ArevaEPRDCPEm Resource

From: Tesfaye, Getachew
Sent: Wednesday, October 20, 2010 10:00 AM
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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), FSAR Ch. 15
Attachments: RAI_428_SRSB_4922.doc

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,
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Hearing Identifier: AREVA_EPR_DC_RAIs
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Request for Additional Information No. 428(4922), Revision 0

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)

15.06.05-78

[Intentionally deleted.]

15.06.05-79

[Intentionally deleted.]

15.06.05-80

[Intentionally deleted.]

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.

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.

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.

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.

15.06.05-85

Provide evidence that introducing the fiber load in larger batches rather than in a series of smaller batches during fuel assembly blockage testing produces results that are representative of the physical process of gradual debris accumulation. For this purpose, comparative results produced with incremental fibrous debris load introduction in smaller amounts, such as 2 gram fiber per batch or less, can be used.

15.06.05-86

The approach currently applied in assessing downstream effects on U.S. EPR core cooling employs fuel assembly blockage testing for determining fuel head loss and

separate sump screen bypass testing for assessing the downstream fiber load. Whereas similar fiber surrogate material is used in both types of testing, in reality length distribution of downstream fiber can differ significantly from that of source fibrous debris upstream of the retaining basket as a result of retention and bypass processes caused by the retaining basket and the sump strainer.

Explain how the fiber length distribution of fibrous source material used in strainer bypass testing for the U.S. EPR can impact the strainer bypass test results. Demonstrate the appropriateness and applicability of sump strainer bypass test results obtained with fibrous surrogate material of certain length distribution characteristics for the purpose of investigating downstream effects on core cooling resulting from fuel assembly blockage. In particular, consider any possible interdependency between fiber length distribution of source fiber material used in sump strainer bypass testing, fiber length distribution of fiber material used in downstream fuel assembly blockage testing, and sump strainer bypass ratio

15.06.05-87

The applicant presented an experimentally derived curve based on existing data from fuel assembly blockage testing. The curve gives a relationship between the observed fuel assembly head loss and the particulates-to-fiber mass ratio in tests performed with a varying amount of particulates and a constant fiber mass load. The curve shows a maximum in the measured head loss at a certain particulates-to-fiber mass ratio. For mass ratios larger or smaller than this observed critical value, the curve predicts a smaller head loss for the specific fiber load considered.

If such a curve is used to determine particulates-to-fiber mass ratios for U.S. EPR fuel assembly blockage testing, present data that support the applicability of such a relationship to the U.S. EPR fuel assembly design. Describe the conditions and assumptions used in obtaining and qualifying the applied test data. Comment on data accuracy, repeatability, and applicability to U.S. EPR prototypical core conditions. Identify and explain key participating and competing mechanisms that cause such a maximum in the observed head loss. Discuss effects related to and appropriateness of values applied for the total fiber mass load, batch size of fiber addition, and coolant mass flow rate on the established head loss versus particulates-to-fiber mass ratio dependency as applicable to the U.S. EPR design.

15.06.05-88

With regard to U.S. EPR fuel assembly blockage testing, address effects associated with length distribution of surrogate fiber material on test results obtained under limiting conditions for determining the maximum applicable ΔP. In addition, consider such effects on test data used in establishing the limiting ΔP versus particulates-to-fiber mass ratio. Demonstrate the conservatism associated with using fibrous surrogate material of certain length distribution characteristics in evaluating the U.S. EPR downstream effects on core cooling.

15.06.05-89

Explain how the strainer bypass testing accounts for effects associated with possible debris basket overflow leading to an increased amount of debris available to reach the strainer surface. In particular, describe testing protocols related to identifying the spillage fiber fraction for partial load (such as ¼ load) or full load.

15.06.05-90

Explain how the strainer bypass testing approach accounts for the most limiting conditions with regard to the number of ECCS trains assumed in operation and the associated uniform or other probable ways of debris distribution among participating strainers.

15.06.05-91

Explain how the fiber length distribution of fibrous source material used in strainer bypass testing for the U.S. EPR can impact the strainer bypass test results. Demonstrate the appropriateness and applicability of strainer bypass test results obtained with fibrous material of certain length distribution characteristics for the purpose of investigating downstream effects from fuel assembly blockage and resulting impact on core coolability.

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.

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.

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.

15.06.05-95

The EPRDM debris deposition model and analysis results for the U.S. EPR design used a limiting thickness criterion for the debris buildups based on the as-designed fuel geometry. Consider effects associated with ballooning and conditions related in post-LOCA long term cooling analyses.

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.

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.