

**MAIN FEEDWATER AND STEAM SYSTEMS AS PART OF THE APR1400 DESIGN  
CONTROL DOCUMENT AUDIT**

**Date: May 10 - 11, 2016**

**Korea Hydro and Nuclear Power Co., Ltd. (KHNP)**

**APR1400 DESIGN CERTIFICATION**

**Docket No.: 52-046**

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

Westinghouse Electric Co.  
11333 Woodglen Dr., Suite 203  
Rockville, MD 20852

Purpose:

The purpose of the audit is to determine if the steam and feedwater systems described in the Advanced Power Reactor 1400 (APR1400) Final Safety Analysis Report (FSAR) adequately address Flow Accelerated Corrosion (FAC). The specific requests for additional information (RAIs) to be resolved are discussed in the Background section.

Background:

On March 4, 2015, the U.S. Nuclear Regulatory Commission (NRC) accepted the design certification application for docketing for the APR1400 submitted by Korea Hydro & Nuclear Power Co., Ltd. (KHNP) (Reference 1). The NRC staff initiated Phase 1 of the application design certification review on March 9, 2015.

On November 16, 2015, the staff issued RAI 314-8378 Agencywide Documents Access and Management System (ADMAS) under Accession No. ML16104A209 which contained 17 questions relating to the material selection for the steam and feedwater system. Three of the questions (Question 10.03.06-4, Question 10.03.06-10, and Question 10.03.06-17) sought information on how the APR1400 plant incorporated FAC operational experience.

In its response to Question ADMAS under Accession No. ML16104A209 10.03.06-4, the applicant provided an overview on the differences between the KHNP FAC program and an EPRI NSAC-202L program. The applicant stated that the FAC program was based on the OPR1000 standard nuclear plant and provided information on the flow characteristics of the OPR1000 plant's steam and feedwater system.

Enclosure

In its response to Question 10.03.06-17, the applicant provided CHECWORKS data which was used to inform the APR1400 design. The KHNP CHECWORKS data showed that the APR1400 feedwater and steam systems Point-to-Point (PTP) wear rates and predicted average wear rates are not consistent with wear rates described in FSAR Section 10.3.6.3. The KHNP CHECWORKS data also indicated that some components in the piping systems were more prone to wear than the U.S. nuclear power plants. Finally, the average predicted wear rates described in Question 10.03.06-17, exceeded the wear rate formula submitted by the applicant in its response to Question 10.03.06-4.

#### Regulatory Audit Basis:

Bulletin 87-01, "Thinning of pipe walls in nuclear power plants," required operating plants or licensees with construction permits to provide information on high energy piping systems maintenance programs. Integrity high energy systems such as the feedwater and steam systems are important for safe operation. Failure of the steam or feedwater system can cause undesirable challenges to safe shutdown and accident mitigation and could impact the effectiveness of electrical distribution, fire protection, and security systems. Generic Letter 89-08 "Erosion/Corrosion- Induced Pipe Wall Thinning" followed up on Bulletin 87-01 and required that formalized procedures or administrative controls be maintained to ensure that FAC would be assessed on a continual basis.

In NRC NUREG-0800, "Standard Review Plan" (SRP) Chapter 10, Section 10.3.6 "Steam and Feedwater System Materials," Part III of the SRP section provides the staff with review procedures that are derived from the SRP acceptance criteria. Item III.3 described the review of the FAC program; this includes verifying that the corrosion allowance is sufficient to meet the ASME design code for the life of the plant and verifying that piping systems that are subject to FAC degradation, are designed using materials resistant to FAC.

#### Regulatory Audit Scope:

The scope of this audit is to determine how the APR1400 uses operating experience pertaining to FAC resistance in the design of the steam and feedwater systems.

#### Documents and Information Necessary for the Audit:

Documents are to be made available to the NRC staff, either at the KHNP Washington, District of Columbia Center, or in the electronic reading room.

The staff requests the following documents or document that cover the general topics of:

- 1) Any additional CHECWORKS data/information that would help the staff determine: 1) how FAC operating experience is designed into the APR1400 plant and 2) how the corrosion allowance covers the design life of the APR1400 plant.
- 2) Additional information on the CHECWORKS data submitted in response to Question 10.03.06-17:

Enclosure

- a. Basic information on the power plant (no identification of the power plant was provided).
- 3) Additional details on the KHNP FAC program. Specifically, the following topics from the response to Question 10.03.06-4:
- a. More detailed information on “Wear rate decision method, such as LSPTP, LSSM, and NAM (Near Area of Minimum), for the piping inspected repeatedly over twice.”
  - b. More detailed information on “Decision method for follow-up inspection timing.”
  - c. More detailed information on “Using method of UT inspection instrument.”
- 4) P&ID diagrams of feedwater and steam piping in the OPR1000 plant; the diagrams will be compared to the APR1400 to determine if any configuration differences that cause the APR1400 to be more vulnerable to FAC.
- 5) Materials specifications for the OPR1000 plant design.
- 6) Relevant documentation that provides justification that the APR1400 is designed to prevent FAC:
- a. Documents that provide the detailed technical basis for the wear rate specified in FSAR Section 10.3.6.3.
  - b. The basis for describing carbon steel portions of the steam or feedwater system as “low FAC susceptibility.”
  - c. FAC Susceptibility Analyses as described in EPRI NSAC-202L.

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

Audit Team:

Andrew Yeshnik, Materials Engineer, Audit Lead (NRC)  
George Wunder, Senior Project Manager

Applicant Contacts:

Chris Tyree (757) 846-7482

Special Requests:

The NRC staff requests that KHNP provide:

- A subject matter expert knowledgeable in FAC and the KHNP use of FAC data to inform the design of the APR1400 plant available during the meetings.

Enclosure

- Searchable electronic copies of the documents related to selected components listed in Table 1, including available references in each specification.

#### Audit Activities and Deliverables:

The NRC audit team review will cover the technical areas identified in the Regulatory Audit Scope of this audit plan.

The audit is scheduled between 8:00 a.m and 4:00 p.m. between May 10 - 11, 2016.

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, Virginia, if the technical information is only retained in hard copy.

The NRC Project Manager will coordinate with KHNP in advance of audit activities to identify specific documents and any changes to the audit schedule and requested documents. The NRC staff acknowledges the proprietary nature of the information requested. It 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 RAIs (if necessary) for the licensing review of APR1400 DCD Chapter 10 and any related information provided in other chapters, in preparation of the NRC staff's Safety Evaluation Report.

If necessary, any circumstances related to the conductance of the audit will be communicated to George Wunder (NRC) at 301-415-1494 or via email at [George.Wunder@nrc.gov](mailto:George.Wunder@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. APR 1400 Design Control Document, Revision 0, issued December 2014.
4. SRP Section 10.3.6, "Steam and Feedwater System Materials."

Enclosure