

APR1400 DESIGN CERTIFICATION DOCUMENT CHAPTER 8, ELECTRIC POWER AUDIT

Date: May 25 - 26, 2016

Korea Hydro & Nuclear Power Co., Ltd. and KEPCO

APR1400 DESIGN CERTIFICATION DOCKET NO.: 52-046

Location: NRC Headquarters
Two White Flint North
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Purpose:

The purpose of this audit is to: (1) examine and evaluate technical, procedural, and process information and (2) to understand or verify information to support the basis of licensing and regulatory design certification decisions related to specific areas of Chapter 8, Section 8.1, 8.2, 8.3.1, 8.3.2, and 8.4 of the APR1400 DCD (Applicant Korea Hydro & Nuclear Power Co., Ltd. and KEPCO). The staff will review the documentation provided and review the applicant's methodologies and to determine whether Chapter 8 of the APR1400 DCD design meets the applicable regulations.

Background:

Under C.I.8.3.1.3 of RG 1.206, the APR1400 applicant, will perform electrical power system calculations and distribution system studies for onsite alternating current (ac) power systems. These calculations and studies are described in DCD Section 8.3.1.3, "Electrical Power System Calculations and Distribution System Studies for AC System," and Section 8.3.2.3, "Electrical Power System Calculations and Distribution System Studies for DC System."

Furthermore, these studies and calculations are also described in several responses to U.S. Nuclear Regulatory Commission (NRC) requests for additional information (RAIs), which are currently under the NRC staff's review.

The electrical power system calculations and distribution system studies by the applicant utilized electrical transient analyzer program (ETAP), Nuclear Version 12.0.0N, to analyze the ac distribution system for load flow and voltage (V) regulation, short-circuit studies and motor starting studies. ETAP is qualified for nuclear power plants in Title 10 of *The Code of Federal Regulations* (10 CFR) Part 50 Appendix B, and also complies with 10 CFR Part 21, American Society of Mechanical Engineers NQA-1, International Organization for Standardization 9001, and Institute of Electrical and Electronic Engineers Standard 730.1-1989.

Enclosure

As provided in Sections 8.2, 8.3.1.3 and 8.3.2.3 of the DCD, the following is a list of specific calculations that will be performed by the APR1400 applicant:

- Load Flow/Voltage Regulation Studies and Under/Overvoltage Protection.
- Short-Circuit Studies (AC and DC systems).
- Equipment Sizing Studies.
- Equipment Protection and Coordination Studies.
- Insulation Coordination (Surge and Lightning Protection).
- Power Quality Limits (Harmonic Analysis).
- Grounding Grid studies.
- Grid Stability studies.

All the above analyses and studies are Combined License (COL) Information Items, as listed in Chapter 8, Electrical Power, of the DCD. However, 10 CFR 52.47(a)(2) requires the design certification document description to be "sufficient to permit understanding of the system designs and their relationship to the safety evaluations." Further, 10 CFR Part 52.47(c)(1), in part, requires that "An application must provide an essentially complete nuclear power plant design except for site-specific elements."

In RAI responses, the applicant has stated that these calculations have been performed with information from the reference plant. This audit is intended to learn how these calculations and studies were performed and examine some sample calculations, methodologies, and evaluations that were described in DCD and RAI responses, in order to determine whether the design of the electrical systems meet the applicable regulations.

The staff expects that this audit will address issues specifically raised in response to the NRC staff's RAIs contained in the following RAI response letters:

- RAI 61-7984, Question 08.03.01-6. Degraded Voltage and Loss of Voltage Relay Protection and Setpoints [DVR and LOV] (Response letter: ML15251A246, dated September 8, 2015).
- RAI 148-8104, Question 08.03.01-13. AC System Calculation, (Response letter: ML16015A418, dated January 15, 2016, with Technical Report APR1400-E-E-NR-14001-P, Revision 1).
- RAI 148-8104, Question 08.03.01-14. Equipment Sizing Study, (Response letter: ML16015A419, dated January 15, 2016).
- RAI 148-8104, Question 08.03.01-15. AC System Calculation - Insulation Coordination, Surge and Lightning Protection, and Power Quality, (Response letter: ML15301A937, dated October 28, 2015).
- RAI 413-8529, Question 08.03.01-22. Follow-up RAI to Question 08.03.01-13 on AC System Calculation, (Response awaiting).

