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Development of Simplified Head Assembly with internal ducts in Westinghouse 3 Loop Plants

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1. Introduction

The objective of SHA (Simplified Head Assembly) is to simplify and to hasten the process of removal and installation of the reactor vessel head for refueling and inspection, which makes it possible to shorten outage time, to enhance reliability as well as personnel safety and to reduce occupational radiation exposure. The existing service structure components and lift rig may be re-used, modified or replaced, as needed. As a minimum, the SHA shall include the following modifications to several subsystems.

2. Methods and Results

The SHA includes replacing integral missile shield and CRDM cooling system with the external missile shield and CRDM cooling system fans and eliminating the CRDM cooling system ductwork. Further, the SHA simplifies the CRDM/DRPI cable configuration, allows the lifting tripod to remain permanently assembled to the head assembly and improves access to the head assembly for inspection and maintenance purposes.

2.1 Missile Shield

The SHA shall incorporate an integral missile shield to protect against missiles created by an upper control rod ejection FSAR event or any other design basis event. The missile shield and SHA shall be easily removed as a unit to facilitate access to the seismic platform for CRDM and cable maintenance. Current missile shield composition is three concrete blocks but SHA missile shield is 1~2 inch thickness steel plate.

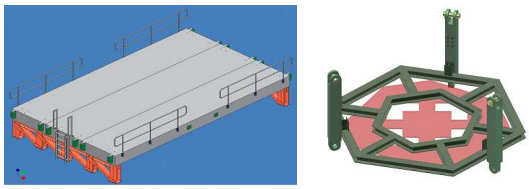

Fig. 1 Current Missile shield and SHA

2.2 CRDM (Control Rod Drive Mechanism) Cooling System

The SHA shall incorporate an integral ventilation system for cooling of the CRDM assemblies. The current CRDM ventilation system, which is mounted on the reactor vessel head missile shield and connected to the head ventilation shroud by external ductwork, shall be replaced with the SHA integral ventilation system which is a self-contained ventilation system that is part of the SHA. Design and fabrication of the integral ventilation system shall meet the following requirements.

The existing ventilation system has four (4) 26,300 cfm cooling fans. Normally, three fans operate with one in standby. Westinghouse 3 loops plant has conducted an evaluation for operation with two fans in operation and one in standby. The current system maintains a cooling air average velocity 50ft/sec at CRDM region during operation, as measured by the installed instrumentation. This type of operational flexibility shall be evaluated for the new cooling system.

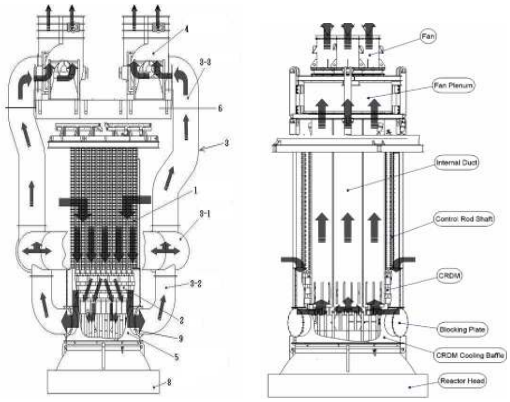

Fig. 2 Current CRDM Cooling system and SHA

So, we performed Computational Fluid Dynamics. And the result is 47.5~56.3 ft/sec cooling air velocity distribution result of CRDM upper and low region.

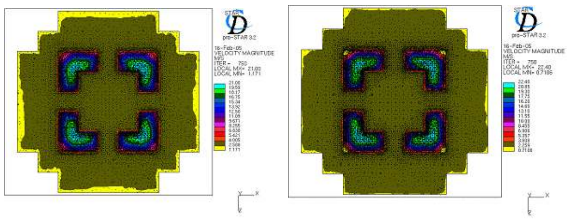

Fig. 3 Cooling air velocity distribution result of CRDM upper and low region

2.3 CRDM and DRPI cable trays/bridges

The cable modification shall include new or modified cable trays/bridges that span from the edge of the reactor cavity to the head assembly to support the cables. The cable trays / bridges shall be retractable and stored on the SHA without the use of the polar crane and must not interfere with head removal or refueling operations, and shall have positive locking attachments.

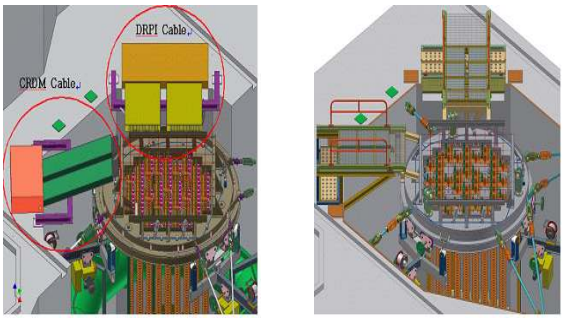

Fig. 4 Current Trays/bridges and SHA

2.4 Results

The SHA shall modify the CRDM cooling system, missile shield and cable trays/bridges. The SHA allows the lift rig to remain attached to the head assembly during plant operation. The head lift rig should be easily field removable for servicing and access to the SHA components.

Finally, Fig. 6 shows Westinghouse 3 loops Rx vessel head assembly in advance of modification and Fig. 7 shows SHA

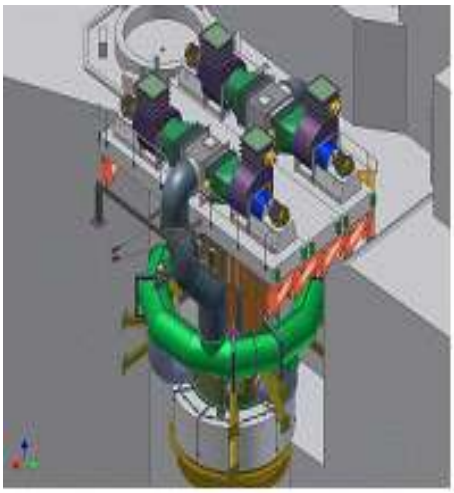

Fig. 6 Westinghouse 3 loops Rx vessel head assembly before SHA

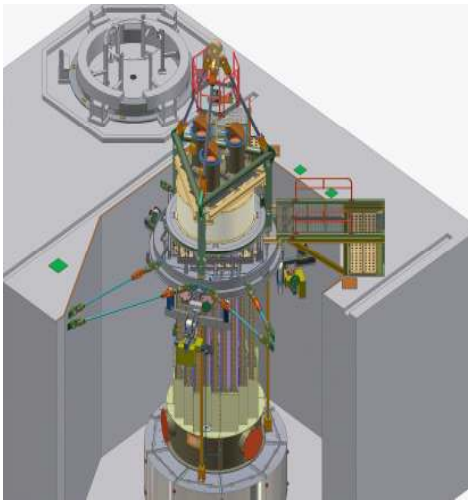

Fig. 7 Westinghouse 3 loops Rx vessel head assembly after SHA

3. Conclusions

The SHA makes it possible to reduce refueling outage time about 48~50 hours, worker radiation exposure associated with these efforts, occupational safety risks, polar crane and containment laydown space demand.

The most important thing is that Cost could be expected to be reduced because refueling is the primary progress at nuclear power plant.

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