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. 03.05.02-1

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. In addition, SRP 3.5.2 acceptance is based, in part, on conformance with the guidance of RG 1.117.

DCD Tier 2, Section 3.5.2 states that “openings and penetrations through the exterior walls and roofs of seismic Category I structures and the location of equipment in the vicinity of such openings are arranged so that a missile passing through the opening would not prevent the safe shutdown of the plant and would not result in an offsite release of nuclides exceeding the limits defined in 10 CFR Part 100 (Reference 15).” However, RG 1.117 position C.3 specifies that failure of an SSC from a wind-borne missile should not result in an offsite exposure greater than 25% of the limits defined in 10 CFR Part 100.

The applicant is requested to revise DCD Tier 2, Section 3.5.2 in order to conform to the guidelines set forth in RG 1.117.

Response

DCD Section 3.5.2 will be revised to conform to the guideline set forth in RG 1.117 position C.3 by stating that offsite release of nuclides would not exceed 25% of the limits defined in 10 CFR Part 100.

Impact on DCD

DCD Tier 2 Section 3.5.2 will be revised as indicated in the attached markup.

Impact on PRA

There is no impact on the PRA.

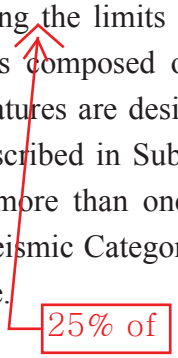
Impact on Technical Specifications

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.

Openings and penetrations through the exterior walls and roofs of seismic Category I structures and the location of equipment in the vicinity of such openings are arranged so that a missile passing through the opening would not prevent the safe shutdown of the plant and would not result in an offsite release of nuclides exceeding the limits defined in 10 CFR Part 100 (Reference 15). Otherwise, structural barriers composed of enclosures, missiles-resistant doors and covers, and physical protection features are designed to resist tornado missiles in accordance with the design procedures described in Subsection 3.5.3. Tornado and hurricane missiles are not postulated to strike more than once at a target location. Because of the robustness of the exterior wall, all seismic Category I structures are capable of withstanding the impact of each identified missile.



3.5.3 Barrier Design Procedures

Missile barriers, whether steel or concrete, are designed with sufficient strength and thickness to prevent local damage including perforation, spalling and scabbing, and overall damage. The procedures by which structures and barriers are designed to perform this function are presented in this subsection.

3.5.3.1 Evaluation of Local Structural Effects

The prediction of local damage in the immediate vicinity of an affected area depends on the basic material of construction of the barrier itself. Corresponding procedures are described below.

3.5.3.1.1 Concrete Barriers

Local damage prediction for concrete structures includes the estimation of the depth of missile penetration and an assessment of whether secondary missiles could be generated by spalling. Design criteria for concrete barriers are consistent with the National Defense Research Council (NDRC), “A Review of Procedures for the Analysis and Design of Concrete Structures to Resist Missile Impact Effects” (Reference 16). The modified NDRC formula is used to estimate the missile penetration depth, and barrier thickness to prevent perforation, spalling, and scabbing effects. The design thicknesses of missile barriers are 20 percent greater than the threshold values for the phenomenon being prevented. The design thicknesses also satisfy the minimum acceptable barrier thickness requirements for local damage prediction against tornado-generated missiles as well as

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Question No. 03.05.02-2

GDC 2 requires, in part, that SSCs important to safety be protected against natural phenomena, including tornados and hurricanes. GDC 2 also states that "[t]he design bases for these structures, systems, and components shall reflect…the most severe of the natural phenomena."

DCD Tier 2, Section 14.3.2.7 specifies that ITAAC for plant systems are developed to require or verify heat removal capabilities for design basis accidents (DBAs) as well as tornado and missile protection. In addition, DCD Tier 2 Section 3.5.2 states that "…physical protection features are designed to resist tornado missiles in accordance with the design procedures descripted in Section 3.5.3." However, as indicated in DCD Tier 2, Subsection 3.5.1.4, the design basis hurricane and associated missiles of the APR 1400 design are more severe than design basis tornado winds and associated missiles.

The applicant is requested to revise these statements, and any other similar statements, in the DCD to also include hurricane winds and associated missiles which can be more limiting than tornado effects.

