August 8, 2016

Mr. W. Anthony Nowinowski, Program Manager
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1000 Westinghouse Drive, Suite 380
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SUBJECT: REQUEST FOR ADDITIONAL INFORMATION RE: PRESSURIZED WATER REACTOR OWNERS GROUP TOPICAL REPORT WCAP-17788, "COMPREHENSIVE ANALYSIS AND TEST PROGRAM FOR GSI-191 CLOSURE" (TAC NO. MF6536)

Dear Mr. Nowinowski:

By letter dated July 17, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15210A668), the Pressurized Water Reactor Owners Group (PWROG) submitted Topical Report (TR) WCAP-17788, "Comprehensive Analysis and Test Program for GSI-191 [Generic Safety Issue-191] Closure," to the U.S. Nuclear Regulatory Commission (NRC) staff for review. Upon review of the information provided, the NRC staff has determined that additional information is needed to complete the review of Volume 3. On July 12, 2016, Jay Boardman, PWROG Project Manager, and I agreed that the NRC staff will receive the response to the enclosed RAI questions for Volume 3 within 120 days from the date of this letter.

If you have any questions regarding the enclosed RAI questions, please contact me at 301-415-4053.

Sincerely,

/RA/

Jonathan G. Rowley, Project Manager
Licensing Processes Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Project No. 694

Enclosure:
WCAP-17788, Volume 3 RAI Questions (Non-Proprietary)

August 8, 2016

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DATE	7/13/2016	7/21/201616	7/20/2016	8/3/2016	8/8/2016

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REQUEST FOR ADDITIONAL INFORMATION

RELATED TO VOLUME 3 OF TOPICAL REPORT WCAP-17788,

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

PRESSURIZED WATER REACTOR OWNERS GROUP

RAI-1, Vol 3

In Table 1 of Volume 3, the input for fraction of fiber concentration lost to Containment Spray System has a value of 0.0. The comment says "Use non-zero value when justified or defendable value is available." Would the non-zero value be a result of testing? How would a justifiable value be determined?

RAI-2, Vol 3

On Page 3-9 of Volume 3, parameter c_2 is defined as 0.0022026 grams per pound mass (g/lbm). It appears to be the inverse of the intended value. Using this value will have a significantly non-conservative effect. The correct value should be 454 g/lbm (or 0.0022026 lbm/g). Clarify whether the value will be revised.

RAI-3, Vol 3

The use of average core boil off values as discussed in Section 5.1 of Volume 3 may result in unrealistic values of fiber at the core inlet. Most of the fiber will penetrate the strainer early in the loss-of-coolant accident (LOCA) response. Using an average value when the actual flow rate decreases during the event can result in unrealistic values of debris transported to the core. Provide justification that the use of an average value results in realistic or conservative values for debris entering the core.

RAI-4, Vol 3

The example summarized in Table 7-1 of the supplement to Volume 1 (Attachment 1 to WCAP-17788-P) assumes that recirculation begins at 45 minutes. Is this a bounding assumption? Historically, it is assumed that sump recirculation begins at 20 minutes for limiting cases. How do the results of the evaluation change if it is assumed that recirculation starts at 20 minutes?

RAI-5, Vol 3

Section 7.1.1 of the supplement to Volume 1 states that for regions where flow is upward, debris may collect at the core inlet.

a. As the debris collects, will flow shift to other areas of the core inlet or does the pressure differential remain low enough that flow is not significantly affected?

b. How does the evaluation account for the diversion of flow and debris to areas of the core where debris has not collected?

c. Can a relatively uniform debris bed build at the core inlet as flow is redirected to areas of less debris resistance? If so, how would this affect the conclusions of the evaluation?

RAI-6, Vol 3

Section 7.1.1 of the supplement to Volume 1 states that the quality of the steam exiting the vessel remains low enough to limit the buildup of boron in the core. How was it determined that maintaining steam quality below 0.8 ensures carryover that will adequately limit the buildup of boron solutes in the core? What is the maximum allowable quality that will ensure excessive boron concentrations will not occur? Provide the basis for this value.

RAI-7, Vol 3

In Figure 7-5 of the supplement to Volume 1, the exit steam quality does not appear to increase significantly at 45 minutes as might be expected when flow to the core is stopped for 2 minutes during swapover. Also, after swapover, the exit quality might be expected to be higher because the temperature of the coolant being injected to the core is assumed to be higher. Discuss the trend in exit quality with respect to these observations. Will these results be used as justification for crediting entrainment?

