UNITED STATES - ADVANCED PRESSURIZED WATER REACTOR INTERNAL FLOOD ANALYSES AUDIT REPORT

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1.0 SUMMARY

An audit was conducted by the U.S. Nuclear Regulatory Commission (NRC) staff at the Mitsubishi Nuclear Energy Systems office in Arlington, Virginia on April 17, 2013 in accordance with the NRC Office of New Reactors (NRO) Office Instruction NRO-REG-108, "Regulatory Audits." The plan for this audit was documented and can be found in the Agencywide Document Access and Management System (ADAMS) under accession number ML13092A160, dated April 5, 2013. A list of attendees is provided as Enclosure 2. A list of documents made available to the NRC staff is provided as Enclosure 3.

The purpose of the audit was to review the basis, assumptions and results of the United States – Advanced Pressurized Water Reactor (US-APWR) internal flood protection analyses. The scope of the audit, as described in the NRC audit plan included the review of documents, analyses, drawings, and other relevant design information used to support the US-APWR internal flood evaluation results contained in Design Control Document (DCD) Tier 2, Section 3.4.1, "Flood Protection," and Appendix 3K, "Components Protected From Internal Flooding."

2.0 OBSERVATIONS AND RESULTS

The NRC audit team reviewed the applicant's calculations and drawings and verified that the supporting analyses for the internal flooding evaluation was performed in accordance with the methodology and criteria described in the DCD. This included verification of the design information contained in DCD Tier 2, Section 3.4.1 and Appendix 3K. The review also confirmed that the applicant evaluation of the internal flooding was appropriate, and that the assumptions and methodology used in the evaluation gives conservative results for the flooding events evaluated. A discussion of the focus areas within the audit follows.

The staff notes that it reviewed only a sample of the documents made available during the audit and that the review of any particular document made available during the audit does not represent the staff approval of a document, as that is outside scope of the audit.

Identification of Worst Case Flooding Event

In DCD Tier 2, Section 3.4.1.5, "Evaluation of Internal Flooding," the applicant describes the flood evaluation process used to determine how to provide an adequate level of flood protection for the structure, systems and components important to safety. Flooding from internal water sources arises as a result of the following:

- Earthquakes.
- Pipe breaks and cracks.
- Firefighting operations.
- Pump mechanical seal failure.

In DCD Tier 2 Section 3.4.1.5, flooding results are provided for various areas of the plant based on applicable contributor to internal flooding. As part of the audit, the staff reviewed the supporting documentation to verify that the internal flooding calculations were performed appropriately, accounted for appropriate flooding contributors, and their results were supportive of the information provided in the DCD.

Based on its review, the staff found that the applicant correctly identified all the potential sources of internal flooding for the each of the affected plant areas, and based on evaluating the resulting flooding for each flooding scenario, chose the most limiting case to use for flood design consideration. The staff found that, the applicant often conservatively rounded up calculated volumes, and used conservative times for system isolation.

Flooding Contributions from Moderate Energy and High Energy Lines

In the applicant's second revised response to request for additional information (RAI) 841-6055, dated April 2, 2013, the applicant made revisions to the internal flooding analyses based on changes in moderate energy line crack contributions to internal flooding due to changes in the design to some portions of moderate energy lines. In its response, the applicant stated “most of the water-containing moderate energy piping is excluded from flooding source because that piping is to be designed so that a crack is not required to be postulated in the line in accordance with the criteria described in Section 3.6.2.1.2.2.” According to the RAI response, this will be attained in design by maintaining stress on the pipes below the threshold by means of route and support design. It was also noted that cracks are not postulated only if the cracks are excluded based on the criteria specified in DCD Tier 2, Sections 3.6.2.1.2.1 or 3.6.2.1.2.2, and that full-circumferential breaks of non-seismically designed pipes are considered in the flooding evaluation in conformance with SRP Section 3.4.1, “Internal Flood Protection for Onsite Equipment Failures.”

Markups to DCD Tier 2, Section 3.4.1 were also provided as part of the second revised response to RAI 841-6055. The terminology used in the DCD markups of sections discussing the moderate energy line flooding evaluation often states that most of the water-containing moderate energy piping in the area is excluded from flooding sources because the piping is to be designed so that a crack is not required to be postulated in accordance with the criteria described in DCD Tier 2, Subsection 3.6.2.1.2.2.

As part of the staff’s audit of the US-APWR flooding evaluations, the staff reviewed the applicant’s calculations and drawings and confirmed that the applicant’s treatment of flooding from moderate energy lines where flooding occurs was appropriate. However, the staff finds that the applicant does not clearly identify in the DCD the moderate energy line systems and lines where flooding does not occur due to piping being designed to

meet the “no crack” criteria. Therefore, the staff indicated that the applicant should provide additional information in the DCD to (1) more clearly identify the criteria used for classification of the moderate energy piping (or systems) to be designed as “no crack,” (2) identify the moderate energy piping systems (or portions of piping system) that the “no crack” design is being applied, and (3) identify the moderate energy piping (or systems) that is assumed to crack or break. Subsequent to the audit, the staff issued RAI 1030-7105, Question 03.04.01-33, to address this concern.

The staff also reviewed the calculations and supporting documentation to confirm that the applicant selected the most limiting high energy line break for areas analyzed, and performed their analyses using isolation time that were sufficiently conservative. The staff confirmed that the applicant appropriately assumed the failure of all non-seismic piping. Based on its review, with the exception of the concern in RAI 1030-7105, Question 03.04.01-33, the staff found the applicant’s treatment of high energy and moderate energy lines relative to flooding to be adequate, and the flooding information associated with breaks and cracks in high and moderate energy lines in DCD Section 3.4.1, to be adequately supported by the flood analyses reviewed.

Calculation of Room/Area Flood Levels

In DCD Tier 2, Section 3.4.1.5, “Evaluation of Internal Flooding,” the applicant reports the maximum level in each area to which water would rise for the various flooding events. The audit team reviewed the analyses on which the information in the DCD was based and found that these analyses were performed to provide conservative results for water level. The water levels were calculated based on water release volume for the different events, and on the net available surface area of the room that the water was accumulating. The water volumes used had additional margin over the actual calculated values due to rounding up of the volumes by the applicant. The net available volume subtracted floor areas not available because it was occupied by structures and equipment in the room. Based on the audit review, the staff found that the calculation of room/area flood levels to adequate.

Divisional Separation and Use of Flood Barriers

One approach to flood protection used by the US-APWR, is the use of flood barriers and credit for divisional separation. The staff reviewed the plant general arrangement drawing and the equipment and floor drain piping drawing to confirm that the flood barriers, such as watertight doors were properly included in the plant design, and that cross divisional flooding not credited in the analyses would not occur. Based on the audit review, the staff found that the design incorporated the flood barriers credited in the analyses, and provided adequate protection against cross divisional flooding.

3.0 ACTION ITEMS

Based on the information reviewed during the audit, the staff identified the need to prepare a RAI to have the applicant provide additional information in the DCD to (1) more clearly identify the criteria used for classification of the moderate energy piping (or systems) to be designed as “no crack,” (2) identify the moderate energy piping systems (or portions of piping system) that the “no crack” design is being applied, and (3) identify the moderate energy piping (or systems)

that is assumed to crack or break. Subsequent to the audit, the staff issued RAI 1030-7105, Question 03.04.01-33, to address this concern.

4.0 CONCLUSION

Based on the staff's review of the information provided at the audit, the staff concludes that the flood analyses performed by the applicant supports the internal flood information in DCD Tier 2, Sections 3.4.1, and Appendix 3K.