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Your ref: Docket No. 52-006
Our ref: DCP/NRC2164

June 20, 2008

Subject: AP1000 Response to Requests for Additional Information (SRP3.9.5)

Westinghouse is submitting a response to the NRC request for additional information (RAI) on SRP Section 3.9.5. This RAI response is submitted in support of the AP1000 Design Certification Amendment Application (Docket No. 52-006). The information included in the response is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification and the AP1000 Design Certification Amendment Application.

A response is provided for RAI-SRP3.9.5-EMB1-01 through -04, as sent in an email from Mike Miernicki to Sam Adams dated April 30, 2008. This response completes all requests received to date for SRP Section 3.9.5.

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

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

/Enclosure

1. Response to Requests for Additional Information on SRP Section 3.9.5

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ENCLOSURE 1

Response to Requests for Additional Information on SRP Section 3.9.5

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP3.9.5-EMB1-01
Revision: 0

Question:
DCD Section 3.9.5.1.4 re: addition of the flow skirt:

a. In accordance with ASME III, Subsection NG-1120, is the flow skirt classified as a core support structure or as an internal structure?
b. If classified as an internal structure, what design criteria are specified as the basis for design and construction of the flow skirt?
c. Explain how flow-induced vibratory loadings have been incorporated in the design of the flow skirt.
d. Is a stress report or design report summary available to document the design stress margins for the flow skirt?

Westinghouse Response:

a. Following the requirements in ASME Section III Article NB-1132.1(a), NB-1132.1(b)(2)(b), and NB-1132.1(c)(1)(b), the AP1000 flow skirt is classified as a permanent, non-pressure-retaining structural attachment to the reactor vessel.

Consistent with Article NB-1132.2(d), the jurisdictional boundary between the reactor vessel and the flow skirt is the first attachment weld; specifically, the flow skirt to flow skirt support lug. The attachment weld is analyzed to NB-3200 as part of the reactor vessel as shown in Figure 1 below.

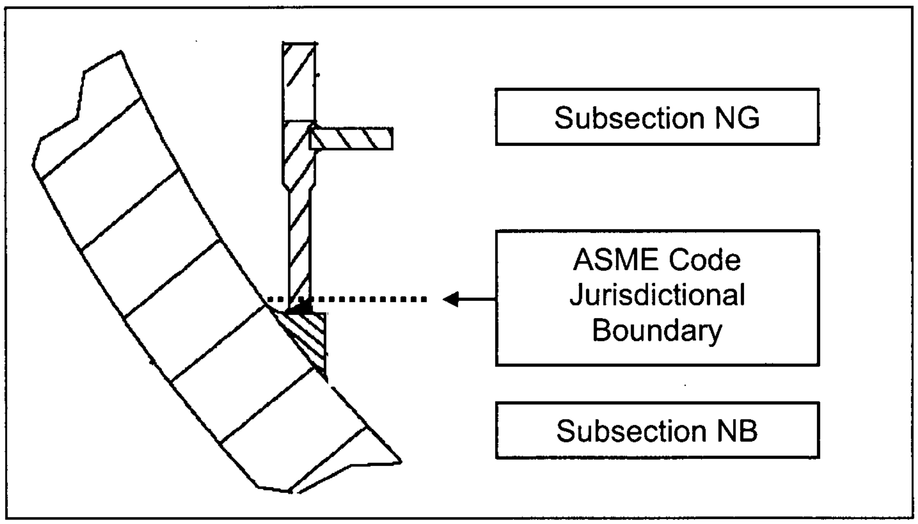

Figure 1 – Flow Skirt ASME Code Jurisdictional Boundaries

b. The ASME B&PV Code Subsection NG rules for core support structures have been conservatively applied to the flow skirt itself.

c. Westinghouse has considered flow induced vibratory loadings including down-comer flow turbulence, random turbulence of the reactor vessel lower head and vortex shedding through the flow skirt flow holes. The structural qualification calculation for the flow skirt is not currently complete; however, early results indicate that all ASME Code, Subsection NG requirements (including flow-induced vibratory loadings) will be met.

d. Westinghouse has considered flow induced vibratory loadings including down-comer flow turbulence, random turbulence of the reactor vessel lower head and vortex shedding through the flow skirt flow holes. A preliminary structural qualification calculation of the flow skirt indicates that all ASME Code, Subsection NG requirements (including flow-induced vibratory loadings) are met. The final calculation will be available for NRC review by August 15, 2008.

