REVISED RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

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

Docket No. 52-046

RAI No.:	**161-7992**
SRP Section:	**09.01.04 – LIGHT LOAD HANDLING SYSTEM AND REFUELING CAVITY DESIGN**
Application Section:	**09.01.04**
Date of RAI Issue:	**08/20/2015**

Question No. 09.01.04-1

a. NUREG-0800, SRP 9.1.4.III.3.D.i states that the refueling cavity should be provided with a robust refueling cavity water seal that is built to appropriate engineering codes, or manufacturing association standards, will not catastrophically fail during a seismic event, and is not vulnerable to a single failure (passive or active) that results in a gross failure that significantly affects the refueling cavity water level.
The staff noted that the refueling cavity seal has been classified as Seismic category II component. DCD, Tier 2 Section 3.2.1, “Seismic Classification,” defines seismic category II as ‘‘designed to preclude a gross structural failure resulting from an SSE that could degrade the ability of an adjacent safety-related SSC to function to an unacceptable level or result in incapacitating injuries to personnel in the main control room (MCR).” This definition does not preclude the seal from failing and draining the refueling cavity. Therefore, the staff requests the applicant to upgrade the seismic design of the refueling cavity seal to seismic category I, or to provide a justification as to how the seal design prevents a failure that significantly affects the refueling cavity water level.

b. NUREG-0800, SRP 9.1.4.III.3.D.ii states that the refueling cavity design should include an evaluation of all paths capable of inadvertently draining the refueling cavity, the potential for, and consequences of the refueling cavity to drain through these paths. The design of the cavity should be configured to assure sufficient water will be retained above fuel temporarily placed in the upender or other safe laydown location such that the worst-case draindown scenario will allow operators to add inventory before: (1) the loss of adequate shielding for personnel, (2) postulated boiling of the water, and (3) top of active fuel is reached.
The staff determined that the applicant has not provided an evaluation of all the paths capable of inadvertently draining the refueling cavity, the potential for, and consequences of the refueling cavity to drain through these paths.

Therefore, the staff requests the applicant to complete a refueling cavity drain evaluation, as described in SRP 9.1.4.III.3.D.ii.

c. NUREG-0800, SRP 9.1.4.III.3.D.iii states that the refueling cavity design should include provisions so that any leakage that occurs is readily identified and corrected. The applicant proposed a license condition (LC 9.1 (4)) that will require a COL applicant to provide plant procedures for preventing and mitigating inadvertent refueling cavity drain down events, maintenance procedures for the maintenance and inspection of refueling pool seal, and emergency response procedures for the proper measures during pool drain down events. The staff determined that the applicant has not described the design provision for readily identifying leakage, as described in SRP 9.1.4.III.3.D.iii.
Therefore, the staff requests the applicant to describe the design provisions so that any leakage that occurs is readily identified.

d. DCD Tier 2 Table 3.2-1 describes the refueling pool seal as NNS. The applicant provided the safety class definitions in DCD Tier 2 Section 3.2.3.
The staff finds that the refueling pool seal provides assurance of required cooling for the fuel temporarily stored in the cavity (upender); therefore, the refueling pool seal meets the definition of Safety Class 3 (SC-3).
Therefore, the staff requests the applicant to reclassify the refueling pool seal as a SC-3 or to provide justification for retaining the NNS classification.

Response – (Rev.1)

Item No. a

The refueling pool seal is a steel structure. The refueling pool seal consists of several components, such as seal plate, inner and outer supports, rib plates and inner and outer flexures (refer to Figure 1). These components are made of stainless steel plates and continuously welded together. The refueling pool seal is designed to permanently seal the annulus between the reactor vessel seal ledge and the embedment ring in the refueling pool floor.

NUREG-0800, SRP 9.1.4.III.3.D.i states that the refueling cavity should be provided with a robust refueling cavity water seal that is built to appropriate engineering codes, or manufacturing association standards, will not catastrophically fail during a seismic event, and is not vulnerable to a single failure (passive or active) that results in a gross failure that significantly affects the refueling cavity water level.

