

ArevaEPRDCPEm Resource

From: Pederson Ronda M (AREVA NP INC) [Ronda.Pederson@areva.com]
Sent: Monday, July 13, 2009 6:42 PM
To: Tesfaye, Getachew
Cc: BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC); NOXON David B (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 236, FSARCh. 19
Attachments: RAI 236 Response US EPR DC.pdf

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 236 Response US EPR DC.pdf" provides technically correct and complete responses to 3 of the 5 questions.

The following table indicates the respective pages in the response document, "RAI 236 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 236 — 19-309	2	5
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A complete answer is not provided for 2 of the 5 questions. The schedule for a technically correct and complete response to these questions is provided below.

Question #	Response Date
RAI 236 — 19-312	September 11, 2009
RAI 236 — 19-313	September 11, 2009

Sincerely,

Ronda Pederson

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Licensing Manager, U.S. EPR Design Certification

AREVA NP Inc.

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From: Tesfaye, Getachew [mailto:Getachew.Tesfaye@nrc.gov]

Sent: Friday, June 12, 2009 10:55 AM

To: ZZ-DL-A-USEPR-DL

Cc: Fuller, Edward; Clark, Theresa; Phan, Hanh; Hamzehee, Hossein; Mrowca, Lynn; Chowdhury, Prosanta; Rycyna,

John; Colaccino, Joseph; ArevaEPRDCPEm Resource

Subject: U.S. EPR Design Certification Application RAI No. 236 (2589), FSARCh. 19

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on May 21, 2009, and discussed with your staff on June 11, 2009. Draft RAI Question 19-308 was deleted and Draft RAI Question 19-313 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
NRO/DNRL/NARP
(301) 415-3361

Hearing Identifier: AREVA_EPR_DC_RAIs
Email Number: 650

Mail Envelope Properties (5CEC4184E98FFE49A383961FAD402D310110EF60)

Subject: Response to U.S. EPR Design Certification Application RAI No. 236, FSARCh.
19
Sent Date: 7/13/2009 6:42:01 PM
Received Date: 7/13/2009 6:42:02 PM
From: Pederson Ronda M (AREVA NP INC)

Created By: Ronda.Pederson@areva.com

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Files	Size	Date & Time
MESSAGE	2407	7/13/2009 6:42:02 PM
RAI 236 Response US EPR DC.pdf		106220

Options

Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

Response to

Request for Additional Information No. 236

6/12/2009

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 2
(ESBWR/ABWR Projects) (SPLB)**

Question 19-309:

(Follow-up to RAI 19-160)

In response to RAI 19-160, the results of EPR-specific RELAP5 analyses are presented for a main steam line break inside containment for about 3 hours after accident initiation. These results show that after 2.8 hours, the containment pressure is within ~45 psi of the median failure pressure of the containment.

Please provide the results of the analyses that extend to 24 hours and supply all the “best estimate” reactivity coefficients used in these analyses (i.e., Boron, Scram, Doppler and Moderator as a function of the relevant independent variable).

Response to Question 19-309:

The Response to RAI 19-160 (set 22, supplement 3) included a RELAP5 analysis. Because the RELAP5 analysis lacks a containment pressure response, a separate MAAP4 analysis was performed to determine the containment pressure response. This MAAP4 analysis has been extended to 24 hours and the containment pressure is shown in Figure 19-309-1.

The best estimate reactivity coefficients used in the RELAP5 analysis can be found in Tables 19-309-1 – 19-309-5. The scram worth in \$ is -19.634. All reactivity information is from an 18 month, equilibrium cycle at end-of-cycle conditions.

Table 19-309-1—Post-Scram Reactivity vs. Boron Density

Boron Density (kg/m³)	Reactivity (\$)
0.0000	0.00
0.2787	-5.40
0.5573	-10.68
0.8360	-15.87
1.1147	-20.97
1.3934	-25.98
1.6720	-30.91
1.9507	-35.77
2.2294	-40.55

Table 19-309-2—Pre-Scram Doppler Reactivity vs. Fuel Temperature

Fuel Temp. (°F)	Reactivity (\$)
1252.8	-3.87592
1123.5	-3.34851
1000.3	-2.78126
884.7	-2.17226
777.7	-1.52343
677.6	-0.82717
577.9	0.00

Table 19-309-3—Post-Scram Doppler Reactivity vs. Fuel Temperature

Fuel Temp. (°F)	Reactivity (\$)
2000	-3.01
1600	-1.90
1400	-1.31
1000	-0.03
991	0.00
800	0.65
600	1.38
400	2.14
300	2.54
200	2.95
100	3.37

