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.:	**93-8075**
SRP Section:	**16 – Technical Specifications**
Application Section:	**DCD Chapter 16 TS Section 4.0**
Date of RAI Issue:	**07/21/2015**

Question No. 16-1

10 CFR 50.36, "Technical Specifications" and 10 CFR 52.47(a)(11) provides the regulatory basis for the following questions. 10 CFR 50.36 sets forth requirements for technical specifications to be included as part of the operating license for a nuclear power facility. Subsection 52.47(a)(11) requires that technical specifications be provided in the application for a design certification.

NUREG-1432, "Standard Technical Specifications-Combustion Engineering Plants," provides NRC guidance on format and content of technical specifications as one acceptable means to meet 10 CFR 50.36 requirements.

SRP 16, Part III.2.A states, in part, "when reviewing a difference between the proposed TS provision and the reference TS provision, verify that the applicant's written technical or administrative reasoning in support of the difference is logical, complete, and clearly written."

1. In generic TS 4.3.1, "Criticality," paragraph 4.3.1.1.b states:

   The spent fuel storage racks are designed and shall be maintained with: $K_{eff} < 1.0$ if fully flooded with unborated water, which includes an allowance for uncertainties as described in [FSAR] Section 9.1, "Fuel Storage and Handling.";

   This is different from STS 4.3.1 where equivalent paragraph 4.3.1.1.b states:

   The spent fuel storage racks are designed and shall be maintained with: $k_{eff} \leq 0.95$ if fully flooded with unborated water, which includes an allowance for uncertainties as described in [Section 9.1 of the FSAR],

STS paragraph 4.3.1.1.b conforms to the regulatory requirements of 10 CFR 50.68(b)(4), which states:

If no credit for soluble boron is taken, the k-effective of the spent fuel storage racks loaded with fuel of the maximum fuel assembly reactivity must not exceed 0.95, at a 95 percent probability, 95 percent confidence level, if flooded with unborated water. If credit is taken for soluble boron, the k-effective of the spent fuel storage racks loaded with fuel of the maximum fuel assembly reactivity must not exceed 0.95, at a 95 percent probability, 95 percent confidence level, if flooded with borated water, and the k-effective must remain below 1.0 (subcritical), at a 95 percent probability, 95 percent confidence level, if flooded with unborated water.

The applicant is requested to clarify how the stated Specification meets 10 CFR 50.68(b)(4) requirements. A similar construction for TS 4.3.1.1 as shown in the AP1000 DCD Rev. 19, generic TS can be used if soluble boron is credited in the NRC-approved specific analysis identified in Specification 4.3.1.1.f.

2. In generic TS 4.3.1, “Criticality,” paragraph 4.3.1.1.f, states:

   The spent fuel storage racks are designed and shall be maintained with:

   f. New or partially spent fuel assemblies with a discharge burnup in the “unacceptable domain” of Figure 3.7.16-1 will be stored in compliance with the NRC-approved specific document containing the analytical methods, title, date, or specific configuration or figure.

   This is different from STS 4.3.1 where equivalent paragraph 4.3.1.1.f states:

   The spent fuel storage racks are designed and shall be maintained with:

   f. New or partially spent fuel assemblies with a discharge burnup in the “unacceptable range” of Figure [3.7.18-1] will be stored in compliance with the NRC approved [specific document containing the analytical methods, title, date, or specific configuration or figure].

   The applicant is requested to complete the necessary details regarding the referenced NRC-approved document.

Response

1. The criticality analysis for the spent fuel pool (SFP) was performed taking credit for soluble boron. TS 4.3.1.1.b will be revised to clarify how the spent fuel storage criticality requirements in accordance with 10 CFR 50.68(b)(4) are met; refer to Attachment 1.

Additionally, DCD 9.1.1 will be revised to have consistency between TS 4.3.1.1.b and DCD 9.1.1; refer to Attachment 2.

2. The criticality analysis for the SFP was described in the technical report (TeR) titled "Criticality Analysis of New and Spent Fuel Storage Racks (APR1400-Z-A-NR-14001-P, Rev.0)", which is currently under NRC review.

