

January 27, 2014

APPLICANT: KOREA HYDRO AND NUCLEAR POWER CORPORATION

APPLICATION: ADVANCED POWER REACTOR 1400 DESIGN CERTIFICATION

SUBJECT: SUMMARY OF THE DECEMBER 11 - 12, 2013, PUBLIC AND CLOSED MEETINGS WITH KOREA HYDRO AND NUCLEAR POWER CO., LTD., TO DISCUSS VARIOUS TOPICS RELATED TO THE SEPTEMBER 30, 2013, SUBMISSION OF A DESIGN CERTIFICATION APPLICATION FOR THE ADVANCED POWER REACTOR 1400 DESIGN

Between December 11 - 12, 2013, a series of Category 1 public and closed meetings were held between the U.S. Nuclear Regulatory Commission (NRC), Korea Hydro and Nuclear Power Corporation (KHNP), and the public at the office of the U.S. Nuclear Regulatory Commission, located at Two White Flint North, 11545 Rockville Pike, Rockville, Maryland, 20852. The meetings were publicly noticed on November 26, 2013. The notice is available in the Agencywide Documents Access and Management System (ADAMS) under accession number ML13330B023. These meetings were part of a series of acceptance review clarification interactions held with KHNP. KHNP previously submitted a Design Certification application as well as topical and technical reports in support of the design.

The purpose of the meetings was to explain staff concerns to KHNP personnel that resulted from review of the APR1400 Final Safety Analysis Report (FSAR) Chapter 7, "Instrumentation and Control Systems;" Chapter 18, "Human Factors Engineering;" and Chapter 19, Probabilistic Risk Assessment and Severe Accident Analysis, and the Environmental Report." KHNP attendees provided presentations regarding their understanding of the significant issues identified during the acceptance review. The publicly available (non-proprietary) version of the KHNP presentations can be found in ADAMS under accession numbers ML13340A784, ML13340A785, and ML13340A787. There were no NRC presentations.

The open portion of the meetings consisted of introductory remarks and general discussion of topics to be covered over the next two days, and introduction of meeting participants. The remainder of the meetings was closed to the public due to the proprietary nature of the KHNP material being discussed.

#### Instrumentation and Control System

The closed portion of the meetings began with KHNP presenting proprietary information regarding Chapter 7 of the APR1400 design control document (DCD). Eight discussion topics were included in the KHNP presentations (ML12240A784 and ML13340A787), consisting of the following:

- Core Protection Calculator System (CPCS) design, functionality, and interface.

- Correlation of the instrumentation approach coincidence logic, independence, and redundancy to the technical specifications (e.g., limited condition of operations, completion of protective systems, etc.).
- Priority functions within the safety instrumentation and controls (I&C) systems.
- Diversity and defense in depth analysis.
- Anticipated transient without scram (ATWS).
- Scope of software Program Manual (SPM) and Secure Development and Operational Environment (SDOE) vulnerability assessment.
- General Discussion on APR1400 Application (quality, clarity, and sufficiency).
- Software common cause failures in non-safety control systems.

The applicant proceeded through these topics throughout the day, with the NRC staff requesting clarification and asking questions throughout the process. Interactions occurred throughout the morning and continued after the lunch break into the afternoon proprietary session, and were completed the following day.

Although the applicant's proposed resolutions to some of these items appear to be on the path to address the NRC staff's concerns, the applicant stated that it will not be able to implement these resolutions until mid to late FY2014. Specifically, the applicant proposed to provide revisions to the APR1400 Final Safety Analysis Report (FSAR) and referenced technical reports between March 2014, and July of 2014. As such, the NRC staff expressed that they could not begin to review the acceptability of these proposed revisions.