Response

In accordance with GDC 2, KHNP has included hurricane winds and associated missiles in the design of the APR1400 as shown in sections 3.3, 3.5, 3.8, 3.9 and 3.12 of the DCD. A review was performed to ensure DCD statements adequately reflect the hurricane winds and missiles. Hurricane winds are adequately reflected in the DCD Sections. Sections 3.5.2 and 14.3.2.7 will be revised to reflect both tornado and hurricane missiles.

Impact on DCD

DCD Tier 2 Sections 3.5.2 and 14.3.2 will be revised as indicated in the attached markups.

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.

Openings and penetrations through the exterior walls and roofs of seismic Category I structures and the location of equipment in the vicinity of such openings are arranged so that a missile passing through the opening would not prevent the safe shutdown of the plant and would not result in an offsite release of nuclides exceeding the limits defined in 10 CFR Part 100 (Reference 15). Otherwise, structural barriers composed of enclosures, missiles-resistant doors and covers, and physical protection features are designed to resist tornado missiles in accordance with the design procedures described in Subsection 3.5.3. Tornado and hurricane missiles are not postulated to strike more than once at a target location. Because of the robustness of the exterior wall, all seismic Category I structures are capable of withstanding the impact of each identified missile.

and hurricane

3.5.3 Barrier Design Procedures

Missile barriers, whether steel or concrete, are designed with sufficient strength and thickness to prevent local damage including perforation, spalling and scabbing, and overall damage. The procedures by which structures and barriers are designed to perform this function are presented in this subsection.

3.5.3.1 Evaluation of Local Structural Effects

The prediction of local damage in the immediate vicinity of an affected area depends on the basic material of construction of the barrier itself. Corresponding procedures are described below.

3.5.3.1.1 Concrete Barriers

Local damage prediction for concrete structures includes the estimation of the depth of missile penetration and an assessment of whether secondary missiles could be generated by spalling. Design criteria for concrete barriers are consistent with the National Defense Research Council (NDRC), "A Review of Procedures for the Analysis and Design of Concrete Structures to Resist Missile Impact Effects" (Reference 16). The modified NDRC formula is used to estimate the missile penetration depth, and barrier thickness to prevent perforation, spalling, and scabbing effects. The design thicknesses of missile barriers are 20 percent greater than the threshold values for the phenomenon being prevented. The design thicknesses also satisfy the minimum acceptable barrier thickness requirements for local damage prediction against tornado-generated missiles as well as

b. As-built plant reports for reconciliation with post-fire safe shutdown analyses to provide reasonable assurance of consistency with design requirements of SSCs for fire protection and mitigation

c. Heat removal capabilities for design basis accidents (DBAs) as well as tornado and missile protection

/hurricane

d. Net positive suction head for key pumps

e. Physical separation for appropriate systems

f. The minimum inventory of alarms, controls, and indications—as derived from emergency procedure guidelines, NRC RG 1.97 (Reference 26), and PRA insights—is provided for the main control room and remote shutdown stations.

g. The following design attributes for plant systems commensurate with the importance of the design attribute to safety:

1) Functional arrangement

2) Key design features of systems

3) Seismic and ASME Code classifications

4) Weld quality and pressure boundary integrity, as necessary

5) Valve qualification and operation

6) Controls, alarms, and displays

7) Logic and interlocks

8) Equipment qualification for harsh environments

9) Required interfaces with other systems

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Question No. 03.05.02-3

In the review of DCD Tier 2 Table 3.5-4, the staff found several items that need further clarification. For this reason, the staff requests the applicant to address the following items:

a) DCD Tier 2, Section 3.5, states “Essential SSCs outside containment to be protected from missiles are provided in Table 3.5-4.” However, the title of Table 3.5-4 is “Essential Systems and Components to Be Protected from Externally Generated Missiles.” It is unclear to the staff if Table 3.5-4 is also applicable to internally-generated missiles. The applicant is requested to revise either the statement in the DCD or the title of Table 3.5-4.

b) It is unclear to the staff whether this table is meant to be an all inclusive list containing all SSCs requiring protection against missiles. For example, RG 1.117, Appendix A specifies that any SSC required for attaining safe shutdown should be protected against external missiles. DCD Tier 2, Section 7.4 contains a list of systems required to achieve and maintain the reactor shutdown; however, some systems are not listed in DCD Tier 2, Table 3.5-4 (e.g., auxiliary feedwater system). The staff requests the applicant to clarify the purpose of Table 3.5-4 and whether there are SSCs requiring missile protection that are not listed in Table 3.5-4.

c) DCD Tier 1, Section 2.2.2.1 states that the EDG building is designed and constructed to withstand external events, including tornados and hurricanes. DCD Tier 2, Section 8.3.1.1.4, item d, states that Class 1E EDGs and associated equipment are located in separate rooms of the auxiliary building and EDG building. However, DCD Tier 2, Table 3.5-4 does not list the EDG building as a structure necessary to protect essential SSCs.

