ArevaEPRDCPEm Resource

From: Getachew Tesfaye
Sent: Tuesday, December 16, 2008 4:04 PM
To: 'Pederson Ronda M (AREVA NP INC)'
Cc: Jason Carneal; Prosanta Chowdhury; Fred Forsaty; Shanlai Lu; Joseph Donoghue; Joseph Colaccino; John Rycyna; ArevaEPRDCPEm Resource; 'DUNCAN Leslie E (AREVA NP INC)'
Subject: Feedback Re: AREVA's Approach to RLBLOCA Topical Report RAI (ANP-10278P)
Attachments: Staff Feedback Re Proposed Response to RAI-3 RLBLOCA TR Final.doc

Ronda,
Attached please find the staff's written assessment of your approach, as presented in a public meeting on September 10, 2008 (ML083460142), to the third round of request for additional information (RAI) on ANP-10278P, “U.S. EPR Realistic Large Break Loss of Coolant Accident Topical Report”, (ML0815703650).

Please review the document 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 document publicly available.

If you have any question regarding this matter, I may be reached at (301)-415-3361.

Thanks,

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Office of New Reactors
U.S. Nuclear Regulatory Commission
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Subject: Staff response to AREVA's proposed resolution to the third round of RAIs related to ANP-10278P "EPR Realistic LBLOCA topical report"

On September 10, 2008, NRC staff held a public meeting with AREVA regarding its proposed approaches to address staff's 3rd round of RAIs [3] on AREVA's EPR Realistic Large Break Loss of Coolant Accident Topical Report [4]. Staff has evaluated the AREVA's proposal. The attached is the staff response to AREVA's proposed resolution.

CONTACT: Fred Forsaty, NRO/DSRA/SRSB
(301) 415-8523

Enclosure: As stated

Staff Responses to AREVA's Proposed Approach Regarding Third Round RAIs on U.S EPR Realistic Large Break Loss of Coolant Accident Topical Report

References:

1. ANP-10278P, "U.S. EPR realistic large break loss of coolant accident (RLBLOCA) topical report", ML 0708807391.

2. AREVA's proposed response to the U.S. NRC request for additional information (RAI) regarding the EPR RLBLOCA TR, September 10, 2008, (ML083460142).

3. EMF-2103(P)(A), Revision 0, "Realistic Large Break LOCA Methodology for Pressurized Water Reactors", (ML 012400026).

4. Third Round of Request for Additional Information (RAI) ANP-10278P, "U.S. EPR Realistic Large Break Loss of Coolant Accident Topical Report", (ML0815703650).

RAI 21

RAI 21 provided staff position that the non-parametric order statistic approach taken by AREVA requires a sample size of 124 cases to obtain the required 95/95 multivariate tolerance limit for the three random variables - peak clad temperature, maximum oxidation, and maximum hydrogen generation. With this position, AREVA shall update EPR RLBLOCA methodology topical report as described in Reference 1 to incorporate sample size of 124 cases instead of the present 59 sample runs.

In response to staff request, AREVA has agreed with the staff's request and stated during the public meeting that, "For the U.S. EPR, AREVA NP will modify the number of case sets run to 124".

Staff accepts AREVA's response to RAI # 21. However, staff does not agree with AREVA's approach of establishing the minimum break size based on the number of sampling cases. Staff position is that RAI 21 and RAI 29 are separate issues and need to be addressed separately.

RAI 22

In this RAI, staff stated that emergency core cooling system evaluation must be performed for onsite power available (offsite power unavailable) and offsite power available (onsite power unavailable). Staff has stated that a full set of analyses needs to be performed with the worst configuration of offsite power in order to show compliance with GDC-35.

In response to this RAI, AREVA indicated that for the U.S. EPR, by design, there is no significant difference in results between LOOP and non-LOOP case although LOOP assumption may result in more conservative results. Therefore, only LOOP will be assumed. Staff accepts AREVA's proposed approach of complete LOOP input assumption in the LOCA analysis.

