PIPE RUPTURE ANALYSIS REPORT AS PART OF THE APR1400 DESIGN CONTROL DOCUMENT AUDIT PLAN AUGUST 31 – SEPTEMBER 4, 2015

Korea Hydro and Nuclear Power Co., Ltd. (KHNP) and Korea Electric Power Corporation (KEPCO)

APR1400 DESIGN CERTIFICATION
Docket No. 52-046

Location: NRC Headquarters
Two White Flint North
11545 Rockville Pike
Rockville, MD 20852-2738

KHNP Washington DC Center
8100 Boone Blvd. Suite 620
Vienna, VA 22182

Purpose**:**

The purpose of this audit is for the staff to: (1) gain an understanding of the Advanced Power Reactor 1400 (APR1400) supporting documents to reach a reasonable assurance finding; (2) review related documentation and non-docketed information to evaluate conformance with the Standard Review Plan (SRP) or technical guidance; and (3) verify that the APR1400 pipe rupture analyses are performed in accordance with the methodology and criteria described in the APR1400 design control document (DCD), in support of the KHNP design certification (DC) application.

Background:

On March 5, 2015, the U.S. Nuclear Regulatory Commission (NRC) accepted the DC application for docketing for the APR1400 submitted by KHNP (Reference 1). The staff initiated Phase 1 of the application DC review on March 9, 2015.

The NRC staff determined efficiency gains would be realized by auditing the documents supporting the applicant's implementation of the pipe rupture analysis methodology and criteria as presented in the DCD to verify and ensure that adequate protection will be provided such that the effects of postulated pipe ruptures do not adversely affect the functionality of structures, systems and components (SSCs) relied upon for safe reactor shutdown, and for mitigating the consequences of the postulated pipe ruptures.

The purpose of this audit is to allow the NRC technical staff to gain an understanding of the supporting documents to better focus staff inquiries to the applicant. During the audit and interactions with the applicant, there may be detailed NRC requests for information developed, which would be part of future formal correspondence.

Enclosure

Regulatory Audit Basis:

Title 10 of the *Code of Federal Regulations* (10 CFR), Section 52.47(a)(3)(i) states that a DC application must contain a final safety analysis report (FSAR) that includes a description of principal design criteria for the facility. A regulatory audit is needed to evaluate the safety conclusions that need to be made regarding Chapter 3, "Design of Structures, Components, Equipment, and Systems," of the APR1400 DCD, and to identify detailed information related to the applicant's principal design criteria. The NRC staff must have sufficient information to document its safety findings in the NRC staff's safety evaluation report (SER).

This regulatory audit is based on the following:

- GDC 4, as it relates to the testing of SSCs and the design of reactor internals, requires that the SSCs and reactor internals be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operations, maintenance, testing, and postulated pipe ruptures, including loss of coolant accidents.

- Additional detailed acceptance criteria in Sections 3.4.1, 3.6.1, and 3.6.2, as well as Branch Technical Position (BTP) 3-3 and 3-4 of the NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants."

Regulatory Audit Scope:

The NRC staff intends to review the pipe rupture analysis report including supporting documents related to the evaluation of the following three areas:

1. Determination of rupture locations and dynamic effects (excluding issues related to dynamic effects of blast wave and jet impingement as they have not yet completed by the applicant) associated with the postulated rupture of piping (SRP Section 3.6.2 and BTP 3-4).

2. Plant design for protection against postulated piping failures in fluid systems outside containment (SRP Section 3.6.1and BTP 3-3).

3. Internal Flood Protection for Onsite Equipment Failures (SRP Section 3.4.1).

Specifically the NRC staff plans to audit the following detailed information provided in the pipe rupture analysis report including supporting documents:

- Review the pipe break locations and their associated configurations in high energy piping to verify that the DCD methodology (excluding intermediate location based on cumulative usage factor criterion) was followed to identify the pipe rupture locations.

- Review through-wall crack locations and their associated configurations in high and moderate energy piping to verify that the DCD methodology was followed to identify the through-wall locations.

- Review how the DCD break exclusion area design requirements are considered and

applied to the results of the design of the portions of system piping within the break exclusion areas (including the main steam valve house).

- Review pertinent essential SSCs which are in close proximity to the postulated pipe rupture locations to ensure that all were addressed in the report.

