ArevaEPRDCPEm Resource

From:	WILLIFORD Dennis (AREVA) [Dennis.Williford@areva.com]
Sent:	Tuesday, September 18, 2012 12:21 PM
To:	Tesfaye, Getachew
Cc:	BENNETT Kathy (AREVA); DELANO Karen (AREVA); LEIGHLITER John (AREVA); ROMINE Judy (AREVA); RYAN Tom (AREVA); GUCWA Len (EXTERNAL AREVA); BALLARD Bob (AREVA)
Subject:	Response to U.S. EPR Design Certification Application RAI No. 535 (6229), FSAR Ch. 6, Supplement 2
Attachments:	RAI 535 Supplement 2 Response - US EPR DC.pdf

Getachew,

AREVA NP Inc. (AREVA NP) provided a preliminary schedule for a response to the one question in RAI 535 on January 25, 2012. Supplement 1 Response to RAI 535 was submitted on February 17, 2012 to provide a revised schedule for the one question.

The attached file, "RAI 535 Supplement 2 Response - US EPR DC.pdf," provides a technically correct and complete final response to Question 06.02.02-128.

The following table indicates the respective pages in the response document, "RAI 535 Supplement 2 Response - US EPR DC.pdf," that contain AREVA NP's response to the subject question.

Question #	Start Page	End Page
RAI 535 — 06.02.02-128	2	7

This concludes the formal AREVA NP response to RAI 535, and there are no questions from this RAI for which AREVA NP has not provided responses.

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
7207 IBM Drive, Mail Code CLT 2B
Charlotte, NC 28262
Phone: 704-805-2223
Email: Dennis.Williford@areva.com

From: WILLIFORD Dennis (RS/NB)
Sent: Friday, February 17, 2012 5:09 PM
To: Getachew.Tesfaye@nrc.gov
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); GUCWA Len (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 535 (6229), FSAR Ch. 6, Supplement 1

Getachew,

AREVA NP Inc. (AREVA NP) provided a preliminary schedule for a response to the one question in RAI 535 on January 25, 2012.

The schedule for a technically correct and complete response to the one question has been reevaluated, and a revised schedule is provided below.

Question #	Response Date
RAI 535 — 06.02.02-128	**September 21, 2012**

Sincerely,

Dennis Williford, P.E.
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7207 IBM Drive, Mail Code CLT 2B
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From: WILLIFORD Dennis (RS/NB)
Sent: Wednesday, January 25, 2012 2:05 PM
To: Getachew.Tesfaye@nrc.gov
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); GUCWA Len (External RS/NB); Michael.Miernicki@nrc.gov; bill.gleaves@nrc.gov
Subject: Response to U.S. EPR Design Certification Application RAI No. 535 (6229), FSAR Ch. 6

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 535 Response US EPR DC.pdf," provides a preliminary schedule since a technically correct and complete response to the one question cannot be provided at this time.

The following table indicates the respective pages in the response document, "RAI 535 Response US EPR DC.pdf," that contain AREVA NP's response to the subject question.

Question #	Start Page	End Page
RAI 535 — 06.02.02-128	2	3

A preliminary schedule for a technically correct and complete response to the one question is provided below. This schedule is being reevaluated and a new supplement with a revised schedule will be transmitted by February 21, 2012.

Question #	Response Date
RAI 535 — 06.02.02-128	February 21, 2012

Sincerely,

Dennis Williford, P.E.
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From: Tesfaye, Getachew [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Friday, December 16, 2011 9:03 AM
To: ZZ-DL-A-USEPR-DL
Cc: Peng, Shie-Jeng; McKirgan, John; Segala, John; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 535 (6229), FSAR Ch. 6

Attached please find the subject request for additional information (RAI). A draft of the RAI was provided to you on November 9, 2011, and on December 15, 2011, you informed us that the RAI is clear and no further clarification is needed. As a result, no change is made to the draft RAI. The schedule we have established for review of your application assumes technically correct and complete responses within 30 days of receipt of RAIs, excluding the time period of **December 24, 2011 thru January 2, 2012, to account for the holiday season** as discussed with AREVA NP Inc. For any RAIs that cannot be answered **within 40 days**, it is expected that a date for receipt of this information will be provided to the staff within the 40-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: 4045

