

## RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

### APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.: 4-7830

SRP Section: 03.07.04 - Seismic Instrumentation

Application Section: 3.7.4

Date of RAI Issued: 04/13/2015

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### **Question No. 03.07.04-1**

The licensee's APR1400 DC Subsection 3.7.4.4 describes comparison of the DC to RG 1.166, but the DC does not describe its criterion for determining exceedance of the OBE or its procedures to determine CAV limit exceedance, as delineated in RG 1.166.

In accordance with 10 CFR Part 20 and Appendix S to 10 CFR Part 50, regarding APR1400 DCD Subsection 3.7.4.4, please discuss reference to guidance associated with the following and propose associated APR1400 DCD modifications:

- 1) Criterion for determining exceedance of the OBE, and
- 2) Procedures to determine CAV limit exceedance.

### **Response**

1. Criterion for determining exceedance of the OBE

Exceedance of the OBE response spectrum is determined in accordance with position 4.1 of NRC Regulatory Guide 1.166 as follows:

The OBE response spectrum is exceeded if any one of the three orthogonal components of the five percent of the critical damping response spectra generated using the free-field ground motion is larger than:

- 1) The corresponding design response spectral acceleration (OBE spectrum if used in the design, otherwise 1/3 of the SSE spectrum) or 0.2g, whichever is greater, for frequencies between 2 to 10 Hz, or

- 2) The corresponding design response spectral velocity (OBE spectrum if used in the design, otherwise 1/3 of the SSE spectrum) or a spectral velocity of six inches per second, whichever is greater, for frequencies between 1 and 2 Hz.

## 2. Procedures to determine CAV limit exceedance

The Cumulative Absolute Velocity (CAV) is calculated in accordance with position 4.2 of NRC Regulatory Guide 1.166 and EPRI TR-100082. For three orthogonal components of the free-field ground motion, the CAV is calculated as follows:

- 1) The absolute acceleration (g units) time-history is divided into 1-second intervals,
- 2) Each 1-second interval that has at least 1 exceedance of 0.025g is integrated over time,
- 3) All the integrated values are summed together to arrive at the CAV.

The CAV limit is determined to be exceeded if any CAV calculation is greater than 0.16 g-second.

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### **Impact on DCD**

DCD section 3.7.4.4 and related section will be revised as indicated on the attached markup.

### **Impact on PRA**

There is no impact on the PRA.

### **Impact on Technical/Topical/Environmental Reports**

There is no impact on any Technical, Topical or Environmental Reports.

### **Impact on Technical Specifications**

There is no impact on the Technical Specifications.

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When an earthquake occurs, ground motion data are recorded by the seismic instrument. These data are used to make a rapid determination of the degree of severity of the seismic event. The data from the plant's free-field seismic instrument, coupled with information obtained from a plant walkdown, are used to make the initial determination whether the plant must be shut down.

three orthogonal components of the

The evaluation to determine whether the OBE was exceeded is performed using data obtained from the free-field ground motion. The evaluation consists of a check of the response spectrum and CAV and a check on the operability of the instrument.

Deleted

If the response spectrum and the CAV cannot be obtained because the seismic instrument or data processing is inoperable, the criteria of NRC RG 1.166 (Reference 28) Appendix A are used to determine whether the OBE has been exceeded.

The seismic instrumentation program is designed in accordance with the guidelines of NRC RG 1.166 and EPRI NP-6695 (Reference 29).

The plan for post-earthquake walkdown inspections is established using preselected equipment and structures and is used to quantify the damage caused by the earthquake. It is also used to establish the extent of inspections, tests, and evaluations necessary to demonstrate readiness for plant restart.

The procedures for actions immediately after an earthquake contain a check of the neutron flux monitoring sensors and a check of containment isolation valves. The earthquake-induced vibration of the vessel could lead to a change in neutron flux, so a prompt check of the neutron flux monitoring sensors would provide an indication that the reactor is stable. The containment isolation valve may have malfunctioned during the earthquake. Inspection of the containment isolation system is necessary to ensure continued containment integrity.

