August 11, 2010

MEMORANDUM TO: Eileen McKenna, Chief
AP1000 Projects Branch 2
Division of New Reactor Licensing
Office of New Reactors

FROM: Phyllis Clark, Project Manager ***/RA/***
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SUBJECT: SUMMARY OF THE APRIL 19 − 21, 2010, AUDIT OF AP1000 DESIGN CERTIFICATION – REGULATORY AUDIT OF OPEN ITEMS: J-GROOVE WELDS AND CONTAINMENT RECIRCULATION SCREENS

During April 19 − 21, 2010, the U.S. Nuclear Regulatory Commission's (NRC) staff conducted an on-site review of two specific open items (OI) identified in the staff's Safety Evaluation Report Section 3.9.3 associated with the AP1000 design control document (DCD) review of American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code Class 1, 2, and 3 Components, Component Supports, and Core Support Structures. The purpose of this on-site audit was (1) to assess the plastic analysis of the J-Groove Weld Design in the reactor vessel closure head performed by Westinghouse Electric Company (Westinghouse) that meets the ASME Code identified in OI-SRP3.9.3-EMB2-05, and (2) to review documents satisfying the design requirements of in-containment refueling water storage tank and containment recirculation screens identified in OI-SRP3.9.3-EMB2-08.

Westinghouse had provided design documents to support the closure of the OIs. Based on the information reviewed, the staff found that the design documents for the reviewed components reflected the methodology and criteria contained in the DCD. Based on audit findings, the staff identified outstanding issues for both OI-SRP3.9.3-EMB2-05 and OI-SRP3.9.3-EMB2-08. During the audit, some issues and questions were raised by the staff, and are considered as follow-up items. These follow-up items will be addressed by Westinghouse through a letter to address the resolution of the identified follow-up items or provision of additional supporting design documents to resolve the identified follow-up items for the staff's review at Westinghouse's Rockville, Maryland office. The follow-up items are detailed in the enclosure, "Summary of Audit Report."

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The NRC staff noted that the design report for the containment recirculation screens identified in OI-SRP3.9.3-EMB2-08 will be completed by the vendor. The final design reports of containment recirculation screens will need to be reviewed by NRC staff. AP1000 DCD, Tier 1, Table 2.2.3-4, inspection, test, analysis, and acceptance criteria 5.a) would be added to require review of this design report.

Docket No. 52-006

Enclosure:
As stated

The NRC staff noted that the design report for the containment recirculation screens identified in OI-SRP3.9.3-EMB2-08 will be completed by the vendor. The final design reports of containment recirculation screens will need to be reviewed by NRC staff. AP1000 DCD, Tier 1, Table 2.2.3-4, inspection, test, analysis, and acceptance criteria 5.a) would be added to require review of this design report.

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Enclosure:
As stated

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SUMMARY OF AUDIT REPORT

I. INTRODUCTION

A regulatory audit in support of the U.S. Nuclear Regulatory Commission (NRC) staff reviews of the AP1000 Design Certification application was held during April 19 - 21, 2010, to allow resolution of open items (OIs) addressing concerns with the J-groove welds and containment recirculation and in-containment refueling water storage tank (IRWST) screen designs. The purpose of this document is to highlight the follow-up items resulting from the Westinghouse regulatory audit of April 19 - 21, 2010.

II. BACKGROUND

During October 13 - 17, 2008, the NRC staff conducted an on-site review of the AP1000 component design based on the requirements of Standard Review Plan (SRP) Section 3.9.3 at the Westinghouse office in Monroeville, Pennsylvania. The purpose of the on-site review was to verify that the AP1000 component design was in accordance with the methodology and design criteria described in the design control document (DCD). Specifically, Section 7 of Appendix A to SRP Section 3.9.3 provides guidance that the staff may request the submission of the American Society of Mechanical Engineer's (ASME) Boiler and Pressure Vessel Code-required design documents (such as Design Specifications, Design Reports, Load Capacity Data Sheets, or other related material or portion thereof), in order to establish that the design criteria, and analytical methods, and functional capability satisfy the guidance provided by SRP Section 3.9.3. This includes verification that the design information described in the DCD was adequately translated into documentation for each of the components designed to ASME Code Section III, Class 1, 2, and 3 requirements.

Westinghouse had provided a list of major mechanical components for which the certified design specifications and design reports would be completed and available for the NRC audit. These include the reactor vessel, reactor vessel internals, control rod drive system, steam generator, pressurizer, passive RHR heat exchanger, core makeup tank, and accumulator. In addition, in the interest of Generic Safety Issue - 191, the NRC staff reviewed the design specification for the containment recirculation screens.

