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ITR/2-6: The ITER Blanket System Design Challenge

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The blanket system is one of the most technically challenging components of the ITER machine, having to accommodate high heat fluxes from the plasma, large electromagnetic loads during off-normal events and demanding interfaces with many key components (in particular the vacuum vessel and in-vessel coils) and the plasma. Plasma scenarios impose demanding requirements on the blanket in terms of heat fluxes on various areas of the first wall during different phases of operation (inboard and outboard midplane for start-up/shut-down scenarios and the top region close to the secondary X-point during flat top) as well as large electromagnetic (EM) loads and transient energy deposition during off-normal plasma events (such as disruptions and vertical displacement events (VDE)). The high heat fluxes resulting in some areas have necessitated the use of "enhanced heat flux"panels capable of accommodating an incident heat flux of up to 5 MW/m² in steady state. The other regions utilize "normal heat flux"panels, which have been developed and tested for a heat flux of the order of 1-2 MW/m2. The FW shaping design requires a compromise between the conflicting requirements for accommodation of steady state and transient loads (energy deposition during off-normal events). A shaped surface increases the heat loads which are due to plasma particles following the field lines compared to a perfectly toroidal surface. The blanket provides a major contribution to the shielding of the vacuum vessel and coils. A challenging criterion is the need to limit the integrated heating in the toroidal field coil (TFC) to ˜14 kW. This is particularly severe on the inboard leg where approximately 80% of the total nuclear heat on the TFC is deposited. Several design modifications were considered and analyzed to help achieve this, including increasing the inboard blanket radial thickness and reducing the assembly gaps. This paper summarizes the latest progress in the blanket system design as it proceeds through its final design phase, focusing in particular on the challenge of accommodating demanding and sometime conflicting design and interface requirements.

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