RAI 23

In this RAI staff noted that AREVA has not provided sufficient documentation to support the containment model used to calculate the containment back pressure during a LBLOCA. In addition, ICECON code was not approved for calculating containment back pressure during LBLOCA for EPR. In response to this RAI, AREVA indicated that a new topical report on ICECON for LBLOCA will be submitted to NRC for review.

Staff will not accept the topical report to review unless the following issues are fully addressed in the submittal:

a) explain how total heat transfer area is obtained and how heat transfer to the IRWST water surface is treated;

b) explain how the "best estimate containment pressure curve" obtained as shown in Figure 3-1 (Reference 1) is confirmed to be a best-estimate curve for LBLOCA analysis.

c) discuss differences in the containment back pressure during a LBLOCA, for a one node ICECON containment modeling vs. a multi-node modeling.

RAI 24

In this RAI, staff requested the range and the EPR RLBLOCA analysis values of the accumulator liquid temperature, liquid volume and initial pressure, and IRWST liquid temperatures, and the basis of the sampling parameter ranges. Staff asked AREVA to show how the upper bound values compare with the EPR's Technical Specification values.

In response, AREVA stated that, "AREVA will provide detailed justification for the source of initial pressure, temperature, and volume of accumulators and IRWST", and that, "the response will relate to technical specifications and explain relationship between building locations environment and the technical specification values." During the meeting, AREVA discussed the calculated containment internal temperature distribution and the justification to support the selected upper bound accumulator liquid temperature.

Staff reviewed AREVA's proposed approach to address this RAI and expects to see justification for the source of initial pressure, temperature, and volume of accumulators and the IRWST. Staff will not accept the response unless AREVA clearly describes the method used to calculate the containment internal temperature, justifies the lower and upper bounds of accumulator liquid temperatures and provides the basis of the assumed probability distribution within the sampling range considering the normal operating condition at full power level.

RAI 25

In this RAI, staff requested that AREVA demonstrate that the MSRT will not operate for any of the break sizes being considered in the RLBLOCA methodology or demonstrate that if it did operate, it would have no significant effect upon the course of the transient and the resulting PCT, oxidation and hydrogen generation.

Staff reviewed AREVA's documented rational for the approach, set point analysis and sensitivity studies that were provided as part of AREVA's response to this RAI. Staff requires that any changes to MSRT setpoint that would invalidate its assumed function in the small and large break LOCA analyses should be addressed and documented. Since MSRT setpoint may significantly affect the steam generator side heat removal, AREVA needs to clarify the impact of MSRT setpoint on the lower bound break size value.

RAI 26

In this RAI, staff has expressed concern regarding the amount of core inlet flow rate oscillation during reflood (35 to 200 second time frame, Figure A-13 of the subject topical report, Reference 1). The effect of such oscillations is to drive water up into the core and provide an additional cooling mechanism. This could be an S-RELAP5 code characteristic rather than an EPR specific phenomenon. Staff requested justifications that S-RELAP5 is adequately capable of realistically characterizing the oscillations, specifically during the reflood phase of the RLBLOCA analysis or that S-RELAP5 conservatively predicts PCTs in spite of the oscillations.

In response, AREVA indicated that further studies will be performed to evaluate the S-RELAP oscillation issue.

Staff acknowledges the existence of the core flow oscillation during the reflood period of a LBLOCA but does not believe that the magnitude of the oscillation as predicted by the S-RELAP5 code is realistic. Based on the information provided by AREVA at this point regarding this issue, staff does not believe the existing integral test data can be readily applied to justify that S-RELAP5 code can conservatively predict oscillatory flow conditions during reflood. Therefore, staff plans to impose a 200 F^{o} penalty on PCT unless new information is provided to address the 3D effects in the lower plenum and upper plenum, the capability of S-RELAP5 code to model the downcomer region momentum transfer, and the scalability of the specific test data to EPR.

