## ArevaEPRDCPEm Resource

**From:** Pederson Ronda M (AREVA NP INC) [Ronda.Pederson@areva.com]
**Sent:** Wednesday, February 11, 2009 4:59 PM
**To:** Getachew Tesfaye
**Cc:** NOXON David B (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC)
**Subject:** Response to U.S. EPR Design Certification Application RAI No. 138, Supplement 1
**Attachments:** RAI 138 Supplement 1 Response US EPR DC.pdf

Getachew,

AREVA NP Inc. (AREVA NP) provided responses to 14 of the 15 questions of RAI No. 138, with a schedule for the remaining question, on December 19, 2008.

The attached file, "RAI 138 Supplement 1 Response US EPR DC.pdf" provides a technically correct and complete response to the remaining question, as committed. Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response.

The following table indicates the pages in the response document, "RAI 138 Supplement 1 Response US EPR DC.pdf" that contain AREVA NP's response to RAI 138 Question 19-249.

| Question # | Start Page | End Page |
|---|---|---|
| RAI 138 — 19-249 | 2 | 6 |

This concludes the formal AREVA NP response to RAI 138 and there are no questions from this RAI for which AREVA NP has not provided responses.

Sincerely,


*Ronda Pederson*
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**From:** WELLS Russell D (AREVA NP INC)
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**To:** 'Getachew Tesfaye'
**Cc:** Pederson Ronda M (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC); SLIVA Dana (EXT); 'John Rycyna'
**Subject:** Response to U.S. EPR Design Certification Application RAI No. 138, FSAR Ch 19

Getachew,

The proprietary and non-proprietary versions of the response to RAI No. 138 are submitted via AREVA NP Inc. letter, "Response to U.S. EPR Design Certification Application RAI No. 138," NRC 08:104, dated December 19, 2008. The enclosure to that letter provides technically correct and complete responses to 14 of the 15 questions in RAI No. 138. An affidavit to support withholding of information from public disclosure, per 10CFR2.390(b), is provided as an enclosure to that letter.

The schedule for technically correct and complete responses to the remaining RAI No. 138 question, is provided below and remains unchanged.

| Question # | Response Date |
|---|---|
| RAI 138 — 19-249 | February 13, 2009 |

Sincerely,

(Russ Wells on behalf of)
Ronda Pederson
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**From:** Getachew Tesfaye [mailto:Getachew.Tesfaye@nrc.gov]
**Sent:** Wednesday, November 19, 2008 12:37 PM
**To:** ZZ-DL-A-USEPR-DL
**Cc:** Theresa Clark; Hanh Phan; Edward Fuller; Lynn Mrowca; John Rycyna; Joseph Colaccino
**Subject:** U.S. EPR Design Certification Application RAI No. 138 (1598), FSARCh. 19

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on November 6, 2008, and discussed with your staff on November 13, 2008. Draft RAI Question 19-248 was modified as a result of that discussion. The schedule we have established for review of your application assumes technically correct and complete responses within 30 days of receipt of RAIs. For any RAIs that cannot be answered within 30 days, it is expected that a date for receipt of this information will be provided to the staff within the 30 day period so that the staff can assess how this information will impact the published schedule.

Thanks,
Getachew Tesfaye
Sr. Project Manager
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**Hearing Identifier:** AREVA_EPR_DC_RAIs
**Email Number:** 210

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**Request for Additional Information No. 138, Supplement 1 (1598), Revision 0**

**11/19/2008**

**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**

**QUESTIONS for PRA Licensing, Operations Support and Maintenance Branch 1 (AP1000/EPR Projects) (SPLA)**

**Question 19-249:**

Page 19.1-37 of the FSAR describes the heating, ventilation, and air conditioning (HVAC) dependencies for the U.S. EPR. The importance of these dependencies appears to be driven by the assumption that the CCWS pumps in Divisions 1 and 4 are initially running. Loss of the CCWS common header after HVAC-induced switchover failure results in failure of the CCWS-cooled safety chilled water system (SCWS) equipment in Division 2 or 3. However, if the CCWS pumps in Divisions 2 and 3 were initially running, the air-cooled SCWS divisions could still provide HVAC to safeguard buildings 1 and 4 following failure of the CCWS common header, and only one building would be impacted by the initial HVAC failure. The staff needs additional information to ensure that conservatism in this assumption is not masking important PRA contributors. Specifically:

a. Discuss the rationale for assuming the Divisions 1 and 4 CCWS pumps are initially running.
b. Discuss, with support from sensitivity studies as needed, how the results and insights of the U.S. EPR PRA (e.g., important initiating events, sequences, and failures) would be different if the Divisions 2 and 3 CCWS pumps were initially running.
c. If the U.S. EPR profile is significantly different in the two scenarios, revise the FSAR to include this insight.
d. Discuss whether one configuration would be preferable from a risk perspective and how this information would be communicated to plant operators.
e. Discuss any design changes that have been considered to reduce the importance of this assumption, and why they were not implemented.

