US-APWRRAIsPEm Resource

From: Ciocco, Jeff
Sent: Thursday, June 07, 2012 1:03 PM
To: us-apwr-rai@mhi.co.jp; US-APWRRAIsPEm Resource
Cc: Haider, Syed; McKirgan, John; Otto, Ngola; Hamzehee, Hossein
Subject: US-APWR Design Certification Application RAI 938-6535 (8.4)
Attachments: US-APWR DC RAI 938 SCVB 6535.pdf

MHI,

The attachment contains the subject Request for Additional Information (RAI). This RAI was sent to you in draft form. Your licensing review schedule assumes technically correct and complete responses within 30 days of receipt of RAIs. However, MHI requests, and we grant, 45 days to respond to the RAI questions. We will adjust the schedule accordingly.

Please submit your RAI response to the NRC Document Control Desk.

Thank you,

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United States Nuclear Regulatory Commission
Protecting People and the Environment

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REQUEST FOR ADDITIONAL INFORMATION 938-6535 REVISION 3

6/7/2012

US-APWR Design Certification

Mitsubishi Heavy Industries

Docket No. 52-021

SRP Section: 08.04 - Station Blackout
Application Section: 8.4

QUESTIONS for Containment & Ventilation Branch (SCVB)

08.04-16

Transient Calculations of the Turbine-Driven Emergency Feed Water Pump Room Heat-up under Station Blackout

On May 9, 2012, the NRC staff conducted an audit of the transient heat-up calculations of the Turbine-Driven Emergency Feed Water (TDEFW) pump room under Station Blackout (SBO). The staff reviewed "US-APWR Standard Design, Room Heat-up Calculation for TDEFW pump room" (Document No. 4CS-UAP-20120004), and the supporting referenced material. This calculation report was prepared by the applicant to support the response to DCD RAI No. 875-6211, and describes the room heat-up calculations for the TDEFW pump room given the loss of all HVAC. A Microsoft Excel spreadsheet was used to develop the transient model for the room bulk-air temperature rise due to the loss of cooling. The audit has led to the following questions for the applicant to address. (No proprietary information is included in the eRAI system).

- A constant heat transfer coefficient of [--] was used for both the room inside and outside surfaces. The staff was informed that though the heat transfer coefficient was based on natural convection, it was not computed based on the temperature difference between the bulk air and the surfaces. The reference made in the calculation report for the heat transfer coefficient could not be found. Provide a reference for the heat transfer coefficient value used and justify it to be conservative for the wall and bulk-air temperature difference range encountered. Also justify using the same heat transfer coefficient for both the room inside and outside surfaces, while the outside surfaces are expected to have smaller temperature differences with the bulk air. Otherwise, update the model with a conservative heat transfer co-efficient or correlation[s] for vertical and horizontal orientations of the wall, ceiling, and floor; and have the staff review the revised model results.

- The wall areas reported in the RAI 875-6211 response were significantly higher than the ones appearing in the calculation report and the Excel model. The applicant admitted the error in reporting the areas in the response. However, as correct areas were used in the calculations, the error did not affect the model results. Please submit a modified response to RAI 875-6211 to bring it to closure.

- The concrete thermo-physical properties (thermal conductivity, density, and specific heat) used in the model were taken from 2005 ASHRAE Fundamentals. The ASHRAE Fundamentals identified a range of concrete properties, but the applicant had not used the most conservative values with respect to the room heat up calculations. Justify the concrete thermo-physical properties values used. Otherwise, update the model with conservative property values for wall, ceiling, and floor; and have the staff review the revised model results.

- The Excel model used [--] elements across each wall, ceiling, and floor; and a [--] minute time step for the transient heat-up calculations of the concrete structures. The stability of the numerical scheme used to solve the conjugate transient heat transfer from the bulk air into the concrete structures, as implemented in the Excel model, was not discussed in the calculation report. The staff expects the numerical scheme to be based on the 1-D transient conduction equation discretized through the solid structures exposed to convective boundary conditions on both sides. Demonstrate by analysis that the chosen time step and element widths are small enough to satisfy the corresponding Fourier number and Biot number based stability criteria emerging from the discretization of the energy equation and convective boundary conditions. Otherwise, use thinner elements and/or smaller time step to satisfy the stability criteria for the walls, ceiling, and floor; and have the staff review the revised model results.

- The problem formulation presented in the calculation report assumed a linear temperature profile through the wall. The appearance of the term containing the temperature difference between the indoor and outdoor surfaces is not consistent with the wall nodalization scheme described later in the calculation report. Please explain how the temperature profile was linearized through the entire wall while still accounting for the wall nodalization for the transient heat sink analysis. The term should not have appeared anywhere in the formulation.

- The calculation report did not explain how the model accounted for the soil underneath the floor as an extended heat sink. Please explain whether the floor and soil were considered two separate thermal resistances, or a single thermal resistance based on geometrically weighted properties, etc.

- During the audit, the applicant confirmed that the roof of the TDEFW pump room was not exposed to the sun. Confirm that none of the exterior walls of the room were exposed to the sun either, in order to justify the 115 ^{o}F bulk-air temperature assumed for the room surroundings. Besides, 115 ^{o}F bulk-air temperature may not be conservative for the surrounding spaces if there is heat generation, such as, by some equipment run by the back-up DC power supply under the SBO. Please identify any heat generation inside the adjacent spaces, and revise the heat-up model accordingly.

- The initial TDEFW pump room indoor air temperature was assumed to be 105 ^{o}F. Please confirm that 105 ^{o}F is the absolutely maximum temperature inside the TDEFW pump room for all abnormal and normal operating conditions, and the “initial” indoor room temperature could not exceed 105 ^{o}F, even if the room HVAC system were under an LCO (limiting condition for operation) when the SBO occurred.

- Even though, the TDEFW pumps do not require AC power for startup, room coolers and their heat removal systems are powered from AC buses. The US-APWR analyses include credit for loading of the AAC GTGs to supply the

TDEFW room cooling equipment within one hour after the SBO. The US-APWR safety-related DC batteries can supply power for a rated duration of two hours without recharging under design basis loading conditions. Thus, extended operation of the TDEFW pumps for longer than two hours also requires restoration of AC power to the safety-related battery chargers. Therefore, present the estimate when TDEFW control failures are expected to occur if the room heat-up continues for longer than one hour.

- Please state whether or not an operator would need to enter the post-SBO high temperature environment of the TDEFW pump room to support a safety-related function or to mitigate an accident. If so, identify any additional provisions needed or made by the applicant to offset the high heat stress due to the high TDEFW pump room temperatures.

- Please verify that the TDEFW pump room transient heat-up calculations are performed following the 10 CFR, Part 50, Appendix B, Quality Assurance criteria. Also update any applicable changes to the US-APWR, DCD Tier 1 and Tier 2 contents and the related topical/technical reports, resulting from the current RAI.

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