According to the definition of seismic category II which is designed to preclude a gross structural failure resulting from an SSE, the potential leakage through the refueling pool seal is considered even though the refueling pool seal maintains its structural integrity. The assumed leakage path may be a crack on the structure or weld failure which would cause negligible leakage.

When the refueling pool seal is initially installed, its welds are non-destructively inspected to confirm that there are no weld deficiencies. Therefore, the probability of leakage through the refueling pool seal is very low. If leakage occurs through the refueling pool seal, the operator

can readily identify the leakage by monitoring various water level instruments. Then, the operator can take the appropriate actions to add makeup water to the refueling pool inventory. As a result, the refueling pool water level can be maintained to have sufficient inventory. Therefore, the seismic category II classification of the refueling pool seal as non-safety equipment satisfies the related regulation requirements, such as NUREG-8000. But, to ensure that the refueling pool water level is not affected by a failure, KHNP will upgrade the seismic class of the refueling pool seal to seismic category I for this design certification.

Item No. b

As the worst-case drain-down scenario, the applicant considered the case that the spent fuel assembly is already located in the cavity fuel carrier and another fuel assembly in transit, as shown in Figure 2. The potential leakage pathways, refueling water monitoring and make-up system for refueling cavity drain evaluation are described belows:

1. Pathways capable of draining the refueling cavity

a) Refueling pool seal

The refueling pool seal will be designed to the seismic category I. A leakage resulting from an SSE is not considered in the refueling cavity. Furthermore, the operator checks the structural integrity of the seal by the visual inspection before the refueling cavity is filled during every refueling period. It was concluded that the leakage through the refueling pool would not occur.

b) Inadvertent draining due to system misalignments

- The spent fuel pool cooling and cleanup system is a potential pathway for inadvertently draining the refueling cavity. For the system misalignments, sufficient time is available to detect and isolate the drain path and to place a handled fuel assembly, if necessary, in a safe storage location.

- The shutdown cooling system (SCS) is designed such that inadvertent draining of water from the refueling pool is prevented. According to DCD Tier 2 Figure 6.3.2-1, the potential flow paths are from SCS suction to the in-containment refueling water storage tank (IRWST) through the safety injection pump suction line and from the SCS suction line to the IRWST through shutdown cooling pump (SCP) test line. For flow path to IRWST through the safety injection pump suction line, check valves prevent draining if the normally closed valve is opened inadvertently. For the other possible flow path, three isolation valves in the SCP test line are closed normally and the probability of inadvertent draining due to opening three isolation valves simultaneously is extremely low.

2. Operator cognition system

The operator can readily identify the drainage from the refueling pool by monitoring various water levels such as refueling pool level, ICI cavity sump level, reactor cavity level, and

spent fuel pool level. The level instruments for each area are described in the response to question c.

3. Make up water system

After the operator identifies that significant inventory loss has occurred in the refueling pool, the operator takes the appropriate recovery actions to add makeup to the refueling pool inventory. In the APR1400 design, at least three available means of adding inventory to the refueling pool are available whenever the refueling pool is in a reduced inventory condition. One is IRWST and the other is Boric Acid Storage Tank (BAST). The shutdown cooling pump or containment spray pump can directly inject borated water through the direct vessel injection (DVI) nozzles to the refueling pool from IRWST. Use of the charging pump or boric acid makeup pump also provides the flow delivery to refueling pool from BAST. If no method of pumped inventory addition is available, a source for gravity feed inventory addition is used via the Safety Injection Tanks (SITs). This is considered only as a last resort.

Due to the above-mentioned system, the refueling cavity is guaranteed to have sufficient water. If an inadvertent drain down event occurs, operators will be able to add inventory before: (1) the loss of adequate shielding for personnel, (2) postulated boiling of the water, and (3) top of active fuel is reached.

Item No. c

An inadvertent drain down of the refueling pool will be detected visually or by installed instrumentation. Instrumentation used to detect reduced inventory in the refueling pool is outlined below.

