# RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

**APR1400 Design Certification**

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

**Docket No. 52-046**

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|---|---|
| **RAI No.:** | **79-7990** |
| **SRP Section:** | **09.01.02 - New and Spent Fuel Storage** |
| **Application Section:** | **9.1.2** |
| **Date of RAI Issue:** | **07/15/2015** |

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## Question No. 09.01.02-1

GDC 2 requires that nuclear power plant SSCs important to safety be designed to withstand the effects of natural phenomena. The design of these SSCs also must reflect appropriate combinations of the effects of accidents and natural phenomena. NUREG-0800, SRP Section 9.1.2.III.2.C states that non-safety-related SSCs not designed to seismic Category I standards located in the vicinity of the new and spent fuel storage facilities are reviewed for whether their failure would cause an increase in Keff to more than the maximum allowable.

The staff determined that the applicant's DCD Tier 2, Section 9.1.2, does not discuss this design criterion for the new fuel storage pit (NFSP) or the spent fuel pool (SFP).

The applicant is requested to include in the DCD a discussion on how the APR1400 design prevents the failure of nearby non-seismic category I components from increasing the Keff in the NFSP and the SFP.

## Response

The new and spent fuel storage facilities including the racks and the Auxiliary Building housing those facilities are designed as Seismic Category I. In addition, the structures and equipment not designed to Seismic Category I in the vicinity of the new and spent fuel storage facilities, which may result in a potential damage to stored new and spent fuel, are designed as Seismic Category II by applying the criteria in DCD Tier 2, Section 3.2.1.b stating that the SSCs whose failure by virtue of physical proximity to safety-related equipment or structures could prevent a component or structure from fulfilling its required function are classified as Seismic Category II.

DCD, Tier 2, Table 3.2-1 presents the seismic classification for the SSCs related to the new and spent fuel storage facilities. The auxiliary building housing the fuel handling area is designed as Seismic Category I, and major components such HVAC, electrical design and fuel handling equipment related to the new and spent fuel storage facilities are designed as Seismic Category I or II. The piping in the area is also designed as Seismic Category II as a minimum in

order to prevent a mechanical impact on the NFSP and SFP rack caused by a safe shutdown earthquake (SSE).

The only Seismic Category III SSCs are the fuel handling tools and rails for the spent fuel handling machine used in the SFP. These will not cause an adverse effect on the spent fuel storage racks due to the following reasons.

- The fuel handling tools are designed as Seismic Category III, a drop analysis has been performed for the fuel assembly with its handling tools in order to maintain the mechanical integrity of rack and for minimizing the impact on the criticality due to the drop accident of the handling tools.
- The spent fuel handling machine is designed to prevent the derailment of the machine with the strength of rail mounting design in the event of an SSE even though the rails of the machine are designed as Seismic Category III.

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**Impact on DCD**

DCD Tier 2 Section 9.1.2.2.1 (Page 9.1-10) and Section 9.1.2.2.2 (Page 9.1-11) 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.

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. Subsection 3.5 addresses missile sources and protection of the new fuel storage pit. Non-seismic category I structures and equipment are designed to prevent potential damage to the stored new fuel from their failure following an SSE.

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 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

Non-seismic category I structures and equipment are designed to prevent potential damage to the stored spent fuel from their failure following an SSE.

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## Question No. 09.01.02-2

GDC 61 requires that new and spent fuel storage facilities provide assurance of adequate cooling of stored fuel, appropriate confinement of radioactive materials, and adequate radiation shielding for personnel.

NUREG-0800, SRP 9.1.2.III.2.B states that the new and spent fuel storage racks are designed so that a fuel assembly can be inserted only in specified locations. The pool design also should prevent placement of fuel assemblies in the adjacent regions external to the racks.

The applicant's description of the new storage racks and the spent fuel racks in DCD Tier 2, Section 9.1.2, does not discuss these features (such as interlocks, spacing, sizing, and associated operating procedures) that deny a fuel assembly from being placed outside a storage rack.

The applicant is requested to discuss in the DCD the design features that prevent the storage of fuel assemblies outside of the designated storage racks.

## Response

The new and spent fuel loading operations prevent the placement of a fuel assembly outside their respective racks.

