ArevaEPRDCPEm Resource

From: Getachew Tesfaye
Sent: Thursday, May 21, 2009 9:51 AM
To: Pederson Ronda M (AREVA NP INC)
Cc: 'WELLS Russell D (AREVA NP INC)'; Jason Carneal; Fred Forsaty; Shanlai Lu; Joseph Donoghue; Joseph Colaccino; ArevaEPRDCPEm Resource
Subject: Draft Supplemental RAI - ANP 10278, Realistic Large Break LOCA TR
Attachments: DRAFT Sixth Round RAI ANP10278.doc

Ronda,
Attached please find a draft of the subject supplemental RAI for the Realistic Large Break LOCA Topical Report (ANP-10278). We will have our technical Staff available to discuss them with you as soon as you are ready. Please call me with a proposed date and time for the telecon.

Please also review the RAI to ensure that we have not inadvertently included proprietary information. If there are any proprietary information, please let me know within the next ten days. If I do not hear from you within the next ten days, I will assume there are none and will make the draft RAI publicly available.

Thanks,
Getachew Tesfaye
Sr. Project Manager
NRO/DNRL/NARP

Hearing Identifier: AREVA_EPR_DC_RAIs
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6th REQUEST FOR ADDITIONAL INFORMATION (RAI)

ANP-10278P, "U. S. EPR REALISTIC LARGE BREAK LOSS OF COOLANT ACCIDENT DESIGN TOPICAL REPORT"

DOCKET NO. 52-020

RAI-41

This question is a follow-up to RAI-27. In response to RAI-27, AREVA stated that the vessel pressurization was artificial and was caused by certain deficiencies identified in the critical flow model when choking at the break plane occurs at the break plane coincident with the passage of the cover gas. It was indicated by AREVA that this error did not show up until U.S EPR PCT reached the peak value. Provide detailed description of the potential model errors and clearly identify the range of the impact of this code error and why. If possible, inform staff the plan to fix this error.

RAI-42

This question is a follow-up to RAI-38. The response to RAI-38 contains an error. Figure 38-1 in Reference 1 shows the liquid volume in the lower plenum (all space below the core inlet) and indicates a total LP volume of 700 ft3. The actual volume of this region is 806.7 ft3. It appears that some S-RELAP5 fluid cells were omitted from the liquid volume calculation. Correct figure 38-1 accordingly.

Reference 1: NRC:09:037, Letter from R.L. Gardner to NRC Document Control Desk, "Response to Fifth Request for Additional Information Regarding ANP-10278), "U.S. EPR Realistic Large Break Loss of Coolant Accident Topical Report" (TAC No. MD4978). April 9, 2009.

RAI-43

This question is a follow-up to RAI-39. Please re-plot Figure 39-1 of Reference. 1. The new plot should show two lines. The first line should show the collapsed level in the lower plenum plus lower head, while the second should show the collapsed level in the core.

Reference 1: NRC:09:037, Letter from R.L. Gardner to NRC Document Control Desk, "Response to Fifth Request for Additional Information Regarding ANP-10278), "U.S. EPR Realistic Large Break Loss of Coolant Accident Topical Report" (TAC No. MD4978). April 9, 2009.

RAI-44

This question is a follow-up to RAI-40. Comparison of Figures 38-1, 39-1, and 40-1 of Reference 1 indicates that there is significant positive core flow, which results in cladding temperature turn-around, prior to refill of the lower plenum. Justify why this behavior is

acceptable for the RLBLOCA calculation. Demonstrate the sensitivity of this behavior to LP axial nodalization.

Reference 1: NRC:09:037, Letter from R.L. Gardner to NRC Document Control Desk, "Response to Fifth Request for Additional Information Regarding ANP-10278), "U.S. EPR Realistic Large Break Loss of Coolant Accident Topical Report" (TAC No. MD4978). April 9, 2009.

RAI-45

This question is a follow-up to RAI-35: The response to RAI-35 (page 6 of ANP-10278Q5P) notes that the value of FUELK is set to unity for transient analyses even though it may have been less than unity for the steady state calculation. If the adjustment of FUELK for steady state calculation is to capture the thermal conductivity degradation due to burn-up, why is it not done for transient calculation? Justify returning the value of FUELK to 1.0 for the four hot rods at the start of the transient.

RAI-46

This question is a follow-up to RAI-24. In response to RAI-24 AREVA agreed to change the accumulator liquid temperature sampling range by increasing the upper bound temperature from 122 F to 131 F. With this change the RLBLOCA methodology samples accumulator temperature uniformly from a lower bound of 59 F to an upper bound of 131 F. The lower bound of this range corresponds to the Technical Specification Surveillance Requirements. An appropriate lower bound accumulator temperature is one which is consistent with sustained operation of the reactor at nominal full power since this is the initial condition used in the RLBLOCA analysis. Justify the validity of using the Technical Specification minimum temperature as the lower bound for full power conditions or choose a lower bound temperature which can be justified.