Exceedance of the OBE response spectrum is determined in accordance with NRC RG 1.166 (Reference 28). The CAV is calculated in accordance with NRC RG 1.166 and EPRI TR-100082 (Reference 30). The CAV limit is determined to be exceeded if the CAV calculation is greater than 0.16 g-second.

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29. EPRI Report NP-6695, "Guidelines for Nuclear Plant Response to an Earthquake,"  
Electric Power Research Institute, December 1989.



30. EPRI Report TR-100082, "Standardization of the Cumulative  
Absolute Velocity," December 1992

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### **Question No. 03.07.04-2**

Subsection 3.7.4.6 details information needed in a COL application referencing the APR1400 DCD, but in those sections there is no reference to the appropriate NRC Regulatory Guides that explain in detail the contents of a COL application and the restart of a nuclear power plant shut down by a seismic event.

In accordance with 10 CFR Part 20 and Appendix S to 10 CFR Part 50, regarding APR1400 DCD Subsection 3.7.4.6, please discuss reference to guidance associated with the restart of a nuclear power plant shut down by a seismic event and propose associated APR1400 DCD modifications.

### **Response**

The COL applicant is to prepare a procedure for the post shutdown inspection and plant restart in accordance with the guidance of NRC RG 1.167.

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### **Impact on DCD**

DCD section 3.7.4.6 and related sections and table 1.8-2 will be revised as indicated on the attached markup.

### **Impact on PRA**

There is no impact on the PRA.

**Impact on Technical/Topical/Environmental Reports**

There is no impact on any Technical, Topical or Environmental Reports.

**Impact on Technical Specifications**

There is no impact on the Technical Specifications.

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The COL applicant is to prepare a procedure for the post shutdown inspection and plant restart in accordance with the guidance of NRC RG 1.167 (Reference 31) (COL 3.7(11)).

the effects of the earthquake on essential safe shutdown equipment. Following the earthquake, the equipment must be inspected for any needed resets or repairs, as well as for readiness prior to initiating shutdown activities.

- 3) The post-event inspection procedure supports determination of the degree of damage to equipment and equipment acceptability for continued operation.

### 3.7.5 Combined License Information

COL 3.7(1) The COL applicant is to determine the site-specific SSE and OBE that are applied to the seismic design of the site-specific seismic Category I and II SSCs and the basis for the plant shutdown. The COL applicant is also to verify the appropriateness of the site-specific SSE and OBE.

COL 3.7(2) The COL applicant is to confirm that the horizontal components of the site-specific SSE ground motion in the free-field at the foundation level of the structure satisfy a peak ground acceleration of at least 0.1g.

COL 3.7(3) The COL applicant is to provide the seismic design of the seismic Category I SSCs that are not part of the APR1400 standard plant design. The seismic Category I structures are as follows:

- a. Seismic Category I essential service water building
- b. Seismic Category I component cooling water heat exchanger building

COL 3.7(4) The COL applicant is to confirm that the any site-specific non-seismic Category I SSCs are designed not to degrade the function of a seismic Category I SSC to an unacceptable safety level due to their structural failure or interaction.

COL 3.7(5) The COL applicant is to perform any site-specific seismic design for dams that is required.

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- COL 3.7(6) The COL applicant is to perform seismic analysis of buried seismic Category I piping, conduits, and tunnels.
- COL 3.7(7) The COL applicant is to perform seismic analysis for the seismic Category I above-ground tanks.
- COL 3.7(8) The COL applicant that references the APR1400 design certification will determine whether essentially the same seismic response from a given earthquake is expected at each unit in a multi-unit site or each unit is to be provided with a separate set of seismic instruments.
- COL 3.7(9) The COL applicant is to confirm details of the locations of the triaxial time-history accelerographs.
- COL 3.7(10) The COL applicant is to identify the implementation milestones for the seismic instrumentation implementation program based on the discussion in Subsections 3.7.4.1 through 3.7.4.5.