RAI-8, Vol 3

Section 7.1.1.1 of the supplement to Volume 1 discusses the results of the brine test program. The section states that the head loss across the debris bed at the core inlet was maintained very low, even with equivalent fiber loading of 22.5 grams of fiber per fuel assembly (g/FA). The stated pressure drop was about an order of magnitude lower than non-chemical results obtained during testing under cold-leg conditions with 18 g/FA for the test program included in TR WCAP-16793-P-A, Revision 2, “Evaluation of Long-term Cooling Considering Particulate, Fibrous and Chemical Debris in the Recirculating Fluid.”

a. Why are the head loss results for the brine tests significantly different that those reported in WCAP-16793?

b. Why are the results of the brine test, exclusive of previous testing, applicable to the evaluation in WCAP-17788?

c. Why should the results from prior testing not be considered in conclusions for WCAP-17788?

d. The particulate to fiber ratios used during the tests in WCAP-16793 found that the limiting ratios were different for hot and cold leg flow rates. Do the conditions tested during the brine test program provide adequate assurance that particulate has no effect on the test results?

RAI-9, Vol 3

Section 7.1.1.3 of the supplement to Volume 1 provides the SKBOR case study that was performed to study the sensitivity of boron concentration levels in the core and lower plenum (LP). The results of the study are informative, but may not provide realistic or bounding results.

a. Provide a basis for the variables and values chosen for the study.

b. What are realistic assumptions for the core blockage area and accumulation start time for boron?

c. Provide the results of boric acid concentration over time for a case using bounding values for the variables in part so that the behavior under limiting conditions can be understood.

d. The submittal states that the reactor vessel (RV) steam exit quality remains less than 80 percent until about 40 minutes after the LOCA. Is this based on a recirculation swapover time of 20 or 45 minutes? What effect does swapover timing have on steam exit quality?

RAI-10, Vol 3

PWROG-15091-P, Section 4.2.2, in describing the selection of the working fluid, provides insights into how the trend of viscosity as a function of mass percent of the working fluid is similar to that of boric acid. Figure 4-2 shows the relationship of concentration versus dynamic viscosity for various combinations of boric acid and buffers compared to the studied working fluids. Potassium Bromide (KBr), the working fluid ultimately chosen for the testing, has an opposite trend as the boric acid results. Describe why KBr was chosen as the working fluid despite this apparent difference.

RAI-11, Vol 3

For brine tests without debris injection in PWROG-15091-P, the following table summarizes the discussion in Section 9.

Test	Time onset of exchange flow (sec)	Core Concentration	Average Boric Acid (BA) Concentration	Brine source concentration
T012	50	**[ ]** weight percent (wt%) BA	lower	49 wt% BA
T032	45	**[ ]** wt% BA	lower	52 wt% BA
T051	55	**[ ]** wt% BA	higher	52 wt% BA

a. Describe why the core concentration in test T032 is lower than in test T051 at the onset of exchange flow if the brine source concentration is the same between the two tests.

b. Test T032 has a water supply temperature of 60.1 degrees Fahrenheit (°F), which is outside the desired range of 64-72 °F. Operating outside of the desired range decreases the accuracy of the conductivity probes. How was this aspect taken into account in the results?

c. Table 9-2 is used to describe the differences in the table above by comparing temperatures in the water supply to the brine supply for all three tests. The submittal states that the lower water injection temperature of T032 makes it more comparable to T051. However, the lower temperature would mean the density differences are increased, and take longer for exchange to occur, but T032 has the earliest onset of exchange flow. Explain why the lower temperature case has the earliest onset of exchange between the core and LP.

d. Explain why the highest core concentration test (T051) has the latest **[ ]**. Logically, it seems a higher concentration would **[ ]**.

RAI-12, Vol 3

In Section 10.3 of PWROG-15091-P, results of tests conducted with 15 wt% KBr are presented. These results show that in the AREVA Inc. (AREVA) tests, **[ ]** and in the Westinghouse Electric Company (Westinghouse) tests, **[ ]**. It is stated that the core concentration in the AREVA cases is higher, which could lead to these results. It is also stated that the AREVA inlet geometry is **[ ]**.

a. How were differences in core geometry addressed when determining the conditions under which **[ ]** will occur?

b. Does the core KBr concentration have a higher influence than core geometry on whether or not exchange flow completely stops and on the timing of core breakthrough? Provide a comparison of test results that shows the influence of these factors on the phenomena.

