ArevaEPRDCPEm Resource

From: Tesfaye, Getachew
Sent: Wednesday, June 29, 2011 9:53 AM
To: 'usepr@areva.com'
Cc: Forsaty, Fred; Lu, Shanlai; Donoghue, Joseph; Carneal, Jason; Colaccino, Joseph
Subject: U.S. EPR Design Certification Application RAI No. 493 (5810), FSAR Ch. 15
Attachments: RAI_493_SRSB_5810.doc

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on June 6, 2011, and discussed with your staff on June 27 and 28, 2011. Drat RAI Questions 15.06.05-104, 15.06.05-111 and 15.06.05-112 were deleted and Draft Questions 15.06.05-101 and 15.06.05-106 were modified as a result of those discussions. 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: 3282

Mail Envelope Properties (0A64B42AAA8FD4418CE1EB5240A6FED132ABCE5A91)

Subject: U.S. EPR Design Certification Application RAI No. 493 (5810), FSAR Ch. 15
Sent Date: 6/29/2011 9:52:59 AM
Received Date: 6/29/2011 9:52:00 AM
From: Tesfaye, Getachew

Created By: Getachew.Tesfaye@nrc.gov

Recipients:
"Forsaty, Fred" <Fred.Forsaty@nrc.gov>
Tracking Status: None
"Lu, Shanlai" <Shanlai.Lu@nrc.gov>
Tracking Status: None
"Donoghue, Joseph" <Joseph.Donoghue@nrc.gov>
Tracking Status: None
"Carneal, Jason" <Jason.Carneal@nrc.gov>
Tracking Status: None
"Colaccino, Joseph" <Joseph.Colaccino@nrc.gov>
Tracking Status: None
"'usepr@areva.com'" <usepr@areva.com>
Tracking Status: None

Post Office: HQCLSTR02.nrc.gov

Files	**Size**	**Date & Time**
MESSAGE	864	6/29/2011 9:52:00 AM
RAI_493_SRSB_5810.doc	46590	

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

Request for Additional Information No. 493 (5810), Revision 0

6/29/2011

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: 15.6.5

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

15.06.05-98

OPEN ITEM

Throughout the U.S. EPR Final Safety Analysis Report (FSAR) Tier 2, Section 15.6.5, AREVA NP refers to licensing topical report ANP-10278P, "U.S. EPR Realistic Large Break Loss of Accident Methodology Topical Report." This document is currently under review by the NRC staff. This RAI is created to track an open item associated with this review. It will be closed upon completion of the review by the NRC staff and issuance of the final safety evaluation report on ANP-10278P. AREVA is requested to acknowledge receipt of this open item.

15.06.05-99

OPEN ITEM

Follow-up question to RAI 30, Question 15.06.05-04:

Explain if debris from the sump blocks portions of the core inlet and if so, the impact on precipitation timing in the regions where the core boric acid cannot diffuse downward into the lower plenum. Identify the maximum core inlet blockage that can occur and show that local concentrations in the core are below the precipitation limit. With the core inlet blocked, and boric acid and other precipitates in the core, show that the switch to simultaneous injection can flush the core and reduce the concentration to acceptable levels.

15.06.05-100

OPEN ITEM

Follow-up question to RAI 30, Question 15.06.05-07:

Explain if the mixing volume considers the maximum content of sump debris that can accumulate in the core. Provide and explain the value of the maximum amount (volume) of debris that can accumulate in the core and lower plenum regions during recirculation.

based on the review of ANP-10288P, "U.S. EPR Post-LOCA Boron Precipitation and Boron Dilution Technical Report," dated November 2007.

15.06.05-101

Provide a justification for the core void fraction assumed, considering the following contributors: decay heat, system pressure and axial power shape.

15.06.05-102

Explain the impact of effects caused by possible debris bed restructuring, loss of integrity, and redistribution of debris across multiple spacer grids on the maximum flow rate assertion within the expected range of core flow rates for the U.S. EPR. In this regard, show that the assumptions regarding the number of operating ECCS trains and the associated impact on the U.S. EPR downstream effects under hot leg break LOCA conditions with cold side injection, when maximum core flow rates are expected, are appropriate and conservative.

