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Sat-Mo-Po.03-08: Innovative fusion-reactor-specific fatigue design criteria: insights and advances from the DEMO central solenoid study

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The design of the DEMO Central Solenoid (CS) poses significant challenges due to the risk of fatigue failure and the stringent design criteria required to mitigate it. These criteria impose constraints on the allowable size of the solenoid, which, in turn, affect the configuration of the toroidal system and influence the overall performance of the fusion reactor. To address these challenges, the DEMO project focuses on developing a fatigue design criterion specifically tailored to the unique operational demands and loading conditions of a fusion device.

Building on established guidelines, such as ITER's design criteria and the RCC-MRx code, this work aims to pave the way for an optimized criterion that accounts for the combined effects of cyclic electromagnetic forces and thermal loads typical of fusion environments. The approach integrates a multidisciplinary workflow combining analytical, numerical, and experimental methodologies. Key activities include optimizing the CS's dimensions and configurations, performing finite element simulations, and conducting experimental validation to evaluate fatigue behavior under representative loading conditions.

This effort aims at establishing a robust framework for validating a fatigue design criterion for DEMO. It encompasses the development of numerical models to demonstrate compliance and the collection of experimental data to confirm the criterion's reliability. By enabling the design of a CS that meets magnetic flux requirements over multiple plasma pulses while maintaining structural integrity and long-term reliability, this initiative contributes significantly to the feasibility and efficiency of future fusion reactors.

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