AP1000TopRptsPEm Resource

From: Bavol, Bruce
Sent: Thursday, May 12, 2016 9:00 AM
To: AP1000TopRptsPEm Resource
Subject: AP1000 Topical Report WCAP-17938 Revision 1 RAI Letter
Attachments: RAI Response Letter_Non Proprietary.docx; RAIs_WCAP_17938_Rev 1 Non_Proprietary.docx

Bruce M. Bavol

Project Manager
AP1000, Licensing Projects Branch 4
Office of New Reactors
Nuclear Regulatory Commission
Work Phone: (301) 415-6715
Email: Bruce.Bavol@nrc.gov

Hearing Identifier: AP1000_TR_RAI_Public
Email Number: 5

Mail Envelope Properties (a25561fc3d794885b03633b40dfa5d31)

Subject: AP1000 Topical Report WCAP-17938 Revision 1 RAI Letter
Sent Date: 5/12/2016 8:59:45 AM
Received Date: 5/12/2016 8:59:46 AM
From: Bavol, Bruce

Created By: Bruce.Bavol@nrc.gov

Recipients:
"AP1000TopRptsPEm Resource" <AP1000TopRptsPEm.Resource@nrc.gov>
Tracking Status: None

Post Office: HQPWMSMRS06.nrc.gov

Files	**Size**	**Date & Time**
MESSAGE	248	5/12/2016 8:59:46 AM
RAI Response Letter_Non Proprietary.docx	21161	
RAIs_WCAP_17938_Rev 1 Non_Proprietary.docx	33363	

Options
Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

May 11, 2016

Mr. Zachary Harper, Manager
Regulatory Support
Westinghouse Electric Company
1000 Westinghouse Drive
Cranberry Township, PA 16066

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 01
FOR REVIEW OF WESTINGHOUSE ELECTRIC COMPANY'S SUBMITTAL OF WCAP-17938, REVISION 1, "AP1000 IN-CONTAINMENT CABLES AND NON-METALLIC INSULATION DEBRIS INTEGRATED ASSESSMENT"

Dear Mr. Harper:

By letter dated November 20, 2015, Westinghouse Electric Company (WEC) submitted for U.S. Nuclear Regulatory Commission (NRC) staff's review, WCAP-17938, Revision 1, "AP1000 In-Containment Cables and Non-Metallic Insulation Debris Integrated Assessment." The NRC staff is performing a detailed review of this topical report in order to reach a safety conclusion.

The NRC staff has identified that additional information is still needed by WEC in order to continue portions of the review. The staff's requests for additional information (RAIs) are contained in the enclosure to this letter.

To support the review schedule, you are requested to respond within 60 days of the date of this letter. If RAI clarifications are required, please contact me so that arrangements can be made with the applicable technical staff.

If you have any questions or comments concerning this matter, you may contact me at 301-415-6715 or bruce.bavol@nrc.gov.

Sincerely,

/RA/

Bruce M. Bavol, Project Manager
Licensing Branch 4
Division of New Reactor Licensing
Office of New Reactors

Project No. 0811

Enclosures:
Request for Additional Information (Non-Proprietary)

DISTRIBUTION:

Public	RidsNroDnrl	BBavol	LMrowca
RidsAcrsAcnwMailCenter	GMakar	MMitchell	YLi
RidsOgcMailCenter	MHayes	RButler	MPatterson
RidsRgn2MailCenter	JBarr	JMcKirgan	TLupold
RidsNroDnrlLB4	BTravis	CAshley	

*Concur by Email NRO-002

OFFICE	DNRL/LB4:PM	DE/MEB:BC	DSRA/SCVB:BC	DE/MCB:BC
NAME	BBavol	TLupold*	JSegala*	MMitchell*
DATE	05/11/2016	04/19/2016	04/19/2016	05/11/2016

OFFICIAL RECORD COPY

WCAP-17938, Revision 1
Request for Additional Information

10 CFR, Part 50, Appendix A, General Design Criterion (GDC) 35 requires, in part, that abundant emergency core cooling in the event of a LOCA shall be provided. In order to accomplish this, debris generation must be minimized to preclude inhibiting flow paths; for the AP1000, DCD Section 6.3.2.2.7.1, states "a LOCA in the AP1000 does not generate fibrous debris due to damage to insulation or other materials included in the AP1000 design." The purpose of the WCAP is to demonstrate no additional debris generation with these changes, and these requests for additional information are asked in the context of the aforementioned regulatory requirements and commitments for the AP1000.