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Subject: Response to U.S. EPR Design Certification Application RAI No. 535 (6229), FSAR Ch. 6, Supplement 2
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From: WILLIFORD Dennis (AREVA)

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MESSAGE	5160	9/18/2012 12:21:25 PM
RAI 535 Supplement 2 Response - US EPR DC.pdf		104444

Options
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Reply Requested: No
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Response to

Request for Additional Information No. 535, Supplement 2

12/16/2011

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 06.02.02 - Containment Heat Removal Systems
Application Section: 6.2.2

QUESTIONS for Containment and Ventilation Branch 1 (AP1000/EPR Projects) (SPCV)

Question 06.02.02-128:

Based on GDC 16, 38 and 50, the purpose of this RAI is to ensure that the containment design and containment heat removal system will function properly following any postulated accident conditions. The following are follow-up questions of RAI No. 266 Question 06.02.02-33 and RAI No. 82 Question 06.02.02-1a after the calculation notes audit held in Twinbrook, MD in October and November, 2011.

1. Calculation 32-9020299-003, "One-Node GOTHIC Model of the U.S. EPR Containment"

   In Sec. 4.0, it describes that the LHSI/RHR heat exchanger tube plugging level is expected to be made when to perform the LBLOCA containment response analysis as part of the DC effort for the U. S. EPR. In the Section of Areas of Review, the Standard Review Plan (SRP) 6.2.2 specifies that the potential for flow blockage of heat exchangers and the effect on heat exchanger performance should be reviewed. Provide information for tube plugging level assumed during the LBLOCA containment response analysis.

2. Calculation 32-9020299-003, "One-Node GOTHIC Model of the U.S. EPR Containment"

   In Sec. 7.1.2 (heat exchanger input), it uses 0.4 for Prandtl number exponent in the Dittus-Boelter correlation. According to GOTHIC technical manual (Sec. 9.1.1.2), it should be 0.3 instead of 0.4 for the heat exchanger tube (primary) flow that is being cooled. Evaluate the impact of the difference on all currently existing GOTHIC analysis results.

3. Calculation 32-9020299-003, "One-Node GOTHIC Model of the U.S. EPR Containment" and Calculation 32-9036040-003, "Multi-node GOTHIC Model of the U. S. EPR Containment"

   In Sec. 7.1.1.2 of Calculation 32-9020299-003, it states that the Tagami/Uchida correlation is selected for the direct condensation calculation in the LBLOCA containment response analysis based on the approved FANP GOTHIC containment methodology. In Sec. 2.2 of Calculation 32-9036040-003, the multi-node GOTHIC model also uses the Tagami/Uchida correlation. However, the multi-node GOTHIC model (clps_np_s_sd3.gth) for LBLOCA employs DLM for direct condensation calculation. Provide justification for this change and the selection of DLM out of the diffusion layer model options (DLM, DLM-M, DLM-F and DLM-FM).

4. Calculation 32-9020299-003, "One-Node GOTHIC Model of the U.S. EPR Containment"

   There are pre-cautions in blackened wordings cited in this calculation note. For example:

   On page 49, it notes that the MHSI (& LHSI) injection flow used for DC will be made consistent with that used by the system analysis code.

   On page 52, it notes that the lower and upper bound containment initial temperatures need to be considered via sensitivities to determine the initial containment condition yielding the more conservative pressure and temperature responses.

On page 72, it notes that the duration of droplet discharge should be formulated such that the worst containment response is obtained.

On pages 77 and 78, it states that an arbitrary non-zero value for the spillage flow is input for demonstration use only. What is the actual value used in the final DC LOCA analysis? And how is it determined?