3.7. COL 3.7(11) The COL applicant is to prepare a procedure for the post shutdown inspection and plant restart in accordance with the guidance of NRC RG 1.167.

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena," U.S. Nuclear Regulatory Commission.
2. 10 CFR Part 50, Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," U.S. Nuclear Regulatory Commission.
3. Regulatory Guide 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants," Rev. 2, U.S. Nuclear Regulatory Commission, July 2014.
4. Regulatory Guide 1.208, "A Performance-based Approach to Define the Site-specific Earthquake Ground Motion," Rev. 4, U.S. Nuclear Regulatory Commission, March 2007.
5. NUREG-0800, Standard Review Plan, Section 3.7.1, "Seismic Design Parameters," Draft Rev. 4, U.S. Nuclear Regulatory Commission, December 2012.

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29. EPRI Report NP-6695, "Guidelines for Nuclear Plant Response to an Earthquake,"  
Electric Power Research Institute, December 1989.



31. Regulatory Guide 1.167, "Restart of a Nuclear Power Plant Shut  
down by a Seismic Event," U.S. Nuclear Regulatory Commission,  
March 1997.

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Table 1.8-2 (4 of 29)

Item No.	Description
COL 3.7(3)	The COL applicant is to provide the seismic design of the seismic Category I SSCs that are not part of the APR1400 standard plant design. The seismic Category I structures are as follows: <ul style="list-style-type: none"> <li>a. Seismic Category I essential service water building</li> <li>b. Seismic Category I component cooling water heat exchanger building</li> </ul>
COL 3.7(4)	The COL applicant is to confirm that the any site-specific non-seismic Category I SSCs are designed not to degrade the function of a seismic Category I SSC to an unacceptable safety level due to their structural failure or interaction.
COL 3.7(5)	The COL applicant is to perform any site-specific seismic design for dams that is required.
COL 3.7(6)	The COL applicant is to perform seismic analysis of buried seismic Category I piping, conduits, and tunnels.
COL 3.7(7)	The COL applicant is to perform seismic analysis for the seismic Category I above-ground tanks.
COL 3.7(8)	The COL applicant that references the APR1400 design certification will determine whether essentially the same seismic response from a given earthquake is expected at each unit in a multi-unit site or each unit is to be provided with a separate set of seismic instruments.
COL 3.7(9)	The COL applicant is to confirm details of the locations of the triaxial time-history accelerograph.
COL 3.7(10)	The COL applicant is to identify the implementation milestones for the seismic instrumentation implementation program based on the discussion in Subsections 3.7.4.1 through 3.7.4.5.
COL 3.7B(1)	The COL applicant is to evaluate the HRHF response spectra.
COL 3.7B(2)	The COL applicant is to evaluate the representative items listed in Table 3.7B-2.
COL 3.8(1)	The COL applicant is to provide the design of site-specific seismic Category I structures such as the essential service water supply structure and the component cooling water heat exchanger building.
COL 3.8(2)	The COL applicant is to identify any applicable site-specific loads such as site proximity explosions and missiles, potential aircraft crashes, and the effects of seiches, surges, waves, and tsunamis.
COL 3.8(3)	The COL applicant is to determine the environmental condition associated with the durability of concrete structures and provide the concrete mix design that prevents concrete degradation including the reactions of sulfate and other chemicals, corrosion of reinforcing bars, and influence of reactive aggregates.
COL 3.8(4)	The COL applicant is to determine construction techniques to minimize the effects of thermal expansion and contraction due to hydration heat, which could result in cracking.
COL 3.8(5)	The COL applicant is to monitor the safety and serviceability of seismic Category I structures during the operation of the plant and provide the appropriate maintenance.
COL 3.8(6)	The COL applicant is to provide reasonable assurance that the design criteria listed in Table 2.0-1 are met or exceeded.

COL 3.7(11) The COL applicant is to prepare a procedure for the post shutdown inspection and plant restart in accordance with the guidance of NRC RG 1.167.