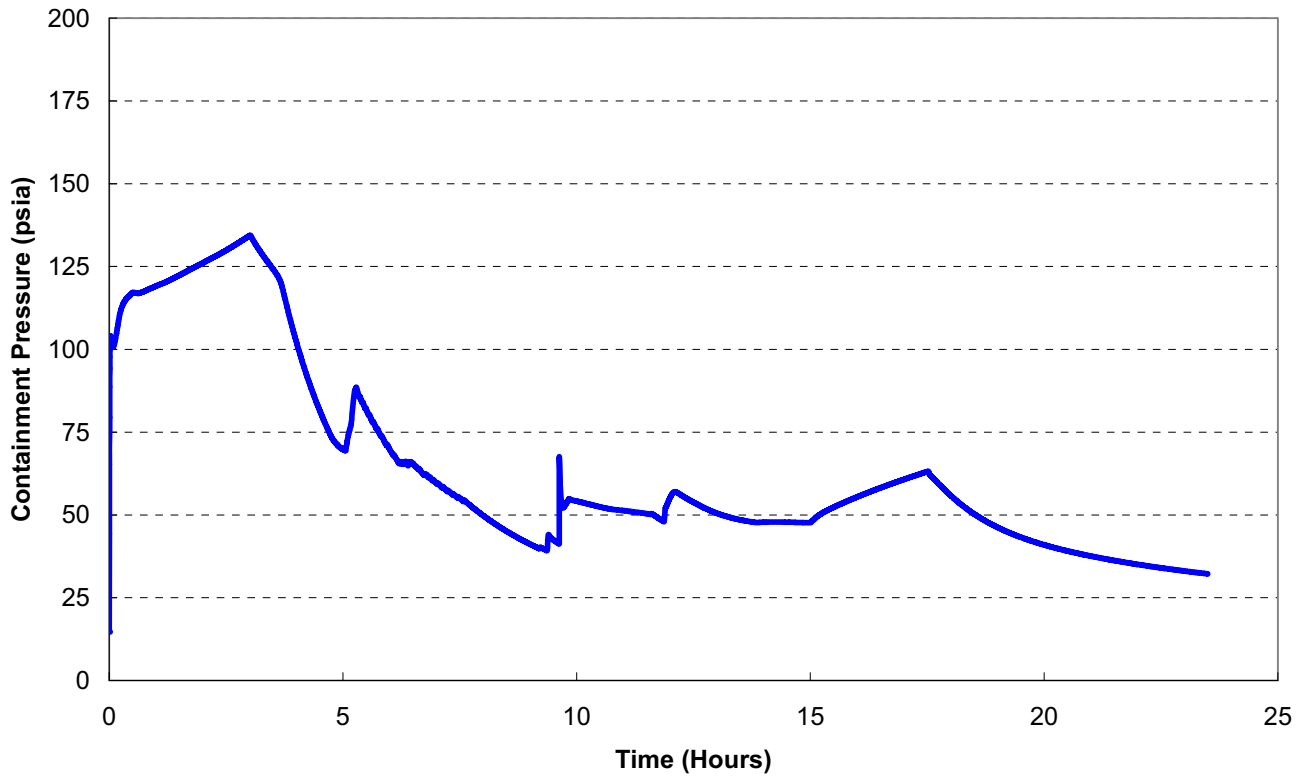
Table 19-309-4—Pre-Scram Reactivity vs. Moderator Density

Average Mod. Temp (°F)	Mod. Density (kg/m ³)	Defect (\$)
639	626.647	-3.94
631	638.622	-3.17
615	666.146	-1.58
596	694.313	0.00
566	731.652	2.03
522	776.423	4.28

Table 19-309-5—Post-Scram Reactivity vs. Moderator Density

Mod. Temp (°F)	Mod. Density (kg/m³)	Defect (\$)
609	678.557	-1.27
600	691.475	-0.36
596	696.682	0.00
500	797.159	5.95
400	870.018	9.26
300	926.199	11.36
200	969.983	12.84
100	999.710	13.89

Figure 19-309-1—MAAP Plot of Containment Pressure for SLBI Sequence with Four SG Blowdown and Failed MFW Isolation (Extended to 24 hours)



FSAR Impact:

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

Question 19-310:

(Follow-up to RAI 19-47)

Please provide the following information for the concrete below the spreading floor that was used in the MAAP MCCI analyses:

- (a) Concrete compositions (mass fraction of each constituent), including any rebar;
- (b) Concrete density;
- (c) Concrete ablation temperature;
- (d) Concrete solidus temperature; and
- (e) Concrete liquidus temperature.

Response to Question 19-310:

The properties of the spreading room concrete used in the MAAP MCCI analyses are as follows:

- (a) Concrete composition is shown in Table 19-310-1.

Table 19-310-1—Mass Fraction of Spreading Room Concrete

Component	Mass Fraction
SiO ₂	35.80e-2
CaO	31.30e-2
Al ₂ O ₃	3.60e-2
K ₂ O	1.22e-2
Na ₂ O	0.08e-2
MgO, MnO, or TiO ₂	0.70e-2
Fe ₂ O ₃	1.44e-2
Fe	0.00e-2
Cr ₂ O ₃	0.01e-2
H ₂ O	4.70e-2
CO ₂	21.15e-2
O ₂	0.00e-2

- (b) Concrete density is 2200 kg/m³.
- (c) Concrete ablation temperature 1277°C.
- (d) Concrete solidus temperature is 1079°C.
- (e) Concrete liquidus temperature is 1560°C.