On page 87, it states that a set of sample values for primary system passive material stored energy, steam generator energy and sensible heat loads etc. are used for demonstration purpose. What are the actual values used in the final DC LOCA analysis? And how are they determined?

Provide their dispositions for the above identified pre-cautions. If they have been addressed in some other calculation notes, it would be acceptable to have them being available for audit without any specific written responses required.

5. Calculation 32-9036040-003, "Multi-node GOTHIC Model of the U. S. EPR Containment"

As mentioned in this calculation note, a one-node MSLB GOTHIC model was developed to determine the EQ. Provide this GOTHIC model file as well as the multi-node MSLB GOTHIC model file and the associated EQ analysis calculation notes for staff to perform confirmatory analysis.

6. Calculation 32-0113080-003, "Suction Break for U. S. EPR Containment Analysis Using Multi-Node model"

The multi-node model GOTHIC file (clps_np_s_sd3) has been sent to staff for review. Provide the calculation note (assumed it is 32-0113080-003, "Suction Break for U. S. EPR Containment Analysis Using Multi-Node model") that documents the GOTHIC input data and analysis results for audit.

Response to Question 06.02.02-128:

1. The tube surface area used in the low head safety injection/residual heat removal system (LHSI/RHR) heat exchanger GOTHIC model was obtained from the reference plant design (5560.3 ft^2). The surface area used bounds the U.S. EPR design (5801 ft^2). The value of 5801 ft^2 represents the effective heat transfer area and is based on an assumed tube plugging level of 15 percent.
2. The LHSI/RHR heat exchanger is a tube-shell design with residual heat removal (RHR) flow on the tube (primary) side and component cooling water (CCW) flow on the shell (secondary) side. The Dittus-Boelter correlation was used to determine the heat transfer coefficient in the LHSI/RHR GOTHIC heat exchanger model.

   Since the primary Prandtl number exponent used (0.4) in the Dittus-Boelter correlation was larger than recommended (0.3), it was compensated for during the benchmark of heat exchanger model performance. Another parameter (the shell side flow area) was iteratively adjusted until the desired heat exchanger performance was obtained. The benchmark resulted in a conservative heat exchanger GOTHIC model with respect to the U.S. EPR design as the benchmark was made to the UA value (product of the overall heat-transfer coefficient and transfer area) of the reference plant design (2.2939E+06 BTU/hr -F), which is conservatively lower than the value specified for the U.S. EPR design (3.5361E+06 BTU/hr-F).

Additionally, the assumption in the long term plant model of fouling as well as bounding values of CCW flow (608.5 lbm/sec) and inlet temperature (113°F) conservatively provides degraded heat exchanger performance in the large break loss of coolant accident (LBLOCA) containment response calculations.

3. The U.S. EPR single node LBLOCA model of Calculation 32-9020299-003 used the Tagami/Uchida condensation correlations. The U.S. EPR multi-node main steam line break (MSLB) model of Calculation 32-9036040-003 used the Uchida correlation. These models were base models. None of these models were used to carry out the LBLOCA containment response calculations for the U.S. EPR.

   The multi-node base model was further developed to implement the LBLOCA containment methodology described in U.S. EPR Technical Report, ANP-10299P Revision 2, "Applicability of AREVA NP Containment Response Evaluation Methodology to the U.S. EPR™ for Large Break LOCA Analysis." This multi-node model was then used to compute the containment response to LBLOCA. The diffusion layer model (DLM) was applied to the conductors in this multi-node model. Per the GOTHIC User Manual (pages 14-28), the Tagami correlation is based on a blowdown to a single lumped parameter volume. This correlation is not appropriate for the multi-node model.

   The DLM is based on well-established principles for heat and mass transfer analogy, and has been accepted by the NRC for containment integrity analysis, as stated on pages 22-17 of the GOTHIC User Manual.

   The heat transfer correlation options DLM-M, DLM-F and DLM-FM include heat transfer enhancements due to mist formation (DLM-M), film roughening (DLM-F), and both film roughening and mist formation (DLM-FM). No credit was taken for these heat transfer enhancements in the LBLOCA containment response calculations.

