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Validation of a MELCOR model of Reactor Cavity Cooling System through support of CFD simulation

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This work aimed to validate a MELCOR model of the Reactor Cavity Cooling System (RCCS) by conducting Computational Fluid Dynamics (CFD) simulations. The development of a passive heat removal system design falls under the category of safety systems, which require guaranteed functionality and verification during the licensing process for the construction and operation of nuclear reactors, both under normal operating conditions and during accident scenarios. In the High Temperature Gas-cooled Reactor (HTGR), the containment structure differs from typical Light Water Reactors (LWRs) and is typically designed to be non-leaktight confinement. Therefore, the RCCS plays a crucial role as a safety function, aiming to control reactivity by maintaining fuel temperature below a limit (set at 1600℃) during an accident scenario with increased fission product release probability.

Based on the validated model of RCCS, a series of variant simulations were performed. The simulations were aimed at studying and analyzing various scenarios related to the RCCS, considering its effectiveness in heat removal and reactivity control during accident conditions. The results obtained from these simulations contribute to the understanding of the system's behaviour, performance, and safety features. The findings of this study have implications for the design, construction, and operation of future nuclear reactors, particularly in terms of safety system performance and accident mitigation strategies.

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