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.:	**396-8463**
SRP Section:	**12.3-12.4 – RADIATION PROTECTION DESIGN FEATURES**
Application Section:	**12.3 – RADIATION PROTECTION DESIGN FEATURES**
Date of RAI Issue:	**02/03/2016**

Question No. 12.03-50

10 CFR 50, GDC 61, requires that the fuel storage and handling, radioactive waste, and other systems which may contain radioactivity shall be designed to assure adequate safety under normal and postulated accident conditions. These systems shall be designed (1) with a capability to permit appropriate periodic inspection and testing of components important to safety, (2) with suitable shielding for radiation protection, (3) with appropriate containment, confinement, and filtering systems, (4) with a residual heat removal capability having reliability and testability that reflects the importance to safety of decay heat and other residual heat removal, and (5) to prevent significant reduction in fuel storage coolant inventory under accident conditions.

ANSI/ANS-57.1-1992, which is referenced by the applicant, indicates that fuel handling equipment shall be designed so that the operator will not be exposed to greater than 2.5 mrem/hour from an irradiated fuel unit, control component, or both, elevated to the up position interlock with the pool at normal operating water level.

This question is a follow-up to RAI 8275, Question 12.03-28.

In Question 12.03-28, the staff requested that the applicant provide the maximum lift height of the maximum raised fuel assembly in the refueling pool and spent fuel pool in the FSAR and to ensure that the dose rate to operators during fuel movement met the 2.5mrem/hour criteria provided in ANSI/ANS-57.1-1992. In the response, the applicant updated the FSAR to include the lift height, but indicated that shielding would need to be included in the design in order to meet the 2.5 mrem/hour criteria from the maximum assembly. SRP 12.3-12.4 specifies that the staff will evaluate the radiation shielding and zoning design.

1. Please provide information on this shielding (such as what material the shielding is made out of, its density, its thickness, where it will be located, how it will be held in place, is the

refueling platform capable of holding the shield, and information demonstrating that it is adequate to ensures that the 2.5 mrem/hour criteria will be met).

2. Update the FSAR to include information on the material, density, thickness, and location of the shields.

3. Since additional shielding is needed to reduce the dose to operators on the refueling platform and spent fuel pool handling machine platform to less than 2.5 mrem/hour, please provide additional information on the dose rate to personnel in the general refueling pool and spent fuel pool area during fuel movement. Indicate if any shielding or design features will be in place to ensure that the dose rate to these individuals will be in accordance with the 2.5 mrem/hour radiation zone designation provided for the general spent fuel pool area in FSAR Figure 12.3-7.

Response – (Rev. 1)

1. Information on the shielding of the Fuel Handling Equipment is as follows :

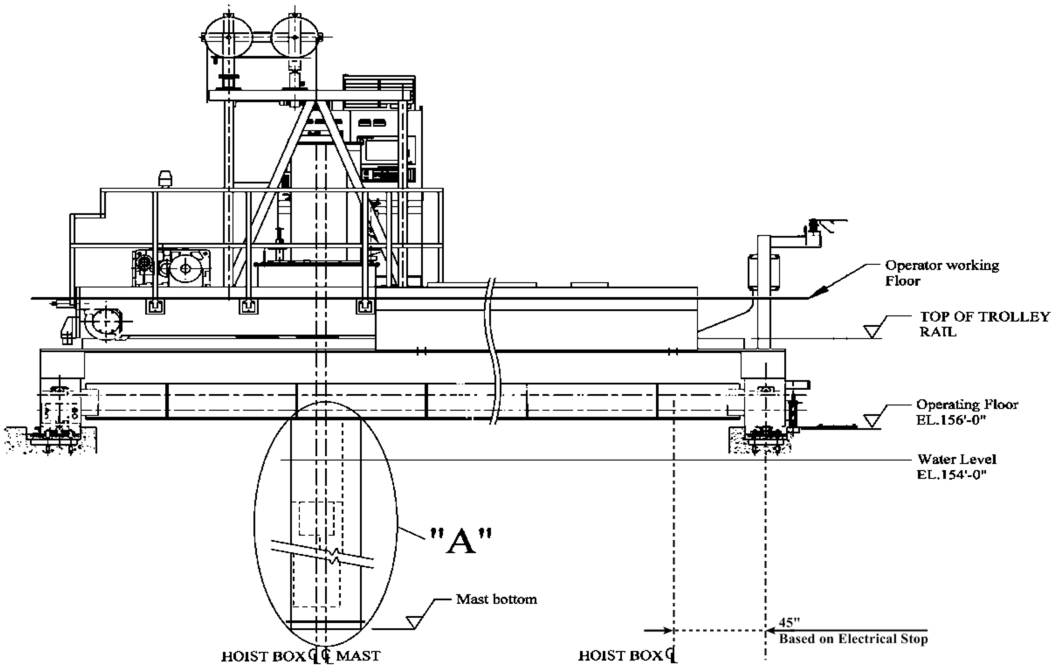
   The refueling machine has a stainless steel hoist box surrounding the fuel assembly and a mast surrounding the hoist box. The spent fuel handling machine has a stainless steel hoist box surrounding the fuel assembly and no mast.

