From: Galvin, Dennis
Sent: Monday, February 14, 2011 2:33 PM
To: Green, Sharon
Cc: Galvin, Dennis
Subject: ESBWR RAI 3.6-6 S05

Sharon,

ESBWR RAI 3.6-6 S05 is below.

Dennis Galvin
Project Manager
NRC/NRO/DNRL/NGE1

From: Cruz, Zahira [mailto:Zahira.Cruz@nrc.gov]
Sent: Tuesday, January 12, 2010 11:16 AM
To: Cruz, Zahira; Cubbage, Amy; Dixon-Herrity, Jennifer; Li, Yueh-Li; 'Steve Hambric'; Kingston, Rick E. (GE Infra, Energy); Deaver, Gerald A. (GE Infra, Energy); McLamb, Jon W (GE Infra, Energy); Piepmeyer, David A (GE Infra, Energy); Upton, Hugh A. (GE Infra, Energy)
Cc: Steve Hambric
Subject: RE: ESBWR: Discussion on RAIs 3.6-6 and 3.6-24
Importance: High

Here are the follow-up questions to be discussed during this afternoon's conference call.

ESBWR DCD SECTION 3.6.2 FOLLOW-UP RAIs
Engineering Mechanics Branch -2

Follow-up RAI 3.6-6 S05, Part B

(1) This portion of the RAI is now closed.

(2) For part B(2), GEH provides a mesh convergence study. The results of the study, however, are not consistent with the calculations shown previously in the report. GEH is requested to explain why the results of the mesh convergence study for the Ho and Nossier benchmark are inconsistent with other calculations in Technical Report 0000-0105-2955, Rev. 5. Specifically, the 'Mesh 100%/Base Mesh' time histories shown in Figures 3.27 - 3.29 do not match those shown in Figures 3.10 and 3.13; the levels and character of the curves are different, and GEH has not subtracted the mean pressures from the data in Figures 3.27 - 3.29. The time histories in Figures 3.27-3.29 are more than an order of magnitude shorter than those in Figures 3.10 and Figure 3.13, and do not appear to have achieved mesh convergence. Once these issues are resolved, GEH should reassess the conclusions of their mesh convergence study, keeping in mind that errors computed based on mean pressure (see discussion on page 42 where errors are computed based on a maximum pressure which includes mean pressure) are irrelevant to a discussion of the errors in oscillating pressures. GEH should assess errors in oscillating pressure amplitudes after subtracting mean pressure from their time histories. Also, GEH has declined to produce a time step resolution convergence study; this decision is not consistent with standard numerical practices and must be explained. GEH must provide a physically meaningful, well substantiated rationale for the time step size(s) they have chosen.

(3) For part B(3), GEH has included Technical Report 000-0105-2955, Rev. 5 as an Appendix to NEDE-33440P, which is referenced by DCD Tier 2, Section 3.6.2.3.1. GEH has also included a very brief description of their dynamic jet impingement analysis capability in the DCD. While GEH Technical Report 0000-0105-2955-R3 provides reasonably rigorous details of GEH's jet impingement modeling procedure as applied to two benchmarks, it does not commit formally to using those procedures for ESBWR design support. As requested in version S04 of this RAI, GEH should provide a formal description of the general procedure that they will commit to using to assess dynamic blowdown forces caused by impinging jets emanating from high energy line breaks in ESBWR plants. This description, which must include guidelines and rules of thumb for generating meshes and grids, procedures for assessing solution convergence (grid distribution and resolution and time series resolution, including time step length and overall solution length), means of assessing sensitivity of loading solutions to uncertainties, and bias errors and uncertainties (if any) GEH may apply, may reference existing sections in GEH Technical Report 0000-0105-2955, Rev. 5. Finally, GEH should clarify whether they plan to run conservative 2D analyses for ESBWR design calculations, or less conservative (but possibly more accurate) 3D analyses. GEH argues in Section 4.7 of the report that the most significant geometric uncertainties in their solution approach are subsumed by using conservative 2D modeling. While the staff concurs with this argument, GEH then states that 3D modeling may be used for ESBWR design calculations at the end of section 4.7.1 and at the end of section 4.7.3. Since GEH's 3D modeling approach has not been benchmarked and proven to be conservative, GEH must provide suitable benchmarking prior to the staff's acceptance of a 3D approach. This requested formal methodology description and commitment may be included as a new section in the Technical Report, or in the DCD.

Follow-up RAI 3.6-24 S01

GEH responded to this RAI in Enclosure 1 of MFN 09-787, dated 15 December 2009. GEH provided a detailed description of the Fluent analysis tool, citing articles in the open literature relevant to the analyses that will be conducted during the ESBWR design process. GEH also explained and substantiated their choice of turbulence modeling.

However, GEH has not addressed how their calculation approach will capture the range of worst-case conditions throughout a blowdown event, instead stating that analyzing only the initial portion of the blowdown is conservative. While this is true of jet impingement on systems and structures that are close to a jet source, this is not necessarily true for systems and structures that are far (but less than 25 pipe diameters) from a source. For systems and structures that are far from a source, the jet shape during initial blowdown is severely underexpanded, and loads may diminish significantly far from the source. Later, during blowdown, however, the jet expansion angle reduces, and strong jet loads are sustained even up to 25 diameters from a source. GEH is one again asked to provide a description of how jet impingement loading calculations will be performed to capture the range of worst-case conditions throughout a blowdown process. Will GEH run their analysis throughout blowdown, or compute loads for different stages of blowdown separately to reduce computational time? Also, how long (in simulated time) will GEH run a given analysis to capture sufficient detail to resolve dominant loading frequencies? These explanations should be part of the overall procedure description requested in follow-up RAI 3.6-6 S05 Part B.