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.:	**227-8274**
SRP Section:	**03.08.04 – Other Seismic Category I Structures**
Application Section:	**3.8.4**
Date of RAI Issue:	**09/25/2015**

Question No. 03.08.04-6

10 CFR 50.55a and 10 CFR Part 50, Appendix A, General Design Criteria (GDC) 1, 2, 4 and 5 provide the regulatory requirements for the design of the seismic Category I structures. Regulatory Guide 1.29, “Seismic Design Classification,” classifies spent fuel pool racks as Seismic Category I structures. Standard Review Plan (SRP) 3.8.4, Appendix D, “Guidance on Spent Fuel Pool Racks,” describes the acceptance criteria for the spent fuel pool racks.

In APR 1400 DCD Tier 2, Section 3.8.4.1.3, “Spent Fuel Storage Rack” the applicant provided general description of the spent fuel storage racks. In DCD Section 3.8.4.4, “Design and Analysis Procedures,” the applicant described that the spent fuel storage rack is designed to withstand the seismic loads applied simultaneously in orthogonal directions. In DCD Section 3.8.4.5, “Structural Acceptance Criteria,” the applicant described that the spent fuel storage rack meets the load combinations in Table 3.8-9C, “Spent Fuel Storage Rack – Design Loading Combination Table,” which is in accordance with SRP 3.8.4, Appendix D. However, the applicant did not reference DCD subsection 9.1.2, “New and Spent Fuel Storage,” in DCD Section 3.8.4 and vise-versa to provide an association between these sections. In addition, DCD Section 3.8.4 does not discuss the new fuel storage racks which are classified as seismic Category I and are also described in DCD subsection 9.1.2. Therefore, the applicant is requested to address the following, and include this information in the DCD:

Applicant should revise DCD Section 3.8.4 to also describe the new fuel storage racks and then revise DCD Section 3.8.4 and DCD subsection 9.1.2 to cross reference each other to associate these sections.

Response

The DCD will be revised to include the description of the new fuel storage rack in DCD Tier 2, Subsections 3.8.4.1.3, 3.8.4.4, 3.8.4.5, and Table 3.8-9C. A cross reference between DCD Tier 2, Subsections 3.8.4 and 9.1.2 will be added.

Since subsection 9.1.2 references Table 3.8-9C for loads and load combinations of the new fuel storage rack and spent fuel storage rack, cross reference for the description of the auxiliary building, including the new fuel storage pit and spent fuel pool, will be included in the attached markup.

Impact on DCD

1. DCD Tier 2, Subsections 3.8.4.1.3, 3.8.4.4, 3.8.4.5, and Table 3.8-9C will be revised, as indicated in Attachment 1.
2. DCD Tier 2, Subsections 9.1.2.2.1and 9.1.2.2.2 will be revised, as indicated in Attachment 2.

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.

The EDG building block is a seismic Category I reinforced concrete rectangular structure. The EDG building is approximately 19.2 m (63 ft) wide, 40.8 m (134 ft) long, and 10.7 m (35 ft) high and the DFOT building is 20.3 m (66 ft 8 in) wide, 21.6 m (71 ft) long, and 10.5 m (34 ft 6 in) high. The EDG building block is separated from the other buildings by an isolation gap of 900 mm (3 ft).

The EDG and DFOT buildings are both single-story structures with a basemat and roof slab. The buildings are founded on a 1.2 m (4 ft) thick continuous mat foundation. The roof slab for the EDG building is at elevation 135 ft 0 in, and the roof slab for the DFOT building is at elevation 97 ft 6 in.

The lateral load-resisting system of the two buildings is composed of a diaphragm slab at roof level and shear walls monolithically interconnected at the roof. The lateral loads, such as wind load and horizontal earthquake load, are transferred to the soil foundation through the shear walls and the basemat. The vertical load-resisting system in each of the buildings consists of columns and shear walls. The vertical loads due to gravity and earthquake are carried by slabs, floor beams, columns, and shear walls down to the basemat and soil foundation.

The outlines of the emergency diesel generator building are shown in Figures 1.2-20 and 1.2-22.

3.8.4.1.3 ~~Spent~~ Fuel Storage Rack s

The new fuel storage rack is bolted to embedments at the bottom of the new fuel storage pit and designed as a seismic Category I structure.

The spent fuel storage rack is designed as a free-standing type, i.e., neither anchored to the pool floor nor attached to the side walls, and designed as a seismic Category I structure. The new fuel storage rack and spent fuel storage rack ~~is~~ are designed to meet the following criteria even under the plant abnormal condition, such as seismic or fuel handling accident:

a. Protect the stored fuel against a physical damage

b. Maintain the stored fuel in a subcritical configuration

c. Maintain the capability to load and unload fuel assemblies

The designs of the new fuel storage rack and spent fuel storage rack are described in Subsection 9.1.2.

d. Maintain the store fuel in a coolable geometry (spent fuel storage rack only)

3.8.4.2 Applicable Codes, Standards, and Specifications

The following design codes, standards, specifications, regulations, Regulatory Guides, and other industry standards are used in the design, fabrication, construction, testing, and inspection of all seismic Category I structures other than the reactor containment building.