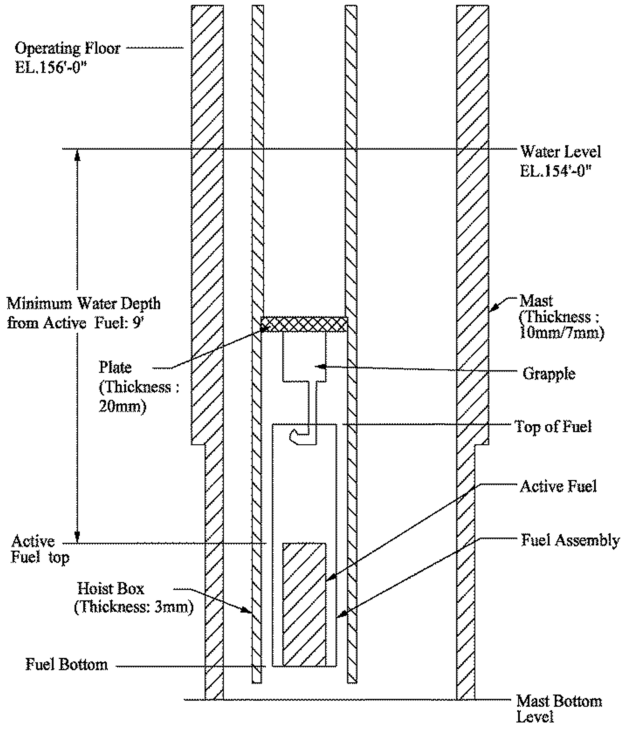
   I. Refueling Machine in refueling pool (Refer to Figure.1)

      a. Material specification
         - Grapple : 17-4 PH stainless steel
         - Mast/Hoist box : 304 SST

      b. SST Density : 0.29 lb/in^3 (8.03 g/cm^3)

      c. Thickness
         - Mast : Upper part : 10 mm
                  Lower part : 7 mm
         - Hoist box : 3 mm





DETAIL "A"

Fig.1 Fuel assembly position in the hoist box at the Up stop (RM)

II. Spent Fuel Handling Machine in spent fuel pool (Refer to Figure 2)

a. Material specification
   - Grapple : 17-4 PH stainless steel
   - Hoist box : 304 SST

b. SST Density : 0.29 lb/in^3 (8.03 g/cm^3)