RAI 27

In this RAI, staff noted that the S-RELAP5 analysis for the RLBLOCA indicates a relatively high system pressure increase of about 70 psi during accumulator injection phase. Staff requested justification to support the validity of the S-RELAP5 code vessel pressure prediction during the accumulator injection phase of the RLBLOCA analysis.

During the public meeting, AREVA explained the possible causes of the pressurization and discussed plans to study this phenomenon further and provide response to this RAI.

Staff reviewed AREVA's proposal and found that current information provided to staff by AREVA has not justified the magnitude of the pressure increase predicated by the S-RELAP5 code. Unless AREVA fully addresses the scalability of the relevant tests and demonstrates that the non-condensable gas mass and heat transfer within the primary system support the S-RELAP5 code vessel pressure prediction during the accumulator injection phase of the RLBLOCA analysis, staff intends to impose a penalty on the predicted PCT.

RAI 28

In this RAI, the staff had noted, "Achilles test that showed a surge into the core due to nitrogen caused some momentary cooling. However later, the increased surge caused an increase in entrainment and a loss of cooling due to a lower quench level that resulted in an overall increase in PCT for the test." Staff requested explanation on how the code captures the detrimental effect due to nitrogen injection after the initial insurge of the liquid into the core.

Similar to RAI 27, AREVA indicated its intention to study this phenomenon further and provide response to this RAI at a later date.

The information and the supporting documents submitted by AREVA have not provided acceptable justification why this test can be used to validate SRELAP5 code for EPR application. Specifically, the scalability of the test facility needs to be properly documented.

RAI 29

In this RAI staff stated that break size is a phenomenological issue and is different from the issue associated with realistic sampling. Staff requested justifications of break size spectrum used in the RLBLOCA analysis for US EPR.

Staff believes that RAI 21 and RAI 29 are separate issues and need to be addressed separately since the increase of sampling case number from 59 to 124 shall not affect the break size spectrum.

AREVA's proposal of using 10% of A_{pipe} as the lower limit break size is not acceptable as proper phenomenological criteria have not been applied to determine the break size lower limit. Instead, staff understands that AREVA determined the lower bound break size based on the need to cover entire break spectrum and the increase of sampling cases from 59 to 124. AREVA needs to submit justifiable phenomenological criteria to determine the lower bound break size. If this is not submitted, staff intends to mandate a lower bound break size based on staff's own evaluation, e.g, 20% of $A_{pipe.}$

RAI 30

Staff has determined that (Reference 4) Forslund-Rohsenow heat transfer correlation has been applied outside of its range of application for operating plant LBLOCA analysis. Since Reference 3 methodology is used by AREVA as a basis and applicable to the EPR's RLBLOCA methodology, staff requests that AREVA quantify the impact on the EPR RLBLOCA results.

During the meeting, AREVA noted "An S-RELAP code modification limits the amount of Forslund-Rohsenow heat transfer correlation's contribution to no more than 15% for void fractions above 90% and that this approach will be taken for the U.S. EPR RLBLOCA."

Staff reviewed AREVA's proposal to address this RAI and considers the approach acceptable,

RAI 31

In this RAI, the staff had expressed concerns regarding the insensitivity of downcomer nodalization on downcomer boiling following large break LOCAs. Staff requested that AREVA quantify the downcomer boiling impact on the EPR RLBLOCA results. It is noted that the staff had also agreed (Reference 3) that with the high containment pressures and PCTs of the order of less than 1800 °F, sufficient margin exists relative to the 10CFR50.46 criteria to not warrant further investigations. However, should PCTs increase above 1800 °F and/or the containment design result in pressures below the containment design pressure in the order of 30 psia, the staff plans to establish the limitation of this RLBLOCA method regarding downcomer boiling modeling.

In response to this RAI, AREVA stated during the meeting "Cold leg condensation is important to the predication of downcomer boiling phenomena and will be modeled in a new case set and that AREVA NP will document sensitivity studies that have been performed in the revised ANP-10278P."