**Response to Question 19-249:**

***Response to Question 19-249a:***

At any given time one component cooling water system (CCWS) pump from the following divisional pairs: Divisions 1-2 and 3-4 are running to support the associated common header. Component cooling water/essential service water (CCW/ESW) pumps are typically rotated during a year to provide an equal wear per pump; approximately six months operation per pump. Table 19-249a-1 gives operating configurations and corresponding rotating strategies. The rotating strategies will be defined in the plant online maintenance strategies.

Because of a typical switchover strategy associated with the CCW pumps supplying the CCW common header, modeling of all different configuration and strategies results in a complex PRA model unpractical for calculations with RiskSpectrum®. Configuration 14: Divisions 1 and 4 CCW/ESW pumps initially running, is selected for the PRA model to capture specific risk impacts, such as the potential for the inter-divisional heating, ventilation, and air conditioning (HVAC) dependencies discussed in the question. In addition, Divisions 1 and 4 are most challenging, because all the breaks are assumed to occur in Division 4, and these two divisions are potentially supplied from the station blackout (SBO) diesel generators.

***Response to Question 19-249b:***

Sensitivity analyses are performed using a simplified model allowing different CCW operating configurations. Due to the use of flag events, this model produces conservative results; therefore, the core damage frequency (CDF) for Configuration 14 is slightly higher than in the standard model.

Using that model, the total CDF (at power) for the operating configurations defined in the response to Question 19-249a, is as follows:

Using the U.S. EPR FSAR PRA Model:

- Configuration 14: CCW Pump 1 and Pump 4 operating: CDF=5.3E-7/yr

Using the simplified multi-configuration model for this sensitivity study:

- Configuration 14: CCW Pump 1 and Pump 4 operating: CDF=5.7E-7/yr
- Configuration 13: CCW Pump 1 and Pump 3 operating: CDF=4.0E-7/yr
- Configuration 23: CCW Pump 2 and Pump 3 operating: CDF=3.6E-7/yr
- Configuration 24: CCW Pump 2 and Pump 4 operating: CDF=4.4E-7/yr

An average CDF based on these results, and different rotating strategies,is:

- Strategy 1: CDF = 4.4E-7/yr
- Strategy 2: CDF = 4.2E-7/yr
- Strategy 3: CDF = 4.7E-7/yr

As shown above, the selected strategy has no significant impact on the average CDF. The average CDF is approximately 20 percent lower than the Configuration 14 total CDF at power presented in the U.S. EPR FSAR. In the shutdown PRA model the CCW/ESW pumps supporting operating residual heat removal (RHR) trains are always running, and the overall impact of different configurations is negligible.

Based on the above results, the risk insights from Configuration 23 are compared with the risk insights from Configuration 14 (two configurations with the highest and the lowest CDF values). The following risk insights are compared: top initiating events, top cutsets/sequences, a few selected Fussel-Vesely (FV) and risk achievement worth (RAW) importance measures.

A comparison of the important initiating events (with percentage contribution higher than 1 percent) is presented in Table 19-249b-1. As can be seen from this table, although the individual contribution of each initiator is affected by the selected configuration, the overall effect on the initiators selected as important is negligible. Change in the IE contribution associated with Configuration 23 versus Configuration 14 can be explained by two major insights:

(1) Fires in Safeguard Buildings 1 and 4 are now less important than fires in Safeguard Buildings 2 and 3;

(2) Loss of offsite power (LOOP) events, which disable maintenance HVAC trains, are a major player in the HVAC dependency in Configuration 14; thus the share of LOOP events in the total CDF decreases, mechanically resulting in an increase in the share of other initiators.

A review of the results shows the expected change in the top cutsets: failure of two divisions because of the HVAC dependency does not appear in any of the top 200 cutsets. However, this does not change the main conclusions given in U.S. EPR FSAR Tier 2, Chapter 19. Importance measure values for HVAC components–chillers, fans, SCWS pumps, operator HVAC recovery actions–are reduced in this configuration, but these components would still be identified as important.

A combination of these two configurations, as presented in Strategy 3 (or Strategy 1) defined in the Table 19-249a-1, reduces any identified deviations.

***Response to Question 19-249c:***

The U.S. EPR risk profile is not significantly different between Configuration 14 and Configuration 23 and especially not in a combination of different configurations that is likely to occur in the plant operation. However, the insight from this sensitivity study will be added to the U.S. EPR FSAR.

In U.S. EPR FSAR Tier 2, Section 19.1.4.1.2.5, under *Major Modeling Assumptions*, after: "For a running system, Trains 1 and 4 are assumed to be running. These assumptions affect train-specific importance measures", the following will be added:

> "The assumption on the running CCW trains results in an inclusion of the HVAC dependency between two safety divisions, and presents a slightly higher risk configuration."

