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## REVISED 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.: 270-7894  
SRP Section: SRP 19  
Application Section: 19.1.  
Date of RAI Issue: 10/22/2015

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### **Question No. 19-14**

10 CFR 52.47(a)(27) states that a DC application must contain an FSAR that includes a description of the design-specific PRA and its results. In addition, SRP Chapter 19, Revision 3 (Draft), Section III. "REVIEW PROCEDURES," Item 1A under Subsection "Design-Specific PRA" states that "The applicant's analyses should be comprehensive in scope and address all applicable internal and external events and all plant operating modes." Therefore, in order for the staff to reach a reasonable finding that the scope, level of detail, and technical adequacy of the design-specific PRA are appropriate, please describe the quantitative or qualitative, as applicable, risk assessment associated with the applicable external hazards (e.g., high winds, tornados, external flooding), provide the results of the probabilistic evaluation of these hazards, and include the discussions in the DCD.

### **Response – (Rev.2)**

The results of Other External Events Risk Evaluation are summarized in the DCD Section 19.1.5.4, which is replaced in its entirety to this response as shown in the [DCD Rev. 1](#).

The DCD markups associated with Issue #'s PRA-19 (AI 19-019), PRA-119 (AI 19-126), and Issue # PRA-156 (AI 19-163) was incorporated in the DCD Rev. 1 'as-is.'

The DCD mark ups associated with Issue #'s PRA-118 (AI 19-125) and PRA-151 (AI 19-158) are incorporated in the attachment of this RAI response.

The DCD mark ups associated with Issue # PRA-130 (AI 19-137) are incorporated in the attachment of this RAI response.

The DCD markups associated with Issue # PRA-98 (AI 19-098) is no longer applicable, since the associated texts were removed from the DCD.

Issue # SA-4 (AI 19-117) was addressed in the response to Issue # PRA-156 (AI 19-163) above.

**Impact on DCD**

DCD will be revised as discussed above.

**Impact on PRA**

There is no impact on the PRA.

**Impact on Technical Specifications**

There is no impact on the Technical Specifications.

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

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

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- f. The lowest flood areas in each quadrant of the auxiliary building are designed to contain over 2,271 m<sup>3</sup> (600,000 gal) of water without impacting equipment in adjoining quadrants. Watertight barriers, designed to withstand at least 9 ft of accumulation, are provided between quadrants on the lowest elevation of the auxiliary building.

Table 19.1-80 summarizes the results of the other external events risk evaluations discussed in this section.

#### 19.1.5.4 Other External Events Risk Evaluation

This section summarizes the analysis of hazards to the APR1400 design from external events other than plant fires and seismic events. The sections that follow detail the evaluation of external hazards.

##### 19.1.5.4.1 Assumptions

The following assumptions were used to develop the APR1400 Other External Events analysis:

- a. All SSCs that are modeled in the PRA are designed to withstand the design-basis tornado (DBT) and design-basis hurricane (DBH) including all effects, i.e., pressure loading, pressure drop and missile impacts.
- b. The non-safety related systems, structures, and components (SSCs) are designed such that they will not collapse on or impact the seismic Category I structures containing SSCs (item 1 above) and will not generate missiles more damaging than the DBT and DBH missiles. a

##### 19.1.5.4.2 Analysis

The external hazard probabilistic risk assessment (PRA) methodology for currently-operating plants is described in a number of references. Examples include References 2, 4, and 40. The major elements of an external hazard PRA are:

- a. Initial screening of external hazards based on a set of qualitative criteria,
- b. Bounding analysis for the screened-in external hazards,
- c. Detailed PRA for the remaining external hazards.

model to provide the conditional core damage probability (CCDP) and conditional large early release probability (CLRP) for each defined external hazard plant damage state and (c) evaluate the unconditional CDF and LRF by integrating the CCDP/CLRP with the frequencies of the plant damage states obtained by combining the results of hazard analysis and fragility analysis.

d. While this methodology is equally applicable to new reactors under design certification, some key differences do exist.

e. Most of the external hazards are location specific. Since the plant site is not known, initial screening of the external hazards cannot be performed. However, the combined operating license (COL) applicant is expected to select the site that meets the enveloping site parameters (DCD Table 2.0-1) and conforms to the NRC regulatory guides and SRP. This practice will provide the basis for screening of many external hazards.

f. The plant design will not have progressed to the extent that plant-specific fragilities of SSCs could be evaluated. Therefore bounding or demonstrably conservative analysis of many screened-in external hazards cannot be meaningfully done.

