Transactions of the Korean Nuclear Society Spring Meeting
Jeju, Korea, May 19-20, 2022

Evaluation of the Effect of Debris in the SFP on Fuel Integrity

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1. Introduction

The spent nuclear fuel storage pool (SFP) is a facility for storing spent nuclear fuel as well as nuclear fuel to be reloaded into a nuclear reactor. In the case of nuclear power plants in Korea, one of the biggest causes of damage is blockage of the flow path by debris. Therefore, although the power plant thoroughly manages to prevent the inflow of debris into the SFP where nuclear fuel assembly (FA) is stored, it is difficult to completely prevent the inflow of debris while large-scale operations such as planned preventive maintenance are being performed. This technical support was conducted to evaluate whether a metallic material, such as a ballpoint pen spring, could float into the fuel while handling the nuclear fuel when it falls on the bottom of the SFP.

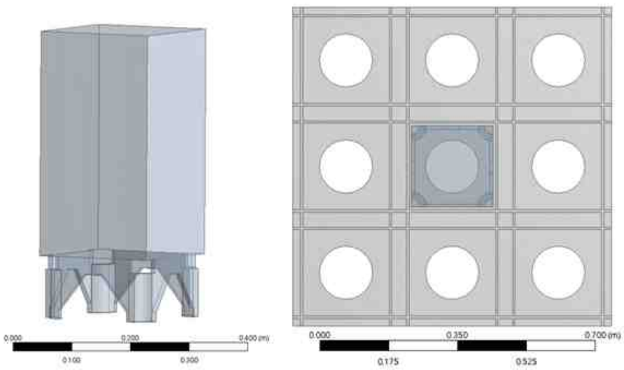

Fig. 1. FA Bottom and HDSR Configuration

2. Methods and Results

The floating velocity for the ballpoint pen spring to rise up in the water from the bottom of the SFP was calculated [1] [2], and then the flow velocity around the fuel in bottom of SFP was evaluated using CFD analysis. For the flow velocity evaluation around the fuel, the fuel unloading or loading speed was considered through CFD analysis that simulated a part of the highly density storage rack (HDSR) in the SFP and the bottom of the nuclear fuel. At this time, if the flow velocity around the nuclear fuel derived through CFD analysis is less than the floating velocity of the spring, it can be determined that debris cannot be blockage of the nuclear fuel.

As a result of the evaluation, the minimum floating flow velocity for a spring-shaped metal material to rise up from the bottom of the SFP to the water was calculated to be 0.17 m/s. In addition, the maximum flow velocity of 0.05 m/s was generated in the circular flow path at the bottom of the storage stand regardless of the separation distance under fuel loading conditions, and it was evaluated that the flow velocity was less than 0.03 m/s in the vicinity of the fuel. It was evaluated that the maximum flow velocity of 0.05 m/s was generated at the bottom of the fuel substructure regardless of the separation distance under fuel unloading conditions, and flow velocity of less than 0.04 m/s was generated around the fuel.

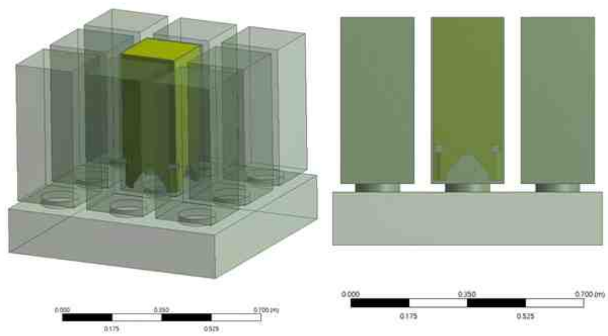

Fig. 2. Calculation Domain of CFD for FA & HDSR

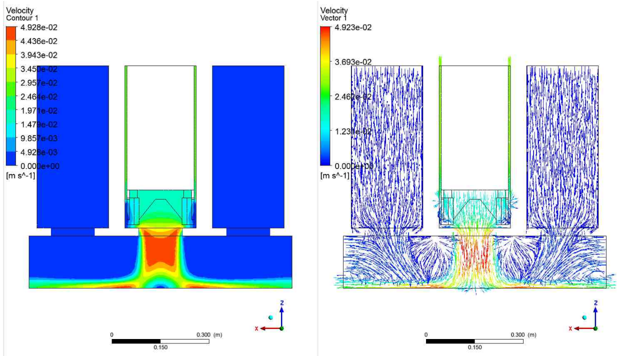

Fig. 3. Flow Velocity Results for FA Loading Condition

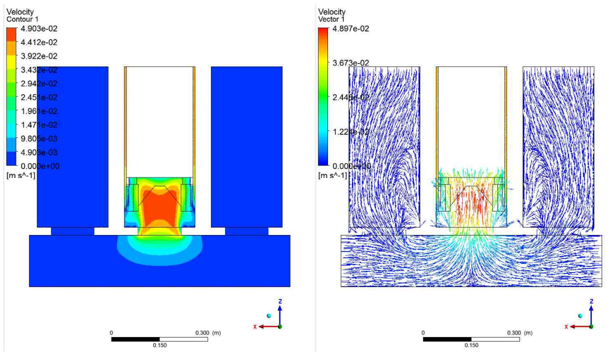

Fig. 4. Flow Velocity Results for FA Unloading Condition

3. Conclusions

In conclusion, it was evaluated that debris do not affect fuel integrity because debris do not flow into the inside of nuclear fuel under fuel loading and unloading conditions.

REFERENCES

[1] KAERI, A State of the Art Report on the Characterization of the spent PWR Cladding Hull, KAERI/AR-630/2002, 2002

[2] Hoener, S.F., Fluid-Dynamic Drag, 2nd ed. Midland Park, NJ: Published by the author, 1965