c. Thickness :
   - Fixed type Hoist box : 10mm

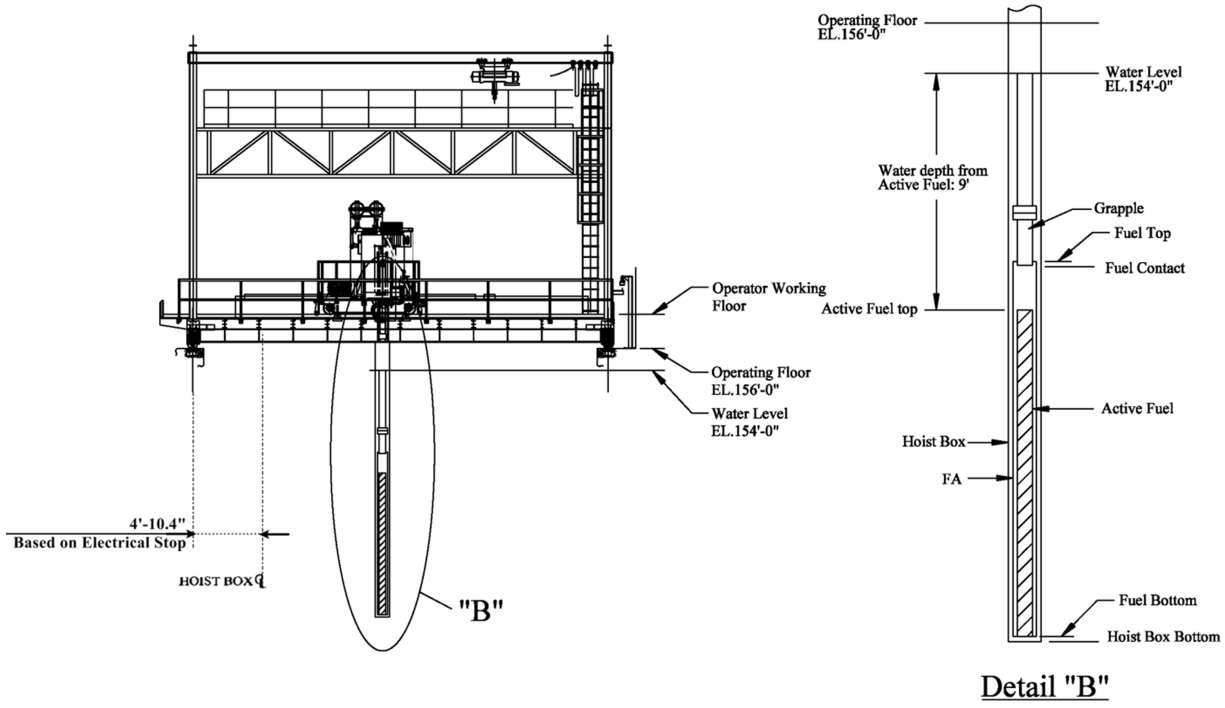


Fig. 2 Fuel assembly position in the Fixed Hoist box at the Up stop (SFHM)

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2. It's not adequate to describe the detailed equipment design information in the FSAR(Tier 2). Refer to response No. 1 for the shielding locations .

3. Additional shielding is not necessary since the dose rate to the operators is less than 2.5 mrem/hr when shielding effects of the fuel handling equipment are considered in the shielding analyses. The shielding analysis has been performed using the DORT code with the BUGLE-93 cross section library as described below.

- Shielding design source term

The gamma activities of a spent fuel assembly with a decay time of 100 hours are used as the shielding design source terms, which are obtained from the depletion and decay calculations of a PLUS7 fuel assembly under APR1400 operating conditions. The initial enrichment and discharged burnup of the spent fuel assembly considered in the depletion and decay calculations are 4.2 wt% and 56.4 GWD/MTU, respectively. The axial gamma source distribution is assumed as the long term axial power distribution of APR1400 and the radial source distribution is assumed as a flat distribution.

- DORT R-Z model

The shielding analysis models of the refueling pool (RP) and the spent fuel pool (SFP) for the DORT code are provided in Figures 3 and 4. The spent fuel assembly is modeled from the center of the active fuel to the upper end fitting. And the fuel handling tools (grapple, grapple weight and grapple rod) and the hoist box are included in the model. Water is modeled to cover up to 9’ above the active fuel and dry-air is modeled above the water. For the refueling pool model, the mast of the refueling machine is included. Other structures in the RP and SFP are not considered in these analyses for the purpose of conservatism.

- Fluence-to-Dose conversion factor, Uncertainty and Radial peaking factor

The fluence-to-dose conversion factors are generated based on guidelines provided in ANSI/ANS-6.1.1-1991. The analysis results include 20% uncertainty to take into account calculation uncertainties, mechanical tolerances, and geometric modeling uncertainties. Also, a design radial peaking factor of 1.55 was applied to the analysis results to estimate the dose rate for the most active fuel assembly.

- Analysis results

During the fuel transfer operation, the operators are located on the trolley assembly of the refueling machine and the spent fuel handling machine. The elevations of the trolley assembly bottom of the RP and SFP are EL. 160'-2.38" and EL. 160'-6.38", respectively. The dose rates at EL. 160'-2.38" of RP and SFP are provided in Figure 5.

Another working area for the operators during the fuel transfer operation is the operating floor (EL. 156’). The minimum distances from the centerline of the fuel assembly to the operating floor in the RP and SFP are 3’-9”' (114.3 cm, Figure 1) and 4'-10.4" (148.34 cm, Figure 2), respectively. The dose rates on the operating floor of the RP and SFP are provided in Figures 6 and 7, respectively.

