ArevaEPRDCPEm Resource

From: Pederson Ronda M (AREVA NP INC) [Ronda.Pederson@areva.com]
Sent: Wednesday, August 05, 2009 2:48 PM
To: Tesfaye, Getachew
Cc: BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC); GUCWA Len T (EXT)
Subject: Response to U.S. EPR Design Certification Application RAI No. 241 (2769, 2804),FSAR Ch. 15
Attachments: RAI 241 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 241 Response US EPR DC.pdf" provides a technically correct and complete response to 1 of the 6 questions.

The following table indicates the respective pages in the response document, "RAI 241 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 241 — 15.02.01-15.02.05-9	2	3
RAI 241 — 15.06.05-51	4	4
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A complete answer is not provided for 5 of the 6 questions. The schedule for a technically correct and complete response to these questions is provided below.

Question #	Response Date
RAI 241 — 15.06.05-51	December 3, 2009
RAI 241 — 15.06.05-52	December 3, 2009
RAI 241 — 15.06.05-53	December 3, 2009
RAI 241 — 15.06.05-54	December 3, 2009
RAI 241 — 15.06.05-55	December 3, 2009

Sincerely,

Ronda Pederson
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From: Tesfaye, Getachew [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Tuesday, July 07, 2009 7:57 AM
To: ZZ-DL-A-USEPR-DL
Cc: Liang, Chu-Yu; Forsaty, Fred; Lu, Shanlai; Donoghue, Joseph; Carneal, Jason; Colaccino, Joseph; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 241 (2769, 2804),FSAR Ch. 15

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on June 5, 2009, and discussed with your staff on July 2, 2009. Draft RAI Question 15.06.05-50 was deleted 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: 715

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Subject: Response to U.S. EPR Design Certification Application RAI No. 241 (2769, 2804),FSAR Ch. 15
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From: Pederson Ronda M (AREVA NP INC)

Created By: Ronda.Pederson@areva.com

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MESSAGE	2550	8/5/2009 2:47:57 PM
RAI 241 Response US EPR DC.pdf	73012	

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Return Notification: No
Reply Requested: No
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Response to

Request for Additional Information No. 241

7/07/2009

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 15.02.01-15.02.05 - Loss of External Load; Turbine Trip; Loss of Condenser Vacuum; Closure of Main Steam Isolation Valve (BWR); and Steam Pressure Regulator Failure (Closed)
SRP Section: 15.06.05 - Loss of Coolant Accidents Resulting From Spectrum of Postulated Piping Breaks Within the Reactor Coolant Pressure Boundary
Application FSAR Ch 15

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

Question 15.02.01-15.02.05-9:

A review of the U.S. EPR final safety analysis report (FSAR) concludes that the design does not include an anticipatory reactor trip on turbine trip. The EPR design includes a non-safety related feature which provides a partial trip on turbine trip. The partial trip along with steam dump to condenser is intended to avoid a reactor trip.

Please provide an evaluation of events described in the FSAR Section 15.2, Decrease in Heat Removal by the Secondary System, which shows that these systems are functionally equivalent. Include explicit discussion of loss of external load, turbine trip, and loss or condenser vacuum.

Given a loss of condenser vacuum please explain the functioning of the partial trip and the reactor thermal/hydraulic dynamics including opening of the pressurizer safety valves and the MSRTs.

Show how these features have similar reliability. Please explain the risk trade-offs of the anticipatory reactor trip and the partial reactor trip.

Response to Question 15.02.01-15.02.05-9:

Other than 10CFR50.34(f)(2)(xxiii)(Issue II.K.2.10), which applies only to B&W plants, anticipatory trips are not required by regulation. Furthermore, it is unclear why it is necessary to demonstrate functional equivalence or to compare reliability between an anticipatory full reactor trip and a partial trip. The U.S. EPR design basis safety analysis demonstrates that the U.S. EPR meets all applicable regulatory requirements and acceptance criteria.

Although not a full reactor trip (RT), the U.S. EPR partial trip feature functions as an anticipatory trip to mitigate potential challenges to the plant and engineered safety features (ESF). In the case of the partial trip on turbine trip, this is accomplished by promptly reducing reactor power at the beginning of the transient. As a non-safety-related feature, partial trips are not credited in the design-basis safety analysis. Only safety-related equipment is credited as necessary to mitigate plant transients, including those involving a rapid decrease in heat removal capability by the secondary system.

The U.S. EPR partial trip, non-safety function is intended to rapidly reduce reactor power to approximately 50 percent power from full power under certain plant events such as a turbine trip. The rapid power reduction is designed to respond to a full load rejection without initiating a full reactor trip. The partial trip utilizes preselected control rod groups and/or banks which are inserted to reduce reactor power into a range where the turbine bypass system (TBS) is sufficient to maintain stable plant operation. Following the initiation of the partial trip, the control rods are maneuvered in a controlled manner to correct the mismatch between the programmed average coolant temperature and the measured average coolant temperature. The partial trip results in less plant upset than a full RT.

Once the plant stabilizes and the operators establish normal rod control, normal power escalation occurs through the resynchronization of the turbine/generator, if necessary. Turbine loading is initiated and continues until the TBS closes, and the plant is returned to the desired power level.

The steam capacity of the secondary steam relief systems is approximately 150 percent of full power steam load. This capacity is divided as 50 percent TBS, 50 percent through the main steam relief train (MSRT), and 50 percent through the main steam safety valves (MSSV). The steam relief systems are listed by increasing actuation pressure setpoint.