#### 19.1.5.4.3 Initial Screening of External Hazards

For a selected site, the COL applicant will perform the initial screening of hazards complying with ASME/ANS PRA Standard Part 6 Addendum B and NRC RG 1.200 Revision 2 (COL 19.1(10)).

External hazards screened out during the design stage are:

- a. Transportation accidents: DCD Section 2.2.3 requires the COL applicant to identify and evaluate potential accidents arising from nearby industrial, transportation (aircraft routes, highways, railways, navigable waters and pipelines), and military facilities. The COL applicant will select the design basis event following the standard review plan (SRP) Section 2.2.3 acceptance criteria. The following principal types of hazards will be considered.
  - 1) Toxic vapors or gases and their potential for incapacitating nuclear plant control room operators

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The bounding analysis for extreme winds and tornadoes is based on the following assumptions:

1. All SSCs that are modeled in the PRA are designed to withstand the DBT and DBH including all effects (i.e., pressure loading, pressure drop and missile impacts).
2. The non-safety related SSCs are designed such that they will not collapse on or impact the seismic Category I structures containing SSCs (item 1 above) and will not generate missiles more damaging than the DBT and DBH missiles.

With these assumptions, the contribution to CDF and ~~LERF~~ <sup>← LRF</sup> from extreme winds is judged to be less than  ~~$10^{-7}$  per year~~ and could be screened out from detailed PRA.

<sup>←</sup>  $10^{-6}$  and  $10^{-7}$  per year, respectively,

After an APR1400 unit is built at a site, the COL holder should confirm that the above assumptions are met and complete the external hazard PRA conforming to RG 1.206 and ASME/ANS PRA Standard Part 6 and 7 requirements.

## 19.1.5.4.4.2

External Flooding

river flooding,

There are several types of external flooding phenomena that need to be considered, depending on the site where the APR1400 is located. These include both natural phenomena (high river or lake water, <sup>↓</sup>ocean flooding such as from high tides or wind driven storm surges, extreme precipitation, tsunamis, seiches, flooding from landslides, etc.), and man-made events (principally failures of dams, levees, and dikes). It is also important to consider rational probabilistic combinations of the above phenomena. The consequences of heavy rain and other flooding, such as water collected on rooftops and in low-lying plant area are also within the scope of external flooding PRA.

The maximum flood elevation is specified in DCD Table 2.0-1 as 1-foot below the plant grade in the vicinity of the SSCs important to safety. DCD Section 2.4 describes the flood analysis for different sources that the COL applicant has to perform in the site selection and design of the plant. It is expected that the COL applicant will make use of the on-going studies for reevaluation of external floods at current nuclear power plant sites in response to Fukushima NTF Recommendation 2.1.

It is concluded that the external flooding will not be a significant contributor to CDF and ~~LERF~~ based on the site selection and design features implemented by the COL applicant.

<sup>←</sup> LRF (i.e., judged to be less than  $10^{-6}$  and  $10^{-7}$  per year, respectively)

After an APR1400 unit is built at a site, the COL holder should confirm that the above assumptions are met and complete the external hazard PRA conforming to RG 1.206 and ASME/ANS PRA Standard Part 6 and 8 requirements.

, see COL 19.1(10)

#### 19.1.6 Safety Insights from the PRA for Other Modes of Operation

This section summarizes Level 1 and 2 internal events, internal flooding, and internal fire PRAs for the low power and shutdown (LPSD) operations, including results and risk insights.

##### 19.1.6.1 Level 1 Internal Events PRA for Low Power and Shutdown Operations

A description of the Level 1 internal events PRA for LPSD operations, including the results from the PRA, is provided in the following subsections.

##### 19.1.6.1.1 Description of Level 1 Internal Events PRA for Low Power and Shutdown Operations

###### 19.1.6.1.1.1 Methodology

The scope of this analysis included quantitative evaluation of internal events for the LPSD operations. The development of the LPSD PRA includes the following nine major technical tasks.

- a. Plant Operating State Development
- b. Initiating Events Analysis
- c. Accident Sequence Analysis
- d. Success Criteria Analysis
- e. Systems Analysis
- f. Data Analysis
- g. Human Reliability Analysis
- h. Analysis of Large Early Release

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within 1.67 times the required response spectra (CSDRS-based RRS) in the procurement specification.

COL 19.1(9) When developing post-earthquake safe shutdown procedures, the COL applicant should consider the potential for multiple spurious alarms from photoelectric detectors following a seismic event.

