

Manufacturing and Construction of Spent Fuel Storage Rack for Research Reactor

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1. Introduction

The spent fuel storage rack is a structure to store spent fuel assemblies generated from the core. The spent fuel storage rack is placed at the bottom of the service pool.

2. Design

2.1 Structure

The spent fuel storage rack consists of spent fuel storage racks and support frame. The spent fuel storage racks are installed in the support frame. A spent fuel storage rack consists of frame weldment and storage cell pipe assembly. Storage cell pipe assembly is mounted on the base plate of the frame weldment. Spent fuel assemblies are stored in the storage cell pipes to protect the fuel assemblies and maintain the positions of the fuel assemblies. And a support block is inserted at the bottom of each storage cell pipe to support the fuel assembly.

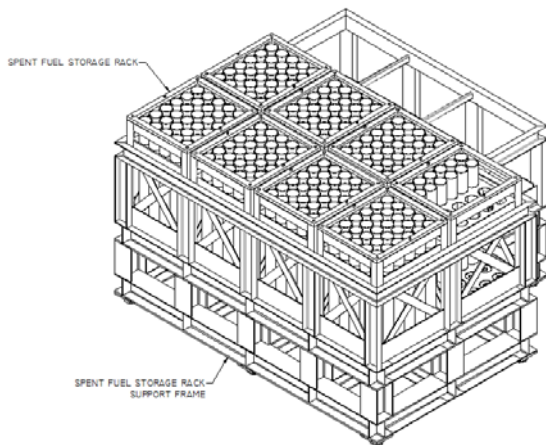


Fig. 1. Configuration of spent fuel storage rack

2.2 Safety

The spent fuel storage rack is submerged in the service pool water at all time for shielding radiation from and cooling of the spent fuel assemblies in the spent fuel storage racks. Stainless steel is used for structural material of the spent fuel storage rack to

prevent corrosion. And stainless steel has good resistivity against radiation.

The spent fuel storage rack is designed to maintain structural integrity under seismic condition. The pitch size of storage cell pipes is set to ensure the effective neutron multiplication factor does not exceed designated value under the seismic condition.

Surveillance equipment is installed at the service pool area for the security of spent fuel assemblies.



Fig. 2. Spent fuel storage rack and dummy fuel assembly

2.3 Analysis

The spent fuel storage rack is designed to withstand seismic load and other loads during earthquake. The structural integrity of the spent fuel storage rack is evaluated in accordance with ASME Section III, Subsection NF. [1, 2] Computer Code used for this analysis is ANSYS version 14.0.0. Dead load and seismic load is considered in load condition and hydrodynamic mass is included in the analysis.

The response spectrum analysis and the time history analysis are performed for seismic analysis of the spent fuel storage rack. [3] The response spectrum analysis is performed by using each directional floor response spectrum. The number of modes considered in mode combination is 300ea. Other modes beyond the 300th mode are considered by using the missing mass method. The hydrodynamic mass is applied to consider the dynamic effect of the fluid. The time history analysis is performed by simultaneously applying the acceleration time history to each direction. The effect of the fluid in the pool is considered by applying the hydrodynamic mass.

It is confirmed through a structural analysis that the spent fuel storage rack maintains its structural integrity against the load condition.

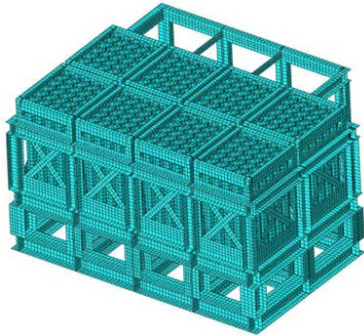


Fig. 3. FEM model of spent fuel storage rack

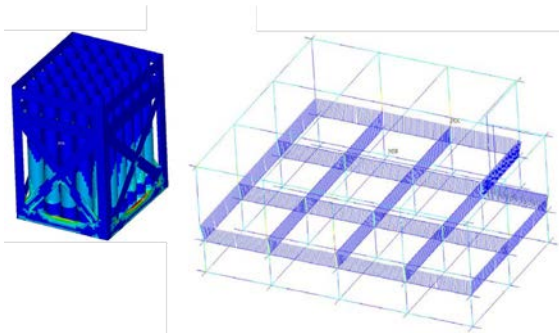


Fig. 4. Analysis results of spent fuel storage rack

3. Construction

3.1 Fabrication

The spent fuel storage rack is fabricated in accordance with the ASME Section III, Subsection NF. Additional attention is paid to the protection of stainless steel from contamination and damage.

3.2 Inspection and Test

The spent fuel storage rack is inspected and pre-assembled to verify proper fit, clearance, and integrity.



Fig. 5. Installation of spent fuel storage rack

3.3 Installation

The spent fuel storage rack is installed in the service pool with designated gap between pool walls and the support frame. Leveling of the spent fuel storage rack is conducted by using leveling bolt at the bottom of the support frame.

4. Summary

Design, manufacturing, and construction of the spent fuel storage rack are introduced. The spent fuel storage rack is for storage of spent fuel assemblies. The spent fuel storage rack should be designed, manufactured, and installed with consideration of predicted number of spent fuel assemblies, structural integrity, resistivity to corrosion and radiation, cleaning, and workability.

Acknowledgements

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REFERENCES

- [1] ASME Boiler and Pressure Vessel Code, Section III, Rules for Construction of Nuclear Facility Components, Subsection NF, American Society of Mechanical Engineers, 2004
- [2] Structural Integrity Evaluation of Spent Fuel Storage Racks and Support Frame for a research reactor, 20th International Conference on Nuclear Engineering, 2012
- [3] Dynamic Analysis of Support Frame of the Spent Fuel Storage Rack, Korea Society of Mechanical Engineers, 2012