A projecting concrete structure along the new fuel storage pit wall decreases the space between the new fuel storage pit wall and the edge of racks is provided to prevent a new fuel assembly from being stored outside of the new fuel storage racks. In addition, the hoist for handling the new fuel is manually operated by the operator in order to prevent potential misplacement of a new fuel assembly outside the rack.

The spent fuel handling machine is designed to move fuel assemblies only within its operating zone, established based on the outermost cells of the spent fuel storage racks. The design

features such as interlocks for limiting the movement of this machine are described in Tier 2, Section 9.1.4. Therefore, the potential misplacement of a spent fuel assembly outside the rack can be prevented.

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**Impact on DCD**

a) DCD Tier 2 Section 9.1.2.2.1, Page 9.1-10, will be revised as indicated in the attached markup (Attachment 1).

b) DCD Tier 2 Section 9.1.2.2.2, Page 9.1-12, will be revised as indicated in the attached markup (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 Reports.

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. 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.

The projecting concrete structure along the new fuel storage pit wall decreases the space between the new fuel storage pit wall and the edge of racks is provided to prevent a new fuel assembly from being stored outside of the new fuel storage racks.

including related connections to the SFP is described in Subsection 9.1.3. Each area can be sealed from its adjacent area by a hinged gate equipped with elastomer seals. The gates are designed as seismic Category I and allow the spent fuel cask loading pit and the fuel transfer canal to be drained without affecting the water level in the SFP. The gates are designed to withstand the water pressure in the SFP when the adjacent areas are dewatered.

The fuel transfer canal contains the fuel transfer system that is used for transporting fuel assemblies to and from the containment building. The spent fuel cask loading pit contains the spent fuel cask that is used for the transport of spent fuel assemblies from the fuel storage area in the auxiliary building.

All the preceding areas are stainless-steel-lined and concrete-walled pools that are integral parts of the fuel handling area building structure.

The SFP is approximately 7.31 m (42 ft) deep and made of reinforced concrete lined with stainless steel plate. The SFP is sufficiently deep that when a spent fuel assembly is being carried over the spent fuel storage racks by the spent fuel handling machine (SFHM) at its maximum lift height, there is sufficient water coverage to provide reasonable assurance that personnel on the SFHM or on the operating floor around the pool are not exposed to radiation levels exceeding 0.025 mSv per hour.

Piping penetrations to the SFP are at least 3.05 m (10 ft) above the top of the fuel assemblies seated in the spent fuel storage racks. The bottom of the gates that lead from the SFP to the fuel transfer canal and the spent fuel cask loading pit are above the top of the stored fuel assemblies. The spent fuel storage racks and the pool floor are designed to withstand the maximum impact energy of a fuel handling tool or a fuel assembly with its handling tool dropped from the maximum lift height. Redundant low- and high-level water alarms and temperature measurement instruments, as described in Subsection 9.1.3.5, minimize the potential for overfilling the pool. The ventilation system for the SFP area is described in Subsection 9.1.3.1.

Pipes that discharge into the spent fuel pool include siphon breaker holes as an anti-siphon device between the normal water level and the level of the SFP pumps' suction connection.

The makeup water to the SFP is provided by a safety Class 3, seismic Category I water supply, as described in Subsection 9.1.3.2.

The SFHM operating zone is established in order to prevent misplacement of the spent fuel assembly outside of the spent fuel storage racks. The design features of SFHM are described in Subsection 9.1.4.

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## Question No. 09.01.02-3

GDC 63, as applicable for the dry storage of new fuel, requires either criticality accident monitors pursuant to 10 CFR 70.24 or an acceptable method of preventing an increase in Keff beyond safe limits pursuant to 10 CFR 50.68. NUREG 0800, SRP Section 9.1.2 states that flood prevention in the new fuel storage pit (NFSP) is required to prevent submerging the new fuel in an unintentional moderator which may lead to an unintentional criticality.

NUREG-0800, SRP Section 9.1.2.III.2.L states that the drain system should be sized to handle the maximum flow from the rupture of the largest water pipe in the area.

