From: Loza, Paul G. [lozapg@westinghouse.com]
Sent: Friday, August 21, 2009 9:52 AM
To: Donnelly, Patrick
Cc: Behnke, Donald H.; Buckberg, Perry; Butler, Rhonda
Subject: Acknowledgement of RAI-SRP6.2.2-SRSB-16 thru -24

Patrick,

I acknowledge receipt for Westinghouse of RAI-SRP6.2.2-SRSB-16 thru -24.

Thanks,

Paul Loza

From: Donnelly, Patrick [mailto:Patrick.Donnelly@nrc.gov]
Sent: Thursday, August 20, 2009 12:33 PM
To: Loza, Paul G.; Behnke, Donald H.
Cc: Butler, Rhonda; McKenna, Eileen; Hebbar, Sudha; Hayes, Michelle; Hsii, Yi-Hsiung; Ford, Tanya
Subject: AP1000 - New Draft RAIs - RAI-SRP6.2.2-SRSB-16 thru -24

Don & Paul,

Below are 9 new draft RAI's on SRP6.2.2. Please let me know whether they are accepted or whether a conference call is desired.

Regards-

Patrick
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SRSB DRAFT RAI ON SUMP SCREEN DOWNSTREAM EFFECTS

RAI-SRP 6.2.2-SRSB-16:

The proposed amendment to AP1000 DCD Section 6.3.2.2.7.1, item 12, provided in the AP1000 DCD Impact Document APP-GW-GLE-002, Revision 3, specifies that the design basis for percentage of the total resident debris that could be transported to (1) the containment recirculation screens is ≤ 100%; and (2) the core (via a DVI [direct vessel injection] or a cold leg LOCA break that becomes submerged) is ≤ 60%. Contrary to this, in APP-GW-GLR-079, Revision 4, the debris that could be transported into the RCS through a submerged LOCA break is changed to be 75% of the debris transported to the containment, which is derived based on a DVI break in the loop compartment. On Pages 17 through 19 in APP-GW-GLR-079, Revision 4, Westinghouse indicates that its evaluation of the double-ended cold leg guillotine (DECLG) break shows 90% of containment flow entering the reactor vessel through the flooded DECLG break, and lists nine conservative assumptions (in 9 bullets) in its DECLG evaluation to justify the most limiting break with regards to debris loading on the fuel assemblies to be the double-ended DVI break in the loop compartment despite the DECLG result. Westinghouse concludes that minor reductions in one or more significant margins of those on the list for a DECLG break (e.g., if 17% of the debris either does not transport into the recirculation water or settles out after entering the water) would result in the same amount of fiber being transported into the RCS as in the DEDVI case. Westinghouse thus considers that DEDVI break is the most limiting with regards to debris transport to the core.

These qualitative arguments do not provide sufficient justification. The leak-before-break and lower rupture probability of a cold leg break (Bullet 1) are not an acceptable arguments because 10 CFR 50.46 requires the break spectrum of all sizes and locations be postulated without considering probability in the design basis analysis. The limiting single failure assumption and the 1971 ANS Standard decay heat plus 20% (Bullets 6 and 8) are the requirements of General Design Criterion 35 and Appendix K to10 CFR 50, respectively. The assumptions related to total debris load, debris transportation, and chemical precipitates (Bullets 2, 3, 4, 5 and 7) are the general design basis values specified in the AP1000 DCD Section 6.3.2.2.7.1. Taking credit for the viscosity difference between the head loss testing and plant operation (Bullet 9) should be done in accordance with the guidance regarding Generic Letter 2004-02 closure. In addition, all the above reasons other than item 1 are applicable to all breaks, including DVI and DECLG breaks. Therefore the staff finds that Westinghouse's conclusion that the DEDVI break in the loop compartment is the limiting break with regards to debris transport to the core is not sufficiently justified. Unless otherwise justified, the staff finds that the DECLG break appears to be the limiting debris-bypass break with 90% of unfiltered flow through the submerged break into the core.

