ArevaEPRDCPEm Resource

From: WELLS Russell (AREVA) [Russell.Wells@areva.com]
Sent: Thursday, March 31, 2011 3:11 PM
To: Tesfaye, Getachew
Cc: GUCWA Len (EXTERNAL AREVA); BENNETT Kathy (AREVA); DELANO Karen (AREVA); ROMINE Judy (AREVA); RYAN Tom (AREVA)
Subject: Response to U.S. EPR Design Certification Application RAI No. 428 , FSAR Ch. 15, Supplement 1
Attachments: RAI 428 Supplement 1 Response US EPR DC.pdf

Getachew,

AREVA NP Inc. (AREVA NP) provided a response to 3 of the 17 questions of RAI 428 on November 18, 2010. The attached file, “RAI 428 Supplement 1 Response US EPR DC.pdf,” provides technically correct and complete responses to 9 of the remaining 14 questions.

The following table indicates the respective pages in the response document, “RAI 428 Supplement 1 Response US EPR DC.pdf,” that contain AREVA NP’s response to the subject questions.

Question #	Start Page	End Page
RAI 428 — 15.06.05-81	2	2
RAI 428 — 15.06.05-82	3	3
RAI 428 — 15.06.05-83	4	4
RAI 428 — 15.06.05-84	5	6
RAI 428 — 15.06.05-92	7	7
RAI 428 — 15.06.05-93	8	9
RAI 428 — 15.06.05-94	10	11
RAI 428 — 15.06.05-96	12	13
RAI 428 — 15.06.05-97	14	14

To provide additional opportunity to interact with the NRC staff on Questions 15.06.05-85 through 15.06.05-88, the response schedule is revised as shown below. These questions include evaluations of the in-vessel, downstream effects of debris bypassing sump strainers. The schedule for responding to the 5 remaining RAI 428 questions has been revised and is provided below.

Question #	Response Date
RAI 428 — 15.06.05-85	April 30, 2011
RAI 428 — 15.06.05-86	April 30, 2011
RAI 428 — 15.06.05-87	April 30, 2011
RAI 428 — 15.06.05-88	April 30, 2011
RAI 428 — 15.06.05-95	April 30, 2011

Sincerely,

Russ Wells
U.S. EPR Design Certification Licensing Manager
AREVA NP, Inc.
3315 Old Forest Road, P.O. Box 10935
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Russell.Wells@Areva.com

From: BRYAN Martin (External RS/NB)
Sent: Thursday, November 18, 2010 11:41 AM
To: Tesfaye, Getachew
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); GUCWA Len (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 428 , FSAR Ch. 15

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 428 Response US EPR DC.pdf," provides technically correct and complete responses to 3 of the 17 questions.

The following table indicates the respective pages in the response document, "RAI 428 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 428 — 15.06.05-81	2	2
RAI 428 — 15.06.05-82	3	3
RAI 428 — 15.06.05-83	4	4
RAI 428 — 15.06.05-84	5	5
RAI 428 — 15.06.05-85	6	6
RAI 428 — 15.06.05-86	7	7
RAI 428 — 15.06.05-87	8	8
RAI 428 — 15.06.05-88	9	9
RAI 428 — 15.06.05-89	10	11
RAI 428 — 15.06.05-90	12	12
RAI 428 — 15.06.05-91	13	14
RAI 428 — 15.06.05-92	15	15
RAI 428 — 15.06.05-93	16	16
RAI 428 — 15.06.05-94	17	17
RAI 428 — 15.06.05-95	18	18
RAI 428 — 15.06.05-96	19	19
RAI 428 — 15.06.05-97	20	20

A complete answer is not provided for 14 of the17 questions. The schedule for a technically correct and complete response to these questions is provided below.