1. Refueling water level monitor

The Refueling Water Level Indication System (RWLIS) consists of the Permanent Refueling Water Level Indication System (PRWLIS), the Local Refueling Water Level Indication System (LRWLIS) and Ultrasonic Level Measurement System (ULMS). Two trains provide the means of monitoring water level for each RCS loop in the MCR. The RWLIS includes an alarm function to alert operator to low-low, low and high RCS water level. The PRWLIS which consists of redundant and independent wide and narrow range level sensors is provided for continuous monitoring of RCS level. The wide range instrument of PRWLIS is to monitor RCS water level from about 20 % of the pressurizer to the bottom of the hot leg and is available with the head on and off the vessel. The narrow range PRWLIS is to monitor RCS water level inside hot leg (from hot leg top to 2 in above of hot leg bottom).

Each train of the LRWLIS is a sight glass which has a minimum visible span of 150 inch (3.81 m) above the bottom of the hot leg covering the reduced inventory operations.

The ULMS is temporarily installed on the both hot legs to monitor the water level of hot leg during mid-loop operation..

2. Refueling pool level instrument

   A temporary refueling pool level instrument is installed in the refueling pool. During the drain down of the refueling pool, the refueling pool level is monitored locally, in the MCR , and RSR. A low level alarm is provided in the MCR and RSR to allow the operator to take appropriate action.

3. Spent fuel pool level instruments

   Two safety-related level instruments are installed in the spent fuel pool. The spent fuel pool level is monitored locally, in the MCR, and the RSR. A low level alarm and low-low level alarm are provided in the MCR and RSR to allow the operator to take appropriate action.

4. In-Core Instrumentation (ICI) cavity sump level instruments

   Two ICI cavity sump level instruments are installed in the ICI cavity sump. During a drain down event caused by a failure of the refueling pool seal, the ICI cavity sump level increases. The level indication is provided in radwaste control room, the MCR, and the RSR to allow the operator to take appropriate action.

5. Reactor cavity level instruments

   Four reactor cavity water level instruments are installed in the reactor cavity. During a drain down event caused by a failure of the refueling pool seal, the water level of reactor cavity decreases. The level indication is provided in the MCR and RSR to allow the operator to take appropriate makeup action.

Item no. d

In accordance with ANSI/ANS-51.1(1983)[1)], the equipment such as the spent fuel storage pool and cooling system, which is needed to ensure required cooling for liquid-cooled stored fuel, is classified as Safety Class 3.
However, the refueling pool seal, which is an only structure for sealing the refueling cavity does not have this safety function which provides cooling for fuel stored temporarily in the fuel cavity (on the upender).

The refueling pool seal is in the category of the fuel handling system in accordance with the ANSI/ANS-57.1(1980) Sec.6.1[2)]. Design requirements for light water reactor fuel handling system shall be meet the ANSI/ANS-57.1(1980), which is stated on ANSI/ANS-51.1(1983).

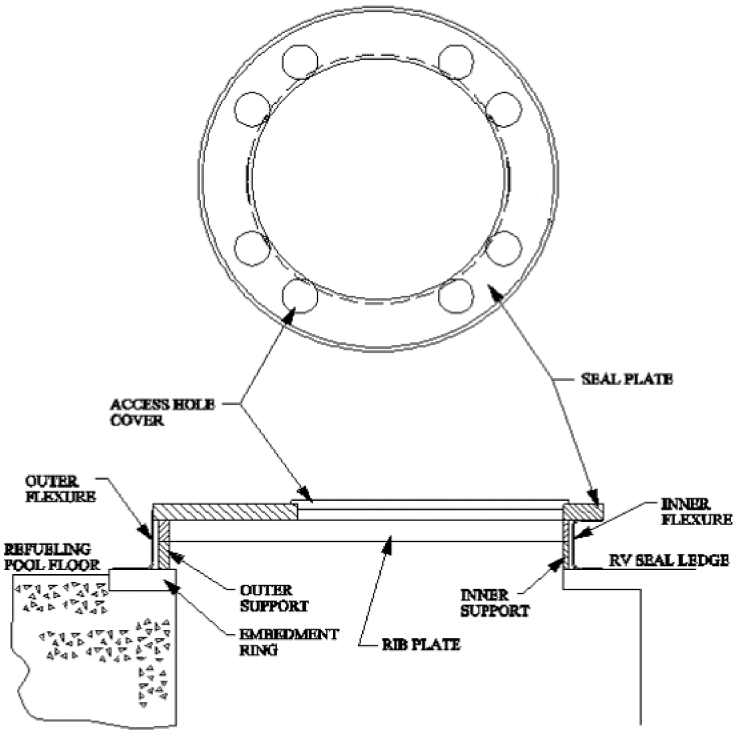
Therefore, refueling pool seal is classified as Non Nuclear Safety Class component.