In DCD Tier 2, Section 9.1.2, the applicant states that a drainage system is provided to prevent accumulation of water or other moderating media in the NFSP; however, the applicant's description of the drain system does not address the sizing criteria for the system or the seismic design of the piping.

The applicant is requested to include in the DCD the design description that demonstrate that the NFSP drain system is capable of handling the maximum flow from the rupture of the largest water pipe in the area, and therefore preventing conditions that may lead to an unintentional criticality.

## Response

There is no piping in the upper area of NFSP. In addition, there is no piping in the adjacent operating floor that would be considered a source of flooding. In addition, a curb with a height of approximately 4 inches is provided around the top of NFSP in order to prevent an inflow from the fuel handling area adjacent to the NFSP. Therefore, the NFSP is designed to prevent the conditions that may lead to an unintentional criticality due to the maximum flow from the rupture of the largest water pipe in the area.

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**Impact on DCD**

DCD Tier 2 Section 9.1.2.2.1, Page 9.1-10, 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.

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. 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.

A curb with an approximate height of 10.16 cm (4 in) is provided around the top of NFSP in order to prevent an inflow from the fuel handling area adjacent to the NFSP

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| **SRP Section:** | **09.01.02 - New and Spent Fuel Storage** |
| **Application Section:** | **9.1.2, Tier 1 2.7.4.1** |
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## Question No. 09.01.02-4

NUREG-0800, SRP Section 14.3 states that the type of information and the level of detail in Tier 1 are based on a graded approach commensurate with the safety significance of the structures, systems, and components (SSCs) for the design. The top-level information selected should include the principal performance characteristics and safety functions of the SSCs and should be verified appropriately by ITAAC. Design-specific and unique features of the facility should be considered carefully for inclusion in Tier 1.

The staff reviewed DCD Tier 1, Section 2.7.4.1, “New Fuel Storage,” which contains the specific ITAACs for the NFSP. Table 2.7.4.1-1, “New Fuel Storage ITAAC,” specifies the inspections, tests, analyses, and associated acceptance criteria for the new fuel storage racks. The staff evaluated the proposed ITAAC and identified that the system design description does not include discussion of the flood prevention features (drain sizing and back-flow prevention), and Table 2.7.4.1-1 does not verify the proper installation of the back flow prevention features. The staff also identified that DCD Tier 2 Section 9.1.2.2.1 identified that the minimum edge-to-edge spacing between fuel assemblies in adjacent rows is maintained to keep the fuel assemblies in a subcritical configuration. However, in DCD Tier 1 Section 2.7.4.1 the system design description does not discuss the minimum separation requirement and Table 2.7.4.1-1 does not include a test to verify this on the final installed new fuel racks. DCD Tier 2 Section 9.1.2 also describes the racks as seismic category I components, bolted to the pit floor to prevent tipping; this description is also missing from DCD Tier 1, as well as the test to confirm this.

The applicant is requested to update DCD Tier 1 Section 2.7.4.1 and DCD Tier 1 Table 2.7.4.1-1 to include:

a. a discussion on the flood prevention features and an ITAAC to confirm the proper installation of back-flow protection check valve,

b. the minimum edge-to-edge spacing between fuel assemblies in adjacent rows and an ITAAC to confirm installed racks have sufficient spacing to prevent criticality,

c. a discussion on the seismic design of the storage racks and an ITAAC to confirm installed racks are adequately design

d. a discussion on the anti-tipping feature of the racks (bolted to the floor) and an ITAAC to confirm installed racks are adequately installed.

## Response

The design description and ITAACs of Tier 1, Subsection 2.7.4.1.1 and Table 2.7.4.1-1 will be updated as follows;

a. Flood prevention features

The design description will include the flood prevention features that include a drain system with provisions for preventing backflow from other drains in the new fuel storage pit and curbs that are installed around the top edge of the pit for preventing the water inflow in the event of flooding in the adjacent fuel handling areas.

Item 1 in Table 2.7.4.1-1 will be modified to extend the scope of the ITAAC requirement from the new fuel storage racks to the new fuel storage facility including the new fuel storage pit and racks. It is considered that item 1 can be applied to verify the flooding prevention feature by inspecting the as-built design related to the functional arrangement in the updated design description without an additional ITTAC.

b. Minimum edge-to-edge spacing

The dimensions of the racks and cells, which include the minimum edge-to-edge spacing and center-to-center spacing between fuel assemblies, are determined based on the results of the criticality analysis and the structural and seismic analysis.