DCD Tier 1, Section 2.2.4, states the exterior walls and roof of the compound building are credited with providing missile protection; however, Table 3.5-4 does not include the compound building as a structure performing a missile barrier function.

The applicant is requested to include the EDG building and compound building in DCD Tier 2 Table 3.5-4 as a structure credited as a missile barrier.

Response

a) The title of Table 3.5-4 will be revised to “Essential Systems and Components Outside the Reactor Containment Building to be Protected from Externally Generated Missiles” since the table does not include internally generated missiles.

b) The purpose of Table 3.5-4 is to provide the essential SSCs outside of the reactor containment building in accordance with R.G 1.117 Appendix A. The auxiliary feedwater system will be included in Table 3.5-4. Upon performing a review of the table, the nomenclature of other SSCs was not accurate and will also be corrected.

c) The EDG building will be included in Table 3.5-4. The compound building is not a structure that is used to function as a missile barrier so it is not included in Table 3.5-4. DCD Tier 1 Subsection 2.2.4.1 will be revised to delete the missile protection function of the compound building.

Impact on DCD

DCD Tier 2, Table 3.5-4 and DCD Tier 1, Subsection 2.2.4.1 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.

3.5 Missile Protection

In accordance with 10 CFR Part 50, Appendix A, GDC 2 and 4 (Reference 1), essential structures, systems, and components (SSCs) important to safety are required to be protected from internal and external missiles.

Missile protection is provided for safety-related equipment and components so that internal and external missiles do not cause the release of significant amounts of radioactivity or prevent the safe and orderly shutdown of the reactor.

The protection of safety-related SSCs is accomplished by one or more of the following:

a. Minimizing the sources of missiles by equipment design features that prevent missile generation

b. Orienting or physically separating potential missile sources away from safety-related equipment and components

c. Containing the potential missiles through the use of protective shields or barriers near the missile source or safety-related facility and equipment

d. Hardening of safety-related equipment and components to withstand missile impact when such impacts cannot be reasonably avoided by the methods listed above

reactor containment building

Table 3.2-1 is the list of SSCs. Essential SSCs outside ~~containment~~ to be protected from ~~missiles~~ are provided in Table 3.5-4. SSCs located inside the seismic Category I containment building are protected from missiles outside ~~containment~~ by thick concrete walls and are therefore omitted. General arrangement drawings showing locations of the SSCs are given in Section 1.2.

reactor containment building

externally generated missiles

3.5.1 Missile Selection and Description

For equipment with energy sources capable of generating a missile, the selection is based on the application of a single failure criterion to the retention features of the component.

Table 3.5-4

Outside Reactor Containment Building

Essential Systems and Components to Be Protected from Externally Generated Missiles

Protected Components	Missile Barrier
Chemical and Volume Control System Regenerative heat exchanger Letdown heat exchanger Charging pump mini-flow heat exchanger ~~Control volume tank~~ Volume control tank Charging pump (auxiliary charging pump) Boric acid storage tank Safety-related pipes and valves	Auxiliary Building
Class 1E electric systems, including on-site safety-related portions of the Emergency Diesel Generator System necessary to provide emergency electric power to the other systems identified in this table.	Auxiliary Building and EDG Building
Spent Fuel Pool Cooling ~~Cleanup~~ and System Spent Fuel Pool Heat Exchanger Spent Fuel Pool ~~Clean Up~~ Cooling Pump Safety-related Pipes and Valves	Auxiliary Building
Main Steam System MSIVs and pipe between MSIVs and containment	Auxiliary Building
Shutdown Cooling System Shutdown Cooling Pump and Heat Exchanger ~~RCPB~~ Pipes and Valves	~~Reactor Containment and~~ Auxiliary Building
Essential Service Water System Essential Service Water Pump Safety-related Pipes and Valves	ESW Building
Control Room HVAC System AHU, ACU Control, ~~Isolate~~ Isolation and Smoke Damper	Auxiliary Building
Component Cooling Water System Component Cooling Water Heat Exchanger Component Cooling Water Pump Component Cooling Water Makeup Pump Safety-related Pipes and Valves	Component Cooling Water Heat Exchanger Building
Auxiliary Feedwater System Auxiliary Feedwater Pump Auxiliary Feedwater Storage Tank Safety-related Pipes and Valves	Auxiliary Building