Also, the permanently welded refueling pool seal was classified as non Nuclear Safety Class in the Design Control Document of SYSTEM 80+, which is the reference plant of APR1400 and certified by the NRC.

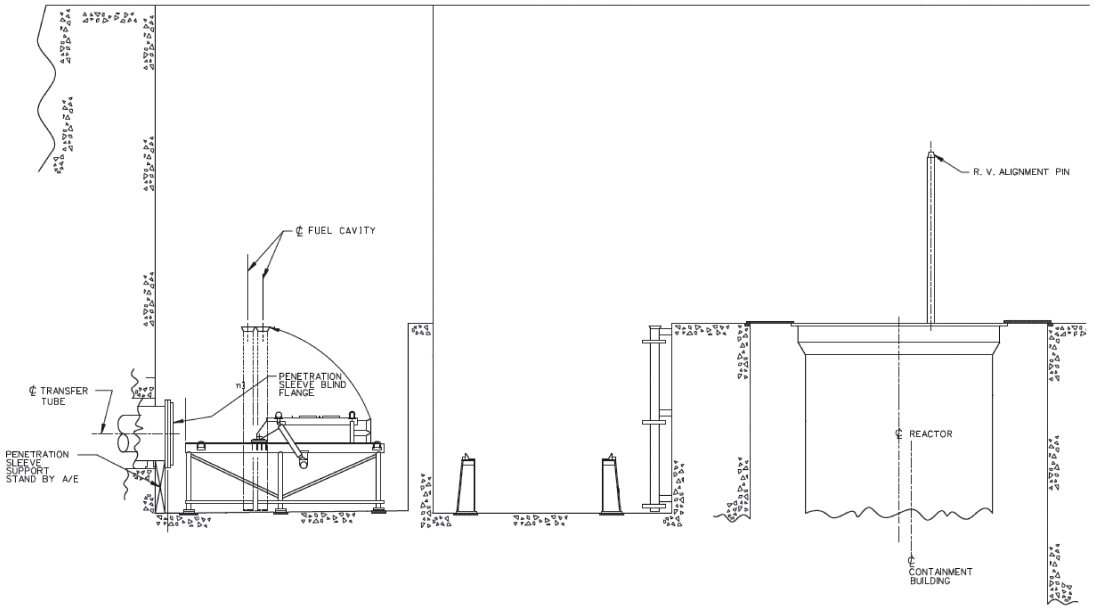
NOTE :

1) 3.3.1.3 j : Ensure required cooling for liquid-cooled stored fuel (e.g., spent fuel storage pool and cooling system)

2) 6.1 Safety Classification and Design Standards : That portion of the transfer tube which serves as part of the primary reactor containment shall be designated Safety Class 2 (SC-2), Seismic Category I, Shall meet the requirements of American National Standard Containment Isolation Provisions for Fluid Systems, N271-1976(ANS-56.2)[5], and shall be designed and fabricated in accordance with the ASME Boiler and Pressure Vessel Code, Section III, “Rules for Construction of Nuclear Power Plant Components”[6] and a quality assurance program meeting the applicable requirements of American National Standard Quality Assurance Requirements for Nuclear Power Plants (ANSI/ASME N45.2-1971)[7]. All other components of the fuel handling system shall be designated as non-nuclear safety (NNS) and shall be designed and fabricated to industry standard requirements which shall be, as a minimum: ~ .



< Figure 1 Configuration of Refueling Pool Seal Assembly >



< Figure 2 Layout of Refueling Cavity>

Impact on DCD

DCD Table 3.2-1 will be revised as indicated in the Attachment 1. Also, Subsection 9.1.4.2.1.11 and Figure 9.1.4-15 in DCD Tier 2 will be revised and added 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 Specification.