Additionally, it was noted that the applicant did not propose a resolution path for two key issues identified in the acceptance review. Specifically, the application did not provide sufficient information to address the following topics:

1. **Software common-cause failures of non-safety related (NSR) control systems that can lead to spurious actuations of redundant safety and non-safety components.** Software-based NSR control systems and displays have the potential to fail in a manner that could challenge safety system performance, induce plant transients, and potentially exceed the boundaries of the plant safety analysis due to the vulnerabilities created by software-based systems and the highly integrated nature of modern, digital I&C platforms. The APR1400 control system is a highly integrated software-based distributed control system that has the ability to control both safety-related and non-safety related components. The applicant has not described how the safety analysis bounds potential spurious failures of non-safety control systems or provide engineering features (e.g. permissives, segmentation of control functions, etc.) that can be used to reduce the likelihood of such failures.

2. **Critical characteristics (e.g. deterministic performance, software development process, etc.) of the safety I&C system platform (i.e. operating system).** Through descriptions of critical characteristics of safety I&C system platform are necessary for the applicant to demonstrate that the safety system meets NRC regulations (e.g. requirements for system integrity, quality, independence, etc.). The applicant has chosen to be platform neutral in its application by not specifying the particular platform that will be used in the APR1400 safety I&C system. This choice is acceptable to the NRC staff, provided that the applicant includes critical characteristics of the platform in the application to demonstrate that any platform that will be used will meet NRC regulations. However, the applicant has not provided such information and has informed the staff that this may be difficult since critical characteristics may not be universal for the potential platforms that they may select in the future.

These are two key areas that were the cause of major issues in other design centers and led to significant delays in I&C reviews of similar designs. The staff mentioned to the applicant, a variety of possible resolutions to these issues. However, it will be up to the applicant to decide a choice of action.

#### Probabilistic Risk Assessment (PRA) and Severe Accident Evaluation

Early on December 12, 2013, before the I&C discussion was concluded, a one hour proprietary discussion was held regarding the main results of the staff's review of the PRA and Severe Accident Evaluation PRA chapter of the FSAR. This discussion included a teleconference link with KHNP attendees in Korea.

The PRA discussion started with a summary of issues associated with the Environmental Report (ER) review. The ER discussion centered on Item 11 of the "Responses to Radiation Protection Acceptance Review Issues – APR1400," provided to KHNP and to which KHNP gave initial responses (ML13345A391 and ML13340A759). The staff clarified Item 11 for KHNP by reviewing the following points:

- The proper guidance document used by the NRC staff for the offsite consequences analysis and SAMDA determinations, namely NUREG-1555 Sections 7.2, Severe Accidents, and 7.3, Severe Accidents Mitigation Alternatives.
- NEI 05-01A, SAMA Analysis Guidance Document, was developed to support license renewal applications and not new reactor applications under Title 10 of the *Code of Federal Regulations* Part 52. If used to inform the analysis of the new reactor severe accident analysis and SAMDA determinations, then the basis for its applicability, how it was applied, and what assumptions were carried from the Nuclear Energy Institute guidance document must be fully discussed in the ER so the staff can determine if it was correctly applied.
- The need to document and discuss the information in the ER so that it is traceable and reproducible to the staff for their independent review.

- Linkage from the Level 2 PRA to the offsite consequences analysis using the MACCS2 code for a generic site (KHNP applied the Surry example problem also known as "Sample Problem A" from the MACCS2 User's Guide) to the SAMDA determination.
- Linkage between the PRA of Standard Review Plan Chapter 19, "Probabilistic Risk Assessment and Severe Accident Evaluation," to the SAMDA determination in the ER (e.g., design specific SAMDAs should be determined in part from the analysis in FSAR Section 19.2.6).
- Using the best available science by applying the full Level 2 PRA for all modes with core damage analysis (i.e., all core damage source terms developed as determined from MELCOR runs) to the offsite consequence analysis (i.e., not just performing MACCS2 calculations for internal events only but also for fire, flooding, and low power/shutdown accident categories).
- The basis for screening out of selected generic SAMDAs must be fully explained and documented in the ER in order for the staff to be able to independently verify the SAMDAs were properly screened out (i.e., traceable and reproducible).
- While there is not a regulatory requirement to perform a Level 3 PRA for the safety review, the offsite consequences must be fully assessed for all modes of plant operation (including external events and shutdown) and fully documented in the ER to properly support the SAMDA determination.

KHNP stated, as was done in its responses to Item 11, that the technical documentation and references of the offsite consequence analysis is described in a technical document that was not provided in the DCD package but is available at its Washington D.C. Center for NRC review. While the NRC staff noted that such a technical document should be included in the DCD package and on the docket, KHNP would potentially make such a determination after receiving a request from the NRC staff to do so.

The remainder of the PRA discussion involved clarification of staff acceptance review deficiencies in the areas of: 1) internal fire and internal flooding PRA for low-power and shutdown, 2) the qualitative rather than quantitative approach used to evaluate the large release frequency that credits containment closure, and 3) a sufficiently developed list of PRA risk insights and key assumptions associated with many design aspects and features described in several chapters of the DCD. KEPCO provided a response to these PRA issues (see ML13345A102 and ML13345A200).

At the conclusion of the ER/PRA discussions KHNP indicated that it would respond to the NRC staff's audits and requests for supplemental information for issues related to the ER and PRA. However, the staff believes the deficiencies are significant enough that, before beginning a review of the KHNP PRA-Severe Accident analysis and SAMDA determinations required by regulatory obligations, a fully referenced and complete Chapter 19 and ER, with all supporting documentation, needs to be submitted on the docket.

### Human Factors Engineering

The final segment of the meeting involved a clarifying discussion of Chapter 18, "Human Factors Engineering," (HFE) issues. The two main concerns that the HFE staff communicated to KHNP were that portions of the HFE submittal were not technically sufficient, and it lacked clear, concise communication. KHNP presented responses to the staff's main HFE concerns (ML13340A784 and ML13340A785) and emphasized that it is developing a process to ensure independent technical review of the HFE documents along with reviews to ensure proper grammar and technical detail. The NRC staff did not pursue a KHNP offer to submit a remedial action plan, nor did they wish to engage KHNP in walkthroughs or regular conference calls. However, the staff noted that, in general, the corrective actions described by KHNP did address accountability, expertise, and resources (both time and people), which seemed like the fundamental factors that needed to be addressed.

The meeting concluded with KHNP representatives re-affirming its desire to answer all concerns and address any deficiencies in the DCD. The NRC staff stated that they would coordinate with KHNP if additional clarification discussions would be helpful, but that there are significant areas that need to be addressed.

Please direct any inquiries to either Bruce Olson at (301) 415-3731, or Wesley Held at (301) 415-1583 or, via e-mail at [Wesley.Held@nrc.gov](mailto:Wesley.Held@nrc.gov) or [Bruce.Olson@nrc.gov](mailto:Bruce.Olson@nrc.gov).

Sincerely,

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Project No. 0782

Enclosure:  
List of Attendees

cc w/encl: See next page

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Sincerely,

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Enclosure:  
List of Attendees

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**ADAMS Accession No.: ML14009A165**

**NRC-001**

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### **List of Attendees**

Public and Closed Meeting with Korea Hydro and Nuclear Power Co., Ltd., to Discuss Various Topics Related to the September 30, 2013, Submission of a Design Certification Application for the Advanced Power Reactor 1400 Design, December 11 and 12, 2013.

