Optimization of General Arrangement for Fuel Handling Equipment in Fuel Handling Area

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1. Introduction

The purpose of this study is to provide an optimized general arrangement for fuel handling in fuel handling area for APR1400. The general arrangement for fuel handling area should be optimized in the viewpoints of safety functions for fuel handling, efficiency for operation and maintenance of fuel handling equipment during the fuel handling from receipt of new fuel to shipment of spent fuel. In this study, general arrangement for the fuel handling area was evaluated and proposed to ensure a safe and efficient operation and maintenance for the fuel handling equipment in the fuel handling area. The results of this study can be a beneficial suggestion regarding the general arrangement of the fuel handling areas and equipment.

2. Transfer Path and Procedures for Fuel Handling

The fuel handling system consists of various equipments to handle a fuel assembly in a safe and reliable manner. Fuel handling is performed by the RM (Refueling Machine), the SFHM (Spent Fuel Handling Machine), the FTS (Fuel Transfer System) and the Upender between the containment building and the fuel handling area in the auxiliary building as shown on Fig. 1.

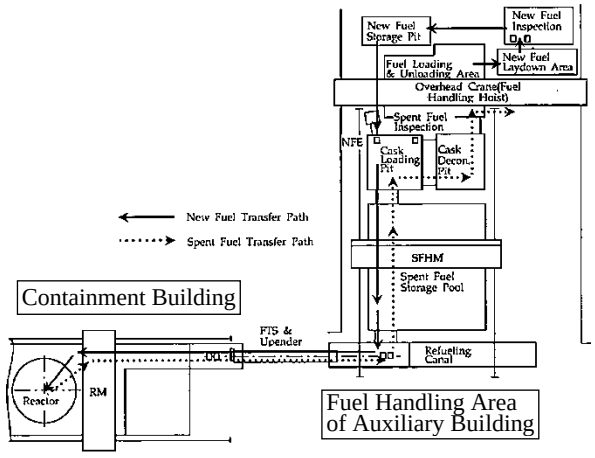

Fig. 1 Transfer Path of New Fuel and Spent Fuel between Containment Building and Fuel Handling Area of Aux. Building

In the fuel handling area, the fuel handling hoist of the overhead crane is used for handling the new fuel during transfer from the new fuel container in the laydown area to the new fuel inspection station, the new fuel storage racks, or the new fuel elevator and for handling the spent fuel shipping cask from the Cask Loading Pit (CLP) thru the cask decontamination Pit to the fuel loading & unloading area. The SFHM transports a fuel among the new fuel elevator, the spent fuel storage racks and the FTS upender in refueling canal. Fig. 1 also shows transfer path of new fuel and spent fuel between the Containment Building and the Fuel Handling Area of Aux. Building. After arrival of the new fuel shipping containers, the containers are transferred and secured to the operating floor in the new fuel laydown area. The new fuel handling tool, attached to the fuel handling hoist, is then locked to a fuel assembly and it is removed from the shipping container. Next, new fuel is inspected by a new fuel inspection device before placement into the new fuel racks and the operation repeated until all assemblies have been placed in the racks. Prior to refueling operations, new fuel is removed from the new fuel storage racks and transferred to the new fuel elevator by using the fuel handling hoist and the new fuel handling tool. The new fuel elevator lowers a fuel assembly into the cask loading pit to allow the SFHM to transfer new fuel to the spent fuel rack of the spent fuel storage pool (Region I) or to the transfer upender. During refueling operations, new fuel is transferred to a reactor in the containment building through the transfer tube.

For unloading from a reactor, spent fuel is moved underwater to the transfer upender in the containment building by using the RM. After the fuel has passed through the transfer tube, the upender machine in the fuel handling area returns the transfer carriage to the vertical position. The SFHM removes the spent fuel from the upended transfer carriage and places it to the spent fuel storage rack. This process continues until all fuel assemblies have been transferred to the spent fuel storage rack. During and after the spent fuel discharge from the reactor to the spent fuel storage pool (SFSP), spent fuel assemblies are examined by visual inspection and ultrasonic test in the refueling canal, the SPSP, or the CLP.

The SFHM can transfer spent fuel from the storage racks to the spent fuel cask for the intermediate storage. This operation will be implemented when the fuel cask loading pit is filled with spent fuel storage pool water and the gate between the SFSP and the CLP is opened. After the spent fuels are loaded into the cask, the cask will be sealed and transferred to the cask decon-tamination pit with the cask handling hoist. Then it will be transferred to the truck loading & unloading area with the cask handling hoist for intermediate and /or ultimate storage as shown in Fig. 1.

