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Your ref: Docket No. 52-006
Our ref: DCP_NRC_002522

June 9, 2009

Subject: AP1000 Response to Request for Additional Information (TR 09)

Westinghouse is submitting a response to the NRC request for additional information (RAI) on Technical Report No. 09. This RAI response is submitted in support of the AP1000 Design Certification Amendment Application (Docket No. 52-006). The information included in this response is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification and the AP1000 Design Certification Amendment Application.

Enclosure 1 provides the response for the following RAI(s):

RAI-TR09-004 R3

Questions or requests for additional information related to the content and preparation of this response should be directed to Westinghouse. Please send copies of such questions or requests to the prospective applicants for combined licenses referencing the AP1000 Design Certification. A representative for each applicant is included on the cc: list of this letter.

Very truly yours,

D. A. Lindgren /FOR

Robert Sisk, Manager
Licensing and Customer Interface
Regulatory Affairs and Standardization

/Enclosure

1. Response to Request for Additional Information on Technical Report No. 09

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NRO

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ENCLOSURE 1

Response to Request for Additional Information on Technical Report No. 09

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-TR09-004
Revision: 3

Question:

There is insufficient description in TR-9 of the local ANSYS models developed for the penetrations. For each penetration, the staff requests the applicant to address the following in TR-9:

- How is local thickening of the containment vessel modeled?
- How is the ANSYS output used to conduct the ASME Code stress checks?
- What ASME categories of stresses are directly obtainable from the ANSYS results: primary, primary + secondary, primary + secondary + peak?

Westinghouse Response: (Revision 2)

The local ANSYS model for the upper equipment hatch is shown in Figure 2-6(b) of the report. This model is included as a refined part of the overall model. Elements are defined so that the local thickening is represented by the element thickness. The thicker portion around the upper equipment hatch is visible in Figure 2-6(b).

Hand calculations are used to check Primary General Membrane stresses (Pm). ANSYS output is used directly to make ASME Code stress checks for the following:

- Primary stresses - Local Membrane (PL)
- Primary and Secondary Stresses (Pb + PL + Q)

There are no loads causing primary bending stresses, Pb, or peak stresses, F, in the vicinity of the large penetrations.

Subsequent to the initial response to this RAI the NRC requested a revised Figure 2-6(b) in APP-GW-GLR-005 to show the thickened portion of the containment. An additional figure to supplement Figure 2-6(b) is shown below and will be added to the technical report.

After review of the initial response for this RAI the NRC requested explanation of the statement "There are no loads causing primary bending stresses, Pb, or peak stresses, F, in the vicinity of the large penetrations." The explanation for this statement is provided below.

A primary stress such as primary bending Pb is one that is necessary to satisfy the simple laws of equilibrium of external and internal forces and moments. A secondary stress Q is one that is developed by the constraint of adjacent parts or by self-constraint of a structure. The bending stresses in and around the large openings are not needed to satisfy equilibrium of the internal and external forces and moments acting on and around the large penetrations. These bending stresses are due to the restraint of adjacent parts caused by the abrupt changes in geometry.

Therefore, the bending stresses in the vicinity of the large penetrations are classified as secondary stresses only. None of it is classified as primary stress.

With reference to Section III, Div. 1, Subsection NE the stresses near a nozzle or other opening originating from external load or moment or internal pressure are classified as Local Membrane Pl and Secondary Bending Q stress in accordance with Table NE-3217-1. There are no Primary Bending Stresses Pb at the nozzle or large openings because Primary Bending Stresses are through thickness bending stresses such as are seen in the center of a flat head under internal pressure as noted in Table NE-3217-1.

As for the subject of peak stresses:
Para NE-3212.11 defines peak stress. It is noteworthy that stress concentrations are not necessary for the classification (the wording is including the effects, if any, of stress concentrations). Peak stress is objectionable only as a possible source of a fatigue crack or brittle fracture. The paragraph notes that it does not need to be highly localized if it is of a type which cannot cause noticeable distortion and cites four examples. Example c) states "the stress at a local structural discontinuity".

Also, FEA results can pick up some peak effects depending on the element size and other modeling details. Generally the portion of the stress above the equivalent linear stress (that obtained by linearizing the stress through the thickness) can be considered peak. But this is not necessarily all the peak stress that can be present. For example, peak stress due to notches or stress concentrations can also be calculated using fatigue strength reduction factors.

In any case, we did not determine peak stresses in and around the openings and did not classify any stresses as peak stresses because a fatigue evaluation is not required by the design specification. The ASME evaluation of peak stress is performed as part of a fatigue evaluation. Fatigue evaluation was not required (because the CV Design Specification Section 3.10 states that analyses are not required for cyclic operation); so we did not classify any stresses as peak.

The statement in question read, "There are no loads causing primary bending stresses, Pb, or peak stresses, F, in the vicinity of the large penetrations." Regarding the peak stresses, we did not classify any stresses in the vicinity of the large penetrations due to any of the considered loads as peak stresses because a fatigue evaluation was not required.

Westinghouse Calculation APP-MV50-S2C-012 includes the reinforcement design methodology and details for containment penetrations requested in this RAI. This calculation was available for review by the NRC staff during the audit in May '08 at the Westinghouse offices in Pittsburgh.

Additional comments based on NRC meeting: (Revision 3)

The containment vessel design specification claims the ASME BPVC exemption from detailed fatigue analysis for cyclic operation. During the NRC review of seismic issues and analyses held April 13-17, 2009, the staff asked that this provision be confirmed. Westinghouse revised calculation APP-MV50-GEC-001, "Verification of AP1000 Containment Vessel Not Requiring Analysis for "Cyclic Service Report" " (Reference 1) for this purpose, and provided it for NRC review.

