Response to

Request for Additional Information No. 4, Revision 0

4/10/2008
U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 19 - Probabilistic Risk Assessment and Severe Accident Evaluation
Application Section: 19 SPLA Branch

Question 19-49:

In accordance with guidance provided in SRP Section 19.1.3.4, please explicitly describe the uses of the EPR internal flooding PRA and insights/assumptions in the design process to reduce the weaknesses/vulnerabilities, to develop design requirements, and to improve the EPR design safety profile.

Response to Question 19-49:

The main insight from the EPR internal flooding PRA that is considered with the U.S. EPR designers is the flood in the RB Annulus, which is discussed in the response to Question 19-52. In evaluation of the U.S. EPR design, no other internal flooding PRA insights were identified as significant. Insights and assumptions associated with the flooding PRA have been and will continue to be considered in the design process as the U.S. EPR design evolves. In accordance with COL item 19.1-8, a COL applicant that references the U.S. EPR design certification will describe the uses of PRA in support of site-specific design programs and processes during the design phase.

FSAR Impact:

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

Question 19-50:

Section 19.1.5.2.1.2 indicates that, for each selected location, the flooding sources of piping, valves, pumps, tanks, and pools in the location were considered in the flooding frequency estimate. However, in the next paragraph, it was mentioned that, EPRI TR-102266 Pipe Failure Study was chosen to evaluate internal flooding frequencies. Please clarify whether the valve, pump, and tank ruptures were included in the frequency estimation. If so, describe the process and provide the references used to assign the equipment rupture frequencies.

Response to Question 19-50:

The valve, pump, and tank ruptures were not included in the internal flooding frequency estimation because they are not explicitly considered in the reference which was used (EPRI TR-102266). However, tank and pump leakages were considered as failure modes in the PRA model.

FSAR Impact:

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

Question 19-51:

Section 19.1.5.2.1.3 states that, “Other effects of pipe breaks, like jet impingement, spray, pipe whip, or humidity, were not specifically evaluated because all equipment at a location is considered failed.” Does EPR internal flooding analysis consider the potential of electrical equipment failures in other divisions or at other locations due to water contact or pipe whip on cables/conduits/electrical cabinets?

Response to Question 19-51:

A response to this question will be provided by June 30, 2008.

Question 19-52:

The following findings and questions relate to the reactor building (RB) annulus flooding scenario.

a. End State 4 of RB flooding event tree (ET) should be named as FLD-ANN SB3.

b. Describe the consequences of End States 2, 3, and 4 and the contributions of these sequences to the total flooding CDF/LRF.

c. What is the initiating flooding frequency of this ET?

d. What are the elevations of the SB2 door, SB3 door, and connection boxes?

e. What are the probability values of top events “Door of SB2 Fails to Open” and “Door of SB3 Fails to Open”?

f. What is the probability of “Operator Fails to Isolate FWDS”?

g. The probability that the connection boxes to the containment would fail if submerged is estimated to be 0.5. If the state of knowledge regarding the penetration design is limited and if these boxes are not watertight, the higher failure probability of 1.0 should be assigned.

Response to Question 19-52a:

It is correct that End State 4 results in SB 3 being flooded due to flood propagation from the Annulus. However, due to the symmetry between SB 2 and SB 3, the same flood scenario, FLD-ANN SB2, is used to model flood propagation to SB 2 and in SB 3. The frequency for this scenario is a sum of the flood frequency in SB 2 and the flood frequency in SB 3. Therefore, FLD-ANN SB2 is a designated scenario for FLD-ANN SB3.

Response to Question 19-52b:

End States 2, 3 and 4 are evaluated in two different flooding scenarios:

1. End State 2 corresponds to the flood scenario FLD-ANN-SB23: All safety systems in SB 2 and SB 3 are assumed to be disabled by the flood. The CDF due to this scenario is smaller than 1E-12/yr, and the contribution to the total flooding CDF/LRF is negligible.

2. End States 3 and 4 correspond to the flood scenario FLD-ANN-SB2, as discussed in response 19-52a above: All safety systems in SB 2 are assumed to be disabled by the flood. The CDF due to this scenario is smaller than 1E-11/yr, and the contribution to the total flooding CDF/LRF is negligible.

Those two scenarios are defined along with the other flood scenarios in the FSAR Table 19.1-39. Their contribution to the total flood CDF is shown in FSAR Table 19.1-40.

Response to Question 19-52c:

The Annulus flooding frequency for this ET is calculated as the frequency of a Fire Water Distribution System (FWDS) pipe break within the Annulus. It is based on the system segment count and the corresponding segment frequency from the EPRI Pipe Failure Study (TR-102266). This frequency is estimated to be 3.2E-04/year, as shown in the FSAR Table 19.1-38.