Staff reviewed AREVA's proposed approach to address this RAI and accepts the proposed approach.

RAI 32

NRC staff has determined (Reference 4) that lack of a rod-to-rod radiation model in S-RELAP5 presents the potential that the uncertainty evaluation of the remaining heat transfer processes may over estimate the associated heat transfer. Staff requested that AREVA quantify the impact on the EPR RLBLOCA results.

In response to this RAI, AREVA stated its intention to provide response to this RAI a later date. Staff accepts AREVA's response to this RAI, however, staff requires that AREVA's response needs to be consistent with the improvements to the EMF-2103 (Reference 3).

RAI 33

In this RAI, staff noted that the ANS/ANSI 5.1-1979 standard decay heat curve was used in the EPR's RLBLOCA analysis (Reference 1). Table A-6, "Summary of Major Parameters for Limiting Transient." indicates a decay heat multiplier of less than one (0.96132) is used in ranging decay heat. Staff has indicated that AREVA has not provided sufficient documentation to support the validity of use of less than 100% decay heat as input to the analysis.

AREVA's response as documented in Reference 2 indicated that the EPR's RLBLOCA analysis had utilized decay heat based on 1979 ANSI/ANS standard in a conservative manner. Only the initial decay heat multiplier would be sampled between the range of ± 2.5 sigma

Staff reviewed AREVA's proposal to address this RAI. Staff does not accept the specific sampling methodology proposed. The staff position is that for each sampled S-RELAP5 case, the total integrated decay heat energy deposition in the core shall not be less than the integral decay heat energy deposition using nominal decay heat value during the entire period of the LOCA accident. In case AREVA decides not to apply the sampling option in the decay heat calculation, the staff does not object to the use of a conservative decay heat curve such as a decay heat curve that is based on the 1979 ANSI/ANS standard plus bias and uncertainty provided in the ANS-79 Standards. At this point, it is not clear why the new decay heat sampling range was defined as ± 2.5 sigma instead of ± 2 sigma, which was approved before. On October 23, 2008, AREVA discussed an alternative approach with staff. AREVA proposed that the 1979 ANSI/ANS decay heat model nominal value be used without performing statistical sampling because it has been shown to be more conservative than that of ANSI/ANS 2000 and ORIGIN decay heat model. Staff does not accept this approach since AREVA has not submitted the information regarding the validity of the ANSI/ANS 2000 or ORIGIN decay heat models. The submittal of the information will require additional staff review effort and possible schedule change.

In summary, AREVA has the following options to model the decay heat based on the information submitted at this point:

1. ANSI/ANS 79 nominal value plus two sigma;
2. Perform statistical sampling within ± 2 sigma using NRC approved decay heat model. The sampling method shall meet the criteria discussed above.

RAI 34

In this RAI the staff has noted that, the limiting time-in-life for analyses of LBLOCAs require two conditions to be analyzed to identify the limiting conditions for determining PCT. These two conditions are; a) the hot rod temperature calculation should be run at the very end-of-life when the pin pressure is highest. If a blowdown rupture occurs, then the earliest time-in-life must be found which just causes a blowdown rupture. The earliest time in life that a blowdown rupture occurs will then assure the stored energy is also at a maximum, and this condition would be applied to the hot rod PCT analysis and b) If a blowdown rupture does not occur, then analysis at the minimum gap conductance should be performed which maximizes the stored energy in the hot rod, which in turn will also maximize PCT.

During the meeting, AREVA indicated that the RLBLOCA methodology employs the sampling of time–in-cycle rather than the limiting condition. Therefore, the limiting time-in-life analysis approach is no longer part of the statistical approach

Staff reviewed AREVA's response to this RAI. Staff accepts AREVA's response that further studies and supporting documentations are needed to properly address this RAI a later date.

Contacts: Fred Forsaty (301-415-8523)