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None

RAI Response Number: RAI-SRP3.9.5-EMB1-02
Revision: 0

Question:

The last sentence of DCD Section 3.9.5.1.4 states, "The flow skirt provides a more uniform core inlet flow distribution."

a. Explain further how this conclusion is established.

b. Are analytical and/or test data available as reference material to verify the conclusion that the addition of the flow skirt improves flow distribution to the lower core support plate, and subsequently through the reactor core?

Westinghouse Response:

a. The primary function of the flow skirt is to assure that the distribution of flow entering the core is within prescribed limits for fuel assembly inlet flow mismatch. A Computational Fluids Dynamics (CFD) analysis of a reactor vessel/internals model which included the inlet nozzle, downcomer, lower plenum (including secondary core support and vortex suppression structures), and lower core support plate was performed to determine the core inlet flow distribution. Analyses were performed with and without a flow skirt. Without the flow skirt the limits were exceeded. These analyses are documented in CN-OA-06-30 (Reference 1).

b. As discussed above, significant CFD analyses have been performed to evaluate the flow conditions in the lower head and at the inlet into the lower core support plate. The CFD approach used in the analyses was used for analyses of similar reactor vessel internals geometry and was benchmarked to scale model testing data with good agreement.

Reference:

1. Westinghouse Calculation Note CN-OA-06-30, Rev. 0, "Evaluation of Flow Distribution at Lower Core Support Plate of AP1000 with CFX10," April 20, 2007.

Design Control Document (DCD) Revision: None.

PRA Revision: None.

Technical Report (TR) Revision: None.

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP3.9.5-EMB1-03
Revision: 0

Question:

DCD Fig. 3.9-8 illustrates the flow skirt as a solid beam-like structure which is not representative of either its function or its description. Further clarification of Fig. 3.9-8, or additional figure details, should be provided to facilitate understanding of the form and function of this newly added component.

Westinghouse Response:

The flow skirt is a perforated cylindrical structure with a horizontal stiffening flange that is supported by eight lugs inside the reactor vessel lower head. Please see the attached Figures 1 and 2, which illustrate the flow skirt.

Design Control Document (DCD) Revision: None.

PRA Revision: None.

Technical Report (TR) Revision: None.

