

**U.S. NUCLEAR REGULATORY COMMISSION REGULATORY AUDIT OF CHAPTER 11 OF
THE APR1400 DESIGN CONTROL DOCUMENT**

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

AUDIT PLAN

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

APPLICANT CONTACTS: Christopher Tyree, KHNP
Andy Jiyong Oh, KHNP

DURATION: An audit will be conducted from March 15, 2016, through March 17, 2016, at the Westinghouse Electric Co. (WEC) facilities in Rockville, Maryland.

Follow-up audit activities at the U.S. Nuclear Regulatory Commission (NRC) Headquarters via KHNP's electronic reading room (or at KHNP's facilities in Vienna, Virginia) may be necessary at various times.

LOCATIONS:

WEC
11333 Woodglen Drive
Rockville, MD 20852

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

AUDIT TEAM: Stephen E. Williams (NRO, Technical Reviewer, Audit Lead)
Zachary Gran (NRO, Technical Reviewer)
John Vera (NRO, Project Manager)

BACKGROUND:

On March 4, 2015, the NRC accepted the design certification application for docketing for the Advanced Power Reactor 1400 (APR1400) submitted by KHNP (Reference 1). The staff initiated Phase 1 of the application design certification review on March 9, 2015.

Enclosure

The assessment of this DCD application is in accordance with The Standard Review Plan (SRP) prepared for the guidance of staff reviewers in the Office of New Reactors (NRO) in performing safety reviews of applications to construct or operate nuclear power plants. Specifically, SRP Section 11.1 that describes various source terms for a variety of purposes, SRP Section 11.2, "Liquid Waste Management System," (LWMS), SRP Section 11.3, "Gaseous Waste Management System," (GWMS) for system design features used to process and treat liquid and gaseous effluents before being released or recycled, and SRP Section 11.5, "Process and Effluent Radiological Monitoring Instrumentation and Sampling Systems," (PERMSS) for radiation protection monitors.

This source term and systems are used to meet the specific regulatory dose and effluent release requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 20 and 10 CFR 50 Appendix I. The application also commits to complying with Regulatory Guide (RG) 1.206, and NUREG 0800 - SRPs 11.1, 11.2, 11.3, and 11.5.

The audit will help the staff to gain an understanding of APR1400 supporting calculations and analysis to reach a reasonable assurance finding, and review related documentation and non-docketed information to evaluate conformance with the SRP and other related guidance. This audit plan provides an overview of the regulatory audit activities the staff will perform.

Purpose and Approach:

The NRC staff reviewed DCD Chapter 11 (Tier 2) and the applicant's responses to:

- 1) Request for additional information (RAI) 8144, Question 11.02-1; issued August 10, 2015 (ML15223B371), and KHNP's response dated January 18, 2016 (ML16008A153).
- 2) RAI 8143, Question 11.03-3; issued August 25, 2015 (ML15237A478) and KHNP's response dated December 14, 2015 (ML15348A337).
- 3) RAI 8087, Question 11.05-1; issued August 7, 2015 (ML15219A713), and KHNP's response dated December 8, 2015 (ML15342A499).
- 4) RAI 8088, Question 11.05-2; issued August 7, 2015 (ML15227A012), and KHNP's response letter dated February 3, 2016 (ML16034A350).
- 5) RAI 8203, Question 11.05-3; issued September 23, 2015 (ML15295A514) and KHNP's response letter dated December 8, 2015 (ML15342A505).

The staff reviewed the applicant's evaluation process and the basis for the applicant's determination that the changes made are consistent with the requirements of NUREG-0800 and RG 1.206.

To achieve the review goals in an efficient manner, the NRC staff assembled an interdisciplinary audit team. To facilitate and expedite the work, it is foreseen that the audit will be attended by representatives from KEPCO and KHNP who will introduce the audit topic and provide supporting documents and technical evidence to the reviewers. The staff will document the audit

findings in an audit report.

The NRC staff will have conducted a review of the docketed information prior to the actual face-to-face meeting of three business days. The NRC may request an ad-hoc extension of the audit at the same location if findings during the ongoing audit reveal the need for additional time. Such an extension will be requested before the meeting is adjourned on March 17, 2016, by the NRC staff responsible for the audit.

