

## ITER diagnostic port plug engineering design analysis in the EU

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A substantial part of the ITER diagnostic systems will be located inside port plugs, sited at the machine equatorial and upper levels. In 2005, the EU has contributed significantly to activities launched within ITER to review and advance the work carried out by the ITER International Team on the engineering design of the ITER diagnostic port plugs. The work presented in this paper focuses on the engineering analysis of a representative equatorial port plug, although illustrative results are also presented for a prototypical upper port plug.

A series of analyses has been undertaken on the port plug outline design to ensure that the structure satisfies the requirements of the ITER environment. This includes Finite Element (FE) analyses of static and dynamic behaviour under electromagnetic loads, FE vibration analysis, FE thermal-structural analysis and nuclear heating and radiation dose studies.

Outcomes from these analyses and consequent design developments will be discussed, including the results of neutronic and structural studies. From the former, the main conclusions involve a revision of the stainless steel/water ratio in the plug neutron shielding modules, bringing the plug overall weight to within the target value of 50t, and the incorporation of improved neutron shielding of the port duct, which reduces neutron streaming due to the port to plug gap and limits activation of the port seal to a local dose rate after shut down smaller than  $100 \times 10^{-15} \text{ Sv/h}$ . Structural analysis resulted, inter alia, in a modification of the plug top plate arrangement, to increase torsional stiffness of the structure under disruption loads, and in improved solutions for cooling arrangements. Manufacturing studies have also been performed, involving the assessment of methods for the production of plug flanges, the analysis of welding techniques for parts assembly and methods for the introduction of cooling features in plug components. Reference design solutions and possible modifications will be presented and discussed.

With the enhanced level of preparations for ITER construction, the scope of these activities is expanding to include a considerably more detailed structural and neutronic analysis. In addition, design studies towards a common upper port plug structure for diagnostic systems and the electron cyclotron launchers will be undertaken.

This work has been performed within the framework of the European Fusion Development Agreement