3.8.4.2.1 Design Codes and Standards

The design codes, standards, and regulations are listed in Table 3.8-1.

3.8.4.2.2 Regulatory Guides

The conformance of other seismic Category I structures to the applicable NRC RGs is addressed in Section 1.9. The NRC RGs that are applicable to the design of all seismic Category I structures other than the reactor containment building are NRC RGs 1.29 (Reference 28), 1.60, 1.61, 1.69 (Reference 29), 1.91 (Reference 30), 1.92, 1.115 (Reference 31), 1.122, 1.142, 1.143 (Reference 32), and 1.199.

3.8.4.2.3 Industry Standards

Nationally recognized industry standards, such as those published by ASTM, are used where practicable to define material properties, testing procedures, and fabrication and construction methods.

3.8.4.3 Loads and Load Combinations

This section presents the structural design load information for the APR1400 seismic Category I structures other than the reactor containment building. This load information consists of a summary list of major loads and load combinations. These load combinations are categorized on the basis of their nature, the probability of occurrence of each of the individual loads, and the probability of simultaneous occurrence of these loads to form a loading combination.

3.8.4.4 Design and Analysis Procedures

The auxiliary building and the emergency diesel generator building are composed of basemat foundation, rectangular walls, floor slabs, columns, and beams. The slabs and shearwalls in the building represent the primary lateral and vertical load-resisting system and are designed for both gravity- and seismic-related loads. Concrete slabs at various elevations in the building distribute lateral forces (via diaphragm action) to the shearwalls as in-plane loads and resist vertical forces (self-weight and seismic forces) as out-of-plane loads. Lateral loads are transferred down to the basemat foundation through shearwalls as in-plane shear forces and moments. Vertical loads on slabs are supported by concrete beams or walls. The loads are transferred to the basemat foundation by the walls and the frames composed of concrete beams and concrete columns. In addition to the structural components, components are designed to provide biological shielding and protection against tornado, hurricane, and turbine missiles.

Structural analyses of the concrete structures are performed by the ANSYS (Reference 9) or GTSTRUDL (Reference 34) program to determine their design forces due to various loads and load combinations.

Other seismic Category I concrete structures are analyzed and designed in accordance with the requirements of ACI 349 with exceptions of the requirements in NRC RG 1.142. Those requirements are incorporated into the design and accommodated in the load combinations described in Subsection 3.8.4.3 for concrete structures.

The design and analysis details for AB and EDGB, including the critical section, are discussed in Subsection 3.8A.2.4 and 3.8A.3.4, respectively.

Other seismic Category I steel structures are designed in accordance with AISC N690 using the allowable stress design method.

new fuel storage rack in the new fuel storage pit and

The spent fuel storage rack in the spent fuel pool ~~is~~ designed to withstand the seismic load that is seismic excitation along three (3) orthogonal directions is applied simultaneously for the design of the rack.

are

The designs of the new fuel storage rack and spent fuel storage rack are described in Subsection 9.1.2.

new fuel storage rack and

The structural acceptance criterion on the spent fuel storage rack is to meet the maximum allowable stress limits with given load combinations described in Table 3.8-9C in accordance with the NRC SRP 3.8.4, Appendix D. When the effects of seismic loads are considered, factors of safety against gross sliding and overturning of racks and rack modules under all probable service conditions is in accordance with the NRC SRP 3.8.5, subsection II.5.

3.8.4.6 Material, Quality Control, and Special Construction Techniques

This section contains information relating to the materials, quality control programs, and special construction techniques used in the fabrication and construction of the seismic Category I concrete and steel structures other than the reactor containment building.

3.8.4.6.1 Material

The seismic Category I structures are poured-in-place reinforced concrete structures. The major materials that are used in the construction are concrete, reinforcing bars, and structural steel.

3.8.4.6.1.1 Concrete

The minimum concrete compressive strength used in other seismic Category I structures is 34.5 MPa (5,000 psi) at 91 days. The basic ingredients of concrete are cement, fine aggregates, coarse aggregates, and mixing water. Admixtures may be used if needed. The concrete conforms with ACI 349 and ASTM C94.

The COL applicant is to determine the environmental condition associated with the durability of concrete structures and provide the concrete mix design to prevent concrete degradation caused by factors such as the reactions of sulfate and other chemicals, the corrosion of reinforcing bars, and the effect of reactive aggregates (COL 3.8(3)).