   The TeR will be identified in TS 4.3.1.1.f as indicated in Attachment 1. Also, TS 4.3.1.1.e and 4.3.1.1.f will be revised to clarify the fuel loading conditions for Region I and II of the SFP as described in the TeR; refer to Attachment 1.

Impact on DCD

DCD section 9.1.1 will be revised as indicated in Attachment 2.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

TS 4.3.1.1 will be revised as indicated in Attachment 1.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical and Environmental Reports.

4.0 DESIGN FEATURES

4.1 Site Location

[Text description of site location.]

4.2 Reactor Core

4.2.1 Fuel Assemblies

The reactor shall contain 241 fuel assemblies. Each assembly shall consist of a matrix of zirconium alloy clad fuel rods with an initial composition of natural or slightly enriched uranium dioxide (UO_2) as fuel material. Limited substitutions of zirconium alloy or stainless steel filler rods for fuel rods, in accordance with approved applications of fuel rod configurations, may be used. Fuel assemblies shall be limited to those fuel designs that have been analyzed with applicable NRC staff approved codes and methods and shown by tests or analyses to comply with all fuel safety design bases. A limited number of lead test assemblies that have not completed representative testing may be placed in non-limiting core regions.

4.2.2 Control Rod Assemblies

The reactor core shall contain 81 full strength and 12 part strength control element assemblies (CEAs). The control material of full strength and part strength CEA shall be boron carbide and Inconel Alloy 625, respectively.

4.3 Fuel Storage

4.3.1 Criticality

4.3.1.1 The spent fu
with:

$K_{eff} < 1.0$ if flooded with unborated water and $K_{eff} \leq 0.95$ if flooded with borated water at a minimum soluble boron concentration described in the LCO 3.7.15, which includes an allowance for uncertainties;

a. Fuel ass
percent;

b. ~~$K_{eff} < 1.0$ if fully flooded with unborated water, which includes an allowance for uncertainties as described in Section 9.1, "Fuel Storage and Handling.";~~

c. A nominal (27.5 cm (10.83 in)) center-to-center distance between fuel assemblies placed in the Region I of spent fuel storage racks;

d. A nominal (22.5 cm (8.86 in)) center-to-center distance between fuel assemblies placed in the Region II of spent fuel storage racks

4.0 DESIGN FEATURES

Fuel assemblies

e. ~~New or partially spent fuel assemblies~~ with a discharge burnup in the "acceptable domain" of Figure 3.7.16-1 may be allowed unrestricted storage in Region I or Region II of spent fuel storage rack(s); and

f. ~~New or partially spent fuel assemblies with a discharge burnup in the "unacceptable domain" of Figure 3.7.16-1 will be stored in compliance with the NRC-approved specific document containing the analytical methods, title, date, or specific configuration or figure.~~

New or partially spent fuel assemblies with a discharge burnup in the "unacceptable domain" of Figure 3.7.16-1 will be stored only in the Region I of spent fuel storage rack(s) in compliance with the technical report titled "Criticality Analysis of New and Spent Fuel Storage Racks".

4.3.1.2 The new fuel stor

a. Fuel assemb
percent;

b. $K_{eff} \leq 0.95$ if fully flooded with unborated water, or mist, which includes an allowance for uncertainties as described in Section 9.1 "Fuel Storage and Handling.";

c. $K_{eff} \leq 0.98$ if moderated by aqueous foam, which includes an allowance for uncertainties as described in Section 9.1 "Fuel Storage and Handling."; and

d. A nominal center-to-center distance between fuel assemblies placed in the new fuel storage racks is 35.5 cm (14 in).

4.3.2 Drainage

The spent fuel pool is designed and shall be maintained above 7m (23 ft) from the top of the spent fuel storage rack to prevent inadvertent draining.