As shown in Figures 5, 6 and 7, the dose rates at the working areas during the fuel transfer operation are below the dose limit of 2.5 mrem/hr. Therefore, the operators will not be exposed to the dose rates greater than 2.5 mrem/hr.

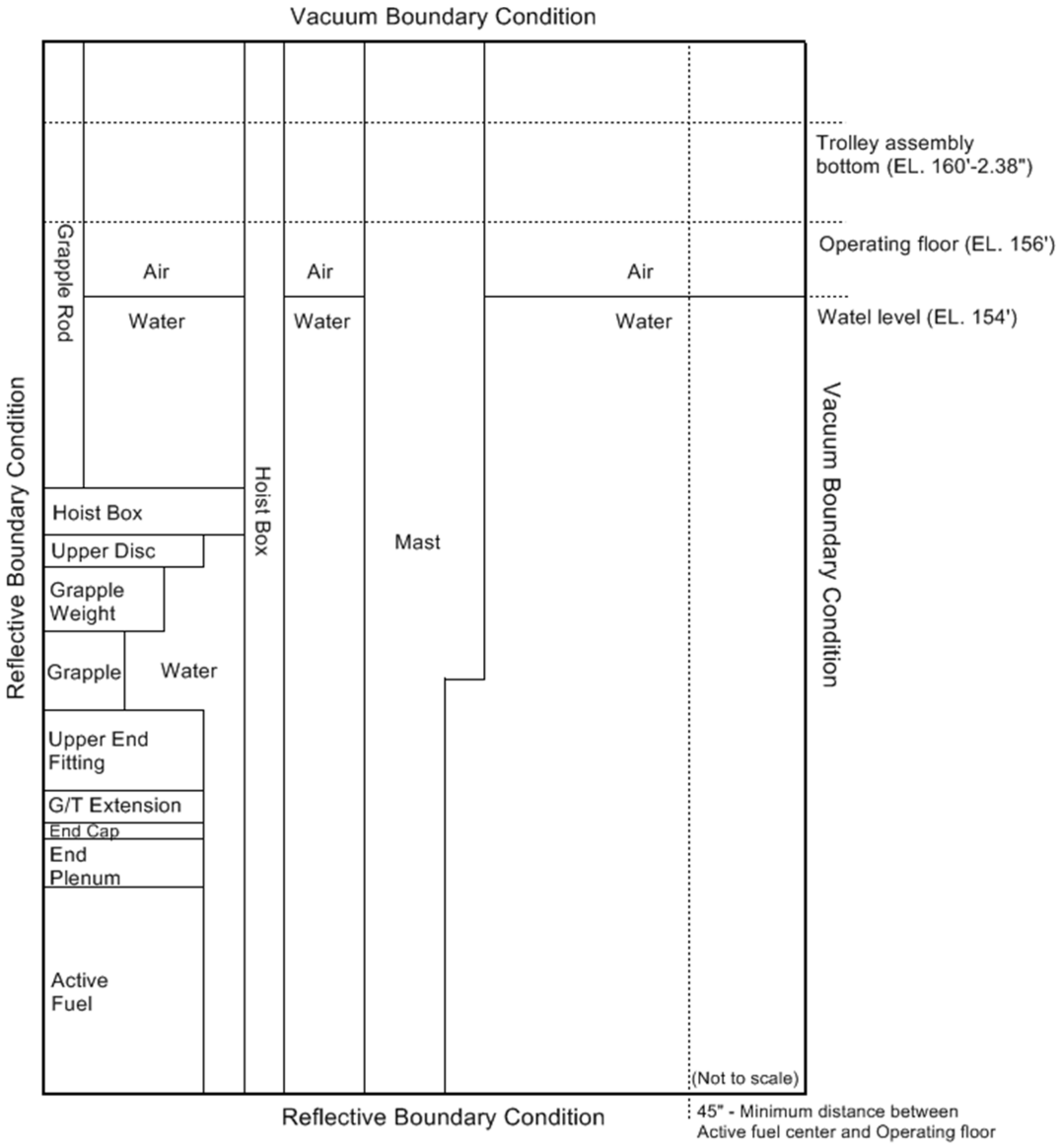

Fig. 3 DORT R-Z calculation model for Refueling Pool

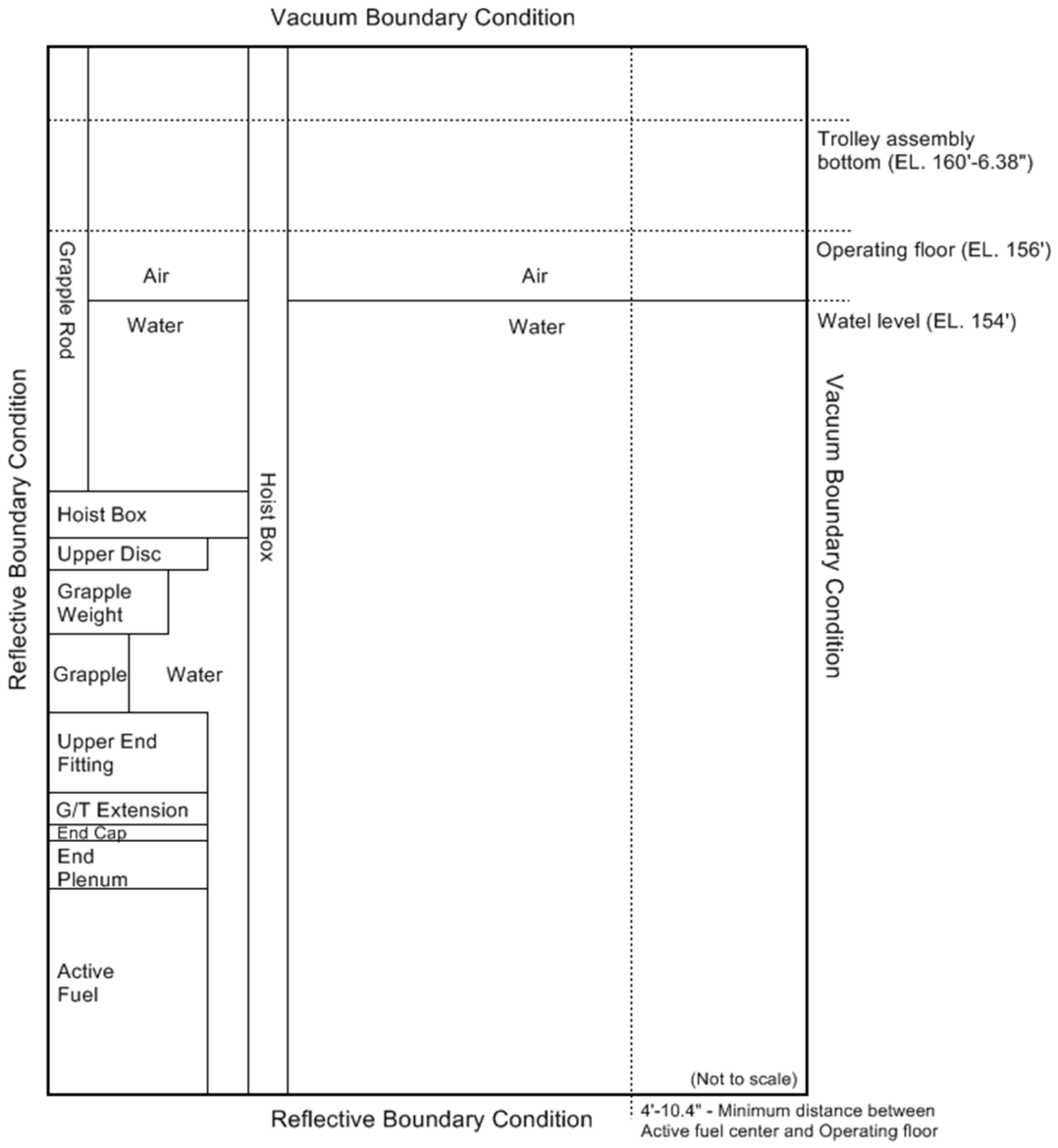