Item 2 in Table 2.7.4.1-1 will be modified to include inspection of the as-built new fuel storage rack dimensions including the center-to-center spacing in the column for Inspection, Test, Analysis and the column for Acceptance Criteria in order to confirm the installation of the new fuel storage racks preventing criticality during normal operation and the postulated accident conditions.

c. Seismic design

For providing an ITAAC confirming the seismic design of the installed new fuel storage racks, the revised item 2 in Table 2.7.4.1-1 included inspection of the new fuel storage rack dimensions determined based on the seismic analysis, as provided in item b above.

d. Anti-tipping feature of the racks

For preventing the tipping of the new fuel storage rack in the event of an SSE, the racks are bolted to the floor as presented in Tier 2, Section 9.1.2.

In Tier 1, the anti-tipping design will be included in the design description for ensuring the design feature of NFSR. In addition, it is considered that item 1 can be applied to

verify the anti-tipping feature by inspecting the as-built design related to the functional arrangement in the updated design description without an additional ITAAC, as provided in item ‘a’ above.

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**Impact on DCD**

DCD Tier 1 2.7.4.1.1 Table 2.7.4.1-1 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.

## 2.7.4 New and Spent Fuel Handling System

### 2.7.4.1 New Fuel Storage

#### 2.7.4.1.1 Design Description

A drain system with a provision preventing backflow from other drains is included in the new fuel storage pit and curbs are installed around the top edge of the pit for preventing the water in-flow in the event of flooding in the adjacent fuel handling areas.

The new fuel storage racks are non safety-related, but seismic Category I for integrity of the new fuel assemblies. The new fuel storage racks provide on-site dry storage for nuclear fuel assemblies. The new fuel storage racks are located in the new fuel storage pit in the fuel handling area of the auxiliary building.

The new fuel storage racks are designed and constructed to accommodate design basis load and load combinations including impact due to postulated fuel handling accidents in a sub-critical configuration.

to prevent tipping of the racks in the event of an SSE earthquake.

1. The functional arrangement of the new fuel storage racks is as described in the Design Description of Subsection 2.7.4.1.1.

   the new fuel storage facility including

2. The new fuel storage racks maintain the effective multiplication factor, $K_{eff}$, less than or equal to criticality limits during normal operation and the postulated accident conditions.

#### 2.7.4.1.2 Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.7.4.1-1 specifies the inspections, tests, analyses, and associated acceptance criteria for the new fuel storage racks.

Table 2.7.4.1-1

New Fuel Storage ITAAC

| Design Commitment | Inspections, Tests, Analyses | Acceptance Criteria |
|---|---|---|
| 1. The functional arrangement of the new fuel storage racks is as described in the Design Description of Subsection 2.7.4.1.1. | 1. Inspection of the as-built new fuel storage ~~racks~~ will be performed. | 1. The as-built new fuel storage ~~racks~~ conform with the functional arrangement as described in the Design Description of Subsection 2.7.4.1.1. |
| 2. The new fuel storage racks maintain the effective multiplication factor, $K_{eff}$, less than or equal to criticality limits during normal operation and the postulated accident conditions. | 2.a Inspection ~~and analysis~~ of the as-built new fuel storage racks will be performed. | 2.a ~~The calculated effective multiplication factor, $K_{eff}$, for the new fuel storage racks is less than or equal to 0.95 during normal operation and postulated accident conditions. In case of immersion in a foam or mist of the optimum moderation density, effective multiplication factor, $K_{eff}$, is less than or equal to 0.98.~~ |
| | 2.b Inspections will be performed to verify that the materials of the as-built new fuel storage racks conform with the criticality analysis of the new fuel storage racks. | 2.b The materials of the as-built new fuel storage racks conform with the criticality analysis of the new fuel storage racks. |

the new fuel storage facility including

facility

The as-built new fuel storage rack dimensions including the center-to-center spacing are consistent with the dimensions used in the criticality analysis and the structural and seismic analysis.

