# Preliminary Criticality Analysis on the OASIS-32K Canister With 32 Spent Nuclear Fuel Assemblies of Kori-1

Young Tae Han *, Joon Gi Ahn, Yong IL Kim
*KEPCO E&C, 111 Daedeok-daero 989 beon-gil, Yuseong-gu, Daejeon, Republic of Korea*
**Corresponding author: ythan@kepco-enc.com*

## 1. Introduction

KEPCO E&C is developing OASIS-32K dry storage canister for 32 PWR spent nuclear fuel (SNF) assemblies of Kori-1 WEC-type 14x14 fuel assembly (FA). This canister has the same external shape and dimensions of the canister in OASIS-32D cask (Fig. 1) [1] which is a dual purpose (for both transport and storage) metal cask developed by KEPCO E&C for ACE7 17x17 FA. OASIS-32D cask is composed of inner canister (loading spent nuclear fuel) and cask body (shielding and structure). Thus, the OASIS-32K canister can be used for transport and/or storage in the OASIS-32D cask body.

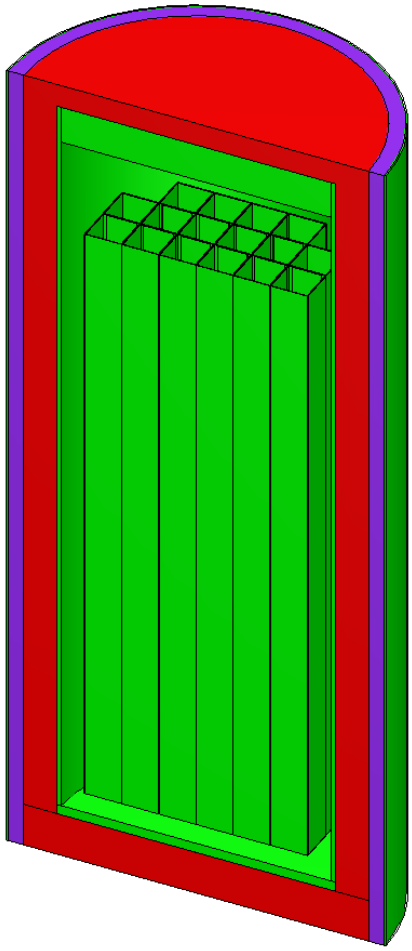

Fig. 1. Geometry Configuration of OASIS-32D cask Model (Front-half Cut)

The amount of uranium loaded in a WEC-type 14x14 FA is slightly less than that in the ACE7 17x17 FA, which is supposed to be loaded in the OASIS-32D cask design. Therefore, the total amount of uranium loaded in an OASIS-32K canister (32 Kori-1 FA) is 13% less than that in OASIS-32D canister (32 ACE7 FA). If both FAs have the same burnup and cooling period, the decay heat and radiation sources of OASIS-32K canisters are less than those of OASIS-32D canister. This means that the results of structural analysis, thermal analysis, and shielding analysis on the OASIS-32D cask model could be applied to the OASIS-32K canister as a preliminary design data having sufficient margin.

However, the criticality safety is influenced by the number of loaded FAs, configuration of FA arrangement, separation distance between FAs, and the design parameters of the loaded FA. Therefore, a preliminary criticality calculation is performed based on the basket cell arrangement, geometry, dimensions, materials of the OASIS-32K canister and design parameters of Kori-1 WEC-type 14x14 FA. The Burnup Credit is applied on the OASIS-32D canister criticality safety evaluation. However, the fresh fuel assumption without Burnup Credit is applied on the criticality safety evaluation of the OASIS-32K canister.

## 2. Methods and Results

### *2.1 Design Parameters of Kori-1 WEC-type 14x14 FA*

The design parameters of the Kori-1 WEC-type 14x14 FA and ACE7 17x17 FA are compared in Table 1.

Table 1. Design Parameters of Kori-1 FA

| Parameters | Kori-1 FA | ACE7 FA |
|---|---|---|
| Array of fuel rods | 14x14 | 17x17 |
| No. of fuel rods (/FA) | 179 | 264 |
| Fuel pellet dia. (mm) | 9.294 | 8.192 |
| Fuel rod pitch (mm) | 14.12 | 12.6 |
| Active Fuel length (mm) | 3658 | 3658 |
| FA width (mm) | 197.7 | 214.2 |
| U loading (/FA) (Kg) | 402.7 | 461.3 |
| U loading (/Canister) (Kg) | 12,886.4 (32 FAs) | 14,761.6 (32 FAs) |