RAI-13, Vol 3

The timing of **[ ]** in Figure 10-11 of PWROG-15091-P spans between about **[ ]**. Explain why the **[ ]** is so diverse. Include a discussion about whether or not measurement uncertainty was credited in the explanation.

RAI-14, Vol 3

In PWROG-15091-P, many brine tests were conducted to understand the effect of particulate on **[ ]**. Figure 10-8 (tests T036 and T042) shows that particulate delays the timing of **[ ]**. Figure 10-12 (tests T040 and T049) shows that **[ ]**. Explain this discrepancy in the results. Justify that the tests conducted without particulate are representative of the behavior that would occur in the plant or state that the results of those tests are not relevant to the conclusions drawn from the testing.

RAI-15, Vol 3

In Figures 7-1 and 7-2 of PWROG-15091-P, it appears that the pressure increases significantly more for the delayed injection tests. Is this an actual result or is Figure 7-1 not showing the extent of the increase? Provide the magnitude of the increase for each test type.

RAI-16, Vol 3

At the bottom of Page 10-8 of PWROG-15091-P, verify that the test that had the lowest core region concentration is T052 instead of T054, as stated.

RAI-17, Vol 3

In PWROG-15091-P, what caused the flow rate for brine test T018 shown in Figure 10-10 to decrease so quickly at both around 1,800 seconds and at the end of the test? Was this a planned evolution?

RAI-18, Vol 3

Table 5-5 of PWROG-15091-P shows the conductivity probe accuracy. The accuracy after Calibration 2 is significantly higher for all probes. Why is the accuracy much higher after Calibration 2? How was the accuracy accounted for in the overall results of the evaluation?

RAI-19, Vol 3

In brine test T022 of PWROG-15091-P, **[** **]**. Can this result be used to predict **[** **]** for this concentration, debris loading, and core inlet geometry?

RAI-20, Vol 3

Were any brine tests with delayed brine injection in PWROG-15091-P run using the AREVA core inlet geometry? If not, how can the Westinghouse results for tests with delayed brine injection be confidently used for making conclusions with the AREVA inlet geometries?

RAI-21, Vol 3

In PWROG-15091-P, how does the scaling and operational parameters of the brine test rig affect the results of the testing as compared to the plant condition? For example, how does the head of higher density solution in the core compare to the head of higher density solution in the test? In the core there is significant voiding while in the test the assembly is not full height. Justify that the test results or observations from the test can be applied to the plant condition considering the physical differences between the test facility and plant conditions.

RAI-22, Vol 3

Section 5.1 states that "the worst-case single failure that maximizes the flow rate to the core is the case that should be utilized." At the same time, the quantity is defined as "total flow rate of emergency core cooling through the strainer." This is not necessarily an accurate statement. Clarify that the STRN concept, defined as the total flow rate through the strainer, which is the sum of the emergency core cooling (ECC) flow and containment spray flow should be to minimize the flow through the strainer in relation to the flow that enters the core.

RAI-23, Vol 3

As described for the cold leg break (CLB) method in Section 3.5.4, Step 4 uses a dimensionless quantity, θ, which is identified as the decay heat (DH) curve.

In the simplified alternate CLB method described in Section 5, an average core boil-off flow is used to calculate the expected core fiber load.

Confirm that the quantity, θ, and the average core boil off flow will be calculated based on "the ANSI/ANS [American National Standards Institute/American Nuclear Society] 1971 + 20% decay heat curve" in accordance with Item 8 in Section 3.6.2, unless explicitly stated otherwise.

RAI-24, Vol 3

As described for the base CLB method in Section 3.5.4, Step 4, a quantity representing the mass of coolant needed to remove the DH generated over one time step by boiling, $M_{Boil\text{-}off,\ i}$, is used to calculate the coolant mass delivered to the core at each time step, $M_{Core,\ i}$. Section 3.5.4 explains that the method increases the boil-off coolant mass by 20 percent to determine the coolant mass delivered to the core at each time step. Section 3.5.4 explains that the "20% factor is added" to the boil-off mass to "to account for uncertainties."