#### **December 11, 2013**

	<b>Last Name</b>	<b>First Name</b>	<b>Middle Initial</b>	<b>Affiliation</b>
1	Chang	Harry	Hyun Seung	KHNP Washington DC Center
2	Choi	Woong	Seock	KEPCO E&C
3	Ciocco	Jeff		NRC/NRO
4	Costa	Arlon		NRC/NRO
5	Dittman	Bernard		NRC/NRO
6	Gil	Joohyun		KHNP
7	Held	Wesley		NRC/NRO
8	Jackson	Terry		NRC/NRO
9	Kim	Chang	Ho	KEPCO E&C
10	Kim	Hang	Bae	KEPCO E&C
11	Kim	Jin	Koo	KEPCO E&C
12	Kim	Joon	Kon	KEPCO E&C
13	Kim	Jung	Ho	KHNP CRI
14	Kim	Yun	Ho	KHNP Washington DC Center
15	Lee	Jae	Yong	KHNP CRI
16	Lee	Samuel		NRC/NRO
17	Mauck	Jerry	L	Tetra Tech
18	Mott	Ken		NRC/NRO
19	Nam	Sang Ku		KEPCO E&C
20	Odess-Gillett	Warren		Westinghouse
21	Oh	Seung	Jong	KHNP CRI
22	Oh	Eung	SE	KHNP
23	Sisk	Robert		Westinghouse
24	Sohn	Se	Do	KEPCO E&C
25	Spaulding-Yeoman	Deirdre		NRC/NRO
26	Steckel	James	A	NRC/NRO
27	Truong	Tung		NRC/NRO
28	Wood	Douglas	C	Tetra Tech
28	Zhang	Deanna		NRC/NRO
30	Zhao	Jack		NRC/NRO

Enclosure

December 12, 2013

	Last Name	First Name	Middle Initial	Affiliation
1	Chang	Harry	Hyun Seung	KHNP Washington DC Center
2	Choi	Woong	Seock	KEPCO E&C
3	Ciocco	Jeff		NRC/NRO
4	Costa	Arlon		NRC/NRO
5	Dittman	Bernard		NRC/NRO
6	Gil	Joohyun		KHNP
7	Hall	Robert	E	REH
8	Held	Wesley		NRC/NRO
9	Hilsmeier	Todd		NRC/NRO
10	Hwang	Seong	Hwan	KEPCO E&C
11	Jackson	Terry		NRC/NRO
12	Jhun	Young	Soo	KEPCO E&C
13	Kim	Chang	Ho	KEPCO E&C
14	Kim	Hang	Bae	KEPCO E&C
15	Kim	Jin	Koo	KEPCO E&C
16	Kim	Joon	Kon	KEPCO E&C
17	Kim	Jung	Ho	KHNP CRI
18	Kim	Yun	Goo	KHNP CRI
19	Kim	Yun	Ho	KHNP Washington DC Center
20	Lee	Jae	Yong	KHNP CRI
21	Lim	Soo	Min	KEPCO E&C
22	Mauck	Jerry	L	Tetra Tech
23	McCoppin	Mike		NRC/NRO
24	Nam	Sang Ku		KEPCO E&C
25	Odess-Gillett	Warren		Westinghouse
26	Oh	Seung	Jong	KHNP CRI
27	Oh	Eung	Se	KHNP
28	Palmrose	Donald		NRC/NRO
29	Park	Jae	Hyuk	KEPCO E&C
30	Pieringer	Paul		NRC/NRO
31	Pohida	Marie		NRC/NRO
32	Sohn	Se	Do	KEPCO E&C
33	Spaulding-Yeoman	Deirdre		NRC/NRO
34	Steckel	James	A	NRC/NRO
35	Truong	Tung		NRC/NRO
36	Walker	Jacqwan		NRC/NRO
37	Wood	Douglas	C	Tetra Tech
38	Zhang	Deanna		NRC/NRO



KEPCO/KHNP Participants in		PRA Discussion		
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3	In	Young	H	MARACOR
4	Kim	Myung	Ki	KHNP (call from Korea)
5	Kim	Young	Ki	KEPCO E&C
6	Kim	Yun	Ho	KHNP Washington DC Center
7	Lee	Jae	Yong	KHNP CRI
8	Lim	Hak	Kyu	KEPCO E&C
9	Moon	Ho	Rim	KHNP (call from Korea)
10	Oh	Ji	Yong	KHNP (call from Korea)
11	Oh	Seung	Jong	KHNP CRI

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