4. As stated in the response to Item 3 of this response, the single node U.S. EPR LBLOCA model of Calculation 32-9020299-003 is a base model. No design-basis containment response calculations were carried out using the base model.

   The containment response calculations were carried out using the multi-node model that adhered to the LBLOCA containment methodology described in the U.S. EPR Technical Report, ANP-10299P, Revision 2.

   MHSI (&LHSI) Injection Flow

   For a given LBLOCA scenario, the same medium head safety injection (MHSI) and low head safety injection (LHSI) flow was used in the calculation of short term and long term mass and energy (M&E) releases. The short term mass and energy was calculated using the system analysis code (RELAP5/MOD2-B&W). The long term mass and energy was calculated using the containment analysis code (GOTHIC). The containment response to this mass and energy was calculated using GOTHIC. The consistency in pumped emergency core cooling system (ECCS) inputs was therefore maintained between the system and containment codes.

Containment Initial Temperature

Sensitivity on containment initial temperature established the lower bound temperature (86°F) to be limiting with respect to containment peak pressure. The change in initial temperature from upper bound (131°F) to lower bound (86°F) resulted in a peak pressure increase of 1.1 psi. Therefore, the lower bound initial temperature was used as the initial temperature input in the containment response calculations for the U.S. EPR analysis.

Duration of Droplet Discharge

The liquid discharge was assumed as droplets during blowdown, and as liquid stream following blowdown.

The droplet discharge during blowdown provides atmospheric heating due to liquid superheat relative to containment atmospheric conditions. The situation is reversed following blowdown and continued droplet discharge would have produced an atmospheric cooling effect. The assumed combination of droplet discharge during blowdown and liquid stream discharge following blowdown therefore leads to the worst containment response.

ECCS Spillage

For the three postulated break locations (hot leg, cold leg pump suction, and cold leg pump discharge), the worst single failure is the failure of one ECCS train in conjunction with another train being out of service for maintenance. This is the minimum ECCS flow scenario in which only two out of the four trains of ECCS are available to mitigate the postulated loss of coolant accidents (LOCAs).

The worst containment response for the suction-break LOCA was obtained with the two available ECCS trains aligned to two intact loops. No direct spillage of ECCS to the containment floor is assumed as a result of this configuration. After loop seal formation in the intact loops is postulated to occur at 1200 seconds (RELAP5/MOD2-B&W-to-GOTHIC transition time), the vessel node in the long term GOTHIC model is conservatively modeled as a boiling pot with the ECCS providing only makeup water for the steam production in the core and along the vent path to the steam generator side of the break. The balance of the ECCS flow is modeled to bypass the vessel and exit on the reactor vessel side of the break. After switchover to hot leg injection, at 60 minutes into the event, most of the LHSI flow (approximately 75 percent) is realigned from the cold legs to the hot legs. The condensation and mixing efficiency in the path of the hot leg injection flow delivered to the vessel node (hot legs, upper plenum and core) determines the extent of suppression of core steam production. The balance of the hot leg injection flow bypasses the vessel node and is thereby not credited for core cooling. The details of the long term models prior to and after LHSI realignment are described in Chapter 8, Sections 8.1.16, 8.3.1.5 and 8.3.2, of the U.S. EPR Technical Report, ANP-10299 Revision 2.

The worst containment response for the discharge-break LOCA was obtained with the two available ECCS trains aligned to one intact loop and one broken loop. The ECCS from the train injecting into the broken loop is assumed to completely spill to the containment floor. ECCS spillage is significantly reduced after manual switchover to hot leg injection, at 60 minutes into the event, as a portion of the LHSI flow realigns from the broken loop cold leg to the corresponding hot leg is no longer lost, but injects into the vessel. This results in both of the available trains delivering hot leg injection flow to the vessel node to suppress core steam production, as in the suction-break LOCA case mentioned previously.

