Preliminary accident analysis of the loss of heat sink for the European DEMO HCPB blanket concept

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Abstract

The helium cooled pebble bed (HCPB) blanket concept of the European DEMO has been changed significantly for DEMO baseline 2017 in comparison to the previous design for the baseline 2015. Accordingly accident analysis has to be performed for the new reference design HCPB2018 with the associated primary heat transfer system (PHTS) regarding the option of direct coupling with the power conversion system (PCS). It starts with the event loss of heat sink, which has not yet been studied in the baseline 2015.

The selected postulated initial event (PIE) is HA99 the loss of heat sink in all first walls (FW), blanket structure, breeding zone (BZ) and divertor primary cooling circuits because trip of both high pressure (HP) and low pressure (LP) turbines due to loss of condenser vacuum [1]. Scenario of the design basis accident assumes conservatively that at the beginning of the transient no helium heat power is removed in the steam generator (SG) in one loop. A fast plasma shutdown (FPS) is activated 3.0 s later after the detection of the event by the defined pressure set point. The FPS causes a mitigated plasma disruption which affects the certain area the FW in two different sectors of other two different loops. It is assumed that the FW fails if EUROFER reaches 1000 °C and an in-vessel LOCA takes place. The pressurization in the VV will be suppressed with the VV pressure suppression system (VVPSS) by pressure set points. The VVPSS is designed with the bleed lines(BL), the rupture discs (RD) and the wet expansion volume (EV). Radioactive inventories (tritium, dust) will be mobilized. A 32 h of loss of off-site power is assumed after the plasma disruption. MELCOR 1.8.6 for fusion is a valid tool for this study. Results during the normal operation at the steady state will be compared with the design to check the generated MELCOR model. The transient results will be discussed for the time evolution of the accident sequences, pressurization in the VV and VVPSS, temperature behavior in different volumes and structures, and tritium and dust transport behavior.

[1] T. Pinna et al., Identification of accident sequences for the DEMO plant, Fusion Engineering and Design, Volume 124, November 2017, Pages 1277-1280.

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