Westinghouse

Westinghouse Electric Company
Nuclear Power Plants
P.O. Box 355
Pittsburgh, Pennsylvania 15230-0355
USA

U.S. Nuclear Regulatory Commission
ATTENTION: Document Control Desk
Washington, D.C. 20555

Direct tel: 412-374-6206
Direct fax: 412-374-5005
e-mail: sisk1rb@westinghouse.com

Your ref: Docket No. 52-006
Our ref: DCP/NRC2400

March 6, 2009

Subject: AP1000 Response to Request for Additional Information (SRP3)

Westinghouse is submitting a response to the NRC request for additional information (RAI) on SRP Section 3. 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:

RAI-SRP3.9.3-EMB2-05 R1

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,

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

/Enclosure

1. Response to Request for Additional Information on SRP Section 3

0062ljb.doc

D063
NRO

cc:	D. Jaffe	-	U.S. NRC	1E
	E. McKenna	-	U.S. NRC	1E
	B. Gleaves	-	U.S. NRC	1E
	T. Spink	-	TVA	1E
	P. Hastings	-	Duke Power	1E
	R. Kitchen	-	Progress Energy	1E
	A. Monroe	-	SCANA	1E
	P. Jacobs	-	Florida Power & Light	1E
	C. Pierce	-	Southern Company	1E
	E. Schmiech	-	Westinghouse	1E
	G. Zinke	-	NuStart/Entergy	1E
	R. Grumbir	-	NuStart	1E
	D. Lindgren	-	Westinghouse	1E

ENCLOSURE 1

Response to Request for Additional Information on SRP Section 3

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP3.9.3-EMB2-05
Revision: 1

Question - Revision 0:

The staff conducted an on-site review of AP1000 component design on October 13 to October 17, 2008. The staff reviewed how Westinghouse translated DCD information into the design specifications for all components audited. The staff also reviewed the way in which Westinghouse documented the design analysis methodologies, criteria, and functional requirements in its design report for each major component in accordance with ASME Code, Section III. The staff requires response to the following Open Item in order to conclude its review of the proposed removal of the COL information item, currently addressed in the DCA.

Reactor Vessel – The design reports for the RV head penetrations indicate that the primary plus bending stresses at the J-groove weld did not satisfy the Code allowables. The reports split the stress components at these locations and justified that since the vessel wall would provide constraints in the radial and circumferential directions, the axial stress component satisfied the Code. Code does not allow splitting stresses for the purpose of satisfying the Code. Provide additional information on how the Westinghouse methodology meets the Code for J-groove weld design.

Question - Revision 1:

Demonstrate with additional information or a detailed analysis how Westinghouse plans to meet the Code requirements for the J-groove weld designs associated with CRDM, UMI and vent pipe penetrations.

Westinghouse claimed that since the penetration tube is constrained in radial and circumferential directions, the vessel would not allow any ratcheting in these directions. Now since all requirements of NB-3228.5 are satisfied in the axial direction, no significant effect due to thermal ratcheting in the axial direction would occur. However, the staff's concern is that the design report for the RV head penetrations split the stress components at these locations to justify the satisfaction of the Code requirements. NB-3228 is based on stress intensities and does not allow splitting stresses for the purpose of satisfying the Code. Westinghouse did not demonstrate why a plastic analysis is not necessary. Westinghouse in its response to -05, Rev. 0 reiterated statements included in the audited design reports.

Westinghouse Response to Revision 1 Question:

This response is specifically to the concern raised in the Revision 1 question. It is followed by the response previously provided in Revision 0, for completeness.

The justification provided for meeting the requirements of NB-3228.5 is compatible with ASME Code methodology as explained below. To clarify, no plastic analysis is required if NB-3228.5 is met. This response explains why NB-3228.5 is met. This explanation relies on an understanding of the importance of a plane of reference in evaluating a component to Code rules.

The limit in question is:

NB-3228.5 (a) "The range of primary plus secondary membrane plus bending stress intensity, excluding thermal bending stresses, shall be $\leq$3Sm."

The reviewer is correct that NB-3228.5 is based on stress intensity. However, the stress intensity can be determined using the appropriate stress tensors. In this case note the following definitions (underline added for emphasis):

> NB-3213.6 Membrane Stress: Membrane stress is the component of normal stress which is uniformly distributed and equal to the average value of stress across the thickness of the section under consideration.
>
> NB-3213.7 Bending Stress: Bending stress is the variable component of normal stress described in NB-3213.4. The variation may or may not be linear across the thickness.
>
> NB-3213.4 Normal Stress: Normal stress is the component of stress normal to the plane of reference….

The Code states, as summarized in the stress definitions, that the evaluation is made for a plane of reference. The fatigue evaluation checks the range of stress intensity values for every potential plane (line) of failure and fatigue usage is determined for a point on that plane using a conservative value of primary plus secondary stress intensity range, for the purpose of determining a conservative value of Ke and therefore a conservative usage factor.

This conservative approach does not satisfy the limits of NB-3228.5(a) so the Code rules are used to perform a more realistic evaluation using membrane and bending stresses normal to the plane of reference. The only stress plane (cut or line) which exceeded the NB-3228.5(a) limit is the cut through the tube illustrated in Figure 1 (cut 2). Using this approach, NB-3228.5(a) is met with very large margin. This approach is within the Code rules specified in the Code definitions.

This evaluation therefore demonstrates compliance with NB-3228.5 and a plastic analysis is not required.