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## Question No. 09.01.02-5

GDC 61 requires that the fuel storage system be designed for adequate safety under anticipated operating and accident conditions. The fuel storage system must be designed with (1) the capability for appropriate periodic inspection and testing of components important to safety, (2) suitable shielding for radiation protection, (3) appropriate containment, confinement, and filtering capability, (4) residual heat removal that reflects the safety importance of decay heat and other residual heat removal, and (5) the capability to prevent a significant reduction in fuel storage coolant inventory under accident conditions.

DCD Tier 2, Section 9.1.2.2.2 indicates that the SFP is separated from the adjacent fuel-handling areas by a single swing gate, designed to allow the draining of the fuel transfer canal and the cask loading pit (CLP) without impacting SFP water level. Since the APR1400 design only has one gate in each location (unlike previous designs that relied on double gates) it is unclear to the staff how the applicant prevents a single operator error from opening the gates while the adjacent fuel-handling areas are drained, particularly when the fuel transfer equipment is undergoing maintenance.

The applicant is requested to discuss how the SFP design prevents and or mitigates the consequences of accidental opening of a gate.

## Response

The SFP is designed to have design provisions for two single seismic Category I gates and two sets of seismic Category I level instrumentation for preventing and mitigating the potential consequences of accidentally opening a single gate and maintain the SFP water level above the minimum water level specified in SRP 9.1.2.III.2.H.i.

1. The SFP has two gates for transferring a spent fuel assembly from or to the adjacent areas, which are the fuel transfer canal and the fuel cask loading pit. Both gates are designed as seismic Category I swing type gates, which can be opened in the direction

of the SFP and can be manually opened only when the related adjacent areas of the SFP are fully filled with water. A manual opening of SFP gate is prevented due to the hydraulic pressure from the SFP when either the fuel transfer canal or the fuel cask loading pit is drained. A single operator error from opening the gates is prevented by this design feature.

2. The SFP has also been designed so that the SFP water level is maintaining above the minimum water level stated in SRP 9.1.2.III.2.H.i even when one side of gate is accidently opened. The information on the SFP water level in the event of a gate failure will be presented in the response to RAI Question 09.01.02-8 (98-8051).

   The water level is monitored by two sets of safety-related level instrumentation interlocked with the SFP cleanup pumps as indicated in Tier 2, Fig 9.1.3-1. The SFP cleanup pumps will stop at the level set-point established above the aforementioned minimum water level. One of the SFP cleanup pumps will be operated after closing the related gate during cask loading pit draining or the related gate and the fuel transfer canal isolation valve V1000 during fuel transfer canal draining, in order to drain the adjacent fuel-handling areas. If the gate is accidentally opened while draining, the drain operation will automatically terminate at the SFP cleanup pump stop set-point between low level alarm and low-low level alarm set-point of the level instruments. In addition, there is an SFP make-up water provision for restoring the SFP water level to normal operating water level when the decrease of SFP water level is identified or alarmed from the SFP level instruments.

   Therefore, the SFP water level is maintained above the minimum water level stated in SRP 9.1.2.III.2.H.i, in case of a single operator error from opening the gates while the adjacent fuel handling areas are drained.

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**Impact on DCD**

There is no impact on the DCD.

**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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| **SRP Section:** | **09.01.02 - New and Spent Fuel Storage** |
| **Application Section:** | |
| **Date of RAI Issue:** | **07/15/2015** |

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## Question No. 09.01.02-6

GDC 61 requires that the fuel storage system be designed for adequate safety under anticipated operating and accident conditions. The fuel storage system must be designed with (1) the capability for appropriate periodic inspection and testing of components important to safety, (2) suitable shielding for radiation protection, (3) appropriate containment, confinement, and filtering capability, (4) residual heat removal that reflects the safety importance of decay heat and other residual heat removal, and (5) the capability to prevent a significant reduction in fuel storage coolant inventory under accident conditions.

NUREG-0800, SRP 9.1.2.III.2.I states that the thermal-hydraulic analysis of the flow through the spent fuel racks must be adequate for decay heat removal from the spent fuel assemblies during all anticipated operating and accident conditions. Furthermore, the analysis should show adequate natural circulation of the coolant during all anticipated operating conditions, including full core offloads during refueling, to prevent nucleate boiling for all fuel assemblies.