The record of change for Revision 1 of this calculation indicates, "Additional clarification added in regard to ASME Section III, Division 1, Subsection NE, paragraph NE-3221.5(d), "Vessels Not Requiring Analysis for Cyclic Service," Item 6, "Mechanical Loads"."

Revision 3 to Technical Report 9 (Reference 2) was prepared to add this explanation and a reference to this calculation, and is sent under a separate transmittal.

References:

1. APP-MV50-GEC-001, Revision 1, "Verification of AP1000 Containment Vessel Not Requiring Analysis for "Cyclic Service Report"."
2. APP-GW-GLR-005, Revision 3, "Containment Vessel Design Adjacent to Large Penetrations"

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision: (Revision 2)

See Revision 1 of the Technical Report.

Revise the first paragraph of Section 2.3 as follows:

Static analyses were performed on a finite element model having greater detail around the penetrations than that described in section 2.1 and used for the time history dynamic analyses in section 2.2. The mesh in the panels around the personnel locks and equipment hatches was refined using elements with a size less than $0.25 \sqrt{(Rt)}$. Three sub-models were generated, one for the upper personnel lock, one for the upper equipment hatch, and one combined sub-model for the lower personnel lock and equipment hatch.

The coarsely meshed panels around the openings in the dynamic model were replaced by the refined mesh panels. The refined model used in static analyses to evaluate the large penetrations is shown in Figure 2-6(a). The refined submodel for the upper equipment hatch is shown in Figures 2-6(b) and 2-6(c).

Add Figure 2-6(c) as follows:

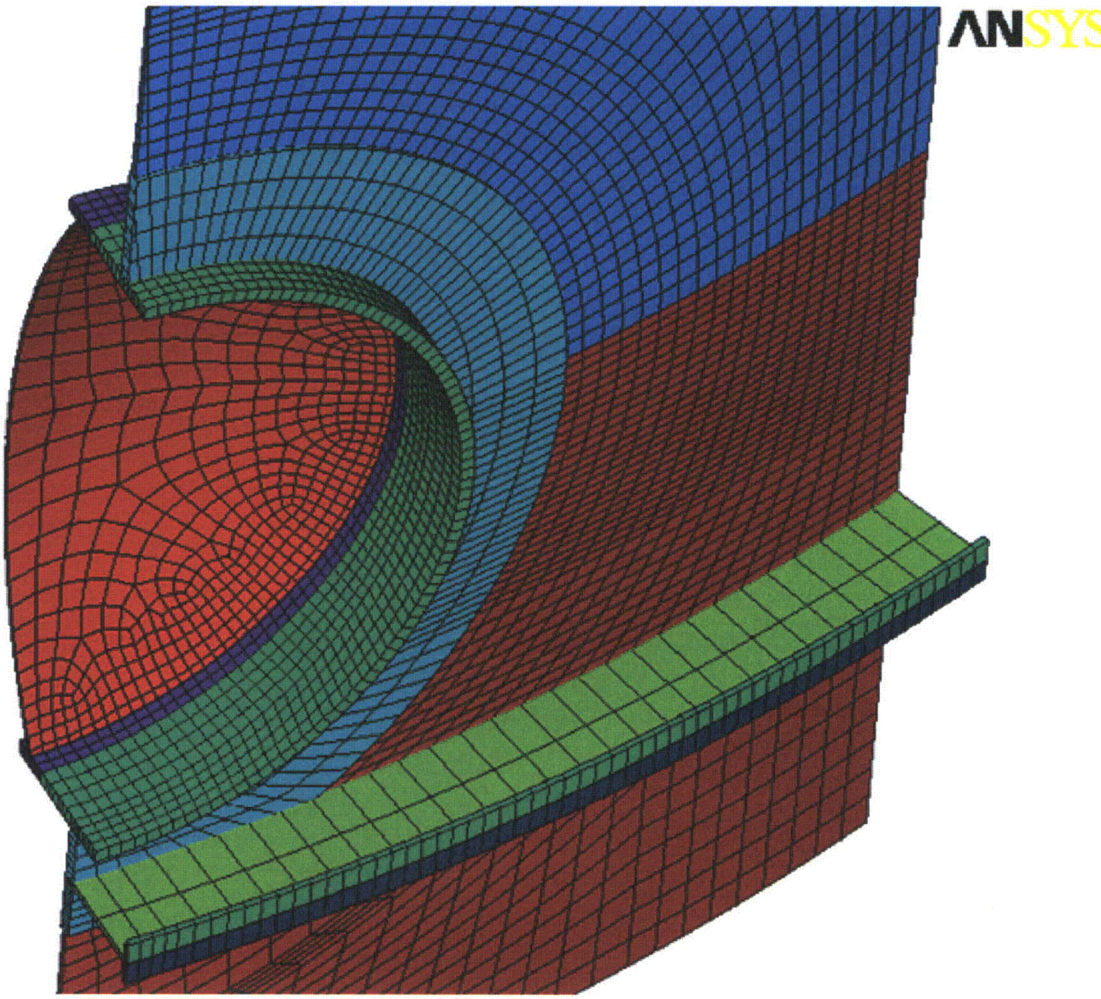

Figure 2-6(c) – Equipment Hatch (El. 141′-6″) Panel – Vertical Section