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## The in-vessel protection components for ITER First Plasma operation

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ITER plasma operations begin with a limited 'first plasma', with the main purpose of concluding integrated commissioning of the tokamak. This first plasma is targeted to last at least 100 ms and with a minimum plasma current of 100 kA. As in other tokamaks, the first plasma is conducted prior to full installation of the baseline in-vessel components. Namely, the blanket and divertor are installed only after first plasma experiments are completed. To avoid potential adverse effects of start-up plasma on the vacuum vessel and other already-installed high-value components (in-vessel coils, cable looms, etc.), several temporary in-vessel components are installed to protect all in-vessel systems that cannot tolerate direct plasma interaction.

Machine protection is in part provided by temporary limiters and divertor replacement structures, which together create a poloidal and toroidal guide to shelter the vacuum vessel from the plasma and possible fast particle beams. 72 temporary limiter structures are distributed around the tokamak as four poloidal loops of eighteen tiles that follow the first wall contour. For engineering safety during plasma commissioning, the system is capable of maintaining plasma pulses of up to 3 seconds, tolerating up to 30 MJ of thermal energy and 1 MA of plasma current. Divertor replacement structures complete the bottom periphery of the poloidal loop to interrupt any potential downward plasma movement.

In addition to protection from the plasma, the vessel also requires protection from the electron cyclotron resonance heating (ECRH) beam. This beam injects 6 MW of microwave energy across the null region of the vacuum vessel to help energize and assist the breakdown of first plasma. To protect the vacuum vessel, an inboard mounted mirror reflects the ECRH beam energy from its upper port origin into an outboard equatorial port, where a second component (a beam dump) can effectively absorb the radiation.

These first plasma protection components (FPPC) are unique to ITER, and fit the need of a simple and cost-effective system that is easily installed and un-installed prior to further plasma operation in such a way as to minimize later impact on machine operation. The initial FPPC effort matured these components to a conceptual design level in preparation for the Conceptual Design Review held in November 2016. This paper summarizes the FPPC design and analysis status resulting from this initial effort.

*Disclaimer: The views and opinions expressed herein do not necessarily reflect those of the ITER Organization.*

### Eligible for student paper award?

No

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