Following the audit, the NRC staff responsible for the audit will assemble and prepare a final audit report. The final report will be made available to all contributors for their concurrence. Any final notes by the contributors will be communicated to Stephen Williams for inclusion in the audit summary report.

If necessary, any circumstances related to the conductance of the audit will be communicated to Stephen Williams (NRC) at 301-415-6498 or via e-mail at Stephen.Williams@nrc.gov.

This audit follows the guidelines in Office of New Reactors (NRO) Office instruction NRO-REG-108 (Revision 0), "Regulatory Audits."

REGULATORY AUDIT BASIS

The purposes of this audit are for the staff to: (1) gain an understanding of APR1400 supporting calculations and analyses to reach a reasonable assurance finding and (2) review related documentation and non-docketed information to evaluate conformance with the SRP or technical guidance.

According to 10 CFR 52.47(a)(3)(i), a design certification application must contain a final safety analysis report (FSAR) that includes a description of principal design criteria for the facility. An audit is needed to evaluate the safety conclusions that need to be made regarding Chapter 11 of the APR1400 DCD and identify detailed information related to the applicant's principal design criteria.

The NRC staff must have sufficient information to ensure that acceptable risk and adequate assurance of safety can be documented in the NRC staff's safety evaluation report (SER).

This regulatory audit is based on the following:

- 10 CFR Part 20
- 10 CFR 50, Appendix I
- Generic Design Criteria (GDC) 64
- NUREG-0800 - Chapter 11, Branch Technical Position (BTP) 11-5
- NUREG-0800 - Chapter 11, BTP 11-6

REGULATORY AUDIT SCOPE AND METHODOLOGY

The NRC staff will conduct this audit in accordance with the guidance provided in NRO-REG-108, "Regulatory Audits" (Reference 2). The staff intends to review information,

documents and supporting calculations related to APR1400 DCD Tier 2 Chapter 11. The following are areas the NRC staff intends to review on this audit:

Question: 11.02-1

The response to RAI 8144, Question 11.02-1 does not fully address SRP 11.2, BTP 11-6 and the NRC staff's concerns. After evaluating the RAI response in accordance with BTP 11-6, the staff did not understand how the applicant determined which tank had a conservative concentration and volume based on the available yard tanks. From the information provided in Table 1 of the RAI response, the staff identified the BAST as the tank with the actual highest effluent concentration comparing the three outside tanks. In addition the staff reviewed the proposed DCD table inserts and determined that the applicants table continued to use a dilution factor of 2,762 for their analysis instead of the stated value of 3,564 modified factor to account for 80 percent tank volumes.

The staff is requesting the following information:

- Provide a DCD Table to describe the expected tank inventories of the CVCS yard tanks used for consideration in the BTP analysis.
- Provide a DCD expert to discuss the source of the data used to determine the location of the expected tank inventories. Is the data source from a DCD Section 11.1 table, or DCD tables found in Chapter 12? The current response to Item 6, of the RAI response describes that ANSI 18.1-1999 is used to determine the tank radionuclide inventory. The staff is requesting that each tank inventory be provided as DCD updates.
- Provide the calculations and rational used to determine which tank is appropriate for use in the BTP procedures. The RAI response identified in item 1 of RAI 8144, Question 11.02-1 did not provide a basis for the staff to verify which tank may be appropriate other than by a review based on the effluent concentration limits.
- Ensure that DCD Table 11.2-9 correctly represents the calculation described in the RAI response to this question.

Question: 11.03-3

The response to RAI 8144, Question 11.03-3, does not completely address SRP 11.3, BTP 11-5, and staff concerns. The response to this RAI does not provide sufficient information to confirm the information provided by the applicant. The staff is unable to reproduce any of the release rates provided by the applicant.

- The staff has identified an error in RAI Table 2, column E, for nuclides Xe-133m and Xe-133. The NRC cannot verify the applicant results.
- In RAI Table 2, the staff will require additional information on what indicates the "Normal GWMS Release."