For the simplified alternate CLB method described in Section 5, a multiplication constant of 1.2 is used to calculate the expected core fiber load. Section 5.1 clarifies that it is "the average core boil-off from the initiation of cold leg recirculation to the transfer to hot leg (HL) recirculation," which is "conservatively increased by 20%" in the derived formula thus relating the 1.2 multiplier to the boil-off rate in a manner similar to the base CLB method.

a. Confirm that the multiplication factor of 1.2 used to calculate the amount of coolant "needed to match boil-off plus margin" for both the base and the simplified alternate CLB methods accounts for uncertainties other than the uncertainty related to the DH model, which is accounted for separately when calculating the applied DH generation rate.

b. Identify the major factors that contribute to uncertainty and explain how uncertainties associated with these factors were assessed and accounted for by application of the multiplication factor of 1.2.

RAI-25, Vol 3

Section 3.3, "Assumptions of the Method," attempts to establish a basis to allow for uncertainties in calculating the amount of fibrous debris deposition at the core entrance. The uncertainty in the debris load is based on the uncertainty in the rate at which the coolant enters the core region. The proposed margin in the assessed debris load is introduced by assuming that the rate at which coolant enters the core can be calculated from the current core boil-off rate multiplied by a constant.

Nuclear Safety Advisory Letter (NSAL) 95-001 (Reference 9) considered criteria for minimum ECC system (ECCS) flow during cold leg recirculation, which if met or exceeded, ensures compliance with Title 10 of the *Code of Federal Regulations* 50.46, "Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors." It was determined that it should be ensured that ECCS flow during cold leg recirculation is at least equivalent to 1.2

times the DH boil-off at the time cold leg recirculation is initiated. As such, Reference 9 does not justify the application of a multiplier of 1.2, or any other value (e.g., 1.5 as recommended in NSAL 92-010), when it comes to describing the rate at which coolant is delivered to the core following recirculation initiation and during the period for which the CLB methods in Volume 3 will be applied.

Verify that the flow assumed to reach the core inlet accounts for phenomena and uncertainties such as those discussed in NSAL 95-001 and 92-010. Provide a justification that the margin added to the calculation by using the multiplier of 1.2 is adequate to account for uncertainties in all plant designs covered by the TR. The methodology assumes that the flow into the core is solely based on fluid boil-off. However, there is likely to be liquid exiting the core. How is the additional flow from any liquid phase accounted for?

RAI-26, Vol 3

Section 3.4, "Overview of the Method Logic," in describing the calculation logic for the CLB method, clarifies the need to "account for sensible heat and heat of vaporization" when determining the core boil-off requirement based on DH and sump fluid temperature. In addition to the sump fluid temperature, the reactor coolant system pressure should be considered as a contributing factor as it defines the boil-off saturation temperature, which determines the degree of subcooling of the coolant. In addition, the system pressure has an effect on the latent heat of evaporation, which is also used to calculate the boil-off rate.

In the list of required inputs to calculate the debris deposition at the core entrance provided in Section 3.6.1, Parameter 11 is identified as "sump fluid temperature curve starting at recirculation initiation," and Parameter 12 is identified as "containment pressure curve starting at recirculation initiation."

What factors and conditions were considered when determining the inputs for Parameters 11 and 12? The response should support the concept that "a method has been developed to conservatively predict and assess the time-dependent delivery of fibrous debris to the RV and core for a CLB." Confirm that the response also applies when determining the "average core boil-off flow" used in the simplified alternate method described in Section 5.

RAI-27, Vol 3

The supplement to Volume 1 attempts to establish the basis for an in-vessel fiber limit of **[ ]** for the CLB scenario. Instead of providing a basis for choosing **[ ]**, various aspects are discussed to show why **[ ]** would not adversely impact Long Term Core Cooling. Testing results from the brine test program and the 3x3 heated rod bundle program are presented to demonstrate that transport between the core and LP will continue in the presence of in-vessel debris without indicating the amount of debris this applies to. Provide a quantitative basis for choosing a debris limit of **[ ]** for the CLB scenario. Provide justification for why the limit applies to all plant categories in WCAP-17788.