Response to Question 19-52d:

The elevations of the SB 2 and SB 3 doors are Elevation ±0'-0" with this being the bottom of door elevation. The elevation of the lowest electrical penetration is approximately at Elevation +16'. The connection boxes at this elevation provide a termination point for the cables routed to the annulus from the Safeguards and Fuel Buildings. The elevation of the lowest containment electrical penetration assembly and junction box is approximately Elevation +24'.

Response to Question 19-52e:

The probability of a door failing to open given a high water column (higher than 20') in the annulus is assumed to be 0.1. This is an estimate based on the fact that these doors are not designed to withstand any water column from the Annulus side. Once one door has opened, the water column will decrease and the likelihood of the second door remaining closed is estimated to be high (0.9). In this analysis it is assumed that the SB 2 door is the first to fail.

These probabilities are shown in Figure 19-52-1, which corresponds to the event tree shown in the FSAR on Page 19.1-117.

Response to Question 19-52f:

The probability of "Operator Fails to Isolate FWDS" is 0.02. Parameters of this evaluation are given in Table 19-52-1.

Table 19-52-1—Parameters for Operator Fails to Isolate FWDS Annulus Break

OPE-FWDS-ANN - Operator Fails to Isolate a FWDS break in the Annulus							
	Basic HEP	**Time available (min)**	**Time Required (min)**	**Timing PSF**	**Stress PSF**	**Other PSFs**	**HEP mean value**
Diagnosis	0.01	27	10	1	2	1	2.0E-02
Action	0.001	27	5	1	2	1	2.0E-03
Total							**2.2-02**

Available time is conservatively based on the time to reach Elevation +0' which is estimated to be 30 minutes. A delay time of 3 minutes is assumed to trigger the sump alarm.

This probability is also shown in Figure 19-52-1

Response to Question 19-52g:

The probability that the connection boxes to the containment would fail if submerged of 0.5 was assumed based on limited design information. The junction boxes used for cable terminations in the annulus are designed to protect against water spray.

It is not known if this scenario would result in an initiating event and what the overall impact on the plant operation would be. In the flooding analysis, a decision was made not to select a conservative penetration failure probability of 1, as suggested in the question, because:

a) A conditional core damage probability of 1 is already conservatively selected for this scenario,

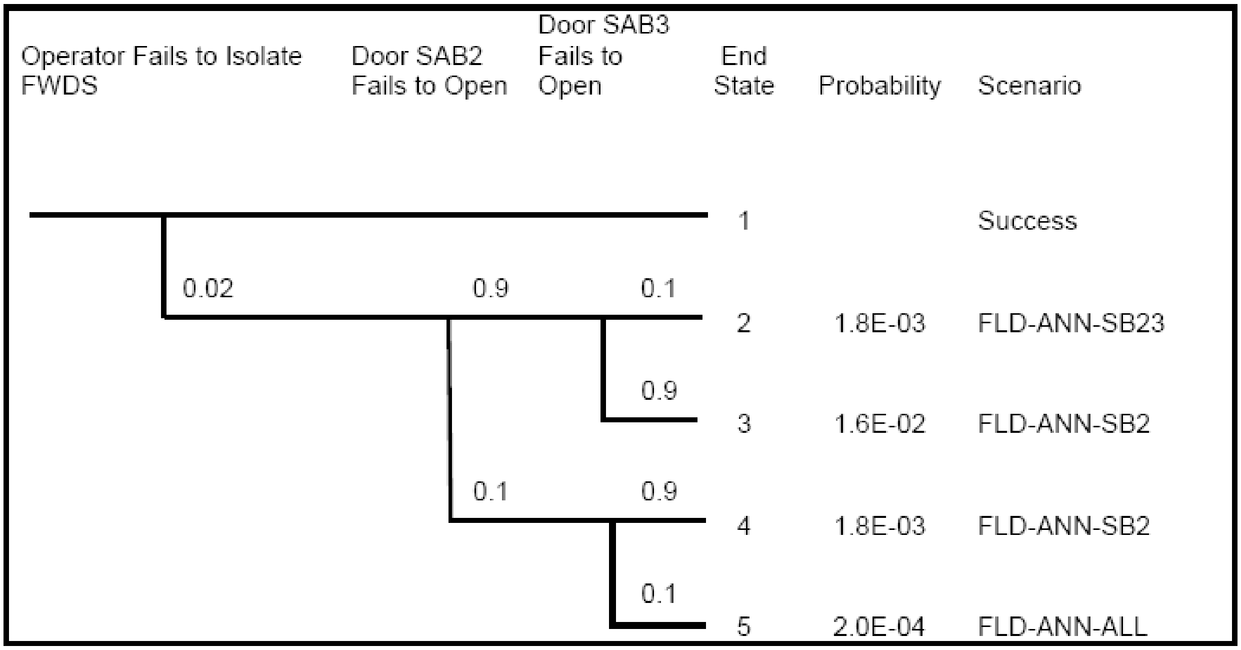
b) This conservative selection would lead to a strong dominance of this flood scenario over the others, so that the flood sequences and importance measures presented in the FSAR would not be informative.