- The staff is unclear on what defines the source term for this calculation. A reference to DCD Tables 11.1-2 and 11.1-9 is seen in the DCD text but does not define the applicant's values to the staff.
- The staff reaches different conclusions than the applicant, using the results directly from the GALE code.
- In RAI Table 2, the staff needs additional information on what defines the "Accident Release from GWMS."
 - From discussions provided in DCD Section 11.3.3.2, the staff observes a description that states the ratio of the accident specific activities but the staff cannot arrive at the results obtained by the applicant using the information contained in the DCD.
- The staff requests that the applicant describe the origin of the data for the release rates used in this analysis for Bq/yr DCD tables (change to Ci/Yr) and supporting DCD text.
- The RAI response stops just short of fully describing the calculation. The conclusions for calculating dose are not described.
- The staff requests that an expert be present to discuss the details of the BTP 11-5 calculation. A spreadsheet calculation would be useful in showing the staff how the calculation was performed.

Questions: 11.05-1 and 11.05-2, for the Gaseous and Liquid PERMSS

Regarding the response to RAI 8087, Question 11.03-3, the main concern is that there is no associated DCD text to describe the monitors in any significant detail. To support this understanding the staff presents the following outline for reference.

Examples of the information that is expected in the Section 11.5 monitor discussions:

XXX effluent monitors (RE-XXX)

1. The main purpose of this detector is
2. RE-XXX monitors are used to detect.... (Particulate gross Beta, I-131...).
3. RE-XXX has the following ranges for detection... (referring to Tables 11.5-1 or 11.5-2 is acceptable here).
4. The process configuration for this monitor is discussion in DCD section... or discuss the configuration. Reference to a figure for this is also useful.
5. RE XXX is located in the YYY Building and is located on on/at....

- a. RE-XXX are found in Figure 11.5-2 (or whatever figure it is found in)....
6. The XXX effluent monitors are used to....
7. RE-XXX is used to demonstrate compliance with....
8. RE-XXX provides (or does not provide) indications to the MCR/RSR and/or locally....
9. RE-XXX is non-safety related (or safety related.)
10. RE-XXX performs the following automatic actions...(interlocks, alarms, etc.).
11. Reference to sampling subsection if generic discussion applies. Otherwise discuss sampling provisions. (Tritium, Radioiodine, Particulate, Noble Gases).
12. Reference to calibration subsection if generic discussion applies. Otherwise discuss calibration procedures and practices.

A subsection should be provided and discussed in the DCD text for the following:

- Process Configuration of each detector.
 - Based on the response provided to the staff, it would appear that it this is common for all detectors. If this is true, provide a DCD update to reflect the response given in the RAI responses.
 - Provide a figure to show the generic process configuration.
- Sampling Provisions
 - Request that a discussion be provided within each monitor where sampling can be performed. A subsection that discusses the sampling process and applicable RGs should be contained in this discussion.
- Purging of Sample Lines
 - Provide DCD text based on the response provided in the RAIs
- Calibration
 - Provide DCD text based on the RAI response. The cited RGs and COL action items are very useful.

Upon review of the DCD figures and the detector locations, the staff believes that DCD Figure 11.5-2, cites the locations of the electronics for each detector, but does not indicate the physical

detector location. The staff requests the applicant to provide a DCD discussion on each detector location and correctly provides the location of each detector in the DCD figures in Chapter 11, that the staff may verify the location of each monitor.

Question 11.05-3 SG Tube Integrity RAI

The staff needs the calculations described. The staff needs to understand the required instrumentation in place to monitor releases from the main steam atmospheric dump valves (MSADVs) for a Steam Generator Tube Rupture (SGTR).

SG Tube Leakage Calculation

In review of Appendix 11 B, the staff has questions on the calculations used to confirm compliance with monitoring SG leakage rates of 30 gal/day, as well as meeting the technical specification limits of 150 gal/day.

In review of the equation provided on page 11B-2, of the DCD, the staff is unable to confirm the parameters Q_P , and A_S within the equation that solves for A_V on page 11B-2.

The staff does not fully understand the parameters based on the descriptions provided in Appendix 11B. The staff normally understands a steaming rate to be in units of kg/hr or lb/hr. However the units provided for Q_P are in cm/sec. The staff believes there may be steps that have not been discussed in determining the Q_P value which would be useful for staff to understand the calculation presented. The staff is also unaware of how the value A_S is being used in the equation provided.