(Boyce Travis)

ICC&NMI – 001
Section 3.2 of the WCAP states that the cold leg break [
] It is unclear why, in the context of the topical, this is the case (for instance, [
]. In the WCAP, provide additional context and clarification why [ ]

ICC&NMI – 002
Section 3.4 of the WCAP states [

] Provide a clarification or correction in the WCAP.

ICC&NMI – 003
Provide further clarification on how tests on the neutron shield blocks at [ ] were considered in deeming the blocks a suitable equivalent (e.g., as an additional sensitivity, providing further assurance). In addition, [

]

ICC&NMI – 004
[

]

ICC&NMI – 005
[
] In the WCAP, provide a justification for [
]

ICC&NMI – 006
[

] In the WCAP, make the intended purpose/conclusion drawn by the [ ] clear.

(Clint Ashley)

ICC&NMI – 007
The WCAP states the water inlet doors are made of [

]. During audit activities, the staff was not able to confirm the WCAP's water inlet doors description based upon a review of the referenced and supplemental information. For example, 1) the drawing for the water inlet doors shows construction using only [ ]; 2) the drawing for the water inlet doors does not indicate [ ]; and 3) the drawing for the water inlet doors does not indicate [
]. Because the drawing provides information that conflicts with the description of the water inlet doors provided in the WCAP [ ] and appears to be missing other important design details [ ], the staff requests that the applicant provide design documentation that confirms the WCAP description for the water inlet doors.

ICC&NMI – 008
WCAP Subsection 2.1.1 provides a description of the cables selected for jet impingement testing. Based on audit discussions, the applicant staff stated that the tested cables bound the in-plant cables. However, the staff needs the WCAP descriptive information to be revised to reflect the audit discussion in order for the staff to accept the Topical Report conclusions. Therefore, the staff requests that the applicant clearly state in the WCAP that the cables selected for testing (i.e., 5 types) bound the AP1000 plant in-containment cables.

ICC&NMI – 009
WCAP Subsection 2.2 does not describe the reactor cavity non-metallic insulation and materials testing needed to support the Topical Report. Because testing was necessary and performed, the staff requests that the applicant provide a description of the reactor cavity non-metallic insulation and materials testing in WCAP Subsection 2.2 comparable with the testing discussion provided in WCAP Subsection 2.1 (cables).

ICC&NMI – 010
WCAP Subsection 2.2.3 (description of lower neutron shielding) does not discuss the material's [ ]. Based on audit discussions with the applicant, the material does have a [ ]. Therefore, the staff requests that the applicant describe the [ ] in WCAP Subsection 2.2.3, comparable to WCAP Subsections 2.2.1 and 2.2.2.

ICC&NMI – 011
WCAP Subsection 5.1.1 states that the shield blocks will not create chemical debris. There is no discussion about the water inlet doors and their potential to create chemical debris. Therefore, the staff requests that the applicant provide a discussion about the water inlet doors and their potential to create chemical debris.

ICC&NMI – 012
Subsection 5.1.1.1.1 describes upper neutron shield (UNS) and lower neutron shield (LNS) blocks. A portion of the descriptive information is marked as proprietary information. The proprietary descriptive information in Section 5.1.1.1.1 related to [ ] is not consistent with proprietary descriptive information in WCAP Subsections 2.2.2 and 3.1. Therefore, the staff requests that the applicant address the inconsistencies related to [ ] information provided for the UNS and LNS blocks.

Confined Jet Behavior
The AP1000 plant design includes non-metallic insulation (NMI) in the reactor vessel cavity that is designed to be a suitable equivalent to metal reflective insulation. The WCAP presents the methodology used in assessing the potential debris generation in the reactor vessel cavity resulting from postulated reactor coolant system (RCL) pipe breaks. The AP1000 reactor cavity annulus is more confined than other regions of containment. In Section 3.5.4 and associated subsections of the WCAP-17938, the applicant discussed the implications of a jet discharging in a confined space. Specifically, the applicant surveyed the open literature for confined jet empirical data, related the data to the AP1000 plant geometric configuration within the confined reactor cavity annulus, develop a prediction of the non-metallic insulation (NMI) jet impingement pressure inside the reactor cavity annulus, and compared these results to the results of jet impingement testing performed at National Technical Systems testing facility in Huntsville Alabama.

