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ITR/P5-04: Transient Electromagnetic Analysis of the ITER Blanket System

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The design of the ITER Blanket System is controlled by three main considerations. Two of these considerations, plasma heat flux to the surface and nuclear heating, determine the cooling requirements and coolant distribution to control thermal stress in the modules. Electromagnetic forces due to off-normal events like disruptions must be controlled to be within the strength of the supports on the vacuum vessel and determine the mechanical stress in the blanket components. First, electromagnetic forces are generated by three different causes during an off-normal event. The shift in plasma paramagnetism during thermal quench generates eddy currents due to the change in toroidal field. Second the changing plasma current during current quench generates eddy currents due to the change in poloidal field. Finally, halo currents flow from the plasma to the wall due to plasma motion during current quench. The analyses conducted are based on disruption simulations , performed using the DINA code. The DINA output includes information on toroidal flux change during thermal quench, plasma shape, current, and position during current quench, and halo current flow to the plasma-facing surface. Raw DINA output was processed to reduce the plasma current temporal and spatial variation to time dependent current in a fixed set of 64 conductors that surround the plasma volume. The OPERA code was used to simulate the transient eddy currents in, and current flow through the complex 3D blanket components. Forces and moments were calculated from the current distribution and the local magnetic field. We studied numerous options for slits to control eddy currents in the shield blocks, electrical connections between the first wall and shield, fault scenarios for insulators in the support system between the blanket and the vessel, and variations on two different types of first wall panels (lower and higher heat flux rating). The support system between the first wall and shield block and between the shield block and vessel contains several insulators to control the flow of halo or eddy currents among the various components. We have examined the consequence of failure of one or more insulators by replacing the insulator with a controlled electrical contact. Insulator failure creates addition conducting loops or current paths. These studies led to revision of the design of the mounts.

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