RAI-47

Provide RODEX3A (with temperature adjustment) comparisons to the following Halden Project experimental rods IFA-681 Rods 1 and 5 (UO2), presented in HWR-873 up to rod average burnups near 30 GWd/MTU, and to IFA-558 Rods 1 and 6, presented in HWR-667 and 553 up to rod average burnups up to 39 GWd/MTU. Also, provide COPERNIC and RODEX4 comparisons to this same data. The most prototypic of these four experimental rods in terms of fuel and cladding dimensions are the IFA-681 rods with a 9.5 mm fuel rod and pellet diameters of 9.5 mm and 8.19 mm, which are the same as for the EPR design. The data from IFA-558 is available in the open literature because it has been used to develop the newly revised ANS 5.4 standard for release of radioactive gases for determining dose for particular accidents. The comparisons to the IFA-677.1 Rod 2 measured fuel temperature data can also be provided but this data is considered to be less prototypic to RODEX3A application to RLBLOCA for the reasons discussed in the Criteria below.

<u>Criteria for Halden Data Selection for RAI-52:</u>

The purpose of the criteria is to select fuel temperature measurements for in-reactor test rods that are applicable to the RODEX3A prediction of fuel temperatures for RLBLOCA. The RODEX3A calculation of initial fuel temperatures for RLBLOCA is unique in that the

DRAFT

ramp to power up to the LHGR limit is for a very short time period such that it does not allow for any fission gas release. Most power operation at the LHGR limit, approximately 44 kW/m for the EPR design, will result in significant fission gas release at burnups above 15 GWd/MTU, particularly for test fuel rods. This fission gas release will degrade the fuel-cladding gap conductance significantly increasing fuel temperatures in test rods. There are two reasons for an increase in fuel temperatures, with a fixed power level, with increasing burnup. The first reason is fuel thermal conductivity degradation, and significant fission gas release resulting in gap conductance degradation that increases fuel temperatures is the second reason.

Degradation in gap conductance due to fission gas release was particularly significant in the early Halden tests, such as IFA-432 Rod 1, near LHGR levels of the EPR limit because the rods were only filled with 1 atmosphere of helium which made the gap conductance much worse than in current PWR designs (20 atmosphere of helium). The early fuel performance codes such as RODEX3A tended to over predict the fission gas release and the resulting thermal feedback provided an over prediction in fuel temperatures that tended to compensate for the lack of a burnup dependence on fuel thermal conductivity at least up to burnups of 25 to 30 GWd/MTU. It is noted that the over prediction of thermal feedback due to gas release was not sufficient to compensate for the thermal conductivity degradation at higher burnup levels. Because the application of RODEX3A to initialize fuel temperatures for LBLOCA does not allow for fission gas release at this power level, near the EPR LHGR limit, RODEX3A comparisons to in-reactor test data with significant fission gas release and gap conductance degradation is not appropriate. This provides a dilemma in selecting in-reactor test rods that could be used to benchmark RODEX3A thermal predictions, particularly at the EPR LHGR limit, up to 30 GWd/MTU. There are three types of tests with measured fuel temperatures that would be applicable to the RODEX3A RLBLOCA application with little fission gas release and no thermal feedback:

1. Very short time power ramp tests up to or near the EPR LHGR limit, resulting in little fission gas release, with measured fuel temperatures at various burnup levels up to 30 GWd/MTU.

2. Test rods with a very large helium fill gas reservoir such that fission gas release will not result in a degradation in gap conductance.

3. Test rods with rod powers just below or slightly above the threshold for fission gas release.

None of the Halden tests examined met the first test type of test, i.e., very short power ramps, because Halden has not had the capability for short time power ramps until very recently. Some of the Halden tests that were examined for benchmarking the RODEX3A code were the IFA-681, IFA-677.1 and IFA-558 tests.

The IFA-681 test Rods 1 and 5 represented the third type of test rods in that they operated only slightly above (Rod1) and slightly below (Rod 5) the release threshold for fission gas release. For reference, see Figures 17, 19 and 34 from HWR-873. The LHGR for IFA-681 Rod 1 the LHGR ranged between 32 to 36 kW/ft up to a burnup of 24 GWd/MTU and the decreased to 25 to 27 kW/m up to 31 GWd/MTU; Rod 5 had approximately 10% lower power than Rod 1. The initial helium fill pressure was slightly

DRAFT

less than 10 atmosphere for both rods that mitigated the thermal feedback due to the small fission gas release experienced in Rod 1.

The IFA-677.1 Rod 2 was examined because it was fabricated with Framatome fuel and operated at high powers (40 kW/m) with a helium fill gas pressure of approximately 13 atmosphere. However, this rod had significant gas release, approximately 20%, which resulted in significant fraction of low conductivity xenon in the gap. This rod was discarded for this reason.

The IFA-558 test rods consisted of a very large helium gas volume with operation at high rod powers (up to 40 kW/m at 27 GWd/MTU and at or above 30 kW/m for burnups up to 40 GWd/MTU). The fission gas release was periodically swept from these rods to measure the release over given time periods such that little gap conductance degradation was present due to fission gas release. The non-prototypic aspect of these rods compared to PWR fuel rods is that they had a relatively large fuel rod and pellet diameters of 12.5 mm and 10.6 mm, respectively, versus the 9.5 mm and 8.19 mm for the EPR fuel design. This larger pellet diameter lowers the fuel pellet temperature versus LHGR such that at 13 kW/ft the centerline temperature is approximately 150°F lower than with a 8.19 mm fuel pellet diameter. The IFA-558 Rods 1 and 6 had fill gas pressures of 40 and 20 bar, respectively.

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