Analysis of External Reactor Vessel Cooling with COASISO During a Core Melt Accident

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Abstract

As an IVR-EVC (In-Vessel Retention through External Vessel Cooling) design concept, external cooling of the reactor vessel was suggested to protect the lower head from being overheated due to relocated material from the core during a severe accident COASISO (*Corium Attack Syndrome Immunization Structures Outside the vessel*) is an external vessel cooling strategy by flooding inside the thermal insulator. Its advantage is the quick response time so that the initial heat removal mechanism of the EVC is nucleate boiling from the downward-facing lower head. The efficiency of the COASISO may be estimated by the thermal margin defined as the ratio of the actual heat flux from the reactor vessel to the critical heat flux (CHF). In this study the thermal margin for the large power reactor as the APR1400 (Advanced Power Reactor 1400 MWe) was determined by means of transient analysis for the local condition of the coolant and temperature distributions within the reactor vessel. The heat split fraction in the oxide pool and the metal layer focusing effect were considered for calculation of the angular thermal load at the inner wall of the lower head. The temperature distributions of the reactor vessel resulted in the actual heat flux on the outer wall. The local quality was obtained by solving the simplified transient energy equation. The unheated section of the reactor vessel decreases the thermal margin by mean of the two-dimensional conduction heat transfer. The peak temperature of the reactor vessel was estimated in the film boiling region as the thermal margin was equal to 1. Sensitivity analyses were performed for the time of corium relocation after the reactor trip, the coolant flow rate, and the initial subcooled condition of the coolant. This methodology will be implemented into the severe accident analysis code MAAP4 for the external vessel cooling with the COASISO.