Fig. 4 DORT R-Z calculation model for Spent Fuel Pool

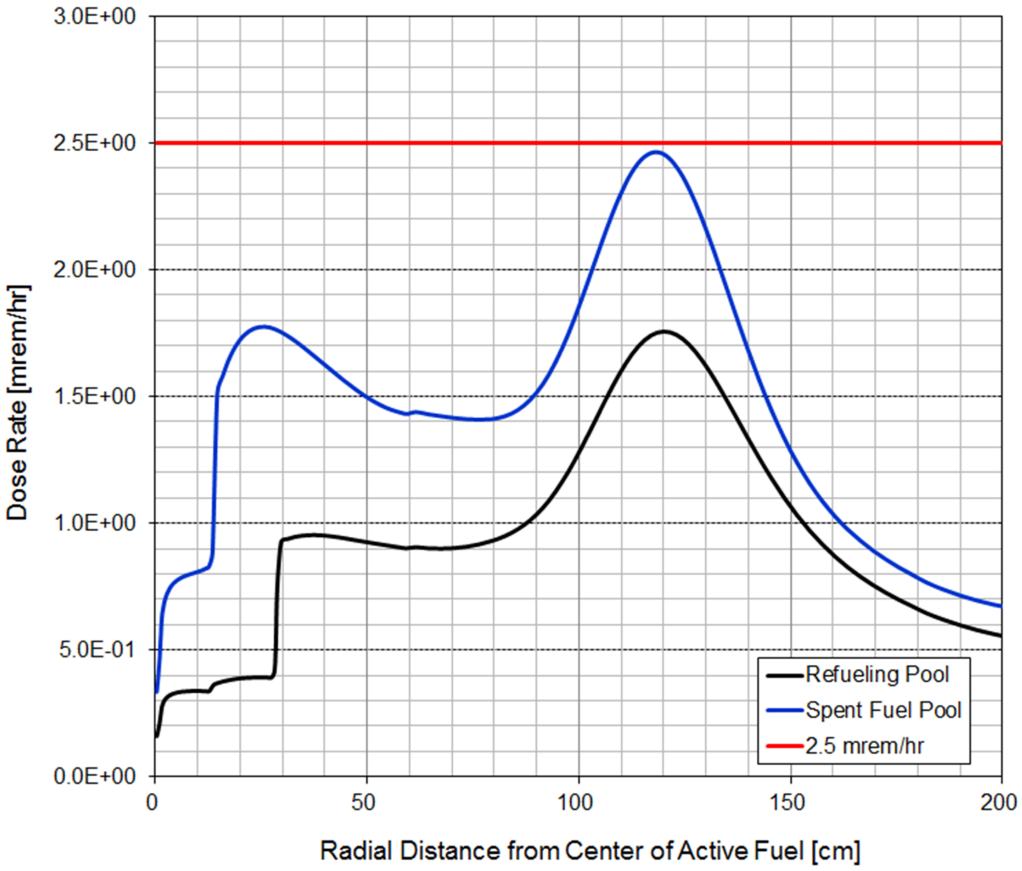

Fig. 5 Dose rate at the bottom of Trolley assembly (EL. 160'-2.38")
(Uncertainty and radial peaking factor are included)