COL 19.1(10) The COL applicant <sup>and/or holder</sup> needs to ensure that screened events do not have a site-specific susceptibility and do not exceed the CDF and <sup>LRF</sup> LERF design targets specified in Subsection 1.2.1.1.1 e. The COL applicant is to address the following issues with a site-specific risk assessment, as applicable:

- ~~Dam failure~~
- ~~Aircraft crash event~~ • Aircraft crash event
- External flooding
- Extreme winds and tornadoes
- Industrial or military facility
- ~~Lightning~~ • Lightning
- Pipeline accident
- Release of chemicals from onsite storage
- River diversion / River flooding
- ~~Sandstorm~~
- ~~Storm surge~~ • Storm surge
- Toxic gas
- Transportation accidents
- ~~Aircraft crash event~~ and/or holder

In addition, the COL applicant is to ensure the site-specific susceptibility is not an outlier for the following issues, as applicable:

- Avalanche
- Biological events

- Coastal erosion
- Dam failure
- Drought
- Forest fire
- High summer temperature
- ← Hurricane
- Landslide
- Low lake/river water level
- Low winter temperature
- ← Sandstorm  
Tsunami
- Volcanic activity

See Subsection 19.1.5.4.

COL 19.1(11) The COL applicant is to develop outage management procedures that limit planned maintenance that can potentially impair one or both SC trains during the shutdown modes.

COL 19.1(12) The COL applicant is to develop procedures and a configuration management strategy to address the period of time when one SC train is unexpectedly unavailable (including the termination of any testing or maintenance that can affect the remaining train and restoration of all equipment to its nominal availability).

COL 19.1(13) The COL applicant is to establish procedures for closing the containment hatch (after being opened during LPSD operations) to promptly re-establish the containment as a barrier to fission product release. This guidance must include steps that allow for sealing of the hatch with four bolts (versus the 40 bolts used to secure the hatch during at-power operation); four bolts are sufficient to secure the hatch so that no visible gap can be seen between the seals and the sealing surface. See Subsection 19.1.6.2.2.5.



56. The Structural Engineer, "The effect of elevated temperatures on the strength properties of reinforcing and prestressing steels," M. Holmes, R.D. Anchor, G.M.E. Cook & R.N. Cook, Vol. 60B, No. 1, March 1982.
57. DC/COL-ISG-020, "Interim Staff Guidance on Implementation of a Probabilistic Risk Assessment Based Seismic Margin Analysis for New Reactors," U.S. Nuclear Regulatory Commission.
58. EPRI 1002988, "Seismic Fragility Application Guide," Electric Power Research Institute, December 2002.
60. Regulatory Guide 1.91, "Evaluations of Explosions Postulated to Occur on Transportation Routes near Nuclear Power Plants."
61. Regulatory Guide 1.115, "Protection against Low-Trajectory Turbine Missiles."
62. Standard Review Plan Section 3.5.1.6, "Aircraft Hazards."

59. RG 1.78, "Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release," USNRC, Rev. 1, December 2001.

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Table 19.1-80 (2 of 5)

External Hazard	Typical Screening Criteria <sup>(1)</sup>	ASME Standard Remarks	APR1400 Treatment
Fog	1	Could increase the frequency of man-made hazard involving surface vehicles or aircraft; accident data include the effects of fog.	Issue screened from consideration in Chapter 19 of the DCD based upon ASME Standard Screening Criteria.
Forest Fire	1, 3	Fire cannot propagate to the site because the site is cleared; plant design and fire-protection provisions are adequate to mitigate the effects.	Issue screened from consideration in Chapter 19 of the DCD based upon ASME Standard Screening Criteria. The design information in Section 6.4.2.2 demonstrates how the MCR would cope with smoke from an external fire. COL Action item entered to ensure the site specific susceptibility is not an outlier with respect to this item.
Frost	1	Snow and ice govern	Issue screened from consideration in Chapter 19 of the DCD based upon ASME Standard Screening Criteria.
Hail	1	Other missiles govern.	Issue screened from consideration in Chapter 19 of the DCD based upon ASME Standard Screening Criteria.
High Summer Temperature	1	Can often be excluded where the ultimate heat sink temperature is designed for at least 30 days of operation, taking into account evaporation, drift, seepage, and other water-loss mechanisms. Evaluation is needed of possible loss of air cooling due to high temperatures.	Issue screened from consideration in Chapter 19 of the DCD based upon ASME Standard Screening Criteria. COL Action item entered to ensure the site specific susceptibility is not an outlier with respect to this item.
High Tide	4	Included under external flooding.	Issue screened from consideration in Chapter 19 of the DCD based upon ASME Standard Screening Criteria.
Hurricane	4	Included under external flooding; wind forces are covered under extreme winds and tornadoes.	Issue screened from consideration in Chapter 19 of the DCD based upon ASME Standard Screening Criteria.
Ice Cover	1, 4	Ice blockage of river included in flood; loss of cooling-water flow is considered in plant design.	Issue screened from consideration in Chapter 19 of the DCD based upon ASME Standard Screening Criteria.