Safety-related

2.2.4 Compound Building

2.2.4.1 Design Description

The compound building is a non safety-related seismic Category II reinforced concrete structure which is located adjacent to the auxiliary building. The compound building houses the access control area, the hot machine shop, the radwaste treatment and drum removal areas, and the operation support center (OSC). The building is composed of reinforced concrete shear walls, interior walls, concrete slabs, girders and columns. The exterior shear walls and roof slabs play a role as a radiation shielding ~~and missile protection~~.

1. The seismic Category II compound building structure does not impair the ability of the safety-related SSCs to perform their safety-related functions.

2.2.4.2 Inspection, Test, Analyses, and Acceptance Criteria

The inspections, tests, analyses, and associated acceptance criteria for the compound building is specified in Table 2.2.4-1.

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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

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" in Subsections 3.7.3.7 and 3.7.5.

Impact on DCD

DCD Tier 2 Subsections 3.7.3.7, 3.7.5 and Table 1.8-2 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.

3.7.3.3 Analysis Procedures for Damping

The analysis procedure used to account for the damping in subsystems conforms with Subsections 3.7.1.2 and 3.7.2.15.

3.7.3.4 Three Components of Earthquake Motion

Seismic responses resulting from analysis of subsystems due to three components of earthquake motions are combined in the same manner as the seismic response resulting from the analysis of building structures as specified in Subsection 3.7.2.6.

3.7.3.5 Combination of Modal Responses

When a response spectrum method of analysis is used to analyze a subsystem, the maximum responses such as accelerations, shears, and moments in each mode are calculated regardless of time. If the frequencies of the modes are well separated, the SRSS method of mode combination gives acceptable results; however, where the structural frequencies are not well separated, the modes are combined in accordance with NRC RG 1.92.

3.7.3.6 Use of Constant Vertical Static Factors

In general, seismic Category I subsystems are analyzed in the vertical direction using the methods specified in Subsection 3.7.3.1. No constant vertical static factors are used for subsystems.

Delete

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

During an earthquake, buried structures such as ~~piping,~~ conduits~~,~~ and tunnels respond to various seismic waves propagating through the surrounding soil as well as to the dynamic differential movements of the buildings to which the structures are connected. The various waves associated with earthquake motion are P (compression) waves, S (shear) waves, and Rayleigh waves. The stresses in the buried structure are governed by the velocity and angle of incidence of these traveling waves. However, the wave types and their directions during an earthquake are very complex. For design purposes, the seismic-

Delete

induced upper-bound strains and corresponding stresses in the buried ~~piping and~~ concrete electrical ducts are calculated using expressions given by ASCE 4-98 (Reference 12).

Seismic design for buried seismic Category I structures takes the effect of wave propagation into consideration, based on the assumption that there is no movement of the buried structure remote from anchor points relative to the surrounding soil referred to in ASCE 4-98, Subsection 3.5.2. That is, the strain of the structure is the same as that of the surrounding soil medium, and the stress of the structure is calculated from the strain. Consideration of relative deformation between anchor points and the adjacent soil is applied to the design using the SRSS method for the three orthogonal stresses calculated from the relative displacements of the seismic analysis results.

The resistance effect of the surrounding soil for deformation or displacement of the buried structures, differential movement of the anchors, and shape or curvature changes of the bent parts is taken into account in the analysis. The structures can be modeled by beam elements supported by an elastic foundation representing the stiffness of the adjacent soil.

Lateral dynamic soil pressure on buried seismic Category I structures is calculated in accordance with elastic theory by Wood referred to in ASCE 4-98, Subsection 3.5.3. The effect of underground water is considered by applying the equation proposed by Matuo and O'Hara based on the theory from Westergaard that is referred to in ASCE 4-98, Subsection 3.5.3.1.