Question #	Response Date
RAI 428 — 15.06.05-81	March 31, 2011
RAI 428 — 15.06.05-82	March 31, 2011
RAI 428 — 15.06.05-83	March 31, 2011
RAI 428 — 15.06.05-84	March 31, 2011
RAI 428 — 15.06.05-85	March 31, 2011
RAI 428 — 15.06.05-86	March 31, 2011
RAI 428 — 15.06.05-87	March 31, 2011
RAI 428 — 15.06.05-88	March 31, 2011

RAI 428 — 15.06.05-92	March 31, 2011
RAI 428 — 15.06.05-93	March 31, 2011
RAI 428 — 15.06.05-94	March 31, 2011
RAI 428 — 15.06.05-95	March 31, 2011
RAI 428 — 15.06.05-96	March 31, 2011
RAI 428 — 15.06.05-97	March 31, 2011

Sincerely,

Martin (Marty) C. Bryan
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From: Tesfaye, Getachew [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Wednesday, October 20, 2010 10:00 AM
To: ZZ-DL-A-USEPR-DL
Cc: Forsaty, Fred; Lu, Shanlai; Thomas, George; Donoghue, Joseph; Carneal, Jason; Colaccino, Joseph; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 428 (4299), FSARCh. 15

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on July 21, 2010, and discussed with your staff on September 13, 2010. Draft RAI Questions 15.06.05-78, 15.06.05-79, 15.06.05-80 were deleted, and Draft RAI Questions 15.06.05-86, 15.06.05-87, 15.06.05-88, 15.06.05-94 were 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: 2790

Mail Envelope Properties (1F1CC1BBDC66B842A46CAC03D6B1CD41042B9B43)

Subject: Response to U.S. EPR Design Certification Application RAI No. 428 , FSAR Ch. 15, Supplement 1
Sent Date: 3/31/2011 3:10:32 PM
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From: WELLS Russell (AREVA)

Created By: Russell.Wells@areva.com

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MESSAGE	5525	3/31/2011 3:10:34 PM
RAI 428 Supplement 1 Response US EPR DC.pdf	128072	

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

Response to

Request for Additional Information No. 428(4922), Revision 0
Supplement 1

10/20/2010

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 15.06.05 - Loss of Coolant Accidents Resulting From Spectrum of Postulated Piping Breaks Within the Reactor Coolant Pressure Boundary
Application Section: Downstream

QUESTIONS for Reactor System, Nuclear Performance and Code Review (SRSB)

Question 15.06.05-81:

The ΔP acceptance criteria for fuel assembly flow blockage for the U.S. EPR design have been determined for several different classes of LOCA conditions based on break location and ECCS injection performance. For each ΔP acceptance criterion established, list the assumptions used to derive the available driving head. In particular, identify the assumptions related to the following aspects.

(1) Two-phase fluid conditions and properties including void fraction distribution in the core region and other participating regions that contain two-phase coolant mixture as participating and accounted for in the driving head balance analyses.

(2) Single phase liquid coolant conditions and properties including temperature profile in regions occupied by liquid coolant only as participating and accounted for in the driving head balance analyses.

(3) Availability, geometry, and flow resistance coefficients associated with each steam flow path available for steam venting from the upper plenum region and as considered for in the pressure balance across the reactor coolant system.

(4) Containment backpressure conditions and related assumptions taking into account post-LOCA containment pressurization.

(5) ECCS flow performance and availability as affected by containment post-LOCA conditions and other related factors and assumptions.

Identify any analytical tools and software codes applied to determine the applicable ΔP acceptance criteria.

Response to Question 15.06.05-81:

Reference 1, Section F.3.2 describes assumptions related to fluid conditions, containment pressure, downcomer voiding, and steam flow paths for steam venting.

Reference 1, Section F.3.2 and Section F.3.4 describes the void fraction in the core.

Reference 1, Section F.3.5 and Section F.3.6 describes core flow conditions used to determine each ΔP acceptance criterion.

References for Question 15.06.05-81:

1. ANP-10293P, Revision 3, "U.S. EPR Design Features to Address GSI-191 Technical Report," AREVA NP Inc., March 2011.

FSAR Impact:

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

Question 15.06.05-82:

Explain how the analyses, performed to determine ΔP acceptance criteria for U.S. EPR, take into account variation in time of thermal-hydraulic conditions in the primary reactor coolant system and in the reactor containment. With regard to the containment thermal-hydraulic response, address effects associated with limiting LOCA conditions associated with most restrictive ΔP acceptance criteria.

Response to Question 15.06.05-82:

Reference 1, Section F.3.2 describes assumptions related to fluid conditions and containment pressure.

Reference 1, Section F.3.5 and Section F.3.6 describes core flow conditions used to determine each ΔP acceptance criterion.

