# Conceptual Design of New Fuel Storage and Handling Subsystem for the Integral reactor

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## 1. Introduction

Through the basic design development of integral reactor SMART, KAERI has established design technology for reactor assembly, main components, fuel channels, and cores, and has been conducting design optimization. The design for the reactor has shown a sufficient progress, but the design of fuel handling system for the refueling has not been performed even conceptual design. KAERI started to develop a design concept of the fuel handling system for SMART different from those of commercial reactors.[1][2] Fuel handling system is largely divided into three subsystems, which are fresh fuel handling subsystem, reactor refueling subsystem, and spent fuel handling subsystem. Among them, conceptual designs of the fresh fuel handling subsystem are introduced in this paper. The fresh fuel handling subsystem ensures receipt of fresh fuel, incoming control and preparation of fresh fuel to be transferred to the containment for loading into the reactor.

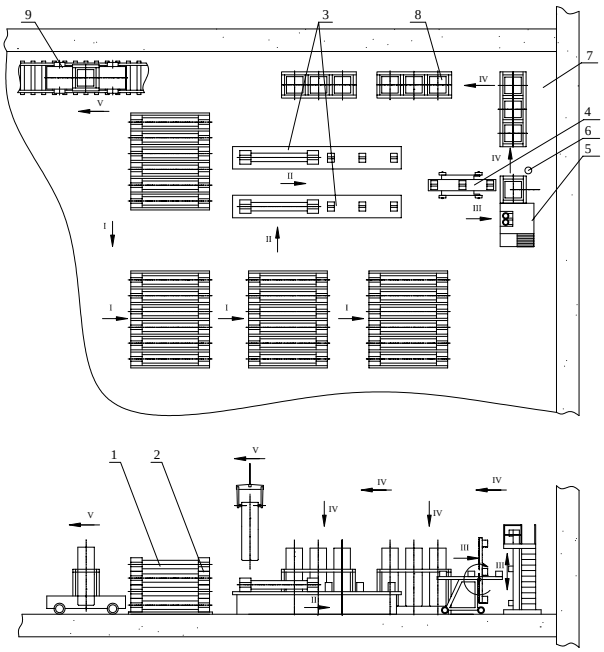
## 2. Design description of fresh fuel handling subsystem

Fresh fuel storage and handling subsystem is intended for the following operations on the fuel handling area in the complex building of SMART:

- arrangement of fresh fuel shipping containers (FFSC) for temporary storage on special support structures;
- removal of horizontally arranged fresh fuel assembly (FFA) from FFSC and their arrangement on the inspection table;
- FFA arrangement in the FFA upender and its tilting to the vertical position;
- FFA installation in the check facility and FFA channel incoming control;
- installation of empty fresh fuel transport casings (FFTC) on the support structure in the fuel building;
- FFA loading into FFTC for storage and transportation to the containment;
- FFTC transportation on a plant transportation carriage to the containment.

The fresh fuel handling subsystem is designed according to the requirement as follows.

- American National Standard, ANSI/ANS-57.3-1983, Design Requirement for New Fuel Storage.
- Regulatory Guide 1.29, “Seismic Design Classification.”



1. FFSC, 2. FFSC support structure, 3. Inspection table, 4. FFA upender, 5. Check facility, 6. FFA gripper, 7. FFTC support structure, 8. FFTC, 9. Transportation carriage.

Figure 1. Fresh handling scheme

Figure 1 shows general layout and arrangement of fresh fuel handling subsystem equipment in the complex building.

FFSC is intended for transportation and safe temporary storage of 4 FFA. FFA in polyethylene film are wrapped with corrugated board to be tightly fitted into the casing of each FFA and packed into the film with silica gel bags.

Support structure for FFSC storage on the fuel handling area in the complex building is a platform with fixing elements and fasteners to fix a group of FFSC with sling. Figure 2 show a design concept of FFSC support structure.

FFA inspection table is support surface in form of a table and support members. The support surface allows one FFSC on it and installing of two beds. FFA removed from the FFSC is horizontally arranged on the bed with three supports.

Once FFA has been inspected, it is transferred to FFA upender with its bed. FFA upender tilts FFA into vertical position and is composed a rotating table and support devices for the bed. FFA tilted to vertical position at the upender is moved into FFA check facility using an overhead crane with FFA gripper.

FFA check facility simulates FFA installation into the reactor in terms of FFA arrangement sizes and seats, which are similar to those of the reactor. The facility has a support structure for FFTC, loaded with checked FFA, near its working floor.