The COL applicant is to perform a seismic analysis of buried seismic Category I ~~piping,~~ conduits, and tunnels (COL 3.7(6)).

3.7.3.8 Methods for Seismic Analysis of Category I Concrete Dams

The COL applicant is to perform seismic analysis for any site-specific seismic Category I dams, if required (COL 3.7(5)).

3.7.3.9 Methods for Seismic Analysis of Above-ground Tanks

Above-ground seismic Category I tanks are generally large, flat-bottomed, single-shell, free-standing cylindrical tanks anchored to reinforced concrete pads or directly on a

COL 3.7(6) The COL applicant is to perform seismic analysis of buried seismic Category I ~~piping,~~ conduits, and tunnels.

Delete

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.

3.7.6 References

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.

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: 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.
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.

Delete

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Question No. 03.05.02-5

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 a missile induced failure of a nonsafety-related SSC should not prevent a safety-related SSC from completing its safety function.

DCD Tier 2, Section 3.5.2 does not have an evaluation or discussion of the adverse interactions from nonsafety-related SSCs. DCD Tier 2 Section 3.3.2.3 evaluates the effects of failures of structures or components not designed to extreme wind loads on nearby safety-related structures; however, Section3.3.2.3 only discusses the effects of wind load, and not missile impact.

The applicant is requested to provide a discussion or analysis in the DCD that determines whether missile induced failure of non safety-related SSCs could prevent a safety-related SSC from completing its safety function.

Response

It is understood that one of the basic design concepts is that failure of non-safety related SSC cannot affect the function of safety related SSCs. Since non-safety related SSCs can be added to the design by the COL applicant as well as defining the site specific missile profiles, subsections 3.5.2 and 3.5.4 will add a COL Item to ensure that failures of non-safety related SSCs due to missiles cannot prevent a safety related SSC from performing its safety function.

Impact on DCD

DCD subsections 3.5.2, 3.5.4 and Table 1.8-2 will be revised as indicated in the attached markups.

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.

Openings and penetrations through the exterior walls and roofs of seismic Category I structures and the location of equipment in the vicinity of such openings are arranged so that a missile passing through the opening would not prevent the safe shutdown of the plant and would not result in an offsite release of nuclides exceeding the limits defined in 10 CFR Part 100 (Reference 15). Otherwise, structural barriers composed of enclosures, missiles-resistant doors and covers, and physical protection features are designed to resist tornado missiles in accordance with the design procedures described in Subsection 3.5.3. Tornado and hurricane missiles are not postulated to strike more than once at a target location. Because of the robustness of the exterior wall, all seismic Category I structures are capable of withstanding the impact of each identified missile.

The COL applicant is to provide reasonable assurance that site-specific structures and components not designed for missile loads will not prevent safety related SSCs from performing their safety function(COL3.5(7)).

3.5.3 Barrier Design Procedures

Missile barriers, whether steel or concrete, are designed with sufficient strength and thickness to prevent local damage including perforation, spalling and scabbing, and overall damage. The procedures by which structures and barriers are designed to perform this function are presented in this subsection.

3.5.3.1 Evaluation of Local Structural Effects

The prediction of local damage in the immediate vicinity of an affected area depends on the basic material of construction of the barrier itself. Corresponding procedures are described below.

3.5.3.1.1 Concrete Barriers

Local damage prediction for concrete structures includes the estimation of the depth of missile penetration and an assessment of whether secondary missiles could be generated by spalling. Design criteria for concrete barriers are consistent with the National Defense Research Council (NDRC), "A Review of Procedures for the Analysis and Design of Concrete Structures to Resist Missile Impact Effects" (Reference 16). The modified NDRC formula is used to estimate the missile penetration depth, and barrier thickness to prevent perforation, spalling, and scabbing effects. The design thicknesses of missile barriers are 20 percent greater than the threshold values for the phenomenon being prevented. The design thicknesses also satisfy the minimum acceptable barrier thickness requirements for local damage prediction against tornado-generated missiles as well as

3.5.4 Combined License Information

COL 3.5(1) The COL applicant is to provide the procedure for heavy load transfer to strictly limit the transfer route inside and outside containment during plant maintenance and repair periods.

COL 3.5(2) The COL applicant is to perform an assessment of the orientation of the turbine generator of this and other unit(s) at multi-unit sites for the probability of missile generation using the evaluation of Subsection 3.5.1.3.2 to verify that essential SSCs are outside the low-trajectory turbine missile strike zone.

