PMSTPCOL PEmails

From: Joseph, Stacy
Sent: Wednesday, October 20, 2010 5:36 PM
To: Gilmer, James; Thomas, George
Cc: STPCOL
Subject: FW: Draft Response 4.4-4
Attachments: 04 04-4 response final R3 DRAFT.pdf

Jim and George,

Please review STP's DRAFT RAI response. Please be prepared to discuss next week.

Stacy

From: Tomkins, James [mailto:jetomkins@STPEGS.COM]
Sent: Wednesday, October 20, 2010 2:32 PM
To: Joseph, Stacy
Subject: Draft Response 4.4-4

Here is the draft RAI response on RAI 4.4-4. Please let us know if you would like a phone call to discuss.

Hearing Identifier: SouthTexas34Public_EX
Email Number: 2458

Mail Envelope Properties (BBC4D3C29CD0E64E9FD6CE1AF26D84D52EDFD35D95)

Subject: FW: Draft Response 4.4-4
Sent Date: 10/20/2010 5:36:00 PM
Received Date: 10/20/2010 5:36:01 PM
From: Joseph, Stacy

Created By: Stacy.Joseph@nrc.gov

Recipients:
"STPCOL" <STP.COL@nrc.gov>
Tracking Status: None
"Gilmer, James" <James.Gilmer@nrc.gov>
Tracking Status: None
"Thomas, George" <George.Thomas@nrc.gov>
Tracking Status: None

Post Office: HQCLSTR01.nrc.gov

Files	**Size**	**Date & Time**
MESSAGE	389	10/20/2010 5:36:01 PM
04 04-4 response final R3 DRAFT.pdf	97824	

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

RAI 04.04-4

QUESTION:

During the NRC staff audit (held on July 12, 2010) of the calculations supporting the downstream fuel effects test acceptance criterion of 5.076 psid (U7-C-STP-NRC-100044 dated February 22, 2010), the staff discovered that the calculations were based on Optima II fuel rather than the GE-7 fuel approved in the ABWR DCD. Explain how the proposed criterion is suitable for the fuel design that is currently the basis for the ABWR design.

RESPONSE:

The analysis that was reviewed by the NRC staff on July 12, 2010, which evaluates the effects of debris downstream of the ECCS sump strainers on fuel coolability, is also applicable to the GE-7 fuel used in the ABWR DCD. The reason the calculations also apply to GE-7 fuel is that the differences between the GE-7 and Optima2 fuel designs are not significant for purposes of these calculations. The calculations determine the maximum flow restriction to the hot channel that will maintain a two-phase flow through the channel and not cause any significant fuel heat up (Vapor Void Fraction ≤ 0.95). As discussed in the STP 3&4 COLA markup to Section 6C provided with the response to RAI 04.04-3, the limiting break used in this analysis is a feedwater line break. The feedwater line break response results in a constant level of water in the RPV downcomer, which is limited by the elevation of the feedwater nozzle. This constant level of water provides the driving hydraulic head for flow into the bottom of the core.

In the ABWR, each assembly is encased within a channel. The power generated by the assembly is determined by the nuclear design of the core, the time after shutdown, and the decay heat, and is not dependent on the specific fuel mechanical design. Because each assembly is a closed channel, the flow into the assembly required to remove the specified assembly power without transitioning to steam cooling is also independent of the specific fuel mechanical design. The flow rate into the assembly is determined by the hydraulic head from the water in the downcomer and the hydraulic characteristics of the fuel assembly. Therefore, the hydraulic characteristics, such as resistance and bundle flows required to remove the specified power from the hot assembly and prevent steam-only cooling, must be similar for any fuel design.