FFTC is intended for temporary storage of FFA in the complex building, which are ready to be loaded into the reactor, and their further transportation to the containment. Conceptual design features of FFTC are shown in Figure 3. FFTC consists of a casing for storage and transportation, a cover, which prevents FFA from dropping out. The casing has drain holes for drainage in case of water ingress into the casing. The pitch of FFA in FFTC is determined to assure nuclear safety during FFA storage. FFA are installed into FFTC casing spacer plate seats, which are fitted with inserts made of a material having the least friction.

## 3. Operating procedure of fresh fuel storage and handling subsystem

The sequence of fresh fuel storage and handling subsystem equipment operation and approximate duration of each procedure is as follows:

1) Before the procedures related to FFA, we assume that unloading of FFSC from the vehicle and installing in groups on support structures for temporary storage have already done.
2) FFSC is installed in horizontal position onto FFA inspection table, and FFSC cover is unfixed and removed. (10 min.)
3) FFA is extracted from FFSC one-by-one, unpacked, and placed on the inspection table. (16 min.)
4) Empty FFSC is removed from the inspection table and installed on the support structure. (6 min.)

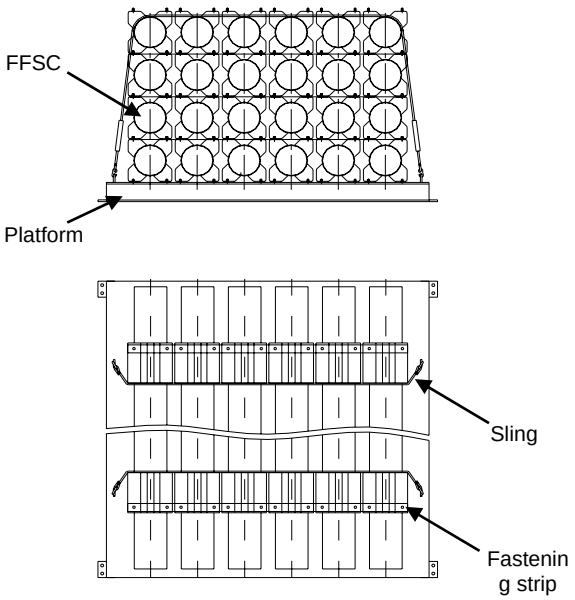



Figure 2. Support structure for FFSC

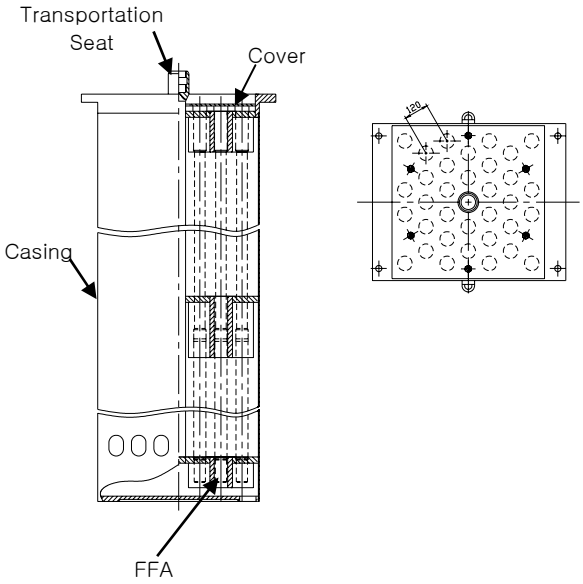



Figure 3. Fresh Fuel Transport Casing (FFTC)

5) FFA visual inspection is conducted in horizontal position. (8 min.)
6) FFA is transferred and fixed in horizontal position with the inspection table bed on the rotating table of FFA upender. FFA head is engaged with FFA gripper. The bed with FFA is tilted into vertical position. (5 min.)
7) FFA is unfixed and removed from the bed supports, and installed into the check facility. (10 min.)
8) Inspection of FFA in the check facility is performed according to the special requirement of article. (10 min.)
9) Checked FFA is installed into FFTC (3 min.)
10) Previous steps (2)-(4) are repeated for the rest 73 FFSC and steps (5)-(9) for the rest 282 FFA.

Total time necessary for FFA preparation for loading into the reactor is approximately 9 days.

## 4. Conclusion

A conceptual design of fresh fuel storage and handling subsystem for the integral reactor SMART were developed. Equipments for storage and handling of FFA were developed. Approximate duration of each procedure for FFA storage and handling was estimated. The developed design concept should be improved and optimized thourgh further study.

## REFERENCES

[1] J. S. Lee et al, Reactor Refueling System Conceptual Design for the Integral Reactor, Proceedings of the Korean Nuclear Society Fall Meeting, 2004.

[2] M. H. Kim et al, State of the Art for Conceptural Design of Fuel Storage and Handling System of Integral Reactor, Proceedings of the Korean Nuclear Society Spring Meeting, 2004.