In U.S. EPR FSAR Tier 2, Table 19.1-109, Assumption No. 3, the following paragraph will be added :

> "Trains 1 and 4 are assumed to be running for CCW/ESW pumps. This assumption on the running CCW trains results in an inclusion of the HVAC dependency between two safety divisions, and presents a slightly higher risk configuration."

***Response to Question 19-249d:***

As discussed in the response to Question 19-249b, even though Configuration 23 could be preferable from a risk perspective, no significant risk differences are identified in the yearly risk for different pump rotating strategies.

***Response to Question 19-249e:***

No design changes are identified as a result of evaluating this assumption. The overall risk is very low in any configuration, and does not significantly vary between different pump rotating strategies.

**FSAR Impact:**

U.S. EPR FSAR Tier 2, Section 19.1.4.1.2.5 and Table 19.1-109 will be revised as described in the response and indicated on the enclosed markup.

**Table 19-249a-1—Operating Configurations and Strategies**

| CCW/ESW Running Pumps | Strategy 1 | Strategy 2 | Strategy 3 |
|---|---|---|---|
| **Configuration 13**: CCW/ESW Pump 1 and Pump 3 operating | 3 months | 6 months | |
| **Configuration 14**: CCW/ESW Pump 1 and Pump 4 operating | 3 months | | 6 months |
| **Configuration 23**: CCW/ESW Pump 2 and Pump 3 operating | 3 months | | 6 months |
| **Configuration 24**: CCW/ESW Pump 2 and Pump 4 operating | 3 months | 6 months | |

**Table 19-249b-1—Comparison of Important Initiating Events for Two Different CCWS Running Pump Configurations**

| No. | Initiating Event ID | Initiating Event Description | Configuration 14 | Configuration 23 |
|---|---|---|---|---|
| 1 | IE LOOP | Initiator - Loss Of Offsite Power | 28.3% | 18.1% |
| 2 | IE FIRE-SAB14-AC | Initiator - Fire in Switchgear Room of Safeguard Building 1 (or 4) | 14.5% | 2.6% |
| 3 | IE SLOCA | Initiator - Small LOCA (0.6 to 3-Inch Diameter) | 8.5% | 13.9% |
| 4 | IE FIRE-MS-VR | Initiator - Fire in One of Two MF/MS Valve Rooms With Spurious Opening of 1 MSRIV | 5.9% | 9.4% |
| 5 | IE FLD-ANN ALL | Initiator - Flood in the RB Annulus (Contained) | 5.7% | 9.0% |
| 6 | IE GT | Initiator - General Transient (Includes Turbine Trip and Reactor Trip) | 5.2% | 2.4% |
| 7 | IE FIRE-SWGR | Initiator - Fire in the Switchgear Building | 4.9% | 1.4% |
| 8 | IE FIRE-MCR | Initiator - Fire in the Main Control Room | 4.5% | 7.1% |
| 9 | IE FLD-SAB14 FB | Initiator - Flood in Safeguard Building 1 or 4 (Pump Room) Including Fuel Building | 3.6% | 1.0% |
| 10 | IE FIRE-SAB-MECH | Initiator - Fire in the Pump Room of Any Safeguard Building | 2.8% | 13.1% |
| 11 | IE SLBI | Initiator - Steam Break Inside Containment | 2.1% | 3.3% |
| 12 | IE SGTR | Initiator - Steam Generator Tube Rupture | 2.0% | 3.2% |
| 13 | IE LOMFW | Initiator - Total Loss of Main Feedwater | 1.8% | 1.7% |
| 14 | IE LBOP | Initiator - Loss of Balance of Plant - Closed Loop Cooling Water or Aux Cooling Water | 1.8% | 1.4% |
| 15 | IE LOC | Initiator - Loss of Main Condenser (Includes MSIV Closure etc.) | 1.2% | 1.2% |
| 16 | IE LOCCW-CH1L | Initiator - Loss of CCWS/ESWS - Leak in Common Header 1 | 1.2% | 1.4% |
| 17 | IE FLD-EFW | Initiator - EFW Pipe Break | 1.1% | 0.7% |
| 18 | IE FLD-TB | Initiator - Flood in the Turbine Building | 1.0% | 0.5% |
| 19 | IE SLBO | Initiator - Steam Break Downstream of MSIV | 0.7% | 1.0% |
| 20 | IE LOCCW-ALL | Initiator - Loss of CCWS/ESWS - Total Loss of 4 Divisions | 0.6% | 1.0% |
| 21 | IE FIRE-SAB23-AC | Initiator - Fire in Switchgear Room of Safeguard Building 2 (or 3) | 0.1% | 2.7% |

# U.S. EPR Final Safety Analysis Report Markups

- In the calculation of the IE frequencies by fault trees, all year mission time was used for the common cause events. However, running and stand-by pumps were modeled in different common cause groups.