COL 3.5(3) The COL applicant is to evaluate site-specific hazards induced by external events that may produce more energetic missiles than tornado or hurricane missiles, and provide reasonable assurance that seismic Category I and II structures are designed to withstand these loads.

COL 3.5(4) The COL applicant is to evaluate the potential for site proximity explosions and missiles due to train explosions (including rocket effects), truck explosions, ship or barge explosions, industrial facilities, pipeline explosions, or military facilities.

COL 3.5(5) The COL applicant is to provide justification for the site-specific aircraft hazard and an aircraft hazard analysis in accordance with the requirements of NRC RG 1.206.

COL 3.5(7) The COL applicant is to provide reasonable assurance that site-specific structures and components not designed for missile loads will not prevent safety related SSCs from performing their safety function.

3.5.5 References

1. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," U.S. Nuclear Regulatory Commission.

2. NUREG-0800, Standard Review Plan, Section 3.5.1.1, "Internally Generated Missiles (Outside Containment)," Rev. 3, U.S. Nuclear Regulatory Commission, March 2007.

3. NUREG-0800, Standard Review Plan, Section 9.1.5, "Overhead Heavy Load Handling Systems," Rev. 1, U.S. Nuclear Regulatory Commission, March 2007.

Table 1.8-2 (3 of 29)

Item No.	Description
COL 3.4(1)	The COL applicant is to provide site-specific information on protection measures for the design-basis flood, as required in Subsection 2.4.10.
COL 3.4(2)	The COL applicant is to provide flooding analysis with flood protection and mitigation features from internal flooding for the CCW Heat Exchanger Building and ESW Building.
COL 3.4(3)	The COL applicant is to confirm that the potential site-specific external flooding events are bounded by design-basis flood values or otherwise demonstrate that the design is acceptable.
COL 3.4(4)	The COL applicant is to identify any site-specific physical models that could be used to predict prototype performance of hydraulic structures and systems.
COL 3.5(1)	The COL applicant is to provide the procedure for heavy load transfer to strictly limit the transfer route inside and outside containment during plant maintenance and repair periods.
COL 3.5(2)	The COL applicant is to perform an assessment of the orientation of the turbine generator of this and other unit(s) at multi-unit sites for the probability of missile generation using the evaluation of Subsection 3.5.1.3.2 to verify that essential SSCs are outside the low-trajectory turbine missile strike zone.
COL 3.5(3)	The COL applicant is to evaluate site-specific hazards induced by external events that may produce more energetic missiles than tornado or hurricane missiles, and provide reasonable assurance that seismic Category I and II structures are designed to withstand these loads.
COL 3.5(4)	The COL applicant is to evaluate the potential for site proximity explosions and missiles due to train explosions (including rocket effects), truck explosions, ship or barge explosions, industrial facilities, pipeline explosions, or military facilities.
COL 3.5(5)	The COL applicant is to provide justification for the site-specific aircraft hazard and an aircraft hazard analysis in accordance with the requirements of NRC RG 1.206.
COL 3.6(1)	The COL applicant is to identify the site-specific SSCs that are safety related or required for safe shutdown that are located near high- and moderate-energy piping systems and that are susceptible to the consequences of piping failures.
COL 3.6(2)	The COL applicant is to provide a list of site-specific high- and moderate-energy piping systems including layout drawings and protection features and the failure modes and effects analysis for safe shutdown due to the postulated HELBs.
COL 3.6(3)	The COL applicant is to confirm that the bases for the LBB acceptance criteria are satisfied by the final as-built design and materials of the piping systems as site-specific evaluations, and is to provide the information including LBB evaluation report for the verification of LBB analyses.
COL 3.6(4)	The COL applicant is to provide the procedure for initial filling and venting to avoid the known causes for water hammer in DVI line.
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 SSE site-specific ground motion in the free-field at the foundation level of the structure satisfy a peak ground acceleration of at least 0.1 g.

COL 3.5(7) The COL applicant is to provide reasonable assurance that site-specific structures and components not designed for missile loads will not prevent safety related SSCs from performing their safety function.

v. 0

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. 03.05.02-6

10 CFR 52.47 (b)(1) requires that a DC application contain the proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient to provide reasonable assurance that, if the inspection, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations.