Based on the NRC staff's review of the information described in the WCAP, the following additional information or clarification is needed to complete the NRC staff's review of the confined jet behavior within the AP1000 reactor cavity annulus.

(Renee Li)

ICC&NMI – 013
The applicant is to explain/define the jet surface characteristics referred on the top of page 3-57 of the WCAP.

ICC&NMI – 014

The applicant is to clarify the statements regarding pressure coefficient on page 3-60 of the WCAP. On the top of this page, it states that the pressure coefficient is approximately unity for AP1000 plant X'/D of [ ]; while at the bottom of the page, it states that the pressure coefficient is approximately zero for AP1000 plant X'/D of [ ].

ICC&NMI – 015
The applicant is to explain/justify the relevance of showing the red vertical line [ ] on Figure 3-67(a) in the WCAP. Note the pressure coefficient as shown on the figure is on the impingement plate (corresponding to RV boundary for the AP1000 plant configuration). However, the NMI in the AP1000 plant is [ ] The applicant is also to explain/clarify from the Reference 3-17 testing results how the jet pressure field is analogous to that of the free jet for the AP1000 plant. Specifically, the applicant is to clarify whether the Reference 3-17 testing results are only applicable to the RV boundary as the impingement plate in AP1000 plant configuration. If this also applies to the jet pressure field in the region of NMI such that the jet pressure field in the NMI region is also analogous to that of the free jet, the applicant is to justify this conclusion. Similar comment is also applicable to other figures included in this section of the WCAP.

ICC&NMI – 016
The applicant is to explain/clarify the statement that the flow deflects about a jet diameter above the impingement plate for a confinement of X'/D<2 (page 3-60) including its implications of the jet flow for the AP1000 configuration.

ICC&NMI – 017
The applicant is to explain/justify the statement that the pressure coefficient of the confinement of X'/D=6 corresponds to that of free jet (page 3-61). Similar to Question ICC&NMI – 016 above, the applicant is also to clarify the statement that for the AP1000 plant confinement ratio of [ ], this implies the jet pressure field is analogous to that of the free jet. Specifically, the applicant is to clarify whether the referred jet pressure field is the local impingement plate pressure as defined per Equation 3-1 on page 3-60 of the WCAP. The applicant is to explain/justify whether the pressure in other jet regions as shown on page 3-55 of the WACP is also analogous to that of the free jet. In addition, the staff noted that in 4th paragraph on page 3-71 of the WCAP, the applicant concludes that the comparison to the jet pressure distribution as conveyed in multiple literatures showed for the AP1000 plant-specific confinement ratio that the confined plate and impingement plate pressure distribution were analogous with that of the free jet. Similar to the ICC&NMI – 016 above, the applicant is requested to make it clear regarding the specific jet region for which the pressure distribution were analogous to the free jet in the WCAP. Also, the applicant is to address the staff's concern on the pressure field for the NMI which is [ ] (i.e., the impingement plate).

ICC&NMI – 018
The applicant is to explain/clarify the relevance of Figure 3-69 (page 3-63) to AP1000 plant confinement. The figure is not clear (i.e., the correlations are not readily apparent and the terms shown in the figure are not defined). The staff also noted that the confinement ratio shown in the figure ranged from 0.25 to 1.0 which does not encompass the geometric confinement [ ] of the AP1000 plant configuration.

ICC&NMI – 019
The applicant is to explain/clarify the definition of unconfined (normal) jet referred in Figure 3-72 (page 3-66) in the WCAP.

ICC&NMI – 020
The applicant is to explain/clarify the second sentence in the 1st paragraph on page 3-72. It states that the NMI would probably experience [
]. The staff noted that Figure 3-77 in the WCAP shows the ratio of the velocity profile of a Region IV jet and a free jet emitting radially from a jet source. Based on the comparison, the applicant concluded [

] Furthermore, the applicant is to explain/clarify Figure 3-77 including the definition of the terms in the equations included in the figure, the assumptions used, the application of NUREG/CR-2913, and how they are relevant to the AP1000 plant condition/configuration.