Cement is Type I and conforms with ASTM C150. In special circumstances, other approved cements may be used.

Aggregates conform with ASTM C33.

Table 3.8-9C

Spent Fuel Storage Rack – Design Loading Combination Table

Load Combination	Acceptance Limit
D + L D + L + T_o D + L + T_o + E	ASME Code Section III, Subsection NF Level A Service Limits for Class 3
D + L + T_a + E D + L + T_o + P_f	ASME Code Section III, Subsection NF Level B Service Limits for Class 3
D + L + T_a + E'	ASME Code Section III, Subsection NF Level D Service Limits for Class 3
D + L + F_d	The functional capability of the fuel racks should be demonstrated.

Where,

D : Deadweight including fuel assembly weight

L : Live load

E : Operating basis earthquake (OBE)

E' : Safe shutdown earthquake (SSE)

T_o : Differential temperature-induced loads, based on the most critical transient or steady-state condition under normal operation or shutdown conditions

T_a : Highest temperature associated with the postulated abnormal design conditions

F_d : Force caused by the accidental drop of the heaviest load from maximum possible height

P_f : Upward force on the racks caused by a postulated stuck fuel assembly

The applicable load and load combination of structural analysis for rack are described in Table 3.8-9C. The acceptance criteria are defined in ASME Code Section III, Subsection NF requirements for Class 3 component supports.

g. The spent fuel storage racks are not anchored to the pool floor or the wall. Clearances are allowed for rack tipping but the rack design and loading preclude rack overturning.

9.1.2.2 Facilities Description

9.1.2.2.1 New Fuel Storage

New Fuel Storage Pit

The approximately 5.18 m (17 ft) deep dry, unlined, reinforced, concrete, new fuel storage pit is designed to provide support for the new fuel storage racks. The new fuel storage pit is designed to maintain its structural integrity following an SSE and perform its intended function following a postulated event such as a fire, internal/external missiles, or pipe break. The walls surrounding the fuel handling area and new fuel storage pit protect the fuel from missiles generated inside the auxiliary building. The fuel handling area does not contain a credible source of missiles. The auxiliary building is a seismic Category I structure and is described in Subsection 1.2.14.2 and 3.8.4. Subsection 3.5 addresses missile sources and protection of the new fuel storage pit.

The structure of the new fuel storage pit supports the weight of the new fuel storage rack at the floor level. The new fuel storage racks (see Figure 9.1.2-1) consists of individual vertical cells interconnected to each other at several elevations. The rack module is anchored to the pit floor. The new fuel storage pit is covered by steel plates and an access platform. The access platform provides passage between racks for inspection of the new fuel. Both the steel plates and access platform are designed not to fall or collapse in the event of an SSE.

The new fuel storage pit is provided with a drain system, which is connected to the auxiliary building sump to minimize adverse effects on the new fuel storage pit from flooding due to an unanticipated release of water. The design of the drainage piping system includes a check valve to prevent backflow into the new fuel storage pit through the drainage system.

All cells of the new fuel storage racks are each designed with openings on the bottom that can drain an unanticipated release of water.

New Fuel Storage Rack

The rack is an assembly cells. The minimum edge-to-edge spacing between fuel assemblies in adjacent rows is maintained to keep the fuel assemblies in a subcritical configuration. The minimum spacing is satisfied even after allowances are made for the rack fabrication tolerances and the predicted deflections resulting from postulated accident conditions. The stainless steel used for fabrication of the new fuel storage racks is physically and chemically compatible with clad-fuel made of Zircaloy. All cells have openings on the bottom to facilitate drainage in a flooding accident. Each storage cell in the racks has a lead-in guide to facilitate fuel assembly insertion without damaging the assembly.

The racks are bolted to embedments at the bottom of the rack storage cavity to preclude tipping.

A new fuel inspection area is provided for the inspection of new fuel assemblies after they are withdrawn from their shipping container and before being placed in the new or spent fuel racks. It contains a seismic Category II inspection device to ascertain whether the fuel assemblies meet the dimensional requirements for installation into the reactor vessel. Visual inspection is also performed to check for shipping damage and to provide reasonable assurance that all protective wrapping material has been removed.

The center-to-center spacing between adjacent fuel assemblies is designed to be 35.5 cm (14 in) to the north and south and 35.5 cm (14 in) to the east and west to maintain subcriticality.

9.1.2.2.2 Spent Fuel Storage

Spent Fuel Pool

The auxiliary building, including the spent fuel handling area, is described in Subsection 3.8.4.

The spent fuel handling area consists of three separate water-filled fuel storage and handling areas—the spent fuel cask loading pit, SFP, and fuel transfer canal—and are designed as seismic Category I within the seismic Category I auxiliary building in accordance with Chapter 3, Table 3.2-1. The design of the spent fuel cooling system