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Analysis of a protected Loss Of Flow Accident (LOFA) in the ITER TF coil cooling circuit

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A detected loss-of-flow accident (LOFA) in the cryogenic cooling circuit of the ITER superconducting magnets will initiate a series of actions aimed at guaranteeing the protection and the integrity of the magnets. In the case of the Toroidal Field (TF) coils, the protection strategy following a LOFA triggered by, for instance, the stop of the cold circulator, is foreseen to determine an "accelerated discharge"of the coil current, followed by a controlled discharge of the CS and of the PF coils, while the plasma pulse will be terminated and the plasma operation will be stopped until the nominal operating conditions of the magnets are recovered. The suitability of the protection strategy following the detection of a LOFA, and the implications on the heat load to the cryoplant and on the re-cooling time needed to recover to normal operations, still deserve some dedicated analysis. Here we apply the 4C code, a well-established numerical tool for the analysis of thermal-hydraulic transients in superconducting magnets for fusion applications, to simulate the dynamics of a detected LOFA in an ITER TF coil and its cooling circuit, following the event tree as currently foreseen by the coil protection system, with special attention to the temperature margin erosion during the accelerated discharge and to the development of hot spot zones inside the winding pack. The time requested to re-cool the magnet will also be estimated, in order to quantify both the additional thermal load on the refrigerator and the impact of a protected LOFA on the machine availability.

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