Impact on Technical/Topical/Environmental Reports

There is no impact on the Technical/Topical/Environmental Report.

Table 3.2-1 (29 of 86)

Item No. / Principal SSCs	Location[2]	Safety Class	Quality Group	Codes and Standards	10 CFR 50, App. B[3]	Seismic Category	Remarks
j. Fuel transfer tube	RCB, AB	NNS	D	N/A	A	II	(3)(d)
k. Refueling machine bridge rails and spent fuel handling machine bridge rails	RCB, AB	NNS	D	N/A	N/A	III	
l. CEA elevator	RCB	NNS	D	N/A	A	II	(3)(d)
m. CEA cutter	RCB	NNS	D	N/A	N/A	III	
n. CEA change platform	RCB	NNS	D	N/A	A	II	(3)(d)
o. Upper guide structure lifting rig	RCB	NNS	D	ASME Sec. III NF - 2007 with 2008 addenda	A	II	(3)(d)
p. Core barrel lifting rig	RCB	NNS	D	ASME Sec. III NF - 2007 with 2008 addenda	A	II	(3)(d)
q. Underwater television	RCB	NNS	N/A	N/A	N/A	III	
r. Refueling pool seal	RCB	NNS	D	N/A	A	~~II~~ I	~~(3)(d)~~
s. In-core instrumentation cutter	RCB	NNS	D	N/A	N/A	III	
t. Gripper operating tool	RCB	NNS	D	N/A	N/A	III	
u. CEA handling tool	RCB	NNS	D	N/A	N/A	III	
v. Refueling supervisory console	RCB	NNS	D	N/A	N/A	III	
w. Refueling simulator	AB	NNS	D	N/A	N/A	III	
x. ICI guide tube	RCB	SC-1	A	ASME Sec. III NB -2007 with 2008 addenda	Yes	I	
aa. ICI guide tube support	RCB	SC-1	A	ASME Sec. III NF -2007 with 2008 addenda	Yes	I	
ab. ICI insertion and removal tool	RCB	NNS	D	N/A	N/A	III	
ac. ICI sealing housing	RCB	SC-1	A	ASME Sec. III NB -2007 with 2008 addenda	Yes	I	

Delete

LIST OF FIGURES

Add

9.1.4.2.1.11 Refueling Pool Seal

The refueling pool seal, as shown in Figure 9.1.4-15,

The refueling pool seal is designed to connect the RV seal ledge to the embedment ring in the refueling cavity floor to permit filling of the refueling cavity for fuel handling activities. During normal refueling operations, the pool seal is designed to withstand the pressure resulting from a water head that is the full depth of the refueling cavity from the elevation of the operating floor. Pool seal welds required for structural integrity or sealing integrity are inspectable. The openings for ex-core detector servicing and inspection and for cavity ventilation are designed to permit pressure testing to verify their integrity before filling with the refueling water. The pool seal is designed for the impact of a fuel assembly drop from the maximum height. Transfer of heavy loads over the RV is prohibited during fuel handling operations. Therefore, the drop of such loads is not considered credible in the design of the pool seal. The COL applicant is to provide plant procedures for preventing and mitigating inadvertent reactor cavity drain down events, maintenance procedures for the maintenance and inspection of refueling pool seal, and emergency response procedures for the proper measures during pool drain down events (COL 9.1 (4)).

9.1.4.2.1.12 In-Core Instrumentation and Control Element Assembly Cutters

A portable underwater hydraulic cutter, similar to that shown in Figure 9.1.4-14, is provided to cut the irradiated CEAs into lengths that are suitable for conveyance to the fuel handling area of auxiliary building using CEA/ICI transport container. A second cutter is used for disposal of the ICI leads.

9.1.4.2.1.13 Gripper Operating Tool

The gripper operating tool is approximately 5.18 m (17 ft) long and consists of two concentric tubes with a funnel at the end to facilitate engagement with the CEA extension shafts. When installed, pins attached to the outer tube are engaged with the extension shaft. The inner tube of the tool is then lifted and rotated relative to the outer tube, which compresses a spring, allowing the gripper to release, thus separating the extension shaft from the CEA.