- IEs representing losses of the CCW headers and trains are conservatively assumed to lead to a loss of the corresponding ESW train, even though this may not always be the case (a loss of one ESW train always leads to a loss of the corresponding CCW train, but not vice versa). This dependency is modeled correctly in the system fault trees, but because of the software limitations, was not captured in the IE model.

- In modeling SLOCA events, if the MHSI system fails, it is assumed that operators would initiate a fast cooldown. However, if a partial cooldown function fails (therefore failing MHSI), it is assumed that operators will initiate feed and bleed. These modeling assumptions and timing of these sequences will be analyzed in more details after operating procedures are available.

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- Breaks/failures are always assumed to occur in Train 4. For a running system, Train 1 and Train 4 are assumed to be running. These assumptions effect train-specific importance measures. The assumption on the running CCW trains results in an inclusion of the HVAC dependency between two safety divisions, and presents a higher risk configuration.

- Because of the circular logic problem, a failure of electrical supplies to the HVAC/CCW/ESW trains used in the electrical system fault trees was not considered. Because of that, some interdependencies between different HVAC divisions may not be completely captured in the PRA model.

- Consequential LOOP is considered. It is assumed that the consequential LOOP probability would be different between plant trips, LOCA events and events likely to lead to a controlled shutdown.

- Recovery of offsite power is considered for transient events in two hours and for RCP seal LOCA events in one hour. Possible recovery for other times is partially credited through modifying the EDG running mission time, which was reduced to 12 hours. SBO DGs mission time was not modified.

- Conservative simplifying assumptions are made when modeling ATWS events; possibility to relieve RCS pressure is not credited for any events which lead to a loss of FW, (e.g., a loss of MFW or a loss of condenser). Exceptions are LOOP events, when the RCP are tripped instantly.

Most of these assumptions are addressed in the sensitivity analysis, Section 19.1.4.1.2.6.

### 19.1.4.1.2.6 Sensitivity Analysis

A sensitivity analysis was performed to evaluate the impact of a series of modeling assumptions, including most of the above assumptions, on the internal events CDF. The sensitivity results are shown in Table 19.1-15—U.S. EPR Level 1 Internal Events

**Table 19.1-109—U.S. EPR PRA General Assumptions Sheet 1 of 15**

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| No. | Category[1] | PRA General Assumptions[2] |
|---|---|---|
| 1 | Model | Because of the circular logic problem, failures of electrical supplies to the HVAC/CCW/ESW trains used in the electrical system fault trees are not considered. Because of that, some interdependencies between different HVAC divisions may not be completely captured in the PRA model. |
| 2 | IE | Initiating event frequencies are based on a full year at power and were not adjusted for time spent at shutdown. For the current estimated shutdown duration, an adjustment factor would be 0.95. This assumption will be evaluated when plant–specific shutdown information is available. |
| 3 | IE | Trains 1 and 4 are assumed to be running for CCW/ESW pumps. This assumption on the running CCW trains results in an inclusion of the HVAC dependency between two safety divisions, and presents a higher risk configuration. Trains 1 and 4 are assumed to be operating for 8760 hr/year in order to calculate the LOCCW/ESW initiating event frequencies. The all year mission time is also used for the system common cause events. |
| 4 | IE | In the U.S. EPR PRA, LOCAs are assumed to occur on RCS loop 4. For medium and large break LOCAs, any injection flow (MHSI, LHSI, or accumulators) into cold leg 4 is assumed to pass out the break and not to reach the reactor vessel and core. In addition, due to the effects of steam entrainment during large break LOCAs, flow into the vessel from LHSI injection into cold leg 1 is also assumed to be unavailable. |
| 5 | IE | Very small leaks are not considered in the LOCA analysis since the response to this event would be similar to that of a transient and are within the makeup capability of the CVCS. |
| 6 | IE | In modeling SLOCA events, if the MHSI system fails, it is assumed that operators would initiate a fast cooldown. However, if a partial cooldown function fails (therefore failing MHSI), it is assumed that operators will initiate feed and bleed. These modeling assumptions and timing of these sequences will be analyzed in more detail after operating procedures are available. |
| 7 | IE | Spurious operation of MHSI and LHSI (a spurious SIS signal) are screened out as initiating events because the pump's shutoff head is lower than the reactor coolant system (RCS) normal operating pressure and spurious operation is not likely to cause an initiating event. |
| 8 | IE | One or few MSIVs closure was not considered as an initiating event; it was assumed that the operators can open the MSIV bypass valves from the control room to support secondary cooling. Closure of all MSIVs is included in the loss of main condenser initiating event. |