4.3.3 Capacity

The spent fuel pool is designed and shall be maintained with a storage capacity limited to no more than 1,792 fuel assemblies.

boron is credited in the evaluation for normal conditions and postulated accidents. The fuel maximum reactivity assumption, worst-case moderator density, and tolerances and uncertainties of the fuel and racks are considered to maximize the calculated K_{eff} for normal conditions and postulated accidents.

The design of the new fuel storage racks is such that K_{eff} (with all biases and uncertainties) must not exceed 0.95 with full density unborated water and 0.98 with optimum moderation in the new fuel rack, at a 95 percent probability and 95 percent confidence level. ~~For spent fuel storage racks, the maximum K_{eff} value, including all biases and uncertainties, must remain below 1.00 with full density unborated water, at a 95 percent probability and 95 percent confidence level.~~

For the spent fuel storage racks, credit is taken for the presence of soluble boron in the SFP. Therefore, the maximum K_{eff} including all biases and uncertainties must not exceed 0.95 with borated water, and must remain below 1.0 with full density unborated water, at a 95 percent probability and 95 percent confidence level.

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accordance with
Appendix A, C
(Reference 2), N
CFR Part 50.68 (b) items (2) and (3) for new fuel storage racks and item (4) for spent fuel storage racks are applied as the criticality safety design criteria. Criticality analysis codes are validated in accordance with NUREG/CR-6698.

9.1.1.2 Facilities Description

The description of new and spent fuel storage facilities is presented in Subsection 9.1.2.2.

9.1.1.3 Safety Evaluation

Prevention of an inadvertent criticality is provided by the adequate design of fuel handling and storage facilities and by administrative control procedures, considering the double contingency principle. The main methods for criticality control are (1) limiting the size of the array of fuel assemblies and (2) limiting the assembly neutron interaction by fixing the minimum separation and/or providing neutron poisons. In addition, rack cells are maintained in a safe geometry with no deformation in any design basis event. Flooding in the new fuel storage racks and boron dilution in the SFP water are minimized. Fuel mishandling is prevented by the fuel handling procedures.

~~For spent fuel storage racks, the maximum K_{eff} value, including all biases and uncertainties, must remain below 1.0 with full density unborated water, at a 95 percent probability and 95 percent confidence level.~~ Rack cells are assumed to be loaded with fuel of the maximum fuel assembly reactivity.

For the spent fuel storage racks, credit is taken for the presence of soluble boron in the SFP. Therefore, the maximum K_{eff} including all biases and uncertainties must not exceed 0.95 with borated water, and must remain below 1.0 with full density unborated water, at a 95 percent probability and 95 percent confidence level.

9.1.1.3.2 Cor

SCALE 6.1 (R

TRITON modul

the CSAS5 module is used for the calculation of the neutron multiplication factor, k, using the TRITON-produced atom densities. The SCALE analysis can be done with a number of different cross-section libraries. The ENDF/B-VII (Reference 6) 238-group library is used for the depletion and criticality calculations.

Depletion calculations are performed using the TRITON t-DEPL sequence. The TRITON t-DEPL sequence uses the NEWT computer code to obtain the detailed 2D flux solutions. The neutron fluxes are used in multiple ORIGEN-S depletion calculations to get the isotope inventories compositions which can be used directly in a criticality calculation. The NEWT calculations are performed using the SCALE 238-energy-group ENDF/B-VII library.

Criticality or K_{eff} calculations are performed using the CSAS5 sequence and the ENDF/B-VII 238-energy-group library. CSAS5 uses the KENO V.a, a 3D Monte Carlo transport code.

The validation of KENO V.a code is performed using the benchmark experiments in the international handbook (Reference 7) and NUREG/CR-6361 (Reference 8), and HTC critical experiments (Reference 9). Through the validation of criticality code, the bias and bias uncertainty are evaluated for new and spent fuel storage racks. The guidance and procedure recommended in the NUREG/CR-6698 is followed for the validation of KENO V.a computer code.

9.1.1.3.3 Analysis Condition

New Fuel Storage Rack

The following analysis conditions are considered in the design of the new fuel storage racks: