DETAILED STRUCTURAL ANALYSES FOR ITER CORE CXRS PORT PLUG COMPONENTS BASED ON 3D ELECTOMAGNETIC TRANSIENT SIMULATION

A. Nemov[1], A. Borovkov[1], I. Voinov[1], O. Antonova[1], A. Khapsasov[1], W.Biel[2], A. Panin[2]

[1] *Computational Mechanichs Laboratory, St. Petersburg State Polytechnical University*
[2] *IEF-4 (Plasma Physics), Forschungszentrum Jülich, Association EURATOM-FZJ, D52425 Jülich, Germany*

Corresponding author: nemov@compmechlab.com

The design of the ITER core charge exchange recombination spectroscopy (core CXRS) Port Plug has been developing by Forschungszentrum Jülich (FZJ), ITER-NL and UKAEA(CCFE). The design concepts should comply with various ITER requirements and, among other factors, to sustain the electromagnetic (EM) loads caused by plasma transients.
The aim of this study is to verify current design options for some CXRS critical components with respect to the EM loads. This has been done by means of 3-D Finite Element (FE) EM analysis and detailed stress analysis. The research is divided in two subsequent steps:
The first step deals with global EM modeling of the ITER magnet system. The purpose of the model is to benchmark it against two others independent global EM models developed for the CXRS (mentioned in the FZJ paper) and to get an input for subsequent EM and structural models of the important CXRS components. The global ANSYS FE model was developed with all necessary Port Plug features. To simulate evolution of the toroidal plasma and Halo currents a special code was developed to transfer the 2D DINA output to the 3D FE model. Two plasma vertical displacements events (VDE) resulting either in the maximum eddy currents or the maximum halo currents in the Port Plug structure have been simulated. The same FE models with certain changes are used for both the eddy and halo current analyses which are performed separately and the results are superimposed.
Time varying magnetic fields together with the induced eddy currents in the Port Plug and the Halo currents flowing through the Port Plug have been obtained. The EM loads acting on the massive Port Plug components was calculated. These results are ready for comparison with other models. The results of global modeling were used as a source of input for detailed local EM analyses.
The main emphasis in this paper is placed on analysis of currently designed CXRS components under the EM loading. The main Port Plug massive structural parts as the Outer Shell holding the Shielding Cassette were represented in the global EM model as bodies with smeared properties. The Shielding Cassette holds the Retractable Tube with the first mirror and the first mirror shutter inside. The reference option of the first mirror shutter and the second option of the first mirror structure have been studied.
The results of the global EM model were carefully analyzed and components to be studied the most critical loading cases were selected. Because these components are relatively small (but require fine and complex mechanical models) and are located inside massive conductive shielding structures the same mesh for their detailed EM and structural models is used. The "air" elements are not generated for the EM models. The boundary conditions for them are derived directly from the global EM model and are specified on boundaries of the conductive structural parts (vector potential components). The applicability of this approach is discussed in the FZJ paper.
The results of the EM and stress analyses of the first mirror and its shutter under the EM loading are discussed in this paper.