References for Question 15.06.05-82:

1. ANP-10293P, Revision 3, “U.S. EPR Design Features to Address GSI-191 Technical Report,” AREVA NP Inc., March 2011.

FSAR Impact:

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

Question 15.06.05-83:

Explain how the analyses, performed to determine ΔP acceptance criteria for U.S. EPR, take into account effects associated with certain thermal-hydraulic phenomena that can take place in the primary reactor coolant system in the post-LOCA period. Such phenomena can have a major impact on the assumptions and pressure balance equations used in ΔP acceptance criteria derivation analyses. Specifically, address the following the thermal-hydraulic phenomena identified below.

(1) Reactor downcomer boiling.

(2) Loop seal reformation in individual primary coolant loops.

(3) Partial loop seal liquid blockage in individual primary coolant loops

(4) Non-uniform flow and void distribution in the core region.

(5) Boric acid accumulation in the reactor core region.

Response to Question 15.06.05-83:

Reference 1, Section F.3.2 describes assumptions related to fluid conditions, loop seals, and containment pressure.

Reference 1, Section F.3.4 describes the core void fraction.

Reference 1, Section F.3.5 and Section F.3.6 describes core flow conditions used to determine each ΔP acceptance criterion.

Reference 1, Section F.3.2 and Section F.3.6.1 addresses boric acid accumulation.

References for Question 15.06.05-83:

1. ANP-10293P, Revision 3, “U.S. EPR Design Features to Address GSI-191 Technical Report,” AREVA NP Inc., March 2011.

FSAR Impact:

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

Question 15.06.05-84:

U.S. EPR RAI 241 Question 15.06.05-51 addresses the reactor two-phase mixture level response during long term cooling. RAI 241 Question 15.06.05-52 considers the core region thermal-hydraulic conditions for the boric acid precipitation analysis. Explain how the core region thermal-hydraulic assumptions and conditions, as applied in the ΔP acceptance criteria analyses for core blockage evaluation, compare to assumptions and conditions considered in RAI 251 Question 15.06.05-51 and in RAI 251 Question 15.06.05-52. Explain and quantify any significant differences related to the same class of LOCA conditions.

Response to Question 15.06.05-84:

The main differences in the assumptions between the ΔP acceptance criteria analysis for core blockage evaluation in a cold leg break with cold leg injection and those in the Response to RAI 251, Question 15.06.05-51 relate to the treatment of downcomer boiling, assumed containment pressure, boron concentration accounting, and treatment of core voiding.

The cold leg break with cold-side safety injection assumes a 20 percent void fraction to account for the possibility of downcomer boiling. Reference 1, Assumption #11 explains that this is a conservative assumption relative to the expected void fraction following a loss of coolant accident (LOCA) and reduces the available driving head for the cold leg break with cold-side safety injection.

An examination of the three S-RELAP5 cases supporting the Response to RAI 241, Question 15.06.05-52 provides the basis for the assumption of a 20 percent void fraction. In these three cases, the volume-averaged void fraction in the downcomer is approximately 10 percent at 15 minutes. The downcomer is approximately full of water by 30 minutes.

Reference 1, Assumption #10 explains that the core boiloff rate calculation uses properties based on the maximum containment pressure. The containment pressure may be as high as 67 psia, which occurs before 100 seconds into the transient.

Reference 1, Section F.3.6.1 explains how boron precipitation is considered in the ΔP acceptance criteria analysis for core blockage evaluation in a cold leg break with cold leg injection.

To address these differences, a sensitivity study is performed using the long term core cooling static-balance modeling used to support the Response to RAI 403, Questions 15.06.05-69 through 78. A 20 percent void fraction is assumed in the downcomer, and the containment pressure is increased to 67 psia. The density of saturated water in the core is increased to account for boron concentration at 10,000 ppm.

Reference 1, Section F.3.4 explains that the ΔP acceptance criteria analysis for core blockage evaluation in a cold leg break with cold leg injection uses a core void fraction of 0.5.

Based on the long term core cooling static-balance modeling, which computes the two-phase level swell, an average fuel assembly resistance factor of 4.419e+6 ft^{-4} verifies core coverage by a two-phase mixture at 1,000 seconds. This loss coefficient is close to the 4.285e+6 ft^{-4} value reported in Reference 1, Section F.3.6.1, which assumes 20 percent voiding in the downcomer and 50 percent voiding in the core. The sensitivity study produces a confirmatory result.

The sensitivity study results also show that the fuel is well covered for the long term. Hot leg injection changes the scenario beyond 60 minutes, and it is excluded from the sensitivity study.