The staff requests the applicant to provide the following information:

- Justify the Q_P parameter and provide a detailed discussion on how to determine this value. This discussion should include the method for calculating and documenting the parameters used to solve for Q_P and provide a reference for staff to verify the calculation. A calculation package would be useful for staff to verify the results of the applicant's analysis.
- Provide a detailed discussion on the use the parameter A_S for solving for A_V .

Monitoring Releases from MSADVs during SGTR

Upon review of DCD Section 11.5, the staff cannot verify the instrumentation in place to monitor dose from a SGTR from the MSADV to meet the requirements of GDC 64 to monitor radioactivity releases that may be released from normal operations, including anticipated operation occurrences, and from postulated accidents.

DCD Section 11.5.2.2.m specifies "Main steam line area and N-16 monitors." The discussion for these monitors does not specify if there are area monitors used to evaluate a release from a SGTR through the MSADVs. The only discussion provided, refers the staff to review Appendix 11B. Currently, the staff has reviewed the information provided in Appendix 11B and has determined that this information relates to the monitors for steam generator leakage rates for N-

16 activity in the main steam, SG blowdown monitor, and the condenser vacuum effluent monitor. Appendix 11B only describes the information used to verify the ability to detecting a required amount of SG leakage rate based on an N-16 high energy gamma.

In review of DCD Section 10.3.5.3.2, the staff confirms that a noble gas activity steam line monitor is briefly discussed in the monitoring section. In review of DCD Table 7.5-1 (5 of 5), the staff confirms the table entry of "Main Steam Line Radiation." Based on these short entries the staff is unable to confirm what monitors these correspond to in Section 11.5 without any specific reference to the monitor numbers.

Under the requirements of GDC 64 to monitor radioactivity releases that may be released from normal operations, including anticipated operation occurrences, and from postulated accidents, the NRC is requesting that the applicant provide information and supporting DCD text to fully describe the effluent monitors being used to assess releases from the MSADVs during a SGTR event. Based on the information discussed above, the staff is seeking DCD text inserts within Section 11.5 to fully describe the monitors used to assess the releases. The staff also expects these updates to conform to the follow-up information requested by the staff to RAI 8087, Question 11.05-1.

INFORMATION AND DOCUMENTS NECESSARY FOR THE AUDIT

The following documents are to be made available to the NRC staff at the audit location, and/or in the electronic reading room. Appropriate handling and protection of proprietary information shall be acknowledged and observed throughout the audit.

- Any documents requested in Section III of this audit plan, and any documents which have not already been provided to the staff in the electronic reading room which may support the above discussion topics.

AUDIT TEAM

The following NRC staff will participate in the audit:

- Stephen E. Williams (NRO, Technical Reviewer, Audit Lead)
- Zachary Gran (NRO, Technical Reviewer)
- John Vera (NRO, Project Manager)

LOGISTICS

The NRC staff and the applicant have agreed that the audit will be conducted from March 15, 2016, through March 17, 2016, at the Westinghouse Electric Co. facilities in Rockville, Maryland. In support of this approach, the applicant has agreed to make knowledgeable staff available, along with relevant documentation, to support staff review and discussion of the material. The NRC staff will have internal meetings throughout the audit to discuss preliminary findings. A summary of audit preliminary findings will be provided to the applicant for discussion.

The audit entrance meeting will be conducted at 9:30 a.m. at the WEC facilities in Rockville, Maryland. The team will audit documents and discuss with the applicant as appropriate throughout the audit. An exit meeting will be conducted to summarize the staff findings at the end of the audit.

SPECIAL REQUESTS

None.

AUDIT ACTIVITIES AND DELIVERABLES

The NRC audit team review will cover the technical areas identified in Section III 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 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 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 Agency wide 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 11 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 John Vera, NRC Project Manager at 301-415-5790 or via email at john.vera@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," issued March 4, 2015, ADAMS Accession Number ML15041A455.
2. NRO-REG-108, "Regulatory Audits," issued April 2, 2009, ADAMS Accession Number ML081910260.