RAI-28, Vol 3

Section 7 in Volume 1 states that the subscale brine test program documented in PWROG-15091, states that "the testing considered a broad range of conditions prototypic of those expected to occur following a postulated large CLB LOCA." Section 7 explains that the flow rate through the test column was scaled "based on the boil-off rate calculated for prototypic post-LOCA conditions." Specifically, "for tests that had brine injection, the flow rate was reduced during each test consistent with the DH curve" and for tests conducted with debris only (no brine injection), the flow rate was held constant at a value consistent with DH boil-off calculated at 20 minutes post-LOCA. Figure 5-5 in PWROG-15091 shows the two flow curves defined for the brine testing. Figures 7-8, 7-9, 7-10, 8-1, 9-1, and 10-10 show measured flow rates for selected tests. The CLB methodology in Volume 3 will be used to calculate the amount of fiber delivered to the core inlet from the time of initiation of sump recirculation to the time of HL switchover. Provide the following information to assure that the flow rates in the brine testing program are bounding for expected large CLB conditions.

a. Identify the DH model used to scale the test flow curves in Figure 5-5 and clarify whether the uncertainty in the model was accounted for (e.g., using a 1.2 multiplier).

b. Justify that the flow rate through the test column (based on boil-off rate post-LOCA) is bounding for all plant categories in the operating fleet. If it cannot be shown as bounding, why is a plant with a flow rate outside the bounds of the test able to apply the test results?

c. What is the accuracy of the flow rate through the test column?

d. What is the accuracy of the brine injection flow rate?

e. Considering the variability in both the time of initiation of sump recirculation and the time of HL switchover among individual plant units using this methodology, explain how the experimentally attained test flow conditions were prototypic. Specifically, provide justification with regard to plant units that have shorter time of initiation of sump recirculation and/or switchover to HL injection. The concern is that earlier times of initiation of sump recirculation and/or switchover to HL injection will have higher flow rates compared to the test flow rates so the bed break-through may occur in the plant at different times than observed in testing.

f. Volume 3 explains "to allow for uncertainties, the fluid volume entering the fuel is assumed to be 1.2 times the boil-off flow rate requirement based on the decay heat at any given time in the transient starting at recirculation initiation." Explain how the test flow condition in the brine test program accounts for the uncertainty of this parameter.

RAI-29, Vol 3

Section 7.4 of PWROG-15091, "Test Column Flow Rates," states that "the outlet flow rate, which is the combination of inlet and brine injection flow rates, is measured during each experiment." The test report lists an accuracy of "0.258% rate" and a range from 0 to 100 gpm for this device.

The maximum main flow rate in all tests was 0.8 gpm equating to 0.8 percent of the flow meter upper range limit. The minimum flow rate in the tests using Flow Control 1 was **[** **]** of the flow meter upper range limit and about **[** **]** in the tests using Flow Control 2. Even with the addition of the brine solution injection flow of 0.5 gpm, the corresponding total flow rates and fractions are **[** **]**. These measured flow rates represent very small quantities compared to the upper range limit of 100 gpm of the flow meter.

a. Clarify whether the accuracy of the magnetic flow meter provided in Table 5-4 as “0.258% rate” is valid for the entire specified range from 0 to 100 gpm or it is based on the upper range limit of 100 gpm.

b. Provide the accuracy for the brine injection flow rate relative to setting the speed of the positive displacement pump in order “to achieve the prescribed brine injection flow rate of 0.5 gpm.”

c. Provide the calculation for the error in the main flow rate used in the tests. Justify the applied main flow rates taking into consideration the applicable measurement error. Taking into consideration that “for all brine testing, the primary flow rate was set … to follow a predetermined flow rate curve based on decay heat,” the justification should substantiate the applicability of the test results on the basis of adequate representation of DH and its uncertainty.

RAI-30, Vol 3

A brine injection flow rate of 0.5 gpm was used in all tests described in PWROG-15091. The source concentration of KBr in the injected solution, while kept constant in each test, was set at several different concentration levels for different tests. Based on the test matrix for the Westinghouse core inlet geometry in Table 6-1, the concentrations were equal to 5, 10, and 15 wt%. As both the rate of fluid injection and the concentration of solute in the fluid were constant in each individual test, the rate of solute injected into the test column was constant.

The scalability of the tests with regard to time is in question. The relation between the timing in the tests and the timing of the process of solute accumulation in the prototype system is not established in the test report. It is not clear how the real time scale can be transposed relative to the experimental time scale at each source concentration level used in the tests. Provide the scaling basis for the applied process of brine solute injection in the tests so that the relevance of the timing aspect of the observed processes can be related to the behavior of the prototype system.

RAI-31, Vol 3

Section 5.3 in PWROG-15091 describes the sparger pipe used for injecting the brine solution into the test section. The resulting average fluid exit velocity at the applied brine injection rate of 0.5 gpm was 0.97 feet per second (ft/sec) (29.5 centimeters per second). Based on the sketch in Figure 5-14, the holes were located along the axial length of the sparger so that the flow velocity through the hole(s) farthest from the blocked end of the sparger should have been noticeably larger than the average injection velocity of 0.97 ft/sec.