In addition, the differences between the GE-7 and Optima2 mechanical designs are not significant for purposes of this calculation. Fuel assemblies used in the ABWR must be hydraulically similar in order for various design features of the ABWR to be met, including reactor internals hydraulic loads, Reactor Internal Pump (RIP) steady state, and coastdown performance. This is confirmed by Reference 1, which provides the NRC-approved methodology used by Westinghouse in providing replacement fuel for a BWR. The methodology described in Reference 1 has been applied for reload applications at a number of BWR's in the US supporting the Westinghouse SVEA-96 OPTIMA2 fuel design. This report demonstrates the application of the methodology by comparing several fuel designs, including

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the 8X8-2 design similar to the GE-7 fuel in the DCD, a 9X9-9 design and the Westinghouse SVEA-96 (10X10, Watercross) design which is similar to Optima2. Sections 5.2.2, 5.3, and Appendix D.4 of this report show that the hydraulic characteristics of the various fuel designs are very similar, as is expected and required in a mixed core. The Westinghouse methodology is designed to assure the hydraulic similarity of the Westinghouse BWR fuel to the fuel specifications for a given BWR.

Additional assurance of the applicability of the results to GE-7 fuel is provided by the additional conservatisms that have been included in the analysis as described below.

The test acceptance is based on the following relationship:

$$\left[\frac{\Delta p_f}{\Delta p_i}\right]_{Test-Measured} = \left[\frac{\Delta p_f}{\Delta p_i}\right]_{Aly} * \left(\frac{w_i}{w_f}\right)^2_{Aly} * \left(\frac{w_f}{w_i}\right)^2_{Test-Measured}$$

where subscript "i" denotes initial (i.e. unfouled conditions), "f" indicates fouled conditions, "Aly" refers to analysis, "*w*" is the flow rate into the assembly and "Δp" is the pressure drop from the bundle inlet to downstream of the third grid.

The elements in the previous equation that are determined from analysis were calculated using the inlet blockage from the hydraulically limiting break case. This blockage loss factor from the analysis was used to determine the pressure drop from the bundle inlet to downstream of the third grid using subcooled water, similar to the fuel test configuration. Including the bundle inlet through the third grid for the test accounts for the effect of debris that passes through the inlet region and is captured in the grids. In addition, the acceptance criteria has been reduced by a factor of 4 to provide margin to bound any small differences in fuel designs that would be used in the ABWR. The comparisons in Appendix D.4 of Reference 1 indicate that the difference in the hydraulic characteristics between different fuel assembly designs is very small and certainly bounded by a factor of 4. The resulting acceptance criterion is:

$$\left[\frac{\Delta p_f}{\Delta p_i}\right]_{Test-Measured} \leq 1200 * \left(\frac{w_f}{w_i}\right)^2_{Test-Measured}$$

This conservative acceptance criterion assures that fuel designs, including the GE-7 fuel described in the ABWR certified design, will remain cooled after a design basis accident for the tested debris composition and quantity. This acceptance criterion allows for a range of values, as opposed to a specific value, which allows for test flexibility and minimizes the number of test iterations should a specific test value, such as flow rate, not be achieved.

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References

1. CENPD-300-P-A, "Reference Safety Report for Boiling Water Reactor Reload Fuel", ABB Combustion Engineering Nuclear Operations, July 1996.

As a result of this response, the license condition included in the response to RAI 04.04-3 Supplement 1 will be revised as shown below with gray shading showing the changes from that response. A future COLA markup will be provided as part of a supplemental response to RAI 04.04-3. This supplemental response will be provided no later than November 2, 2010.

PROPOSED LICENSE CONDITION

A downstream fuel effects test will be conducted and the results provided to the NRC no later than 18 months prior to fuel load. The test plan, analysis basis, and debris assumptions are described in Appendix 6C.3.1.8. The test procedure will be provided to the NRC no later than 24 months prior to fuel load. The acceptance criteria for this test ~~will be a fuel assembly inlet steady-state pressure drop less than 5.076 psid.~~ are based on the following equation:

$$\left[\frac{\Delta p_f}{\Delta p_i}\right]_{Test-Measured} \leq 1200 * \left(\frac{w_f}{w_i}\right)^2_{Test-Measured}$$

where subscript "i" denotes initial (i.e. unfouled conditions), "f" indicates fouled conditions, "*w*" is the flow rate into the assembly and "Δp" is the pressure drop from the bundle inlet to downstream of the third grid.

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