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- RAI 422-8536, Question 08.03.01-24. Follow-up RAI to Question 08.03.01-6 on DVR, (Response awaiting: expected end of April 2016).
- RAI 163-8178, Question 08.03.02-1 and Question 08.03.02-2. DC System Short Circuit Calculation and Sizing, (Response letter: ML16012A555).
- RAI 441-8549, Question 08.03.02-3. Follow-up RAI to Question 08.03.02-1, and Question 08.03.02-2 on DC System, (Response awaiting: expected end of April 2016).

The information to be reviewed is intended to provide direct support for the safety conclusions that apply to the APR1400 Design Certification application under 10 CFR, Part 52. The information to be assessed is intended to augment the staff's understanding and verification. Furthermore, this information will be referenced in the staff's Final Safety Evaluation Report (FSER) on the methodology and assumptions of the APR1400 design certification, regarding how the electrical systems meet the applicable regulations.

Regulatory Audit Scope:

The NRC staff seeks clarification of the APR1400 design approach on the analyses, calculations, methodology, and assumptions made for the following:

1. Maintaining adequate voltage regulation at safety-related equipment terminals, as identified in RAI Questions 08.03.01-13 and 08.03.01-14.
2. The analysis and assumptions, identified in RAI responses to 08.03.01-13, and 08.03.01-14, are used to evaluate:
 - a. Worse case bolted three phase short-circuit fault currents in the onsite ac distribution system.
 - b. Acceptable ratings for equipment such as circuit breakers for switchgear bus and containment penetration assembly.
 - c. Motor starting analysis that shows that all the bus voltages at the Medium Voltage switchgear, 480V Load Centers and 480 V Motor Control Centers are maintained within the minimum allowable voltage limit.
3. The studies, acceptance criteria, and assumptions identified in RAI responses to 08.03.01-13, and 08.03.01-14, are used to determine adequate equipment sizing.
4. A discussion on the power quality limits and results of the analysis which shows that the individual and total harmonic distortion at each Class 1E switchgear meets the acceptance criteria, as identified in RAI Question 08.03.01-15.

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5. The bus transfer analysis which shows that a fast transfer is allowed under the postulated operating condition, including discussion on the residual transfer scenario, as identified in RAI Questions 08.03.01-01 and 08.03.01-21.
6. The DC System Calculation results that demonstrated the impact of the large capacity Class 1E batteries and how it is accommodated by equipment short circuit rating, as identified in RAI Questions 08.03.02-01 and 08.03.02-02.

The APR1400 applicant will provide the following:

1. Documentation (assumptions and calculations) for the aforementioned studies (A revised technical report with supplements).
2. Discussion of how the studies were performed by using available tools as well as assumptions and input data to perform the aforementioned studies and discussions of its validity.
3. Discussion of the documentation for the studies, acceptance criteria, and assumptions and how it will be used for Inspections, Tests, Analyses, and Acceptance Criteria by the COL Applicant.

The NRC staff will provide the following:

1. The staff will provide relevant source documents to the Lead Auditor for inclusion in the Audit Summary. Any specific documents deemed necessary for submittal on the Docket to support safety conclusions will be identified for request under a future RAI.
2. Any documentation deemed to be suitable for submittal or citation will be identified to the Lead Auditor for future quality assurance program audit activities.
3. The staff is to determine if the detailed analysis and calculations described in the RAI responses to RAI Questions 08.03.01-13, 08.03.01-14 and 08.03.01-15 exist (or will exist).
4. The staff will review sample case of studies performed (e.g., load flow, short circuit).

Audit Team:

The audit team comprises of the following NRC staff. These individuals will review the relevant documents that are related to the audit and are available at the time of the audit:

- Jake Zimmerman, Electrical Engineering Branch, Chief
- George Wunder, APR1400 Projects Branch, Senior Project Manager

Electrical Engineering Branch, Technical Reviewers:

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- Sheila Ray, (Point of Contact for the team of technical reviewers)
- Swagata Som
- Ngola Otto
- Adakou Foli
- Fanta Sacko
- Jorge Cintron

Quality Assurance:

No quality assurance support from the NRC Division of Construction Inspection & Operational Programs is required for this audit. Any documents deemed to be suitable for submittal or citation will be identified for future quality assurance program audit activities.

Logistics:

Location, Date & Timing: As stated

Deliverables:

An audit summary will be prepared by the technical staff and shall be submitted to the project branch addressing the areas of concern, if any. Also the staff will submit any follow-on information requests or quality assurance program confirmations necessary to ensure the accuracy of staff conclusions. Information contained in the audit summary may be referenced in Chapter 8 of the FSER, as applicable.