Section 5.3 explains that a brine solution injection velocity of 1.94 ft/sec corresponding to an injection rate of 1 gpm “is sufficient to induce mixing in the subscale core region but is low enough to minimize any impact on the buoyancy-driven process being studied.” Section 7.1, describing the pressure response observed in the tests, states in part that “the pressure trends seen throughout the test program include a small pressure spike corresponding to the start of brine injection...” Figure 7-2 shows the pressure record for Test T021 with delayed brine injection, which is described “typical” for all tests with delayed brine injection. The initiation of brine injection caused a significant jump of about 3 pounds per square inch (psi) gauge in the system pressure. Presumably, the measurement was taken from the upstream pressure transducer, shown in Figure 5-1, which had an accuracy of plus or minus 0.289 psi based on Table 5-4. A similar effect is also seen in Figure 7-1 for Test T029 with no brine injection delay.

Provide justification that jetting did not have an impact on the test results including the timing of the testing observations. Justify that the major findings from the tests relevant to WCAP-17788 are not affected.

RAI-32, Vol 3

Section 3.5, "Equations," explains that the equations for calculating the amount of fiber delivered to the core inlet are solved explicitly as a difference from time step to time step and that they can be easily solved by hand. In addition, Section 3.5.8, "Suggested Time Step Interval," states in part that "for this evaluation, a time step of one minute is suggested."

Section 6.5 of Volume 1, Subsection 6.5.2.1, "Time Step," also discusses time steps for the hot leg break (HLB) methodology. The HLB method states that an iterative solution with respect to time is necessary and recommends that time step sensitivity be performed. The method suggests that the time step should be small enough to ensure that the important processes behave linearly over each time step. A starting time step value of 100 seconds is recommended.

a. Provide results for an example case analyzed with the CLB method to illustrate the effect of the time step size. Provide the results from two calculations performed with time step sizes of 1 second and 10 seconds and compare the results from the calculation using the recommended time step size of 60 seconds.

b. Provide results for an example case analyzed with the HLB method to illustrate the effect of the time step size. Provide the results from two calculations performed with time step sizes of 1 second and 10 seconds and compare the results from the calculation using the recommended time step size of 100 seconds.

c. Provide quantitative criteria for assuring that the results from a calculation performed with both the CLB and HLB methods produce "stable results" along with justification as to how these criteria will be assured. State how the proposed process assures that an appropriate time step size will be applied to the proposed methods.

RAI-33, Vol 3

Section 7 in Volume 1 states that the subscale brine test program documented in PWROG-15091 "considered both Westinghouse and AREVA core inlet geometries by using prototypic fuel components." Provide the following clarifying information regarding the test rig geometry.

a. Explain how the value of **[ ]**, provided in Table 5-2 in PWROG-15091 for the ratio of test column inlet flow area to installed FA inlet flow area, was calculated (the value differs from the open flow area ratio of **[ ]** in the same table, which is based on the flow area of **[ ]** holes).

b. Table 5-2 pertains to the tests for the Westinghouse bottom nozzle. Provide a similar table for the tested AREVA fuel nozzle.

c. For both tested fuel geometries, provide the distance between the test column wall inner surface and the closest point on the surface of the peripheral fuel rod elements for all four sides of the square test column. In addition, provide the fuel rod pitch and the fuel assembly pitch for each fuel assembly as well as the types of the prototypical fuel assemblies considered (e.g., 17x17).

d. Was the gap between the peripheral fuel rods and the column wall measured and controlled during the test program? It appears from Figure 5-9 in PWROG-15091 that the gap on the "west" side of the depicted square is larger than the gaps on the remaining three sides (due to the location of the thimble tubes). Provide the flow area in the fuel bundle test region (Figure 9-11 in Volume 1) and the corresponding flow area of the represented region of the fuel bundle. Provide information for both Westinghouse and AREVA tests fuel bundles.

e. Provide assurance that the test findings using the tested fuel bundle geometries remain valid for other fuel types.

RAI-34, Vol 3

Provide a sectional breakdown of PWROG-15091-P, listing the sections unrelated to the review and approval of WCAP-17788. Also list those sections needing review by the U.S. Nuclear Regulatory Commission (NRC) and explain how that determination was made. Provide any additional clarification to aid the NRC staff in the review.