(a) The staff requests Westinghouse to either re-evaluate the DVI and DECLG breaks using the same assumptions for each evaluation to justify which break is more limiting; or support the current proposed design basis of ≤ 75% of the total resident debris that could be transported to the core via a submerged DVI or DECLB break (not identifying either break as the worse case) by providing a quantitative evaluation justifying that no more than 75% of the total debris would enter the core unfiltered regardless of the type of break. However, any change in the assumptions must be justified and be consistent with the design basis criteria specified in the amended DCD Section 6.3.2.2.7.1.

(b) As the DECLG break is the limiting debris-bypass break, provide justifications on why the long-term cooling sensitivity studies are not performed on the DECLG break.

(c) What is the value of the filtered debris bypassing the IRWST and recirculation screens into the core through the intact DVI lines? Does the total debris entering the core include both the unfiltered debris through the submerged break and the filtered debris through the intact DVI line(s)? If not, why?

<u>RAI-SRP6.2.2-SRSB-17:</u>

The AP1000 reactor internals has been modified with the addition of a flow skirt in the lower plenum. Is the flow skirt included in the WCOBRA/TRAC reactor vessel model for the long-term cooling sensitivity study cases described in APP-PXS-GLR-001, Revision 1? If not, provide a quantitative evaluation of the effects of the flow skirt on the long-term cooling to justify the validity of the sensitivity analysis results.

<u>RAI-SRP6.2.2-SRSB-18</u>:

The AP1000 post-LOCA long-term cooling (LTC) performance is analyzed using WCOBRA/TRAC "window mode" calculations for various windows at limiting times during LTC as judged by the prevailing core decay power, sump level, water temperature, and other conditions. DCD Section 15.6.5.4C.3 includes a "window mode" analysis of the DEDVI break at 14 days with wall-to-wall floodup for containment recirculation. The LTC sensitivity analysis described in APP-PXS-GLR-001, Revision 1, includes three cases with the time windows up to 12,000 seconds into the DVI break initiation.

Explain and justify why no other time windows, such as the time window of wall-to-wall floodup that has the lowest water level in the PXS room and the driving head, are included in the sensitivity analysis.

<u>RAI-SRP6.2.2-SRSB-19</u>:

There appears to be an inconsistency regarding the DVI Line elevation. In Westinghouse's response to RAI-SRP 6.2.2-SRSB-11, Rev. 2, on page 4, it shows the DVI Line elevation to be 97 ft., which is inconsistent with the DVI elevation of 99 feet-7 inches shown in the AP1000 plant layout diagrams. Is 97.0 ft DVI elevation used in the long-term cooling sensitivity analysis? If so, explain the effect of 2 ft-7in difference in the analysis.

RAI-SRP6.2.2-SRSB-20:

On page 30 of APP-GW-GLR-079 (TR26), Revision 4, third paragraph states that "The bump-up factor is implemented in the LOCADM calculation on a mass basis. The basis for the bump-up factor is the assumption that all of the latent fibrous debris mass will pass through the bottom nozzles and protective grids of the fuel and enter the core. To implement the bump-up, all materials that contribute to the formation of chemical precipitates are increased by a uniform percentage so that the resulting precipitates available for deposition have increased by approximately the amount of latent fibrous debris assumed for the AP1000. This conservative method is independent of the type, diameter, or length of the fiber."

The staff also notes that the fibers, which will pass through the IRWST and recirculation screens, are typically different than the unfiltered fibers that pass to the core through the break. This difference was noted in WCAP-17028, Revision 1 where Fiber A is said to represent fiber that passed through a screen.

Due to the significant increase of unfiltered fiber type that is transported to the reactor core, has the bump-up factor used in the LOCADM calculation been adjusted accordingly? Please identify how much fiber was assumed in the bump-up factor calculation and describe the adjustments performed in the calculation to incorporate the longer fibers expected in the unfiltered debris.

RAI-SRP6.2.2-SRSB-21:

On page 9-1 of WCAP-17028-P, Rev. 1, Westinghouse states that 16 fuel assembly head loss experiments were performed. However, only 13 tests results are presented in the technical report and Table 9-1. Explain and justify why three (Test Nos. 7, 12, and 15) of the tests were discarded and not presented in Table 9-1?