ICC&NMI – 021
As a general comment, some figures included in this section of the WCAP are not clear. For example, the reproduction quality of some figures makes it difficult to read the information. Also, for some figures, the correlations are not readily apparent. Moreover, the coordinate and the parameter/term shown on some figures were not clearly defined.

Region II Analysis
Section 4.3 of the WCAP describes the Region II analysis used in determining the AP1000 debris generation break sizes in the RCS main loop piping (hot leg and cold leg loop piping). Region II analysis as described in NEI-04-07 has been previously reviewed and approved by the NRC staff. The Region II analysis allows for more realistic analytical methods and assumptions such as limited pipe displacement. The WCAP proposes that if a structural evaluation of the RCS main loop piping show limited pipe displacement will occur, then an equivalent break diameter for the limited separation break may be used to determine the zone of influence (ZOI) for the Region II analyses. Section 4.3.2 of the WCAP describes how the limited separation break is utilized in the determination of the alternate break size. Furthermore, Sections 4.4.2 and 4.4.3 of the WCAP provide the results of pipe displacement analysis and how these results are applied to Region II analyses for the five postulated break locations discussed in Subsection 4.4.1 of the WCAP.

Based on its review of the information described in the WCAP and in the References 4-6 and 4-7 of the WCAP, the staff determined that additional information or clarification is needed to complete the staff's review pertaining to limited separation break utilized in the AP1000 plant Region II analyses.

ICC&NMI – 022
Section 4.3 of the WCAP states that if no piping analyses have been performed for the RCS main loop piping application, then a doubled-ended guillotine break (DEGB) assuming the full hot leg or cold leg pipe inner diameter must be evaluated; however, other reasonable best estimate assumptions may still be employed in the analysis (page 4-5 of the WCAP). The applicant is to explain/identify other reasonable best estimate assumptions which may be employed in the analysis.

ICC&NMI – 023

As indicated in Section 4.3.2 of the WCAP, the geometry of a limited separation break is discussed in ANSI/ANS 58.2-1988 (Reference 4-4 of the WCAP). The jet geometry of circumferential break with limited separation is shown in Figures 4-1 and 4-2 of the WCAP. It should be noted that Reference 4-4 defines a limited separation break as having an axial displacement of less than or equal to 0.5 diameter and a lateral displacement of less than or equal to the pipe wall thickness. However, the applicant indicates that this definition is extended for the purpose of AP1000 Region II analyses to include lateral displacements greater than the pipe wall thickness and up to 1 diameter. The staff also noted that Section 4.3.2.2 of the WCAP provides an equation for the equivalent diameter of such a limited separation break, [

]. The applicant is to explain/justify the extension of Reference 4-4 definition of a limited separation break, the jet geometry for such a limited separation break, and the basis of the equations provided in Section 4.3.2.2 of the WCAP.

ICC&NMI – 024
Section 4.4.3 of the WCAP states that the hot leg and cold leg displacement results from the ANSYS LS-DYNA analysis presented in Table 4-1 may be used to support the AP1000 plant Region II debris source term calculations in addition to any best estimate assumptions that are deemed reasonable for the individual analysis. The applicant is to explain/identify the reasonable best estimate assumptions which may be used to support the AP1000 plant Region II analysis.

ICC&NMI – 025
Section 4.4.3 of the WCAP describes a qualitative method of comparing the circumferential break jet expansion geometries with limited separation to the full separation DEGB jet expansion geometry. It also describes a simplified volumetric comparison using the methodology outlined in Appendix C of Reference 4-4 of the WCAP. In addition, Figure 4-8 of the WCAP shows the jet geometries including Regions 1 and 2 and up to the asymptotic plane for limited separation (Figure A) and full separation (Figure B). The staff noted that the jet geometry as shown in Figure A is for a limited separation with an axial displacement less than or equal to 0.5 diameter and a lateral displacement less than or equal to the pipe wall thickness as defined in Reference 4-4. However, as noted in Section 4.3.2 of this WCAP, this definition is extended for the purpose of AP1000 Region II analyses to include lateral displacements greater than the pipe wall thickness and up to 1 diameter. The applicant is to explain/show the jet geometry for a limited separation break configuration with the lateral displacement being greater than the pipe wall thickness and up to 1 diameter. In addition, the applicant is to explain how the jet volume for this type of jet geometry will be determined and used in the comparison to the jet volume to that of twice the fully separated jet in the Region II analysis.