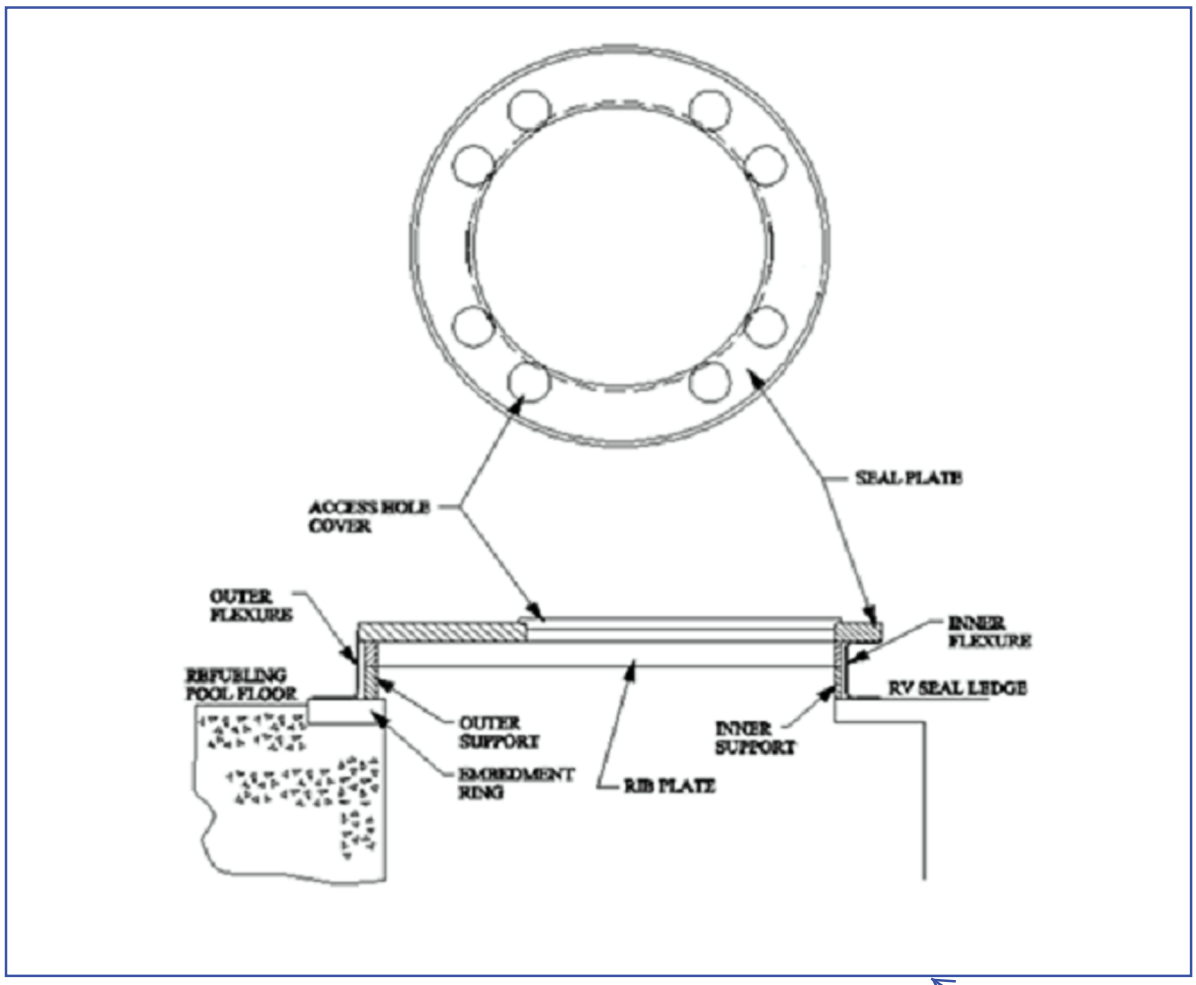


Figure 9.1.4-15 Refueling Pool Seal