RAI-SRP6.2.2-SRSB-22:

In the fuel assembly head loss tests described in WCAP-17028-P, Rev. 1, the first addition of AlOOH results in the increase of the measured head loss. For tests 11 and 14, further additions of AlOOH result in further increase in the measured head loss. However, the measured head losses decrease after the second addition of AlOOH for tests 6, 7, and 8; and the loss decreases after the fourth AlOOH addition for test 16.

Explain the inconsistencies in the test results and why further additions of AlOOH in some tests causes the head loss to decrease.

RAI-SRP6.2.2-SRSB -23:

Page 5-1 of WCAP-17028, Revision 1, states that "For most of the AP1000 fuel assembly tests, the maximum flow rate was assumed since higher flow is conservative for head loss." The maximum core flow rate is the design basis core flow rate specified in DCD Section 6.3.2.2.7.1. In Test #16, Westinghouse reduced the flow rate to accommodate a best estimate value from simulated analyses. If an extrapolation was performed (ΔP is proportional to flow rate squared) to the maximum core flow for the other tests, i.e., approximately 8.4 gpm, the calculated pressure differential for Test #16 is 6.2 psi.

Therefore, the calculated pressure drop of 6.2 psi has small margin to the design pressure drop of 6.5 psi. Explain and justify why Test #16 was not conducted at the full flow rate.

RAI-SRP6.2.2-SRSB-24:

The design basis for the total amount of resident fibrous debris that could be transported to the reactor core is described in APP-GW-GLR-079 (TR26), Revision 4, as 6 lbm based on the 75% of debris bypassing the sump recirculation screen determined from a direct vessel injection (DVI) line break in the loop compartment. However, among the 13 fuel assembly head loss tests described in WCAP-17028-P, Rev. 1, only 3 tests (Test Nos. 3, 5, and 16) were performed with the equivalent core fiber amount ≥ 6 lbm. A review of the test results also provides the following insights:

- With the same test conditions except for different fiber types, Test #5 with fiber type F produces a head loss 200% higher than Test #3 with fiber type A.
- With the same fiber type B, the constant flow test #6 produces a head loss 24% higher than the oscillating flow test #8 with a more gradual addition of chemical debris.
- Among the oscillating flow rate test cases #8, 9, 10 and 11 with different types of fiber, the test results indicate a head loss difference of 35% between fiber Type E and Type D.
- With the same fiber type B, Tests #13 with 5 lbm fiber (core equivalent) and the first chemical addition of 1.9 grams shows a 60% higher head loss than Test #6 with 4.2 lbm fiber and the first chemical addition of 46.2 grams, and 110% higher head loss than the oscillating flow test #8 with 4.2 lbm fiber and the first chemical addition of 11.8 grams.
- As stated in RAI-SRP6.2.2-SRSB-22, there are contradictory test results in that the head loss decreases with more chemical addition after the first addition for some tests.

The head loss Test 16 with Type B fiber at the design basis 6 lbm of core-equivalent amount and 111 lbm/s core inlet flow shows only small margin in the head loss test result to the acceptance criterion. Considering the uncertainty and potential effects of actual plant fiber type and chemical addition increments on the fuel assembly head loss, which was demonstrated in the test cases documented in WCAP-17028, Revision 1, and the observation of the inconsistent test results described above, justify why one test (Test 16) with the design basis fiber amount provides assurance that the long-term cooling acceptance criterion of 10 CFR 50.46 is met, and therefore no additional tests are necessary.

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Hearing Identifier: AP1000_DCD_Review
Email Number: 231

Mail Envelope Properties (6F27D3A0E6C93E4A9212AD1F4FA57B600675DA0D07)

Subject: Acknowledgement of RAI-SRP6.2.2-SRSB-16 thru -24
Sent Date: 8/21/2009 9:51:32 AM
Received Date: 8/21/2009 9:51:35 AM
From: Loza, Paul G.

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