Modelling the effects of oscillating stripe cooling during a LOCA event in a VVER440/213 reactor pressure vessel

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ABSTRACT

A Loss of Coolant Accident (LOCA) is initiated by damage in the primary circuit and subsequent coolant leak of a pressurised water reactor (PWR). The loss of coolant is then compensated by the Emergency Core Cooling System (ECCS) [1]. This system supplies the primary circuit with cold high pressure coolant during emergencies. The mixing of this cold coolant results in stripe cooling of the RPV wall.

This article focuses on the modelling of the mixing processes of this cooling stripe and their effects on the RPV wall in a VVER440/213 Russian type PWR. The mixing processes are modelled in a transient thermo-hydraulic analysis which models the mixing of the coolant flows in the reactor pressure vessel and results in the overtime temperature and pressure fields within the RPV [2]. The analysis results show that the cooling stripe is not stationary. The turbulent mixing causes an unstable oscillatory motion of the cold stripe which has a notable effect on the RPV wall temperature distribution.

Selected results were subsequently transferred into a thermo-mechanical analysis via one way coupling method. This analysis was performed to evaluate the PRV loading state during the LOCA transient. Where the loading stresses were shown to correspond to the oscillatory nature of the cooling strip.

In conclusion, an oscillating cooling strip can result in multiple loading cycles [3,4] of the reactor pressure vessel wall during a single LOCA transient or ECCS high pressure coolant injection.

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