References for Question 15.06.05-84:

1. ANP-10293P, Revision 3, “U.S. EPR Design Features to Address GSI-191 Technical Report,” AREVA NP Inc., March 2011.

FSAR Impact:

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

Question 15.06.05-92:

The U.S. EPR fuel assembly blockage testing as well as the sump bypass testing has not used a micro-porous insulating material. The U.S. EPR design uses Microtherm, which is a micro-porous insulating material. Justify why micro-porous insulating material is not used in the tests. Demonstrate that the test data obtained with a different particulate material are representative for the prototypical U.S. EPR conditions with regard to the type of particulate debris being present.

Response to Question 15.06.05-92:

Reference 1, Section F.3.7 provides the requested justification.

References for Question 15.06.05-92:

1. ANP-10293P, Revision 3, “U.S. EPR Design Features to Address GSI-191 Technical Report,” AREVA NP Inc., March 2011.

FSAR Impact:

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

Question 15.06.05-93:

The presented EPRDM debris deposition model and core thermal analysis results for the U.S. EPR design revealed that the maximum cladding temperature was predicted to occur almost at the onset of the of the analyzed 30-day time period (about an hour or so into the process). As such, the limiting value for this safety criterion is determined by the initial thermal-hydraulic conditions assumed in the core region.

U.S. EPR RAI 241 Question 15.06.05-51 addresses the reactor two-phase mixture level response during long term cooling and RAI 241 Question 15.06.05-52 considers the core region thermal-hydraulic conditions for the boric acid precipitation analysis. Explain how the core region thermal-hydraulic assumptions and conditions applied in demonstrating acceptability of the clad temperature response during long term core cooling using the EPRDM model compare to assumptions and conditions considered in RAI 251 Question 15.06.05-51, RAI 251 Question 15.06.05-52, and in the ΔP acceptance criteria analyses for core blockage evaluation. Explain and quantify any significant differences under comparable LOCA conditions.

Response to Question 15.06.05-93:

This response identifies four analyses:

1. The U.S. EPR Deposition Model (EPRDM) deposition analysis.
2. The long term core cooling static-balance.
3. The boron precipitation analysis.
4. The ΔP acceptance criteria analyses for core blockage evaluation.

The EPRDM calculation examines a cold leg break with cold leg injection. When this configuration is evaluated in the ΔP acceptance criteria analysis, saturated liquid is assumed at the core inlet. A saturated core inlet is also assumed in the most challenging long-term core cooling (LTCC) analysis (related to producing the lowest collapsed liquid level in the core) and the boron precipitation analyses.

The EPRDM analysis does not assume a saturated core inlet, but does assume that the core inlet temperature is the maximum in-containment refueling water storage tank (IRWST) temperature (see Reference 1, Section F.4). The Response to Question 15.06.05-96 provides more information regarding the IRWST pool thermal-hydraulic conditions and explains why these IRWST conditions are appropriate for a conservative downstream effects chemical deposition analysis. The medium head safety injection (MHSI) draws suction directly from the IRWST, while the low head safety injection (LHSI) flow passes through the residual heat removal (RHR) heat exchanger before reaching the injection point to the reactor coolant system (RCS) (see Reference 1, Section F.3.2). The mixture of LHSI and MHSI that flows in the reactor vessel (RV) downcomer is a mixture of warmer water from the IRWST and cooler water from the exit of the RHR heat exchanger. Instead of using a lower, more realistic temperature reflecting the mixture of MHSI and LHSI in the downcomer, the EPRDM analysis uses the maximum IRWST temperature, which conservatively reduces the core inlet subcooling.

Regarding initial thermal-hydraulic conditions assumed in the core region, the most significant difference between the EPRDM calculation and the other three analyses is using the maximum

IRWST temperature versus saturated inlet conditions. The four calculations are conservative and consistent in applying an assumption to reduce core inlet subcooling.

References for Question 15.06.05-93:

1. ANP-10293P, Revision 3, "U.S. EPR Design Features to Address GSI-191 Technical Report," AREVA NP Inc., March 2011.

FSAR Impact:

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

Question 15.06.05-94:

The presented EPRDM debris deposition model and analysis results for the U.S. EPR design revealed that the maximum thickness of debris deposition occurred at the end of the analyzed 30-day time period. As debris deposition rates were based on predicted boiling rates, provide description of the boiling model for each control volume along with corresponding steam generation rates. Consider effects associated with non-uniformity in growth of deposition layers on fuel surfaces, as well as their physical properties determination. In addition, list assumptions made with regard to debris transportation.

