REQUEST FOR ADDITIONAL INFORMATION

RELATED TO VOLUME 1 OF PRESSURIZED WATER REACTOR OWNERS GROUP

TOPICAL REPORT WCAP-17788

"COMPREHENSIVE ANALYSIS AND TEST PROGRAM FOR GSI-191 CLOSURE"

RAI-1, Vol 1

The method to define debris limits provided in the topical report (TR) is said to apply to all fuel designs in production by Westinghouse Electric Company and AREVA Inc. (AREVA) as of January 2015, except for AREVA fuel with the TRAPPER fine mesh filter. This design was not tested as part of the program even though it is still used in some plants. The TR states:

> "The use of the TRAPPER fine mesh filter fuel design in limited quantities would not alter the limits defined by the methodology."

a. Provide justification that the limits in this methodology would not be altered if the TRAPPER fine mesh filter fuel design is in use. Provide any pertinent limitations regarding the presence of fuel assemblies with this filter in the reactor core.

b. Provide a list of fuel types and designs that were tested as part of the program.

c. Provide a list of fuel designs that the method in this TR applies to. Include identification and description of the fuel types, bottom nozzle designs, and spacer grid designs.

d. What are the evaluation criteria for applicability of this method to fuel designs developed after January 2015?

RAI-2, Vol 1

The trends in Figures 6-4, 6-6, and 6-8 show that as the resistance at the core inlet ($K\text{-}K_{split}$) increases, the flow through the alternate flow paths increases for various emergency core cooling system (ECCS) recirculation flow rates..

a. As seen in Figure 6-4, there is a nearly vertical ramp in the fraction of ECCS flow through the upper head spray nozzles (UHSN) at $K\text{-}K_{split}$ of about 10,000 for a flow rate of 40 gallons per minute (gpm) per fuel assembly (FA). What is the reason for this sudden increase in the UHSN flow fraction amounting to about 15 percent of the maximum observed value?

b. Figure 6-6 shows results of the Combustion Engineering analysis. Explain why the results are widely scattered compared to those depicted in Figures 6-4 and 6-8 where the results show less data scatter for each ECCS recirculation flow rate. Describe the reason for the observed behavior of the 12.5 gpm/FA results in Figure 6-8 associated with a change in the exhibited trends and a steep increase in the barrel/baffle flow fraction for $K\text{-}K_{split}$ between 5,500 and 6,000. Explain why the results in Figure 6-8 contain a significant amount of data points that are considerably different from the general trends, especially in the 2000-4000 $K\text{-}K_{split}$ range.

RAI-3, Vol 1

On page 6-24, the particulate to fiber (p:f) ratio is calculated.

a. The TR states that the calculated particulate to fiber (p:f) ratio represents the limiting case and the expected p:f ratios are less than the calculated result. What assumptions were used in the calculation to ensure it is the limiting result?

b. Provide references and/or further justification to show the ratios expected are less than the calculated result.

c. Section 6.4.3.2 discusses sources in open literature that indicate the addition of suspended particulates in a fluid will improve heat transfer. Were the results of these experiments based on mass or volume? Justify the applicability of these results to the expected core conditions considering quantitative particulate characteristics such as shape, size, and density along with their distributions as appropriate.

RAI-4, Vol 1

For the hot leg break (HLB) methodology, it is assumed that all fiber that enters the reactor vessel (RV) remains in the RV and any fiber diverted to the containment spray system will return to the sump. Given these assumptions, Equations 6-16 through 6-19 are simplified to equations 6-20 through 6-23, accordingly. The TR states a utility may use “information about these parameters” instead of taking these assumptions. Under what conditions would alternate assumptions be used if plant-specific information is available? What would this information include? Provide an example calculation where a utility uses plant-specific information for these parameters instead of the assumptions provided to solve the system of differential equations.

RAI-5, Vol 1

For upper plenum injection plants that utilize cold leg recirculation to control boric acid concentration within the core, provide an example of how the debris quantity entering the cold side of the reactor coolant systems (RCS) is calculated and checked against the core inlet fibrous debris limit. In the example include how the calculation is performed, each step of the calculation, and how the outcome is used.

RAI-6, Vol 1

Do the thermal hydraulic evaluations that calculate peak cladding temperature consider the effects evaluated in the loss-of-coolant-accident (LOCA) deposition model, (e.g., crud deposition on the fuel, fiber buildup at the spacer grids)? If not, would the effects be significant?

RAI-7, Vol 1

In Section 4 of the TR, the timing for chemical effects is not clearly described. Volume 5 recognizes six hours as the default timing. Section 4 states 24 hours is the maximum timing. Just above the 24 hour timing it is stated that approximately four to six hours is assumed. Section 5, “Major Assumptions,” also states 24 hours. Clarify what the timing of chemicals is and the reason for the listed discrepancies in the TR.

RAI-8, Vol 1

The discussion in Section 4.3 of the TR states that the maximum fiber limit defined in Section 7.1 is based on the following facts: 1) fiber loads at or below the limit will not form a contiguous bed at the core inlet, 2) the pressure drop through the regions of the core inlet with a fiber and particulate bed is negligible, and 3) the addition of chemical precipitates will not further impede flow into the core. Questions related to Fact 1 will be included in requests for additional information for Volume 3. Reference 4-1 did not explore what the head loss across a debris bed might be without the consideration of chemical effects. The head losses for cold leg break flows, measured with chemical effects and 18 grams of fiber, were significant when compared to the available driving head. Please describe how it was determined that the pressure drop across the core inlet is negligible as stated in Fact 2 above.

RAI-9, Vol 1

How is the flow area used in the thermal hydraulics analysis to simulate resistance due to a debris bed (A_{TH}) calculated in Equation 6-3?

RAI-10, Vol 1

In Section 6.4.3.2 of the TR, provide the basis for assuming a void fraction of 50 percent.

RAI-11, Vol 1

In Section 6.5.2.5 of the TR, does the initial sump fiber load include erosion of larger pieces?

RAI-12, Vol 1

In Section 9.1.2 of the TR, "BAP [Boric Acid Precipitation] Control," what is the specified void fraction and why is it appropriate for this application?

RAI-13, Vol 1

Assumptions regarding BAP are listed on Page 9-2. One of them states: "The initial core boron concentration is equal to the sump mixed mean concentration. The mixed mean concentration is determined by taking all the possible sources of liquid in containment (i.e., Refueling Water Storage Tank (RWST), accumulators, RCS, and Boron Injection Tank) and assuming that they are homogenously mixed within the associated control volumes (RV and sump)." The RWST, and accumulators have set concentrations but the LOCA can occur anytime during a cycle so that the boron concentration in the RCS can vary from zero at the end-of-cycle to a certain maximum value at the beginning-of-cycle. Is the assumption that the RCS boron concentration is at the maximum value at the beginning of the operating cycle for BAP evaluations? If not, explain why.

RAI-14, Vol 1

Please provide details of how the velocity averaging scheme in Section 6.3.1 of the TR was developed and how the test results were used to validate it.

a. Provide the assumptions regarding the velocity averaging.

b. What were the geometric conditions of the testing?

c. How were the various fuel inlet geometries considered?

d. How are the form-loss coefficients (K_{test} and K_{eq}) values validated for the range of conditions to which they are applied?