FSAR Impact:

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

Question 19-311:

(Follow-up to RAI 19-236)

The response to RAI 19-236 discusses the effect of using the mean core damage frequency (CDF) as opposed to point estimate CDF value. The applicant indicated that the point estimate value was used because, "the mean CDF is not unequivocally defined." The applicant added that, "the mean CDF value could vary significantly from one Monte Carlo run to another." If the statement is true, and the applicant has experienced such a significant change in the mean CDF value, the validity of various quantiles (e.g., mean, median, 5th, etc.) listed in the COL FSAR may be uncertain. The fidelity of the simulation should be such that the mean value would remain relatively unchanged from one Monte Carlo simulation to the next. Please confirm that the reported mean values as well as the uncertainty distributions are numerically reasonable representation of the uncertainty bands and are not significantly impacted by the Monte Carlo sampling process.

Response to Question 19-311:

The variation in mean CDF observed between different Monte Carlo simulations does not contradict the fact that the mean values and uncertainty distributions reported in the FSAR are a reasonable representation of the uncertainty bands. A series of Monte Carlo runs performed with different seeds has shown that the variation in mean CDF values between two runs does not exceed 15 percent, and the variation in 5th, 95th and median does not exceed 5 percent.

These statistical fluctuations in mean values do not change the conclusions presented in the Response to RAI 133, Question 19-236 regarding the impact of using a mean CDF value instead of the point estimate in the severe accident mitigation design alternatives (SAMDA) analysis. In fact, the mean CDF would have to be increased by over 50 percent for a SAMDA candidate to become cost-beneficial. The fluctuations introduced by the Monte Carlo sampling process are not capable of producing such an increase.

FSAR Impact:

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

Question 19-312:

(Follow-up to RAI 19-231)

Based on the report containing review of the available test data and results that was made available for NRC audit at the AREVA NP's Twinbrook office, please provide the following additional information for NRC review:

1. The material characteristics of the stabilized ZrO₂ with regard to radiation effect, materials interactions, phase transition, and the thermal/ mechanical shock for the Zirconia bricks planned for the U.S. EPR.
2. The expected loading conditions in the reactor pit/transfer channel relative to the ZrO₂ characteristics to show that thermal and mechanical stability can be maintained under all conceivable severe accidents.
3. The bonding maximum local temperature and thermal gradient with a melt of high temperature inside the reactor pit and the transfer channel under severe accident loading conditions (i.e., melt superheat, compositions, configurations, etc.)
4. A summary of the industrial knowledge base referenced in the report that is applicable to the Zirconia under consideration for U.S. EPR.
5. A summary of experimental data referenced in the report on interaction of metallic melts with ZrO₂ including the impact temperature, metallic melt composition with and without oxidic slag for U.S. EPR-specific Zirconia bricks.
6. Results of experimental data versus theoretical predictions referenced in the report for various severe accident loading conditions, as related to the behavior of ZrO₂ under U.S. EPR-specific conditions with regards to thermo-chemical stability, expected response under high radiation and high temperature conditions (e.g., thermal, mechanical, thermal shock).

Response to Question 19-312:

A response to this question will be provided by September 11, 2009.

Question 19-313:

A New section on risk metrics (Section 4.1) is included in the "AREVA NP Environmental Report Standard Design Certification," ANP-10290, draft Revision 1, wherein the core damage frequency (CDF) is used as the primary risk metric to characterize the frequency of occurrence of a severe accident. The actual radiological risk, as calculated in the U.S. EPR Level 3 PRA, is used to quantify averted costs for offsite consequences. Also, as indicated through various RAI responses, AREVA has corrected the radionuclide core inventory to higher values. The offsite consequence results used in the SAMDA analysis indicate slight reduction in total offsite population dose, which contradicts the expected higher value, even if the release fractions were to remain unchanged. Accordingly:

1. Please provide the fraction of the total CDF that is captured among the release categories considered in the Level 3 PRA, as well as the values of the release category frequencies.
2. Please provide the corrected radionuclide core inventory and released fractions used in the level 3 PRA analysis.
3. For the SAMDA candidate development, the top 100 Level 1 cutsets were chosen, equating to approximately 50% of the total CDF. This may not be conservative, however, because this cutset list may not correspond to the top 100 cutsets contributing to the large release frequency (LRF). Please provide the list of the top 100 LRF cutsets, and indicate the fraction of the LRF these comprise. In addition, please list and describe any additional candidates identified from using the top 100 LRF cutsets instead of the top 100 CDF cutsets, and which of these additional candidates are categorized as "consider for further evaluation." If any do fall into that category, please explain how the Maximum Benefit Evaluation would be affected.
4. In response to RAI 19-238, the applicant indicated that the screening process for the "Vent MSSV's in containment" will be changed from "Not Applicable" to "Excessive Implementation Cost," in the revised report. But, this change was not included in this revision. This change would also affect the "Result and Summary" section. Please make this change in the next revision of the report.

Response to Question 19-313:

A response to this question will be provided by September 11, 2009.