15.06.05-103

Explain how the applied HLI flow rate of 1,997 gpm was determined and describe the assumed conditions used to determine the HLI flow rate. Explain and describe the U.S. EPR supporting analyses used to determine the range for the number of fuel assemblies receiving downward flow (between 72 and 96). In addition, explain and describe the U.S. EPR supporting analyses used to determine the downward flow rates taking into account fluid mixing and explain how the mixing efficiencies were defined and calculated.

15.06.05-104

[Intentionally deleted.]

15.06.05-105

Provide a reference and explain the applicability for the value of 442.3 lbm/s or 3,250 gpm that was assumed for the minimum assured ECCS flow that reached the RCS. Analyze and discuss the impact of uncertainties associated with the assumed number of 84 fuel assemblies receiving downflow on the evaluation of the core blockage.

15.06.05-106

Appendix F of ANP-10293 Revision 2 did not provide a description of the fuel blockage testing and documentation of the test results for the U.S. EPR design. Instead, it was stated in Appendix F that the testing description and results for cold side injection and simultaneous injection "will be provided in a subsequent revision to this report." Provide a complete description of the testing and results for cold side injection and simultaneous injection scenarios. In addition, provide the following based on a May 5, 2011, audit of AREVA's test plans and supporting documentation:

1. For the cold leg break with cold leg ECCS injection, between 15 minutes and 60 minutes into the LBLOCA transient, provide the technical basis for the following

analysis assumptions to demonstrate that they lead to conservative acceptance criteria for the fuel assembly head loss testing:

a. Core average void fraction of 50% considering possible impact of different (lower) containment pressure and safety injection temperature;

b. Downcomer average void fraction of 20% considering possible impact of different (lower) containment pressure and safety injection temperature;

c. The discrepancy between the Appendix F assumption of the non-existence of loop seal (all loops venting steam) and the existence of loop seal assumed by the AREVA static balance confirmatory analysis needs to be explained and justified. Demonstrate that, if loop seals exist, the void fraction assumed at the loop seal location is conservative. Evaluate the impact of loop seal on the available driving head for the core flow;

d. A 0.5 psid pressure drop is assumed in Appendix F to take into account possible pressure drop due to steam condensation at the ECCS injection point. Provide justification to demonstrate that the assumed pressure drop is conservative;

e. The analysis assumes that the steam generated in the core region would go through the steam generators. Confirm that the friction pressure losses across the SG U-tubes are based on the reduced SG flow area at the maximum allowable tube plugging limit. Because of possible heat-up of the steam by the SG secondary side fluid, steam may start to accelerate and cause additional pressure drop. Evaluate this effect and demonstrate why it can be assumed to be zero

f. The analysis assumes that the two-phase flow friction pressure loss in the core, including pressure loss across all spacer grids, as well as the acceleration pressure drop in the core, are zero. Evaluate the pressure loss effects in the core due to friction and flow acceleration at 15 minutes into the LOCA transient and justify why they can be set to zero.

2. For all four LBLOCA cases, evaluate the following:

   a. The most limiting containment pressure to provide the maximum required core flow and the minimum available driving head;

   b. Double-ended-guillotine break versus slot break on top of the pipe (except for the cold leg break with cold leg injection). Justify why the chosen approach bounds the driving head calculated for all four cases;

   c. The minimum SI injection for all four cases and its impact on both the total core flow and minimum driving head;

   d. For cold leg break with hot leg ECCS injection case, it appears that the downcomer liquid gravitational head was not included in the manometric balance calculation for the available driving head. Reconsider and evaluate the possible impact of the downcomer gravitational head on the calculation of the available driving head in this and the other three cases.

3. In determining the SI flow required for the scenarios with hot leg injection, evaluate the following:

   a. The most limiting temperatures for the LHSI and MHSI flows to compute the minimum available SI flow subcooling.

b. The most limiting cold leg MHSI flow and cold leg LHSI flow to compute the minimum available SI flow subcooling in the case of hot leg break with cold leg injection.

c. The most limiting containment pressure to provide the minimum saturated liquid enthalpy and minimum SI flow subcooling.