Response to Question 15.06.05-94:

Instead of modeling flow explicitly, a heat transfer coefficient of 400 W/m²-K is assumed for the transfer of heat between the bulk coolant in the fuel channels and the surface of the deposits (see Reference 1, Section F.4.3). Reference 1, Section F.4.3 describes assumptions regarding debris transportation. The deposit density is conservatively chosen as described in Reference 1, Section F.4.4.3. The thermal conductivity of the oxide and crud layers and the scale deposit are conservatively chosen as described in Reference 1, Section F.4.4.9 and Section F.4.4.10.

As explained in Reference 1, Section F.4.3, coolant saturation pressure is the same as water. Impurities present in the coolant are non-volatile and have the effect of raising the boiling point above pure water. The amount of boiling will be overestimated and provides a conservative estimate of scale thickness.

The steaming rate at each elevation is determined by:

$$\omega_{STEAM} = \frac{\dot{Q}}{h_{fg}}$$

Where ω_{STEAM} = steaming rate, lbm/s.
$\dot{Q}$ = core power at elevation region, BTU/s.
h_{fg} = latent heat of vaporization based on coolant temperature, BTU/lbm.

The mass of scale deposited is determined by:

$$m_S = \frac{C}{1{,}000{,}000} \cdot \omega_{STEAM} \cdot dt \cdot DP$$

Where m_S = mass of deposited scale.
C = concentration.
dt = time step.
DP = deposit percentage.

When boiling occurs, the deposit percentage is 1.0. When boiling does not occur, the deposit percentage is 0.0125, as described in Reference 1, Section F.4.3, Assumption #6. Boiling occurs when the coolant pressure at an elevation region is below the saturation pressure corresponding to the temperature of the crud-oxide interface.

The EPRDM core nodalization is consistent with the U.S. EPR large break loss of coolant model (see Reference 2, Figure A-4). The EPRDM core is represented by five radial regions comprising a hot rod, a hot assembly, surrounding assemblies, average-core assemblies, and lower-powered, outer assemblies. Also, the number of elevations in the EPRDM core is 52. The highest peak cladding temperature (PCT) case for the 124 case sample problem presented in Reference 2, Appendix A provides the relative power for 52 positions along the length of the fuel rod.

Growth of deposition layers is driven by core boiling, which depends on the variation in axial power along the length of the fuel rod. The growth of the deposition layers is non-uniform (see Reference 1, Section F.4.5).

References for Question 15.06.05-94:

1. ANP-10293P, Revision 3, “U.S. EPR Design Features to Address GSI-191 Technical Report,” AREVA NP Inc., March 2011.
2. ANP-10278P, Revision 1, “U.S. EPR Realistic Large Break Loss of Coolant Accident Topical Report,” AREVA NP Inc., January 2010.

FSAR Impact:

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

Question 15.06.05-96:

The U.S. EPR IRWST sump chemistry modeling was performed assuming certain pool thermal-hydraulic conditions. Identify the assumptions and models used in determining the pool fluid temperature response in time. In particular, describe assumptions related to available energy and mass sources and losses as well as initial conditions used in balance equations to determine the pool temperature. Show that the assumptions and conditions are conservative with regard to downstream effects on core cooling and explain the relevance to assumptions used in containment response analyses.

Response to Question 15.06.05-96:

Higher in-containment refueling water storage tank (IRWST) liquid temperatures increase boiling in the core and deposition on the fuel rods. Higher IRWST liquid temperatures also increase mass release rates in the IRWST. As explained in the Response to Question 15.06.05-94, if boiling is present, the U.S. EPR Deposition Model (EPRDM) calculation deposits the available material near the core location as scale. In addition, higher amounts and higher assumed concentration of silica and alumina in the microtherm insulation increase total solids in the IRWST, which increases the deposition on the fuel rods. These condition combinations are consistent with a conservative downstream effects chemical deposition analysis.

The mass and energy release for breaks in the hot leg (HL), cold leg pump suction (CLPS), and cold leg pump discharge were obtained and used for determining the short and long term containment pressure responses and establishing the limiting cases for containment response. The initial conditions, the mass and releases, and the assumptions used for calculations are presented in Reference 1, Chapter 8 and Chapter 9. These mass and energy releases combined with some revisions in the assumptions were used for the IRWST calculation.