The reactor vessel design report and the associated stress calculation for the vessel head penetrations will be revised with this discussion.

Westinghouse Response to Revision 0 Question:

The following is the original response provided for completeness.

The design report indicates that requirement of NB-3228.5 (a): Primary plus secondary stress minus thermal bending was not met. This is one of several requirements which are applied when the Primary plus Secondary stress limit of NB-3222.2 is exceeded and the simplified elastic-plastic analysis per NB-3228.5 is applied.

The equation is satisfied by addressing the purpose for the equation, which is to limit the potential excessive distortion due to incremental plasticity, sometimes referred to as stress ratcheting. The location where this is applied is at the stress cut shown in Figure 1, through the tube, just above the J-groove weld.

The issue is essentially identical for all penetrations so one penetration type, the CRDM, is used to illustrate the stresses which contribute to the total stress intensity used in this stress check. Table 1 summarizes the stress components for a typical case. The final line "Total – Th Bnd" reflects the stress to use for this limit. As this table illustrates the overstress is caused by the large hoop stress combined and to a lesser degree, the axial stress.

The ratchet mechanism cannot occur from hoop stress. The stresses in the radial and axial directions are well less than the limit (3Sm) and therefore the component meets the Code requirements.

The Code permits this equation to be exceeded using a plastic analysis per NB-3228.4, which would explicitly determine that shakedown (no ratcheting) occurs. The judgment being made is that this analysis is unnecessary in this case because it is clear how the impacted stress cut will respond to the loading, without needing to perform the plastic analysis.

Table 1 – CRDM Stress Components (typical)

	SX (Radial)	SY (Axial)	SZ (Hoop)	SXY	SYZ	SXZ	SI
Stress Ranges							
Transient	-260	35,028	-48,527	11,872	0	0	87,177
Mechanical	331	9,603	-1,086	-1,171	0	0	10,835
Total	-591	44,631	-49,613	13,043	0	0	97,736
TH Bnd	20,147	22,204	3,440	0	0	0	18,764
Total - TH Bnd	-20,738	22,427	-53,053	13,043	0	0	79,115

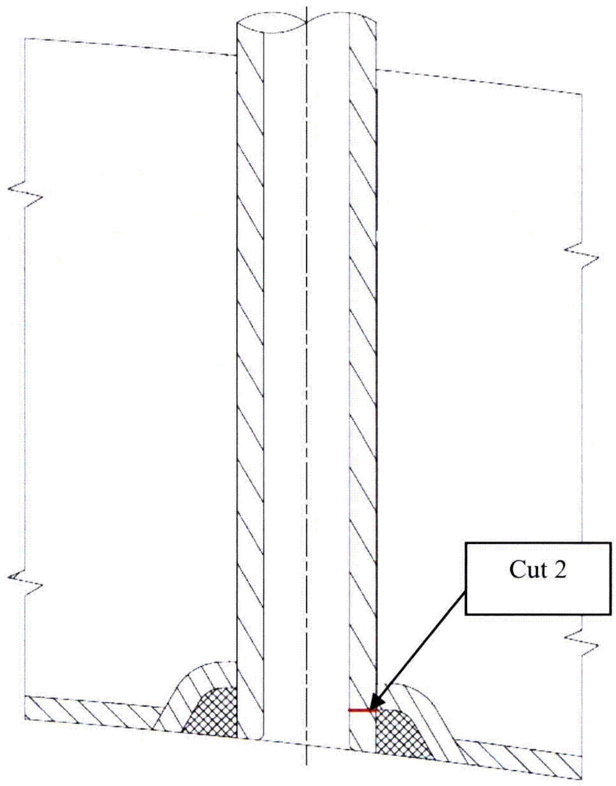

Figure 1 Cut 2 Location (typical all nozzles)

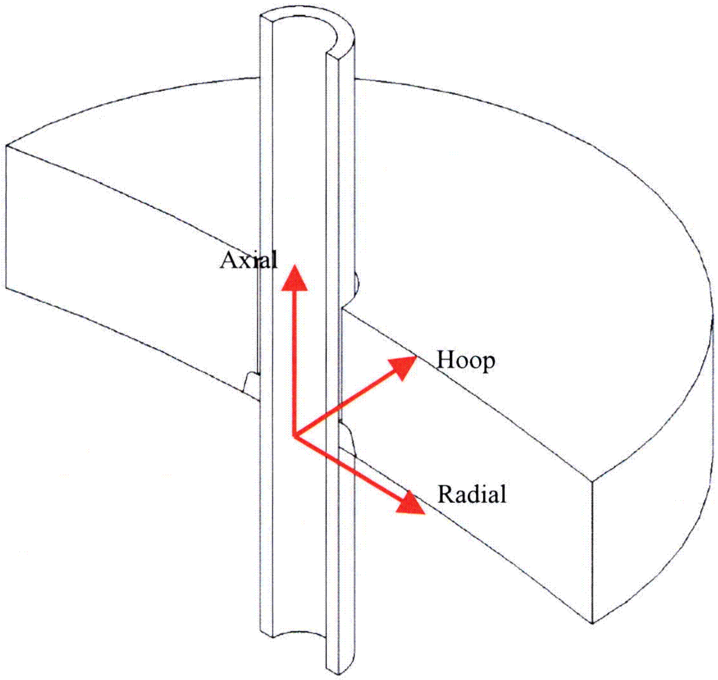

Figure 2 Coordinate System (typical)

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None