15.06.05-107

Describe the validation of EPRDM methodology for the purpose of evaluating the U.S. EPR downstream effects due to chemical precipitates and debris deposition and summarize the validation results along with corresponding references as available. If EPRDM was based on other codes and models, such as LOCADM, explain if these other codes were reviewed by NRC.

15.06.05-108

Provide additional information and explanation regarding the following EPRDM modeling assumptions in order to demonstrate their conservatism.

Assumption (4): As the latent heat of evaporation for water decreases with increasing pressure, explain why neglecting the presence of impurities in water, stated to raise the boiling point above that of pure water, is conservative for estimating the scale thickness.

Assumption (6): Substantiate the conservatism of the assumed non-boiling deposition rate set at 1/80th of the boiling deposition rate for the same heat flux. If the conservatism of the input value can not be substantiated, show the effect of neglecting the non-boiling deposition mechanism on the deposition results as a possible conservative assumption.

Assumption (8): Justify the applicability of the data from density measurements on cross-sectioned calcium sulfate scale density ranging from 12.5 to 106 lbm/ft^3 (200 to 1700 kg/m^3), considered in Appendix F Section F.4.4.3, "Scale Density," to the U.S. EPR conditions. Provide evidence to show that the input value of 12.5 lbm/ft^3 bounds possible effects on deposit density caused by inclusion of hydrates and other adsorbed species.

Assumption (9): Assess the coolant flow rate and velocity for unobstructed core geometry that correspond to convective heat transfer coefficient of 400 $W/(m^2.K)$ and compare the calculated flow rate against the core steaming rate at 100% decay heat. Explain why the heat transfer coefficient can not be even lower due to formation of possible stagnation zones in the core region.

Assumption (11): Provide the rationale for the assumed fiber transport rate in the EPRDM model so that the fiber debris that bypasses the sump strainers gests deposited into the core within one hour. Consider if fiber transport mechanisms can lead to more restrictive timing of fiber deposition within the core and analyze such impact on the U.S. EPR downstream effects.

15.06.05-109

Justify the applicability of the assumed 35 microns combined limiting thickness of zirconium dioxide and crud layers and their thermal conductivities, considered in Appendix F Section F.4.4.9, “Core Data,” to the U.S. EPR conditions. Explain if this thickness corresponds to three fuel cycles and provide fuel data to justify the selected maximum oxide thickness. Substantiate the conservatism of the 0.17 W/(m.K) combined oxide-crud layer thermal conductivity.

15.06.05-110

In addition to the EPRDM analysis presented in ANP-10293 Revision 2 Appendix F Section F.4 to evaluate chemical precipitates and debris deposition, assess the effects caused by rod to rod bowing, contact resistance due to spacer grids presence, enhanced debris trapping at spacer grid locations, and bridging of rod to rod gaps due to scale spallation from fuel rod surfaces. Present and discuss the assessment results with regard to the impact on both the fuel cladding temperature response and the deposition buildup on fuel surfaces to demonstrate the U.S. EPR compliance with the long-term core cooling requirements. Explain the oscillations in the predicted values for the aluminum, calcium and silicon concentration as reported in Table F.4-5.

15.06.05-111

[Intentionally deleted.]

15.06.05-112

[Intentionally deleted.]

15.06.05-113

OPEN ITEM

The staff requested that the applicant provide the validation of S-RELAP to model counter-current flow under such conditions, and demonstrate the applicability of the data obtained at scaled facilities to the U.S. EPR. The staff also requests that the applicant identify counter-current flow limits and associated effects on the U.S. EPR primary system heat extraction, demonstrate applicability of the S-RELAP5 counter-current flow limitation model to the U.S. EPR, including range coverage for mass flow rates, pipe diameter, inclination angle, and pressure, and specify the activation (flags) of the model in the U.S. EPR SBLOCA S-RELAP5 model.