For breaks in the hot leg the ECCS injects into the cold legs; therefore, spillage is not an issue for this break location. After manual realignment of most of the LHSI flow from the cold legs to the hot legs, at 60 minutes into the event, the LHSI flow from one available train is conservatively assumed to realign to the broken loop hot leg from the corresponding cold leg and, as a result, completely spills to the containment floor. This results in significant reduction in the hot leg injection flow delivered to the vessel node (from only the other available train) to suppress core steam production.

For the minimum ECCS flow scenario, degraded ECCS performance data is used to minimize the flow rates delivered by each available train, as stated in Chapter 8, Section 8.1.4, of the U.S. EPR Technical Report, ANP-10299 Revision 2.

Long Term Sensible Heat

The LOCA long term GOTHIC model includes modeling elements which represent the remaining stored energy (i.e., sensible heat) in the nuclear steam supply system (NSSS), primary system passive metal and the secondary system (steam generator) passive metal and fluid inventory at the RELAP5/MOD2-B&W-to-GOTHIC transition time. The remaining sensible heat is conservatively released into the containment by 24 hours post-LOCA using the long term GOTHIC model. The long term GOTHIC methodology for sensible heat release that was used in the containment response calculations for the U.S. EPR is described in detail in Chapter 8, Sections 8.1.16 and 8.2, of the U.S. EPR Technical Report, ANP-10299 Revision 2.

The response to RAI 389, Question 06.02.02-47, Revision 1, demonstrated the conservatism of the long term GOTHIC steaming prediction due to core decay heat and sensible energy removal.

5. Calculation 32-9036040-003, “Multi-node GOTHIC Model of the U. S. EPR Containment”

   The one-node MSLB GOTHIC model does not constitute the design basis for the U.S. EPR environmental qualification (EQ) profiles and has not been maintained. This original analysis was superseded by multi-node analyses that have been previously made available for NRC Staff audit. Therefore, the one-node MSLB GOTHIC model should not be considered for confirmatory analysis by the NRC Staff. The multi-node MSLB GOTHIC model (e20d41_23.GTH) was previously provided to NRC via AREVA NP Inc. letter, “Response Supplement 2 to U.S. EPR Design Certification Application, RAI No. 266,” NRC 09:123, dated December 10, 2009 to aid NRC staff in developing confirmatory analyses. This GOTHIC input model is representative of the MSLB GOTHIC files that were used to constitute the EQ pressure and temperature curves, as requested by the NRC staff.

6. Calculation 32-0113080-003 [sic], “Suction Break for U. S. EPR Containment Analysis Using Multi-Node model”.

   There appears to be a typographical error in the referenced calculation number. Calculation 32-0113080 should instead be 32-9113080. The calculation title is correct. However, there currently is no revision 32-9113080-003 in AREVA’s record system. Calculation 32-9113080-002 is the latest revision.

The multi-node model GOTHIC file named clps_np_s_sd3 was provided to the NRC via AREVA NP Inc. letter, “Response Supplement 2 to U.S. EPR Design Certification Application RAI No. 266,” NRC 09:123, dated December 10, 2009 to aid NRC Staff in developing confirmatory analyses. The calculation file associated with the GOTHIC input file (32-9113080-002) was also previously made available for audit by the NRC Staff following the September 29, 2010 audit at the AREVA Twinbrook office. In addition, calculation 32-7007967-001, “U.S. EPR GOTHIC CLPS LOCA Containment Analysis with Increased LHSI Heat Exchanger Fouling” was made available for audit September 20, 2011 by the NRC Staff at the AREVA Twinbrook office following the NRC Staff’s request on August 15, 2011.

As discussed above, the calculation requested, 32-0113080-003 (or 32-9113080-003), does not exist in the AREVA records system. The two previously provided calculation notes, along with the GOTHIC input model, should provide sufficient information for the NRC staff to prepare confirmatory analyses of the cold leg pump suction break scenario.

AREVA will make the requested calculation files available for NRC audit.

FSAR Impact:

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