8,045	\$10,727	\$8,045
Replacement Power Savings (On-site)	\$129,243	\$62,524	\$36,835	\$36,835	\$73,675
Averted Costs of On-site Property Damage (AOSC)	\$148,353	\$75,577	\$44,880	\$47,562	\$81,720
<b>Total On-site Benefit</b>	<b>\$148,960</b>	<b>\$75,960</b>	<b>\$45,411</b>	<b>\$47,826</b>	<b>\$81,984</b>
Averted Public Exposure (APE)	\$12,354	\$8,438	\$6,248	\$6,248	\$6,248
Averted Offsite Damage Savings (AOC)	\$5,565	\$3,801	\$2,814	\$2,814	\$2,814
<b>Total Offsite Benefit</b>	<b>\$17,918</b>	<b>\$12,239</b>	<b>\$9,062</b>	<b>\$9,062</b>	<b>\$9,062</b>
<b>Total Benefit (On-site + Offsite)</b>	<b>\$166,878</b>	<b>\$88,199</b>	<b>\$54,473</b>	<b>\$56,888</b>	<b>\$91,046</b>
<b>Total Benefit (On-site + Offsite + External Events)</b>	<b>\$221,947</b>	<b>\$117,305</b>	<b>\$72,449</b>	<b>\$75,611</b>	<b>\$121,091</b>

**Table 7.3-3— Maximum Benefit for Sensitivity Cases (Mean Value CDF with 2008 Replacement Power Costs)**

<b>Case</b>	<b>Sensitivity Case 1: Discount Rate 3%</b>	<b>Sensitivity Case 2: Discount Rate - 5%</b>	<b>Sensitivity Case 3: High Estimated Dose (On-Site)</b>	<b>Sensitivity Case 4: High On-site Cleanup Costs</b>	<b>Sensitivity Case 5: Increase Replacement Power Cost via Inflation for 2015 Dollars</b>
Immediate Dose Savings (On-site)	\$136	\$93	\$292	\$69	\$69
Long Term Dose Savings (On-site)	\$712	\$443	\$449	\$300	\$300
Total Accident Related Occupational Exposure (AOE)	\$847	\$535	\$741	\$368	\$368
Cleanup/ Decontamination Savings (On-site)	\$26,682	\$18,225	\$11,233	\$14,977	\$11,233
Replacement Power Savings (On-site)	\$180,452	\$87,298	\$51,430	\$51,430	\$102,867
Averted Costs of On-site Property Damage (AOSC)	\$207,134	\$105,522	\$62,663	\$66,407	\$114,100
<b>Total On-site Benefit</b>	<b>\$207,981</b>	<b>\$106,058</b>	<b>\$63,404</b>	<b>\$66,775</b>	<b>\$114,468</b>
Averted Public Exposure (APE)	\$12,354	\$8,438	\$6,248	\$6,248	\$6,248
Averted Offsite Damage Savings (AOC)	\$5,565	\$3,801	\$2,814	\$2,814	\$2,814
<b>Total Offsite Benefit</b>	<b>\$17,918</b>	<b>\$12,239</b>	<b>\$9,062</b>	<b>\$9,062</b>	<b>\$9,062</b>
<b>Total Benefit (On-site + Offsite)</b>	<b>\$225,900</b>	<b>\$118,297</b>	<b>\$72,466</b>	<b>\$75,837</b>	<b>\$123,530</b>
<b>Total Benefit (On-site + Offsite + External Events)</b>	<b>\$289,151</b>	<b>\$151,420</b>	<b>\$92,756</b>	<b>\$97,072</b>	<b>\$158,118</b>