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.:	**88-8046**
SRP Section:	**03.05.02 – Structures Systems and Components To Be Protected From Externally-Generated Missiles**
Application Section:	**3.5.2**
Date of RAI Issue:	**07/20/2015**

Question No. 03.05.02-4

GDC 2 requires, in part, that SSCs important to safety be protected against natural phenomena, including tornados and hurricanes. GDC 4 requires, in part, that SSCs important to safety be appropriately protected against the effects of missiles that may result from events and conditions outside the nuclear power unit. SRP 3.5.2 specifies that one method for protection against externally-generated missiles is to place the SSC underground at a sufficient depth.

DCD Tier 2, Section 3.7.3.7 indicates that the APR 1400 design has buried seismic category I piping. However, DCD Tier 2, Section 3.5.2 states that “[a]ll safety-related SSCs required to safely shut the reactor down and maintain it in a safe condition are housed in seismic Category I structures.”

The applicant is requested to clarify in the DCD whether the APR 1400 has safety-related piping outside seismic category I structures (e.g., buried piping or piping tunnel), and whether it is protected from externally-generated missiles consistent with the methods of SRP 3.5.2 and RG 1.117.

Response – (Rev. 1)

The APR1400 has no seismic Category I buried piping. All safety-related SSCs are housed in seismic Category I structures. The DCD will be clarified by removing "piping" or change the sentence in Subsections 3.7.3, 3.7.3.7, 3.7.5, 3.12.3.8 and 3.9.2.2.11.

Impact on DCD

The changes that were proposed in the original response to this RAI have been incorporated into Revision 2 of the DCD; therefore, only the pages containing proposed changes as a result of Revision 1 of this response are included in the Attachment.

DCD Tier 2 Subsection 3.7.3, 3.12.3.8 and 3.9.2.2.11 will be revised as indicated in the attached markup.

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 Reports.

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$\{M_i\}$ = subregion of mass matrix associated with component i

$[M]$ = mass matrix of the system

For the stiffness-weighted damping, the formulation is as follows:

$$\beta_j = \frac{\sum_{i=1}^{N} \{\phi_j\}^T \beta_i \{K_i\} \{\phi_j\}}{\{\phi_j\}^T [K] \{\phi_j\}}$$

Where:

$\{K_i\}$ = subregion of stiffness matrix associated with component i

$[K]$ = stiffness matrix of the system

For direct integration method, viscous damping proportional to the mass and stiffness matrix is used; thus

$$[C] = \alpha [M] + \beta [K]$$

where [C] is the damping matrix, [K] is the stiffness matrix, and [M] is the mass matrix. The values of α and β are selected so that the damping in the range of frequency of interest is approximately equal to the damping of the structure.

3.7.3 Seismic Subsystem Analysis

This subsection describes the seismic analysis methods for the APR1400 seismic Category I subsystems as civil structures that are not included in the main structural system, such as miscellaneous concrete and steel structures, buried ~~piping,~~ conduit, tunnel, dam, and above-ground tanks.

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The seismic analysis of the seismic Category I mechanical subsystems, such as piping and equipment, is described in Section 3.9.

3.7.3.1 Seismic Analysis Methods

The seismic analysis of seismic Category I subsystems is performed using either the response spectrum analysis or time-history analysis, as described in Subsection 3.7.2.1, or the equivalent static method described in Subsection 3.7.3.1.1.

boundary anchors are designed considering the plastic hinge moment from the non-seismic piping.

3.12.3.8 Seismic Category I Buried Piping

~~The seismic design of the buried seismic Category I piping is performed in accordance with the procedures described in Subsection 3.7.3.7~~.

The APR1400 design has no seismic Category I buried piping.

3.12.4 Piping Modeling Technique

3.12.4.1 Computer Codes

The following computer programs are used in the analysis of seismic Category I piping designated as ASME Class 1, 2, and 3, and non-ASME piping systems. These computer programs are further described in Subsection 3.9.1.2. The applicable computer programs are as follows:

a. PIPESTRESS

PIPESTRESS is a piping analysis program that is used for the analysis of ASME Class 1, 2, and 3 as well as ASME B31.1 and B31.3 piping systems. This program is described in Subsection 3.9.1.2.1.13.

b. ANSYS

ANSYS is used in numerous applications for all components in the areas of structural, fatigue, thermal, and eigenvalue analysis including static and dynamic; elastic, plastic, creep and swelling; small and large deflections; steady-state and transient heat transfer and fluid flow. This program is described in Subsection 3.9.1.2.1.7.

c. [Deleted]

d. RELAP5/MOD3.3

RELAP5/MOD 3.3 is developed by the NRC is for best-estimate transient simulation of light water reactor (LWR) coolant systems during postulated accidents in the LWR. This program is also used for the analysis of a dynamic

If ISM (Independent Support Motion) method is utilized for alternate method of multiple supports excitation, the criteria for the use of ISM method will be followed in accordance with NUREG -1061, Volume 2, Section 4.

For analyzing the piping systems supported at multiple locations within a single structure or multiple structures, the method used is described in Subsection 3.12.3.2. The SSCs design procedure for differential settlement and relative displacement is described in Subsection 3.8.5.8.

3.9.2.2.9 Use of Constant Vertical Static Factors

A constant static factor is not used for the seismic design of seismic Category I structures, systems, and components specified in Subsections 3.7.2.10 and 3.7.3.6.

3.9.2.2.10 Torsional Effects of Eccentric Masses

All concentrated loads in a piping subsystem, such as valves and valve operators, are modeled as massless members with the mass of each component lumped at its center of gravity. Massless members are modeled by connecting the center of gravity of components to the centerline of piping so that the torsional effects of the eccentric masses are considered.

Torsional effects of eccentric masses are also considered in the analysis of seismic Category I subsystems other than piping.

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3.9.2.2.11 Buried Seismic Category I ~~Piping~~ Conduits, and Tunnels

The seismic criteria and methods used to analyze buried seismic Category I ~~piping,~~ conduit, and tunnels are addressed in Subsections 3.7.3.7 ~~and 3.12.3.8~~.

3.9.2.2.12 Interaction of Other Piping with Seismic Category I Piping

Interaction of other piping with seismic Category I piping is addressed in Subsection 3.12.3.7.

3.9.2.2.13 Analysis Procedure for Damping

The damping values used for seismic analysis are consistent with NRC RG 1.61 (Reference 40) as described in Table 3.7-7.