3. Evaluation of GA in Fuel Handling Area

The fuel transfer path and procedure are discussed in the above section 2. In this section, we will evaluate the

current general arrangement in the fuel handling area and provide an optimized general arrangement to ensure safety functions for fuel handling, efficiency for operation and maintenance of the fuel handling equipment in fuel handling area. Table 1 provides an evaluation on the fuel transfer path and procedures for the current general arrangement in the fuel handling area.

Table 1 Evaluation of the current general arrangement for fuel handling

No.	Area(or Equipment)	Fuel handling equipment from and to	Design tips and lessons learned from the current design
N-1	Fuel Loading & Unloading Area	N/A	
N-2	New Fuel Laydown Area	Fuel Handling Hoist	- Secure a space for new fuel containers on the floor
N-3	New Fuel Inspection	Fuel Handling Hoist	- New fuel inspection be same as the elevation of new fuel storage pit - Needed more accurate control for new fuel handling
N-4	New Fuel Storage Pit	Fuel Handling Hoist	- Needed more accurate control for new fuel handling - SFHM used for new fuel handling
N-5	New Fuel Elevator	Fuel Handling Hoist	- Needed more accurate control for the new fuel - SFHM used for new fuel handling
N-6	Spent Fuel Storage Pool (Region-I) thru the CLP	SFHM	None
		SFHM	- The CLP be relocated for spent fuel handling
N-7	Transfer Upender	N/A	

As stated earlier, new fuel is transferred from the fuel loading & unloading area to the transfer upender by using the fuel handling hoist and the SFHM. This hoist should be designed to meet the interlock system requirements for fuel handling and inspections in accordance with Reference [1]. The fuel handling using the fuel handling hoist would be minimized to secure safety functions for fuel handling because it was designed to handle heavy load such as a new fuel shipping container and a spent fuel shipping cask. The new fuel inspection and the new fuel storage pit would be relocated to be accessible by the SFHM. (See the fuel handling procedures from N-3 to N-5 of Table 1 for details). The new fuel storage pit would be located to be close to the new fuel elevator. The CLP located between the new fuel storage pit and the SFSP would be moved to the location between the SFSP and the cask decontamination pit for spent fuel handling. By doing this relocation, we can secure separated area for each light load and heavy load handling. The spent fuel inspection station would be relocated from the CLP to the refueling canal for more efficient of spent fuel inspection. The 4-faced visual inspection over the transfer upender, which is proposed for spent fuel inspection during the fuel offloading, can reduce the handling time for spent fuel inspection. The new fuel inspection device would be designed to be same as the elevation of new fuel storage pit for efficient operation of the SFHM.

4. Optimization of GA in Fuel Handling Area

Fig.2 provides an optimized general arrangement for fuel handling in the fuel handling area based on the evaluation of Table 1.

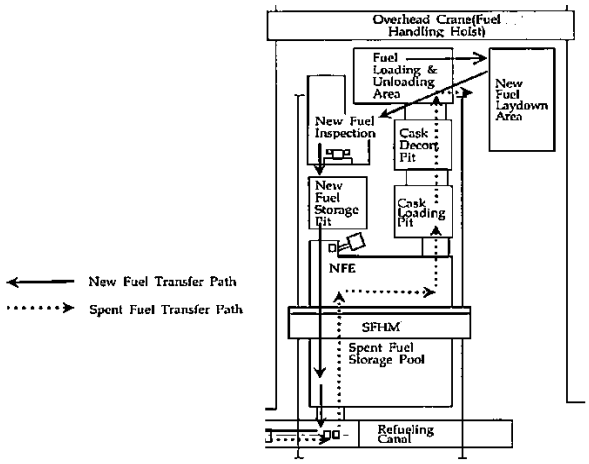

Fig. 2 Optimized General Arrangement for Fuel Handling in Fuel Handling Area

The new fuel inspection and the new fuel storage pit are relocated to be covered by the SFHM operation zone. The rails for the SFHM and a cable support system should be expanded to access these areas. The CLP is relocated to be positioned between the SFSP and the cask decontamination pit for spent fuel handling. And the position of the CLP should meet the minimum distance specified in Reference [2]. We can secure safety functions by separating two operating areas for light load and heavy load handling and also can accommodate spent fuel receiving from the other site.

5. Conclusion

The general arrangement in the fuel handling area is optimized in the viewpoints of safety functions for fuel handling, efficiency for operation and maintenance for fuel handling equipment. The new fuel inspection and the new fuel storage pit are relocated to be accessible by the SFHM. The CLP is relocated to be positioned between the SFSP and the cask decontamination pit for spent fuel handling. The results of this study can be a beneficial suggestion regarding the general arrangement of the fuel handling equipment.

REFERENCES

[1] ANSI/ANS-57.1, Design Requirements for Light Water Reactor Fuel Handling Systems, 1992 (Re-affirmed 2007).
[2] KURD(Korean Utility Requirements Document) Chap.7, Fueling and Refueling Systems, 2002.