This assumption is listed as one of the key assumptions in the flooding analysis section of the FSAR (Chapter 19.1.5.2.2.5). A sensitivity analysis to this assumption was not explicitly presented, because it is a straightforward result from the FSAR Table 19.1-40: Doubling initiating event FLD-ANN-ALL frequency would increase the internal flooding CDF by 50% (CDF delta of 3.2E-8/yr). This would correspond to an increase in the total CDF of less than 6%.

FSAR Impact:

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

Figure 19-52-1—Event Tree used to Evaluate Annulus Flood Sequences



Question 19-53:

What is the probability value used to represent the operator action credited to manually isolate an emergency feedwater pipe break occurring in any of the four switchgear buildings and to initiate demineralized water system makeup to the tanks of the intact trains?

Response to Question 19-53:

The HEP associated with this HFE is calculated to be 4.2E-02. Parameters of this evaluation are given in Table 19-53-1, as follows:

Table 19-53-1—Parameters for Operator Fails to Isolate EFWS Break

OPE-EFW-1H - Operator Fails to Isolate a break in the EFWS								
	Basic HEP	**Time available (min)**	**Time Required (min)**	**Timing PSF**	**Stress PSF**	**Complexity PSF**	**Other PSFs**	**HEP mean value**
Diagnosis	0.01	65	10	1	2	2	1	4.0E-02
Action	0.001	65	35	1	1	2	1	2.0E-03
Total								**4.2E-02**

Available time is based on the estimated time of 70 minutes before losing inventory of three EFW tanks. A delay time of 5 minutes is assumed to detect level drop.

FSAR Impact:

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

Question 19-54:

The control room does not appear to be part of the internal flooding assessment. Please provide justification for excluding the control room from the internal flood model.

Response to Question 19-54:

The main control room (MCR) was not included in the internal flooding PRA because no flood scenario was identified that would affect the MCR. The MCR is located at Elevation +53' of SB 2. Fluid-carrying systems, at or above Elevation +53', that were considered as flooding hazards are given below:

- Fire Water Distribution System (FWDS).
- Safety Chilled Water System (SCWS).
- Potable and Sanitary Water System (PSWS).
- Demineralized Water Distribution System (DWDS).
- Component Cooling Water System, Piping and Surge Tank (CCWS).

The flooding analysis for the Safeguard Buildings, summarized in FSAR Section 3.4.3.4, shows that the floors at and above Elevation +53' are designed to direct water releases from the FWDS, the SCWS, the DWDS, the CCWS, via openings and pipe shafts, to the lower elevations of the building. Therefore, the control room would not be affected by a break in any of these systems.

There are parts of the PSWS that are located within the control room (piping to the operator's toilets). A pipe break or a system malfunction in this area could result in a flooding event. The occurrence of a significant flooding event from this system is judged to be unlikely based on the following:

- The PSWS is fitted with two automatic isolation valves upstream of the connection to SB 2. These isolation valves will close when the water height reaches the actuation level of the local measurements in the operator's toilet rooms.
- If the automatic isolation fails, it is very likely that the operators will notice the flood and manually isolate it. The flow rate for a potable and sanitary water pipe break is expected to be low (1" pipe), giving operators ample time to terminate the flood.

Flooding induced by fire suppression actions in or in the vicinity of the MCR is also analyzed in the SB 2 flooding analysis. The flooding hazard associated with the fire fighting is assumed to be enveloped by the MCR fire scenario, which is modeled as part of the internal fire PRA. Therefore, no flood scenario capable of impacting the MCR is identified in the PRA and the MCR is screened out from the flooding PRA.

FSAR Impact:

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

Question 19-55:

Sections 19.1.5.2.2.1 and 19.1.5.2.3 provide point estimate values for internal flooding CDF and LRF respectively, please discuss the CDF and LRF in terms of mean frequencies in these sections.

Response to Question 19-55:

This response will be provided together with the response to RAI 2 Question 19-5 by May 30, 2008.