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Preliminary accident analysis of ex-vessel LOCA for the European DEMO HCPB blanket concept

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Based on the reference design HCPB2016 (helium cooled pebble bed) in the pre-conceptual design studies for the European DEMO, the primary heat transfer system (PHTS) for DEMO baseline 2015, and current parameter study for the plasma disruption conditions and the affected FW surface areas, ex-vessel LOCA (loss of coolant) with a double-ended guillotine break of a main pipe in the PHTS has been investigated that helium blows down into the tokamak cooling room (TCR). For the design basis accident (DBA) a fast plasma shutdown (FPSS) followed by a plasma disruption is assumed at 3 s after the detection of the LOCA at 80% of the nominal mass flow rate. Three main cases are identified: case I with the affected FW area of 0.1 m^2 in one loop and the mitigated plasma disruption, case II with 1.0 m^2 in two loops and the mitigated plasma disruption, and case III with 5.0 m^2 in two loops and the unmitigated plasma disruption. If EUROFER reaches 1000 ℃ an in-vessel LOCA takes place. Since this LOCA starts in case of the beyond design basis accident (BDBA) without the FPSS much earlier than it in the DBA, to save the computation time, the transport of source terms is performed for the BDBA. Also scenarios due to the options of the suppression tank (ST) with or without water as heat sink, and impact of the cooling ability of the vacuum vessel (VV) have been investigated. MELCOR 1.8.6 for fusion is a valid tool for this study. The ex-vessel LOCA is initialized during the normal operation at the steady state. The transient results of different scenarios will be discussed for the time evolution of the accident sequences, pressurization in the TCR, VV and ST, temperature behavior in different volumes and structures, and tritium and dust transport behavior.

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