The mass and energy release to containment for IRWST temperature calculation was based on the availability of only two out of four emergency core cooling system (ECCS) trains. Each ECCS train includes one residual heat removal (RHR) heat exchanger, conservative decay heat values in the core, stored energy in fluid and metals in reactor cooling system and steam generators, ECCS pump heat, and containment structures and IRWST inventory.

The long term containment analysis consists of two distinct phases. During the first phase, the containment response is calculated using the RELAP5 mass and energy data boundary conditions. The second phase is the containment response beyond the RELAP5 data, and the mass and energy release was based on decay heat power and sensible heat in the fluid and metals in the primary and secondary sides.

In order to calculate the IRWST temperature and maximize the pool temperature response for postulated loss of coolant accident (LOCA) events, certain assumptions in Reference 1, Chapter 8 and Chapter 9 were revised and modified. Sensitivity studies were performed on certain parameters to maximize the IRWST temperature. These parameters include the initial containment pressure and temperature, RHR heat exchanger fouling factors, wall condensation heat transfer, and containment air gap between steel liner and the concrete wall in the Reactor Building containment.

The maximum IRWST temperature profile was obtained based on the following modifications to the cold leg discharge break multi-node subdivided GOTHIC input model:

The initial conditions for primary and secondary sides and the initial conditions for calculating the maximum IRWST temperature remained the same as the values in Reference 1, Chapter 8 and Chapter 9.

The values in Reference 1, Chapter 8 and Chapter 9 provided the peak containment pressure and temperature for postulated LOCAs in the cold leg pump discharge (CLPD), CLPS, and HL breaks using the multi-node GOTHIC model representation of containment. From these calculations, CLPD break case provided the maximum IRWST temperature value. The CLPD case was used as the base deck for the multi-node IRWST temperature analysis.

In the input model, presented in Reference 1, Chapter 8 and Chapter 9, the pool surface area was set to 0.0 ft^2 to limit the interaction between the liquid of the IRWST and the vapor in containment. This was done to maximize containment pressure and temperature. For maximizing IRWST temperature, the interaction between the liquid and vapor was allowed to increase the IRWST temperature. The liquid vapor interface area for the IRWST was changed to 6351.0 ft^2 to match the basemat area of the IRWST.

The IRWST temperature analysis showed an increase in liquid temperature when high fouling factors were applied. The fouling factors for the RHR heat exchanger from Reference 1, Chapter 8 and Chapter 9 were increased to 0.0005 ft^2-hr-F/BTU on both tube and shell sides.

A sensitivity study was performed for the effect of changing the condensation option from the diffusion layer model (DLM), used in Reference 1, Chapter 8 and Chapter 9, to the diffusion layer model with enhancement resulting from film roughening (DLM-FM). This option increases the condensation rate and raises the liquid temperature in the IRWST. The DLM resulted in higher IRWST peak liquid temperature and the DLM option was used for the IRWST liquid temperature calculation.

The base input model presented in Reference 1, Chapter 8 and Chapter 9 included maximum air gap thickness value (3mm). Sensitivity studies were performed with no air gap between steel liner and concrete wall in the containment. The results showed higher IRWST temperature with the air gap model. The IRWST temperature calculation models the air gap condition leading to the higher sump temperature response.

References for Question 15.06.05-96:

1. AREVA NP Document ANP-10299P, Revision 2, “Applicability of AREVA NP Containment Response Evaluation Methodology to the U.S. EPR for Large Break LOCA Analysis”, Technical Report.

FSAR Impact:

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

Question 15.06.05-97:

In assessing the impact of chemical debris for the purpose of determining strainer bypass and fuel assembly head loss in any U.S. EPR-specific tests, explain how the type and amount of surrogate for chemical precipitates, as and if applied in such tests, account for the types, characteristics, generation rates, transportation mechanisms, and deposition rates of chemical compounds present in the U.S. EPR ECCS water. Identify any conservatism in the approach that has been implemented to account for the presence of chemical debris in evaluating downstream effects on U.S. EPR core cooling.

Response to Question 15.06.05-97:

Reference 1, Section F.3.7.1 describes the requested information.

References for Question 15.06.05-97:

1. ANP-10293P, Revision 3, "U.S. EPR Design Features to Address GSI-191 Technical Report," AREVA NP Inc., March 2011.

FSAR Impact:

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