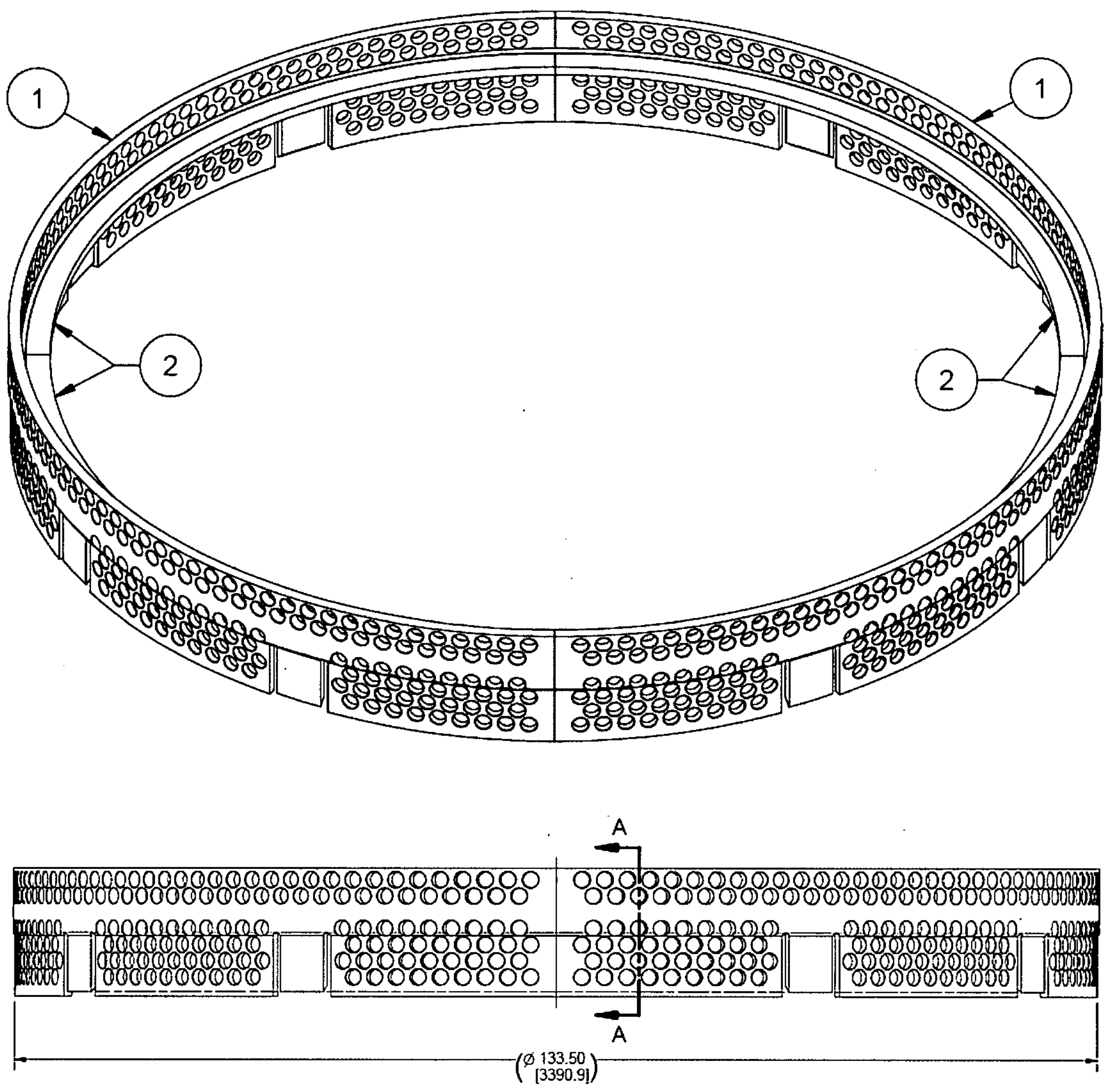

Figure 1 – Flow Skirt Isometric View

Notes:
Item 1 is the "Flow Skirt"
Item 2 is the "Flange"