On January 9, 2009, the staff audited additional documents associated with the design specification for the IRWST and containment recirculation screens at the Westinghouse office in Rockville, Maryland.

During the audit in October 2008, the staff requested in RAI-SRP3.9.3-EMB2-05 that Westinghouse demonstrates how Westinghouse methodology meets the ASME Code for the J-groove weld design.

During the audit in January 2009, the staff reviewed the design specification and other supporting documents associated with containment recirculation screens and found several issues that are incompletely addressed in the design specification. The staff requested in RAI-SRP3.9.3-EMB2-08 for Westinghouse to address the following:

> (a) According to the design specification, the Supplier will provide additional design details, design drawings and requirements. Therefore, the engineering drawings (envelope drawings) of the screen assemblies were not available at the time of site audit or at the Westinghouse office in Rockville, Maryland. Provide these engineering drawings of the screen assemblies for review by the staff.
>
> (b) The loading conditions and combinations are incompletely presented in the documents reviewed by the staff. Provide the following: (i) design and service level A-D loads and load combinations, (ii) fatigue evaluation, and (iii) the origin and the basis of using ±5 psi pressure loading on the IRWST screen from sparger discharge.
>
> (c) While it is possible to design containment cleanliness programs to sustain low latent debris inventory in containment, justify the latent debris mass value used for the screen pressure drop component of the structural load on the IRWST and sump screens. Additionally, justify that the flow rates through the screens are conservatively calculated.

III. AUDIT FINDINGS

(1) Reactor Vessel Closure Head J-Weld Design

Follow-up Item #1: Update the design reports

Westinghouse, in its plastic analysis of control rod drive mechanism (CRDM) and vent pipe penetrations, has demonstrated that the design of the vessel head assembly satisfies the ASME Code requirements. On this basis, the staff finds this acceptable and the OI-SRP3.9.3-EMB2-05 is closed, pending revision to the following documents:

1. APP-MV01-Z0C-015 “Detailed Analysis of Closure Head and Vessel Flange Region for AP1000 Reactor Pressure Vessel (RPV),” Revision 2, September 19, 2009, must be revised to reflect the design change associated with the upper mounted instrumentations (UMI) penetrations.

2. APP-MV01-Z0C-019 “Detailed Analysis of Closure Head Penetrations (CRDM, UMI, and Vent Pipe) for AP1000 Reactor Vessel,” Revision 3, April 16, 2009, must be updated to include the results of the plastic analysis for the CRDM and vent pipe penetrations.

Documents Reviewed

Drawings

APP-MV01-V2-001, “AP1000 Reactor Vessel and Closure Head General Assembly,” Revision 3

APP-MV01-V2-002, “AP1000 Reactor Vessel and Closure Head Assembly Elevation through Outlet Nozzles,” Revision 3

APP-MV01-V2-005, “AP1000 Reactor Vessel and Closure Head Assembly Head Plan View,” Revision 2

APP-MV01-V2-006, “AP1000 Reactor Vessel and Closure Head Assembly Head Details,” Revision 3

APP-MV01-V6-125, “AP1000 Reactor Vessel Vent Pipe,” Revision 0

APP-MV01-V6-126, “AP1000 Reactor Vessel Vent Pipe,” Revision 0

APP-MV01-V6-131, “AP1000 Reactor Vessel Latch Housing Penetrations,” Revision 1

Reports

APP-MV01-Z0-101, “Design Specification – AP1000 Reactor Vessel,” Revision 3, September, 7, 2009

APP-MV01-Z0C-015, “Detailed Analysis of Closure Head and Vessel Flange Region for AP1000 Reactor Pressure Vessel (RPV),” Revision. 2, September, 19, 2009

APP-MV01-Z0C-019, “Detailed Analysis of Closure Head Penetrations (CRDM, UMI, and Vent Pipe) for AP1000 Reactor Vessel,” Revision 3, April 16, 2009

APP-MV01-Z0C-026, “AP1000 Reactor Vessel (RV) Quickloc Instrument Nozzle Detailed Analysis,” Revision 0, November 3, 2009

APP-MV01-Z0C-027, “AP1000 RV CRDM and Vent Pipe Plastic Analysis,” Revision 0, November 3, 2009

(2) IRWST and Containment Recirculation Screen Design

Follow-up Item #1: The final analysis reports and drawings remain to be reviewed by NRC staff. Design reports and detailed design drawings were not available, since they have not yet been provided by the responsible vendor. A set of drawings was reviewed by the staff, but these are categorized as “Envelope Drawings” and not detailed design drawings. Detailed information about design, fabrication and assembly were not included. However, AP1000 DCD, Tier 1, Table 2.2.3-4, ITAAC 5.a) was added to require a report verifying that the as-installed screens include seismic load, post accident operating loads, head loss and debris weights.

