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Neutronic challenges on the way from ITER to DEMO

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Reliable neutronic assessments are essential for the design and the safe operation of high performance fusion facilities. For the under construction ITER device, accurate and complete evaluations of the nuclear responses from the various radiation sources are mandatory to optimize the shielding design, guarantee a sufficient protection of critical components and minimize the occupational exposure of workers. To reduce uncertainties of the computational predictions and the associated risks for the ITER operations, benchmark experiments are in preparation for the future DT campaign at JET within the EUROfusion Consortium, aimed at validating neutronics tools and data used in ITER nuclear analyses. In parallel, design studies are underway in the EU for the development of a demonstration fusion power plant (DEMO) aiming at the production of electricity and the operation of a closed fuel cycle. The DEMO design and related R&D activities will benefit from the ITER experience. Nevertheless, DEMO should demonstrate full tritium breeding capability to achieve self-sufficiency, which is only partially addressed with ITER through the Test-Blanket-Module (TBM) program. Furthermore, the DEMO operative irradiations conditions will be significantly more demanding and the issues related to the degradation and changes of materials properties, including gas production, activation, erosion and corrosion products, contamination, etc.., and the resulting radiation dose loads, will be more severe than in ITER. The significant in-vessel material damage and activation necessitates the development of proper neutron resistant and low activation structural materials which need to be qualified and tested under intense fusion neutron source. Thus, accurate and reliable nuclear analyses to address DEMO design and safety requirements require specific efforts on the improvement and optimisation of simulation tools and nuclear data supported with dedicated experimental activities.
This paper reviews the main ITER neutronic issues, lessons learnt and implications for the DEMO nuclear design and safety, as well as the current R&D activities on codes and nuclear data development and the supporting experimental program. Further needs and challenges to cover the technological gap between ITER and DEMO and efforts to reduce uncertainty margins are discussed.

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