

**COMPUTER PROGRAM CODES AS PART OF THE APR1400 DESIGN CONTROL  
DOCUMENT AUDIT PLAN**

**JUNE 29, 2015 – JULY 2, 2015**

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

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

Location: Westinghouse Office  
11333 Woodglen Drive, Suite 202  
Rockville, MD 20852

Purpose:

The purpose of the audit is to confirm that the design calculations performed in support of the Advanced Power Reactor 1400 (APR1400) design certification calculation are consistent with the descriptions of the computer codes in Tier 2, Section 3.9.1, "Special Topics for Mechanical Components," of the APR1400 design control document (DCD). Specifically, the staff will audit verification and validation (V&V) of the computer programs that are used for static, dynamic, and hydraulic transient analyses of the safety-related APR1400 structures, systems, and components.

Background:

On March 5, 2015, the U.S. Nuclear Regulatory Commission (NRC) accepted the design certification application for docketing for the APR1400 submitted by Korea Electric Power Corporation (KEPCO) and 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.

The NRC staff determined that efficiency gains would be realized by auditing the documents supporting the design calculations presented in the DCD, in lieu of requests for additional information (RAIs), and 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 the staff's 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 a future formal correspondence.

Regulatory Audit Basis:

The audit basis is to verify that the design analyses follow the requirements of the American Society of Mechanical Engineers (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 V&V of computer programs is provided in

Enclosure

the ASME Nuclear Quality Assurance (NQA)-1 standard, which is referenced in the DCD. 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.

#### Regulatory Audit Scope:

The primary scope of this audit is to review computer programs that are used for static, dynamic, and hydraulic transient analyses as they relate to the APR1400 component and piping design. In part, 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, Section 3.9.1, "Special Topics for Mechanical Components," guidance and the information in the DCD. The review scope covers computer programs listed in Table 1 of this audit plan, as well as any additional computer codes that the applicant identifies as significant.

The NRC staff will focus on the review regarding the areas shown in the list below:

- Review individual program documents that describe author, source code, executable file(s), input deck(s), dated version, and user's manual and theoretical formulations.
- Review individual program verification reports.
- Review individual program flow chart logic.
- Review individual program V&V benchmark package.
- Review individual program input and output data and program limitations.
- Observe test runs on individual program as necessary.
- Review quality assurance procedures for control and maintenance of program.

The staff will perform the audit of the selected computer program codes, as highlighted in Table 1 below.

**Table 1: List of Computer Programs<sup>1</sup>**

<b>Computer Codes</b>
ABAQUS
PICEP
ADLPIPE
CLEVER
Head PR (Head Penetration Reinforcement Program)
CEFLASH-4B

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<sup>1</sup> From APR 1400 DCD Tier 2, Section 3.9.1 supplied list of computer program codes for regulatory audit

ANSYS
AFP2D
TSPOST
AFPOST
ATHOS3
PTXIG
PIPESTRESS
REFORC – DEC
RELAP5/MOD3.1
RELAP5/MOD3.3
NOZPROG
ASHSD
CESHOCK
CEFLASH-4B

The 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 following documents are to be made available to the NRC staff, at the Westinghouse Office:

1. Individual program documents that describe author, source code, executable file(s), input deck(s), dated version, user’s manual and theoretical formulations, including the following documents:
  - Individual program verification reports.
  - Individual program flow chart logic.
  - Individual program V&V benchmark package.
  - Individual program input and output data and program limitations.
  - Test runs on individual program as required.
  - QA procedures for control and maintenance of program.
2. Flowcharts for the Implementation of Computer Software Procedures.
3. Flowcharts for the Implementation of Computer Software Control Procedures.
4. Other related documents that support the audit of computer program codes, as suggested by KHNP.

This is not a comprehensive list of documents the staff will be reviewing as part of the audit, as there may be a need to review additional data and calculations supporting the basis for these documents.

The NRC staff requests that KHNP provide the NRC staff with the list of document numbers that covers the above listed scope of information, and names for each computer program associated with these document numbers, prior to the audit.

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

Audit Team:

Tuan Le, NRO Mechanical Engineer, Audit Lead  
Aaron Armstrong, NRO Reactor Systems Engineer (Consultant)  
Luis Betancourt (NRO, Project Manager)

Applicant Contacts:

Steven Mannon (AECOM)  
Seung Choi (KHNP)

Special Requests:

The NRC staff requests that KHNP provide:

- Private conference room to support document review and audit team meetings,
- One or more computers capable to run the computer program using executable file and input deck.
- Internet and power outlet connections available for laptop computers.
- KHNP personnel to provide any necessary overviews of the NRC selected audit computer program codes and perform validation of computer codes.

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 NRC staff and the applicant have agreed that the regulatory audit will be conducted in the Westinghouse Offices located at 11333 Woodglen Drive, Suite 202, Rockville, MD 20852. The audit is scheduled between June 29, 2015, and July 2, 2015, from 7:30 a.m. to 3:30 p.m. The audit entrance meeting will start at 7:30 a.m. on June 29, 2015, and will conclude with an exit meeting at 10:00 a.m. on July 2, 2015.

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. 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 45 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 Luis Betancourt (NRC) at 301-415-6145 or [Luis.Betancourt@nrc.gov](mailto:Luis.Betancourt@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. ASME Boiler and Pressure Vessel Code, NQA-1 "Quality Assurance Requirements for Nuclear Facility Applications."
3. NRO-REG-108, "Regulatory Audits," ADAMS Accession Number ML081910260, issued April 2, 2009.
4. APR Design Control Document, Revision 0, issued December 2014.