The staff confirmed that the above discussed AP1000 DCD, Tier 1, Table 2.2.3-4, ITAAC 5.a) addressed the issue such that this ITAAC allows the staff to review the design reports and verifies the as-installed screens, including seismic load, post accident operating loads, head loss and debris weights. The staff concurred with the ITAAC approach of screen design report. Therefore, the follow-up item #1 is closed.

Follow-up Item #2: Resolve the question about how the 0.25 psi pressure drop loading will be added to the 5 psi loading for the screens.

The head loss component of pressure loading on the IRWST and Containment Sump Recirculation Screen was evaluated by Westinghouse using a simulant experimental program.

The results of the program presented to the auditors were interpreted by Westinghouse as showing negligible head loss across the screens and accumulated debris.

The auditors questioned the loading on the screen. Following discussion, Westinghouse agreed that the screen head loss component of pressure loading on both the IRWST and Containment screens would be a minimum of 0.25 psi as indicated in Westinghouse design specification (APP-GW-GLE-002, page 39). In addition, Westinghouse stated that they would consider augmenting this minimum head loss to allow for additional margin. The final head loss component of pressure loading is an open question. A complete analysis of the head loss component of pressure loading remains to be reviewed when available.

Follow-up Item #3: Confirm the applicability of the 5 psi sparger loading on IRWST screen design.

Operation of the IRWST tank spargers leads to a pressure loading on the IRWST screens. An estimate of the sparger pressure loading is used as one component of the loading for both the IRWST and the containment screens. During discussions, the staff asked Westinghouse for a review of the available documents that support the pressure loading of ±5 psia. Westinghouse responded by saying that the documentation for this was not available at the time. However, Westinghouse stated that the documentation for the magnitude of the sparger pressure loading was available, and that NRC staff had this in their possession.

The staff confirmed that these support documents are available in NRC review and verified the pressure loading of ±5 psia was acceptable by SRP Section 6.2 SER evaluation. The staff concurred with Westinghouse's response of the pressure loading of ±5 psia. Therefore, follow-up item #3 is closed.

Follow-up Item #4: Address sloshing in the IWRST tank as a result of a seismic event. Determine if these loads on the screen need to be included.

NRC staff questioned the potential sloshing of water in the IRWST tank resulting from seismic activity and the magnitude of resulting pressure loading on the IRWST screen structures. Westinghouse did not have a response as to whether or not this potential source of loading had been considered. The follow-up item for Westinghouse is to provide its estimate of the seismic induced pressure loading on IRWST screen structures resulting from sloshing of IRWST tank water.

Documents Reviewed

<u>Drawings</u>

Westinghouse Drawing APP-MY03-V0-001, "Containment Recirculation Screen Envelope Drawing"

Westinghouse Drawing APP-MY03-V0-002, "Containment Recirculation Screen Layout Drawing"

Westinghouse Drawing APP-MY03-V0-100, "IRWST Screen Envelope Drawing"

Westinghouse Drawing APP-MY03-V0-101, "IRWST Screen Layout Drawing"

Reports

APP-GW-GLE-002, “Impacts to the AP1000 DCD to Address Generic Safety Issue GSI-191,” February 2010

APP-GW-GLR-079, “AP1000, Verification of Water Sources for Long-Term Recirculation Cooling Following a LOCA,” Revision 7, February 2010

APP-MT03-Z0-001, “Design Specification,” Revision 4, April 2010

RAI-SRP6.2.2-SPCV-19, “Response to Request for Additional Information (RAI),” Revision 2

Song, Y., “IRWST and Containment Recirculation Screens Overview,” Presentation, April 19 - 20, 2010

IV. CONCLUSION

This summary audit report is to be referenced in Section 3.9.3 of the FSER and represents the design documents that support and are related to the closure of OI-SRP3.9.3-EMB2-05 and OI-SRP3.9.3-EMB2-08 of the AP1000 DCD review. Staff found that there are follow-up items that Westinghouse will need to address to resolve the OIs prior to the design certification. They are:

(1) Reactor Vessel Closure Head J-Weld Design

Follow-up Item #1: Update the design reports.

(2) IRWST and Containment Recirculation Screen Design

Follow-up Item #2: Resolve the question about how the 0.25 psi pressure drop loading will be added to the 5 psi loading for the screens.

Follow-up Item #4: Address sloshing in the IRWST tank as a result of a seismic event. Determine if these loads on the screen need to be included.