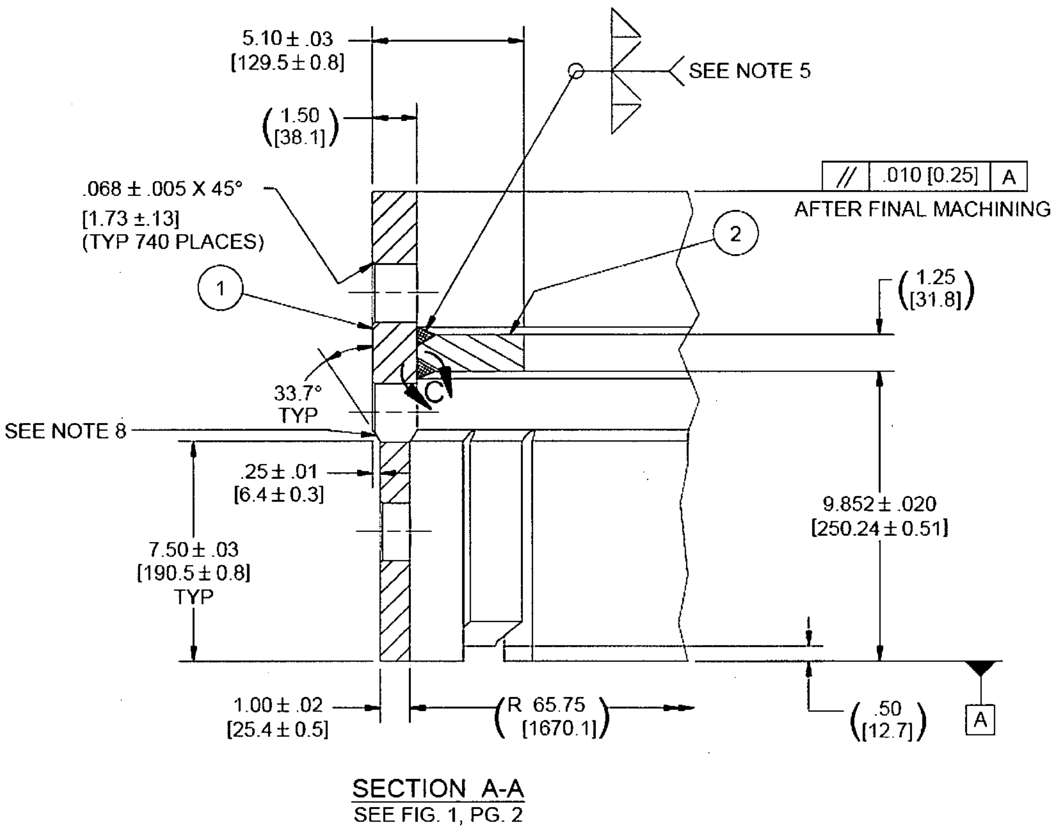

Figure 2 – Flow Skirt Vertical Cross-Section

Notes:
Item 1 is the "Flow Skirt"
Item 2 is the "Flange"

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP3.9.5-EMB1-04
Revision: 0

Question:

DCD Section 3.9.5.1.1 re: addition of neutron panels:

a. In accordance with ASME III, Subsection NG-1120, are the neutron panels classified as core support structures or as internal structures?
b. The design basis for the components described in DCD Section 3.9.5.1.1 is unclear. The description of the lower core support assembly, which includes the neutron panels, suggests that this assembly may provide a core support function which defines the ASME Code classification and design basis for the components. Identify the design basis for this assembly, and the design basis of individual components, if different from the assembly.
c. If the neutron panels are classified as internal structures, what specific design criteria are used as the basis for their design and construction?
d. Describe how the neutron panels are fastened to the core barrel, and how this connection is designed to resist vibratory loading.
e. Describe how the addition of the neutron panels affects the fluid flow in the reactor downcomer annulus, especially with respect to the potential for adverse flow-induced vibration loading.

Westinghouse Response:

a. The only function of the neutron panels is to protect the reactor vessel from detrimental radiation effects by limiting total exposure. Thus, the neutron panels are classified as internal structures.

b. The neutron panels are attached to the core barrel with threaded fasteners. The core barrel is a core support structure; however, the attached components (neutron panels, specimen baskets, and direct vessel injection flow diverter) are classified as internal structures because they do not provide either direct or indirect support of the load from the core support structures.

The neutron panels provide shielding over the active core elevations on the outside of the core barrel. The shielding consists of four strategically located panels. The shielding protects the reactor vessel from detrimental radiation effects by limiting total exposure. For conservatism, the Neutron Panels are analyzed in accordance with the requirements of ASME Subsection NG.

The specimen baskets are located on the periphery of the core barrel. Specimens are located to achieve acceptable lead factors to predict vessel exposure. Specimens are removed from the baskets with long-handled tools from the refueling bridge. The specimen baskets are attached to the core barrel with threaded fasteners. For conservatism, the specimen baskets are analyzed in accordance with the requirements of ASME Subsection NG.

The direct vessel injection flow diverter is attached to the outside of the core barrel; its function is to protect the core barrel from direct impingement from the flow entering the direct vessel injection nozzle and to direct the flow downward in the annulus of the core barrel. For conservatism, the direct vessel injection flow diverters are analyzed in accordance with the requirements of ASME Subsection NG.

c. The ASME B&PV Code Subsection NG rules for core support structures have been conservatively applied to the neutron panels.

d. The neutron panels are attached to the core barrel with threaded fasteners. The neutron panels have been sized to prevent excessive thermal loading on the bolts and to withstand flow, thermal and vibratory loading.

In addition the bolts and preload of the bolts have been sized to accommodate radiation relaxation and radiation induced gamma heating such that preload is maintained. These bolts are secured by locking devices.

Oscillatory forces on the neutron panel have been calculated based on the turbulence in the annulus between the neutron panel and reactor vessel based on correlation with past scale model tests and CFD analysis. The analysis of the forces, as discussed above were evaluated to assure that preload is maintained and that design limits are achieved.

e. The circumferential extent of the neutron panels was limited to correspond to the high vessel fluence levels and thus minimize the flow blockage in the downcomer. The neutron panels are tapered circumferentially (following the reduction in fluence level) to minimize the flow area reduction. In addition, the reactor vessel inside diameter was increased by two inches over the core elevations when the panels were added. This results in a net flow area increase of 4% relative to the flow area before the panels were added. Thus, the lower average downcomer velocity is expected to tend to offset the effects of the turbulence added by the neutron panels.

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None