**U.S. NUCLEAR REGULATORY COMMISSION REGULATORY AUDIT OF COMPUTER PROGRAM CODES AS PART OF THE APR1400 DESIGN CONTROL DOCUMENT**

**APR1400 DESIGN CERTIFICATION**
**Docket No. 52-046**

# AUDIT PLAN

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| APPLICANT: | Korea Hydro and Nuclear Power Co., Ltd. (KHNP) and Korea Electric Power Corporation (KEPCO) |
| APPLICANT CONTACTS: | Steven Mannon (AECOM) |
| DURATION: | May 19, 2016 – June 3, 2016, |
| LOCATION: | US NRC Headquarters Office<br>11545 Rockville Pike<br>Rockville, MD 20852-2738 |
| AUDIT TEAM: | Tuan Le, NRO Mechanical Engineer, Audit Lead<br>John Wu, NRO Mechanical Engineer<br>John Vera, NRO, Project Manager |

## I. BACKGROUND

On March 4, 2015, the U.S. Nuclear Regulatory Commission (NRC) accepted the design certification application for docketing for the Advanced Power Reactor 1400 (APR1400) submitted by Korea Hydro and Nuclear Power Co. (KHNP) (Reference 1). The staff identified that an audit of the DPVIB computer program, would support the staff's safety determination. The NRC staff determined that efficiency gains would be realized by auditing the documents supporting the design calculations presented in the APR1400 design control document (DCD) (Reference 2) in lieu of requests for additional information (RAIs) that the applicant docket the calculation files. The purpose of this audit is to allow the NRC technical staff to gain an understanding of the supporting design calculations 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.

During June 29, 2015, through July 2, 2015, the NRC staff performed a regulatory audit of the computer codes in support of its reviews of the SRP Section 3.9.1. Based on this audit, the NRC staff identified there was no description of the DPVIB computer program in the DCD Tier 2, Section 3.9.1. The DPVIB computer program is used to generate the pump pulsation loads that are used in flow induced vibrations analysis. An audit of the verification and validation (V & V) packages of this computer code supports the NRC staff's safety determination. In addition, the staff has identified a need to audit supporting documents to the response to RAI 8078. Therefore, the NRC staff requests the applicant to provide the documents listed in Section V of this audit plan.

## II. PURPOSE

The purpose of the audit is to confirm that the design calculations performed in support of the APR1400 design certification calculation are consistent with the APR1400 DCD Tier 2, Section 3.9.1, "Special Topics for Mechanical Components." The NRC staff will audit the V&V packages of the DPVIB computer program to confirm that the computer code conforms to Standard Review Plan (SRP) Section 3.9.1 "Special Topics for Mechanical Components." The NRC staff also will review supporting documents related to the applicant's response to RAI 8078, Questions 3.9.2-9, 3.9.2-10 and 3.9.2-11 in order to ascertain the acceptability of the responses.

## III. REGULATORY AUDIT BASIS

The audit basis is to verify that the design analyses follow the requirements of the ASME *Boiler and Pressure Vessel Code*, as required by Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.55a, and are consistent with the descriptions in the DCD. Supporting information on the V&V of computer programs is provided in the American Society of Mechanical Engineers (ASME) NQA-1 standard (Reference 3), which is referenced in the DCD. 10 CFR, Paragraph 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. This regulatory audit is also 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. This audited information provides an additional level of detail that will support the NRC staff's availability to determine the acceptability of the APR1400 design certification application.

## IV. REGULATORY AUDIT SCOPE

The primary scope of this audit is to review the information of computer programs that are used for flow induced vibrations analyses as they relate to the APR1400 reactor internals design provided by the applicant. Particularly, the audit will confirm that the computer program codes that are used in the design of APR1400 are being employed consistently with the guidance in Standard Review Plan (SRP) Section 3.9.1 and the information in the DCD. The review scope of this audit will be focused on confirming the DPVIB computer program and to confirm that its V&V packages conform to SRP Section 3.9.1 and ASME *Boiler and Pressure Vessel Code*. The NRC staff also will review supporting documents related to the evaluation of the applicant's response to RAI 8078, Questions 3.9.2-9, 3.9.2-10 and 3.9.2-11.

The staff will conduct this audit in accordance with the guidance provided in NRO-REG-108, "Regulatory Audits" (Reference 4).

## V. DOCUMENTS/INFORMATION NECESSARY FOR THE AUDIT

The following documents are to be uploaded into the electronic reading room and made available during the NRC staff's audit:

1. The V&V packages of the DPVIB computer program including program flow chart logic, benchmark cases, program input and output data and program limitations.

2. A description of the DPVIB computer program to be included in the DCD Tier 2, Section 3.9.1.

3. Regarding the equations which were used from DCD Reference 45 (M. K. Au-Yang, "Flow-Induced Vibration of Power and Process Plant Components," Professional Engineering Publishing Limited, 2001) resulting in turbulent loading, KHNP will provide the calculation documentation (including reference document number) that documents the detailed calculation of APR1400 turbulent loads on the reactor internal components.

4. KHNP will provide, via the electronic reading room, the reference: "Steam Generator Tube Vibration Tube Vibration Test, Y1201A-160TD-2001, Rev 0, Doosan Heavy Industries and Construction (Proprietary)," which was used as the basis for the damping in the steam generator tubing dynamic analysis. The staff will audit this test report from KHNP's electronic reading room.

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

## VI. SPECIAL REQUESTS

The NRC staff requests that KHNP provide the staff with access to KHNP electronic reading room.

## VII. AUDIT ACTIVITIES AND DELIVERABLES

The NRC audit team review will cover the technical areas identified in Section V 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 regulatory audit is scheduled for May 19, 2016, through June 3, 2016, at the Rockville NRC Headquarters in Rockville, Maryland. The audit entrance meeting and exit meeting will be scheduled within that timeframe as convenient for KHNP and the NRC staff.

The NRC Project Manager will coordinate with KHNP in advance of the 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. 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.

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 3 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 John Vera (NRC) at 301-415-5790 or John.Vera@nrc.gov.

## VIII. 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. APR Design Control Document, Revision 0, issued December 2014.

3. ASME Boiler and Pressure Vessel Code, NQA-1 "Quality Assurance Requirements for Nuclear Facility Applications."

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