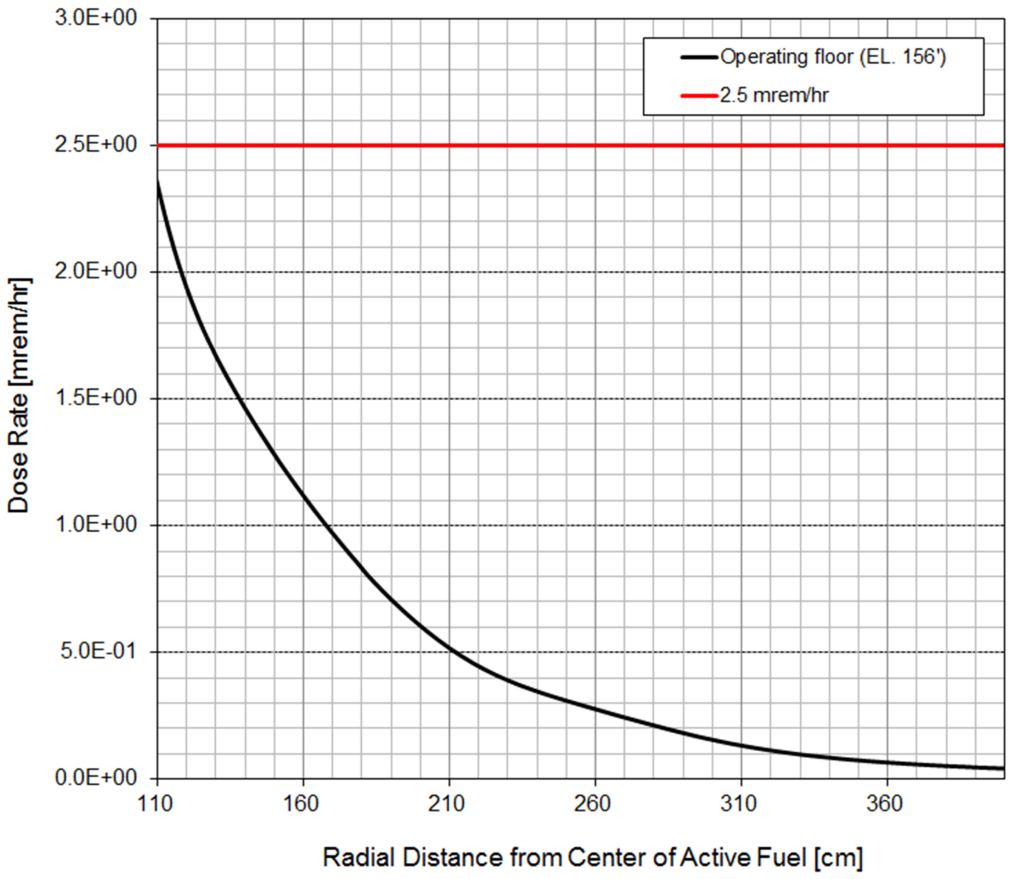

Fig. 6 Dose rate at the operating floor (EL. 156') in the refueling pool
(Uncertainty and radial peaking factor are included)

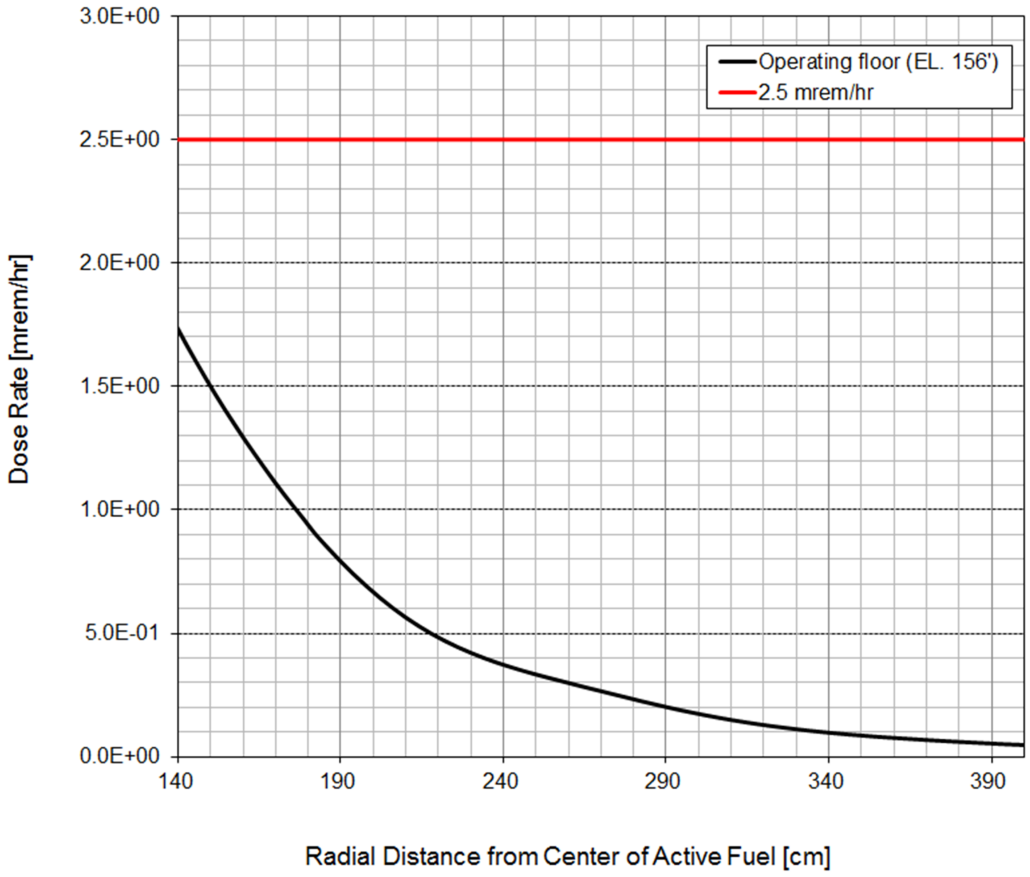

Fig. 7 Dose rate at the operating floor (EL. 156') in the spent fuel pool (Uncertainty and radial peaking factor are included)

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 Environment Report.