ICC&NMI – 026
Section 4.4.3.1.2 of the WCAP states that [

] The applicant is to clarify the discrepancy [

].

ICC&NMI – 027
Section 4.4.3.1.3 of the WCAP (page 4-18) refers to Subsections 4.3.1.1 and 4.3.1.2 of the WCAP. Also, Section 4.4.3.2.4 (page 4-20) refers to Subsections 4.3.2.2 and 4.3.2.3 of the WCAP. In addition, Section 5.1.3 (page 5-16) and Section 7 (page 7-1) both refer to Subsection 3.5.3.3 of the WCAP. It appears that the referred subsection numbers are in error as there are no Subsections 4.3.1.1, 4.3.1.2, 4.3.2.2, 4.3.2.3, and 3.5.3.3 in the WCAP. The applicant is to clarify the above referred subsection numbers.

ICC&NMI – 028
For some Region II analyses described in the WCAP, the applicant took credit for intervening structures such that the ZOI volume is truncated by the intervening structures. For example, in Section 5.1.1.1.5.2, the applicant states that [

] Therefore, for the Region II analysis, the ZOI was truncated [
]. The applicant is to clarify that all the intervening structures credited in the AP1000 plant Region II analyses are adequately designed to accommodate the applicable LOCA jet loads.

(Greg Makar)

ICC&NMI – 029
Clarify which types of [ ] are used in the neutron absorber blocks and water inlet doors. In APP-CA31-GEF-005, Rev. 0, "CA31 Neutron Block Details," page 21 identifies the insulation as [

] The staff needs to understand which materials are being used in the plant.

ICC&NMI – 030
In Subsection 3.6.2.2, clarify what it means that the submergence testing was "limiting" with respect to the post-LOCA plant conditions (pressure, temperature, and chemistry) and ensuring a conservative test result. As described in the NRC March 2008 chemical effects guidance (ADAMS Accession Number ML080380214), Section 3(3)c, the range of post-accident environmental conditions should be considered in order to conservatively evaluate chemical effects. Clarification is needed to identify how the use of limiting conditions ensured a conservative evaluation of chemical precipitation.

ICC&NMI – 031
Clarify the discussion in the last paragraph in Subsection 3.6.2.4 regarding [

] please clarify this in the discussion.

ICC&NMI – 032
The Section 3 references (Section 3.7) include a Reference 3-29 that does not appear to be mentioned in the discussion. Please clarify whether this reference is EPRI Report TR-103300, "Guidelines for Boraflex Use in Spent Fuel Storage Racks," December 1993, and describe how it was used in the topical report.

ICC&NMI – 033
The next-to-last paragraph in Section 4.1 describes the reactor coolant system (RCS) piping as having minimum risk of primary water stress corrosion cracking because of fabrication details. The features listed include the absence of cast fittings and dissimilar metal welds in the RCS loop piping. Describe how these features of the RCS piping are being credited in the determination of debris generation break size. Are there any exceptions to these features, such as a cast reactor coolant pump flange connected to the loop piping?

ICC&NMI – 034
As discussed in Section 5.1.2, aging effects of [

]

ICC&NMI – 035
The chemical debris generation analysis for the AP1000 certified design (DCD Rev. 19) is based on a limit of 60 pounds and 60 square feet of aluminum, which was determined to generate 57 pounds of chemical precipitate. The DCD also states that in order to qualify a suitable equivalent insulation, it would have to be shown that the materials would not generate chemical debris. The approach in the topical report is to prevent chemical effects through the fabrication methods for the blocks containing the insulation and neutron absorber. The topical report also indicates that [

]. Given this approach, specify a condition on the use of the topical report which sets a quantitative limit on the amount of allowable aluminum inside containment (in lbs. and sq. ft.) such that adequate margin will be maintained to accommodate the use of the subject neutron shield blocks. In addition, since the licensing basis for the AP1000 is 60 pounds of aluminum, provide the justification for naming Table 5-2 the "AP1000 Licensing Basis Case," or discuss your plans to revise the title.