DCD Tier 2, Section 9.1.2.3.2 states that the thermal-hydraulic analysis demonstrates that the flow through the spent fuel rack is adequate for decay heat removal from the spent fuel assemblies during anticipated operating conditions. However, the applicant has not provided this report for evaluation.

The applicant is requested to provide the report for staff evaluation.

## Response

For the NRC staff audit of the spent fuel rack (SFR) and the spent fuel pool (SFP) cooling conducted in July, the applicant had submitted the thermal-hydraulic analysis report for SFR & SFP for review in the ERR.

As a result of the audit, the applicant received follow-up questions from the NRC staff. After addressing the questions, the applicant will submit the thermal-hydraulic analysis report in the form of a technical report.

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**Impact on DCD**

There is no impact on the DCD.

**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.

# RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

**APR1400 Design Certification**

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

**Docket No. 52-046**

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|---|---|
| **RAI No.:** | **79-7990** |
| **SRP Section:** | **09.01.02 - New and Spent Fuel Storage** |
| **Application Section:** | **9.1.2, Tier 1 2.7.4.2** |
| **Date of RAI Issue:** | **07/15/2015** |

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## Question No. 09.01.02-7

NUREG-0800, SRP Section 14.3 states that the type of information and the level of detail in Tier 1 are based on a graded approach commensurate with the safety significance of the structures, systems, and components (SSCs) for the design. The top-level information selected should include the principal performance characteristics and safety functions of the SSCs and should be verified appropriately by ITAAC. Design-specific and unique features of the facility should be considered carefully for inclusion in Tier 1.

The staff reviewed DCD Tier 1 Section 2.7.4.2, “Spent Fuel Storage,” which contains the specific ITAACs for the NFSP. Table 2.7.4.2-1, “Spent Fuel Storage ITAAC,” specifies the inspections, tests, analyses, and associated acceptance criteria for the new fuel storage racks. The staff evaluated the proposed ITAAC and identified that the system design description does not contains sufficient relevant design information discussed in DCD Tier 2 Section 9.1.2.

The applicant is requested to update DCD Tier 1 Section 2.7.4.2 in order to include:

a. a discussion on the elevation of the bottom of the gates, weirs and doors and how they relate to the top of the stored fuel, (no opening below the top of the stored fuel)

b. discussion on pool dimensions (minimum depth and volume)

c. a discussion on the pool liner seismic design

d. a discussion on the design criteria for all the SFP gates (leak tightness and seismic design)

The applicant is also requested to update FSAR Tier 1 Table 2.7.4.2-1 in order to include ITAAC to:

e. confirm there are no opening, gate, drain, or connection below the top of the stored fuel

f. confirm as-built pool dimensions

g. confirm proper installation of siphon breakers

h. confirm SFP liner was properly installed as Seismic Category I and leak tight

i. confirm SFP gates were properly installed as Seismic Category I, leak tight, and capable of holding water pressure

## Response

The design description in Tier 1 Subsection 2.7.4.2.1 will be revised to include the detailed description for the spent fuel pool (SFP). The scope of the design and the ITAAC requirements will be extended from the spent fuel storage racks to the spent fuel storage facility, including the design of spent fuel pool. The design description will include the information provided below:

a. The bottom of the gates, weirs and doors are located above the top of the stored fuel

b. The SFP is designed to have sufficient dimensions to maintain the proper water level and volume for spent fuel cooling and radiation shielding

c. The SFP liner plate is seismic Category I. The liner plate is fabricated from stainless steel material and utilizes a welded construction for minimizing potential leakage. A liner leakage collection system is provided to collect possible leakage from liner plate welds on the pool walls and floor.

d. The SFP gates for transferring fuel to the adjacent fuel handling area are seismic Category I. The gates are designed to minimize potential leakage and withstand the water pressure in the spent fuel pool. The water level in the spent fuel pool remains 3 m (10 ft) above the top of fuel assemblies in the event of a single gate failure.

A description on the location of the siphon breaker hole will also be included in the design description.