DCD Tier 2, Section 3.5.2 states that all safety-related SSCs required to shutdown the reactor and maintain it in a safe shutdown condition are housed in seismic category I structures. DCD Tier 2, Table 3.5-4 identifies the ESW building and CCW heat exchanger buildings as providing a missile barrier for externally-generated missiles. DCD Tier 1, Table 2.2.1-3 indicates that the ESW and CCW structures are seismic category 1, however, DCD Tier 1, Section 2.2 does not contain any ITAAC to verify that the ESW and CCW heat exchanger structures have been built and constructed to withstand design-basis loads.

The applicant is requested to include appropriate ITAAC for the ESW building and CCW heat exchanger building structures in DCD Tier 1 in order to provide reasonable assurance that the structures are constructed consistent with the design certification.

Response

ITAAC Items that verify the ESW and CCW heat exchanger buildings are built and constructed to withstand the design basis loads will be added to the DCD Tier 1 document.

Impact on DCD

DCD Tier 1 subsections 2.2.8 and subsection 2.2.9 will be added 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.

APR1400 DCD TIER 1

Added

2.2.8 Essential Service Water Building

2.2.8.1 Design Description

The Essential Service Water (ESW) buildings are classified as seismic Category I buildings with a concrete structure. The ESW building houses essential service water pumps, cooling tower, and cooling tower basin. The structure is composed of basemat, floors, roofs, and shear walls. The ESW structure provides pump rooms that are separated by reinforced concrete walls and operating floor in which the equipment are installed.

The ESW building is designed and constructed to withstand the structural design basis loads associated with:

1. Normal plant operation (including dead loads, live loads, lateral earth pressure loads, and hydrostatic loads, hydrodynamic loads, and temperature loads)
2. External events (including rain, snow, wind, flood, hurricane generated missiles, and earthquake)
3. Internal events (including internal flooding, pipe rupture, equipment failure, and equipment failure generated missile)

    a) The ESW building is designed and constructed to withstand the structural design basis loads.

2.2.8.2 Inspection, Test, Analyses, and Acceptance Criteria

The inspections, tests, analyses, and associated acceptance criteria for the ESW building are specified in Table 2.2.8-1.

APR1400 DCD TIER 1

Table 2.2.8-1 Essential Service Water Building ITAAC

Design Commitment	Inspections, Tests, Analysis	Acceptance Criteria
1. The Essential Service Water Building is designed and constructed to withstand the structural design basis loads.	1. A structural analysis will be performed to reconcile the as-built ESW structure with the structural design basis loads.	1. A report exists and concludes that the ESW building can withstand the structural design basis loads.

Added

APR1400 DCD TIER 1

Added

2.2.9 Component Cooling Water Heat Exchanger Building

2.2.9.1 Design Description

The component cooling water (CCW) heat exchanger buildings next to each ESW building are classified as seismic Category I buildings with a concrete structure. The CCW heat exchanger building houses CCW heat exchangers, debris filters. The structure is composed of basemat, floors, roofs, and shear walls. The load resistance of the structure consists of slabs and shear walls combined with concrete columns and beams as the structural elements.

The CCW heat exchanger building is designed and constructed to withstand the structural design basis loads associated with:

1. Normal plant operation (including dead loads, live loads, lateral earth pressure loads, and equipment loads, including the effects of temperature and equipment vibration)
2. External events (including rain, snow, wind, flood, hurricane generated missiles, and earthquake)
3. Internal events (including flooding, pipe rupture, equipment failure, and equipment failure generated missile)

    a) The CCW heat exchanger buildings are designed and constructed to withstand the structural design basis loads.

2.2.9.2 Inspection, Test, Analyses, and Acceptance Criteria

The inspections, tests, analyses, and associated acceptance criteria for the CCW heat exchanger building are specified in Table 2.2.9-1.

APR1400 DCD TIER 1

Table 2.2.9-1 Component Cooling Water Heat Exchanger Building ITAAC

Design Commitment	Inspections, Tests, Analysis	Acceptance Criteria
1. The Component Cooling Water Heat Exchanger Buildings is designed and constructed to withstand the structural design basis loads.	1. A structural analysis will be performed to reconcile the as-built CCW heat exchanger structure with the structural design basis loads.	1. A report exists and concludes that the CCW heat exchanger building can withstand the structural design basis loads.

Added