### *2.2 Design Parameters of OASIS-32K Fuel Basket*

Fuel baskets in the OASIS-32K canister are a 6x6 array so that 32 FAs can be loaded. Unlike the OASIS-32D canister which has only one Neutron Absorber Plate (NAP) between neighboring two baskets, OASIS-32K canister has two NAPs between the neighboring two baskets to control the reactivity. This configuration enables the OASIS-32K canister to meet the criticality safety requirement without Burnup Credit. Design parameters of fuel basket and canister of the OASIS-32K are presented in Table.2

Table 2. Design Parameters of OASIS-32K Canister

| Parameters | Value |
|---|---|
| Basket cell array | 6x6 |
| No. of basket cells | 32 |
| Basket cell pitch (mm) | 245.0 |
| Basket plate thickness (mm) | 6.0 |
| Neutron absorber plate | |
| - Material | MAXUS |
| - Thickness (mm) | 3.5 |
| - Width (mm) | 175.0 |
| - Areal boron density (g $B^{10}/cm^2$) | 0.04 |
| Canister inner dia. (mm) | 1735.0 |

*2.3 Criticality Calculation on OASIS-32K*

The loaded FA is assumed as 4.15 wt% (U-235) with zero burnup condition. The enrichment 4.15 wt% (U-235) is the maximum enrichment ever loaded in Kori-1 before permanent shutdown on June 2017. To consider the limiting conditions of dry storage, transportation, and handling process, it is assumed that the inner space of the canister is filled with unborated full density water.

The criticality calculation for the OASIS-32K canister was performed using the CSAS/KENO module of SCALE6.2.3 code [2]. Figure 2 shows the top half cut view of the geometry model used in the calculation.

*2.4 Results*

The calculated k-eff of the OASIS-32K canister with 32 FAs of Kori-1 was 0.92973 (+/- 0.00021). The calculational bias and associated uncertainties (typically ~0.015 Δk/k for fresh fuel criticality safety evaluation) should be included to the calculated k-eff to generate the final evaluated k-eff. Even though the typical bias and uncertainties are considered, the final evaluated k-eff will be less than the criticality safety limit (k-eff of 0.95). Thus, it is believed that the OASIS-32K canister can meet the criticality safety requirement.

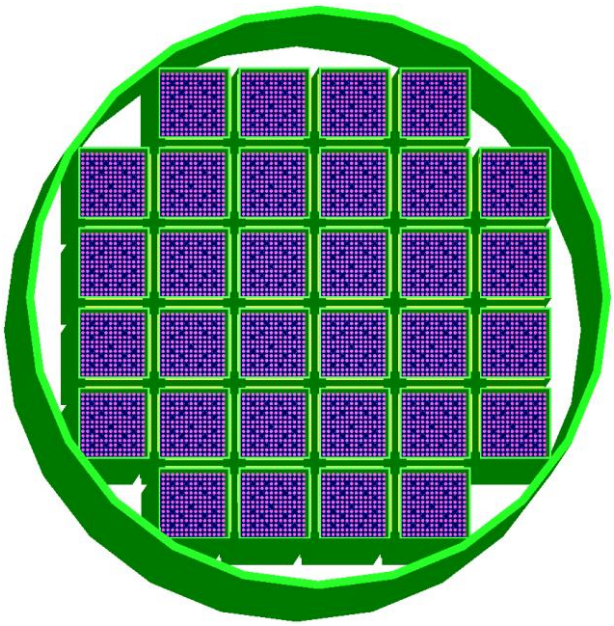

Fig. 2. Geometry Configuration of OASIS-32K Canister Calculation Model (Top-half Cut)

## 3. Conclusions

OASIS-32K dry storage canister for 32 PWR SNF assemblies of Kori-1 WEC-type 14x14 FA is being developed to be compatible with the OASIS-32D cask, which was developed for loading of 32 ACE7 FAs or PLUS7 FAs. The preliminary criticality analysis results showed that the OASIS-32K canister can be used for loading of 32 Kori-1 FAs in the OASIS-32D cask.

## REFERENCES

[1] K.J. Ko, et al, "Design Features of an OASIS-32D Metal Cask for both Transport and Storage of SNF," Transactions of the Korean Nuclear Society Spring Meeting, Jeju, Korea, May 18 -19, 2017.

[2] B. T. Rearden and M. A. Jessee, Eds., SCALE Code System, ORNL/TM-2005/39, Version 6.2.3, Oak Ridge National Laboratory, Oak Ridge, Tennessee (2018). Available from Radiation Safety Information Computational Center as CCC-834.