Item 1 of Tier 1 Table 2.7.4.2-1, which is the spent fuel storage ITAAC, will be modified to extend the scope of the ITAAC requirement from the spent fuel storage racks to the spent fuel storage facility, including spent fuel pool, liner plate, gates and racks. It is considered that Item 1 can be applied to confirm the proper installation of spent fuel storage facility for items e through i, as listed in this question, by inspecting the as-built designs related to the functional arrangement in the updated design description without an additional ITAAC.

The design description in Tier 1 Subsection 2.7.4.2.1 and the Table 2.7.4.2-1 will be revised as indicated on the attached markup.

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**Impact on DCD**

DCD Tier 1 2.7.4.2.1 Table 2.7.4.2-1 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.

The function of spent fuel facility is to store spent fuel in the spent fuel pool of the auxiliary building, which is seismic Category I. The spent fuel pool is designed to have sufficient dimensions to maintain the proper water level and volume for spent fuel cooling and radiation shielding. The spent fuel pool liner plate is classified as seismic Category I. The liner plate is fabricated from stainless steel material and utilizes a welded construction for minimizing potential leakage. A liner leakage collection system is provided to collect possible leakage from liner plate welds on the pool walls and floor.

2.7.4.2 Spent Fuel Storage

2.7.4.2.1 Design Description

The spent fuel storage racks are non safety-related, but seismic Category I for integrity of the spent fuel assemblies. The spent fuel storage racks provide on-site storage capability for a core offload during the design life. The spent fuel storage racks are located in the spent fuel pool ~~in the fuel handling area of the auxiliary building.~~ All piping penetrating the spent fuel pool are located approximately 3 m (10 ft) above the top of irradiated fuel assemblies seated in the storage racks, and all piping extending down into the spent fuel pool have siphon breaker holes at or above this level.

installed on the piping inside the spent fuel pool

The spent fuel storage racks are designed and constructed to accommodate design basis load and load combinations including impact due to postulated fuel handling accidents in a subcritical configuration.

the spent fuel storage facility including the spent fuel pool liner plate, gates and racks

1. The functional arrangement of ~~the spent fuel storage racks~~ is as described in the Design Description of Subsection 2.7.4.2.1.

2. The spent fuel storage racks maintain the effective multiplication factor, $K_{eff}$, less than or equal to criticality limits during normal operation and the postulated accident conditions.

2.7.4.2.2 Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.7.4.2-1 specifies the inspections, tests, analyses, and associated acceptance criteria for the spent fuel storage racks.

. The spent fuel pool has no opening, gate, drain, or connection below the top of the stored fuel. The spent fuel pool gates for transferring fuel to the adjacent fuel handling area are seismic Category I. The gates are designed to minimize potential leakage and withstand the water pressure in the spent fuel pool. The water level in the spent fuel pool remains 3 m (10 ft) above the top of fuel assemblies in the event of a single gate failure.

the spent fuel storage facility including the spent fuel pool liner plate, gates and racks

Table 2.7.4.2-1

Spent Fuel Storage ITAAC

| Design Commitment | Inspections, Tests, Analyses | Acceptance Criteria |
|---|---|---|
| 1. The functional arrangement of ~~the spent fuel storage racks~~ is as described in the Design Description of Subsection 2.7.4.2.1. | 1. Inspection of the as-built spent fuel storage ~~racks~~ will be performed. facility | 1. The as-built spent fuel storage ~~racks~~ conform with the functional arrangement as described in the Design Description of Subsection 2.7.4.2.1. |
| 2. The spent fuel storage racks maintain the effective multiplication factor, $K_{eff}$, less than or equal to criticality limits during normal operation and the postulated accident conditions. | 2.a Inspection and analysis of the as-built spent fuel storage racks will be performed. | 2.a The calculated effective multiplication factor, $K_{eff}$, for the spent fuel storage racks is less than or equal to 0.95 during normal operation and postulated accident conditions. |
| | 2.b Inspections will be performed to verify that the materials of the as-built spent fuel storage racks conform with the criticality analysis of the spent fuel storage racks. | 2.b The materials of the as built spent fuel storage racks conform with the criticality analysis of the spent fuel storage racks. |