If the partial trip does not occur or the TBS is not available, a full RT occurs and the MSRTs actuate to control secondary system pressure.

For the loss of condenser vacuum event in which the TBS is unavailable, the partial trip still prevents the actuation of the pressurizer safety relief valves (PSRVs). This differs from the U.S. EPR FSAR Tier 2, Chapter 15.2.2 turbine trip analysis (which assumes a loss of offsite power (LOOP) and credits only safety-related equipment), where the PSRV actuated once. The loss of condenser vacuum event is bounded by the turbine trip event analyzed in the U.S. EPR FSAR.

The risk of actuating safety relief systems is the same for a loss of condenser vacuum event for either an anticipatory trip or the U.S. EPR partial trip. The MSRTs would be challenged because it is the first secondary steam relief system available if the TBS is unavailable. The PSRVs would not be challenged for either the partial trip or anticipatory trip scenario.

FSAR Impact:

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

Question 15.06.05-51:

If the two-phase mixture level drops below the top of the active fuel anytime during the U.S. EPR long term cooling phase of a LOCA, cladding heatup and oxidation can result.

Please provide the results of a thermal-hydraulic analysis quantifying the two-phase mixture level within the reactor core barrel during the long term cooling of the U.S. EPR core under the most limiting break size, break location and ECCS performance conditions. Discuss the conservatism of the obtained results. For important modeling parameters that are expected to vary within a certain range, substantiate the conservatism in selecting the value for each parameter or provide sensitivity assessments over the expected range of variation.

This question is as a follow-up to the reactor systems audit held on April 21-24, 2009.

Response to Question 15.06.05-51:

A response to this question will be provided by December 3, 2009.

Question 15.06.05-52:

In the mass balance approach for computing boric acid accumulation due to steaming in the U.S. EPR core during post-LOCA cooling, the licensee assumed a certain control (mixing) volume consisting of five different regions (sub-volumes) with individually assigned void fractions. This resulted in assumed core-region liquid volume fractions of 60% and 58% of the total liquid inventory within the mixing volume for the LBLOCA and SBLOCA analyses, respectively.

As the predicted precipitation time is proportional to the assumed liquid content within the mixing volume chosen, please demonstrate that the void fraction values, as applied to the individual mixing sub-regions, are conservative under the thermal hydraulic conditions encountered in the sub-regions over the period of interest. In particular, substantiate the applicability of a single void fraction value for computing the liquid amount within an entire sub-volume and explain any averaging assumptions with respect to both space and time.

This question is a follow-up to the reactor systems audit held on April 21-24, 2009.

Response to Question 15.06.05-52:

A response to this question will be provided by December 3, 2009.

Question 15.06.05-53:

In the mass balance approach for prediction of boric acid accumulation due to steaming in the U.S. EPR core during post-LOCA cooling, the licensee assumed a certain initial boron concentration in the mixing volume.

As the predicted boron concentration buildup and time to precipitation depend on the assumed initial boron concentration, please describe how the values for the initial boron concentration have been calculated in the analyses performed. In the case of a large-break LOCA, explain how the core blowdown flashing and reflood steaming processes have been considered to develop a conservative estimate for the initial boron concentration.

This question is a follow-up to the reactor systems audit held on April 21-24, 2009.

Response to Question 15.06.05-53:

A response to this question will be provided by December 3, 2009.

Question 15.06.05-54:

In the current U.S. EPR post-LOCA boron precipitation analysis provided by the licensee, the control (mixing) volume applied includes the core fluid volume, part of upper plenum, part of lower plenum as well as the fluid volume in the guide tubes and heavy reflector.

The staff questions the applicability of this approach, as it inherently assumes that the averaged boron concentration over the entire control volume is equal to or greater than the maximum boron concentration in the core fluid volume. At this point, no quantifiable justification has been provided to substantiate the above assumption. If no quantifiable justification can be submitted, the analysis approach taken should be revised to conservatively evaluate the boron concentration and precipitation in the core where the decay heat is released. In this case, please provide the results of the revised analysis approach and discuss its impact on hot leg switch-over timing and identify all the areas to be impacted by different boron precipitation timing.

This question is a follow-up to the reactor systems audit held on April 21-24, 2009.

Response to Question 15.06.05-54:

A response to this question will be provided by December 3, 2009.

Question 15.06.05-55:

In predicting the boric acid concentration and precipitation time due to coolant evaporation in the U.S. EPR core during post-LOCA cooling, the licensee applied a mass balance approach with an assumed control (mixing) volume. The core region fluid volume represented 61% and 56% of the total assumed mixing volume in the LBLOCA and SBLOCA analyses, respectively.

As liquid coolant is evaporated within the active core region, the dissolved boron is deposited, almost entirely, in the liquid surrounding the heated fuel surface where the evaporation process occurs. Since the predicted time to precipitation is proportional to the assumed liquid content in the defined mixing volume, please provide substantiation for the inclusion of any liquid containing regions outside of the active core in the mixing volume and explain the mechanisms capable of transporting and mixing liquid within the core region, and from the core region into any additional volumes included in the mass balance mixing volume. In addition, provide evidence that the end result of these mechanisms is perfect boric acid mixing within the liquid phase in the entire control volume as assumed in the calculations.

This question is a follow-up to the reactor systems audit held on April 21-24, 2009.

Response to Question 15.06.05-55:

A response to this question will be provided by December 3, 2009.