COL action item to assess if site is susceptible to this failure mode.

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Table 19.1-80 (3 of 5)

External Hazard	Typical Screening Criteria <sup>(1)</sup>	ASME Standard Remarks	APR1400 Treatment
Industrial or Military Facility	N/A	Site specific, requires detailed study	COL Action Item added to address this issue.
Internal Flooding	N/A	Site specific, requires detailed study	Issue discussed in Chapter 19 of the DCD for standard design.
Landslide	3	Can be excluded for most nuclear plant sites in the U.S.; confirm through walkdown.	Issue screened from consideration in Chapter 19 of the DCD based upon ASME Standard Screening Criteria. COL Action item entered to ensure the site specific susceptibility is not an outlier with respect to this item.
Lightning	1	Considered in plant design.	<del>Issue screened from consideration in Chapter 19 of the DCD based upon ASME Standard Screening Criteria.</del>
Low Lake/River Water Level	1, 5	Can often be excluded where the ultimate heat sink water level is designed for at least 30 days of operation, taking into account evaporation,	Issue screened from consideration in Chapter 19 of the DCD based upon ASME Standard Screening Criteria. COL Action item entered to ensure the site specific susceptibility is not an outlier with respect to this item.
Low Winter Temperature	1, 5	Thermal stresses and embrittlement are usually insignificant or covered by design codes and standards for plant design; generally, there is adequate warning of icing on the ultimate heat sink so that remedial action can be taken.	Issue screened from consideration in Chapter 19 of the DCD based upon ASME Standard Screening Criteria. COL Action item entered to ensure the site specific susceptibility is not an outlier with respect to this item.
Meteorite/Satellite Strikes	2	All sites have approximately the same frequency of occurrence.	Issue screened from consideration in Chapter 19 of the DCD based upon ASME Standard Screening Criteria.
Pipeline Accident	N/A	Site specific, requires detailed study	COL Action Item added to address this issue.
Intense Precipitation	4	Included under external and internal flooding. Roof loading and its effect on building integrity must be checked.	Issue screened from consideration in Chapter 19 of the DCD based upon ASME Standard Screening Criteria.
Release of Chemicals from Onsite Storage	N/A	Site specific, requires detailed study	COL Action Item added to address this issue.

COL Action Item added to address this issue.

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Table 19.1-80 (4 of 5)

External Hazard	Typical Screening Criteria <sup>(1)</sup>	ASME Standard Remarks	APR1400 Treatment
River Diversion ← / River Flooding	1, 4	Considered in the evaluation of the ultimate heat sink; should diversion become a hazard, adequate storage is usually provided. Requires detailed site/ plant study.	COL Action Item added to address this issue.
Sandstorm	1, 4	Included under tornadoes and winds; potential blockage of air intakes with particulate matter is generally considered in plant design.	<del>COL Action Item added to address this issue.</del> ↑ COL action item to assess if site is susceptible to this failure mode.
Seiche	4	Included under external flooding	Issue screened from consideration in Chapter 19 of the DCD based upon ASME Standard Screening Criteria.
Seismic Activity	N/A	Site specific, requires detailed study	Issue discussed in Chapter 19 of the DCD for standard design.
Snow	1, 4	Plant designed for higher loading; snow melt causing river flooding is included under external flooding.	Issue screened from consideration in Chapter 19 of the DCD based upon ASME Standard Screening Criteria.
Soil Shrink / Swell	1, 5	Site-suitability evaluation and site development for the plant are designed to preclude the effects of this hazard.	Issue screened from consideration in Chapter 19 of the DCD based upon ASME Standard Screening Criteria.
Storm Surge	4	Included under external flooding.	Issue screened from consideration in Chapter 19 of the DCD based upon ASME Standard Screening Criteria.
Toxic Gas	N/A	Site specific, requires detailed study	COL Action Item added to address this issue.
Transportation Accidents	N/A	Site specific, requires detailed study	COL Action Item added to address this issue.
Tsunami	4	Included under external flooding.	Issue screened from consideration in Chapter 19 of the DCD based upon ASME Standard Screening Criteria.

COL action item to assess if site is susceptible to this failure mode.