- Review the evaluation of consequences of dynamic effects of pipe whip (excluding blast wave and jet impingement) for rooms with both high energy pipe ruptures and essential SSCs, confirm that there is no adverse interaction between the essential items and the whipping pipe. The essential SSCs are protected from the effects of whipping pipe or the plant layout is modified as required to provide separation to protect essential systems; evaluate consequences of flooding, environment, and compartment pressurization.

- Evaluate consequences of flooding, environment, and compartment pressurization in the break exclusion zones in the vicinity of containment penetrations due to 1.0 square foot breaks in the main steam and feedwater lines to verify the design and location of protective hardware.

- Review isometric piping sketches that identify the break locations, the basis for these locations, and the protective hardware which mitigates the consequences of these breaks.

The NRC staff will conduct this audit in accordance with the guidance provided in NRO-REG-108, “Regulatory Audits” (Reference 2).

Documents and Information Necessary for the Audit:

The pipe rupture analysis report including supporting documents related to the determination of postulated pipe ruptures locations for high- and moderate-energy piping, evaluation of their associated dynamic (excluding dynamic effects of blast wave and jet impingement) and environmental effects, identification and protection of essential SSCs against the postulated pipe rupture effects as well as the isolation and separation provided in the plant design.

It should be noted that as part of the audit, there may be a need to review additional data and calculations supporting the basis for the above documents.

Appropriate handling and protection of proprietary information shall be acknowledged and observed throughout the audit.

Audit Team:

Yueh-Li (Renee) Li, NRO, Senior Mechanical Engineer
Jason Huang, NRO, Mechanical Engineer
Raul Hernandez, NRO, Reactor Systems Engineer
Chang-Yang Li, NRO, Senior Reactor Systems Engineer
Luis Betancourt, NRO, Project Manager

Applicant Contacts:

Steve Mannon, AECOM
Harry Chang, KHNP

Special Requests:

The NRC staff requests that KHNP provide:

- searchable electronic copies of the documents described above.

Audit Activities and Deliverables:

The NRC audit team's review will cover the technical areas identified in the documents and information section of this audit plan. Depending upon how much effort is needed in a given area, the NRC team members may be reassigned to ensure adequate coverage of important technical elements.

The audit will be conducted from the NRC Headquarters via KHNP's electronic reading room; however the audit may also be carried out at KHNP's facilities in Vienna, VA, if the technical information is only retained in hard copy.

Follow up audits at the NRC Headquarters via KHNP's electronic reading room (or at KHNP's facilities in Vienna, VA) may be necessary at various times through September 2016, and will be addressed through separate audit plans.

The NRC Project Manager will coordinate with KHNP in advance of audit activities to verify specific documents and identify any changes to the audit schedule and requested documents.

The NRC staff acknowledges the proprietary nature of the information requested and proprietary information will be handled appropriately throughout the audit. While the NRC staff will take notes, the NRC staff will not remove hard copies or electronic files from the audit site(s).

At the completion of the audit the audit team will issue an audit summary within 90 days that will be declared and entered as an official agency record in the NRC's Agencywide Documents Access and Management System (ADAMS) records management system. The audit outcome may be used to identify any additional information to be submitted for making regulatory decisions, and it will assist the NRC staff in the issuance of requests for additional information (if necessary) for the licensing review of APR1400 DCD, Chapter 3, and any related information provided in other chapters, in preparation of the NRC staff's SER.

If necessary, any circumstances related to the conductance of the audit will be communicated to Jessica Umana (NRC) at 301-415-5207 or via e-mail at jessica.umana@nrc.gov.

References:

1. "Letter to Korea Hydro and Nuclear Power Co., Ltd., and Korea Electric Power

Corporation – Acceptance of the Application for Standard Design Certification of the Advanced Power Reactor 1400," ADAMS Accession Number ML15041A455, issued March 4, 2015.

2. NRO-REG-108, "Regulatory Audits," ADAMS Accession Number ML081910260, issued April 2, 2009.

3. APR1400 Design Control Document, Revision 0, issued December 2014.

4. Standard Review Plan (SRP) Section 3.4.1, "Internal Flood Protection for Onsite Equipment Failures" Revisions 3, 2007.

5. SRP Section 3.6.1, "Plant Design for Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," Revision 3, issued March 2007.

6. SRP Section 3.6.2, "Determination of Rupture Locations and Dynamic Effects Associated with the Postulated Rupture of Piping," Revision 3, issued March 2007.

7. BTP 3-3, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," Revision 3, issued March 2007.

8. BTP 3-4, "Postulated Rupture Locations in Fluid System Piping Inside and Outside Containment," Revision 2, issued March 2007.