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## ITR/P5-03: Simulation of Eddy Current and Electromagnetic Loads in ITER Conducting Structures

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A modelling technique has been developed to efficiently predict EM loads in conducting structures. A set of models that integrally covers the structures has been developed in the course of activities requested and supervised by the IO ITER. Reasoning from the simulation efficiency, a local model based either on the 3D solid body or shell approximation is applied. Detailed models were built for the system “vacuum vessel (VV), cryostat, and thermal shields (TS)” which enable description of its complex multiply connected thin-walled structures with required accuracy. The EM transients are simulated through the space and time variations of the toroidal plasma current, halo current, the toroidal magnetic flux, and the coil currents, that covers practically all field sources. These data are derived from results of MHD simulations. This enables simulations for all plasma scenarios and operating modes. At the first step, induced eddy currents are simulated in the system «VV+TS+Cryostat» that has crucial EM effect on other structures. A shell model of the system implements an integral-differential formulation, and a single unknown is determined in terms of the vector electric potential taken at the nodes of a FE mesh on a shell surface. EM loads on massive in-vessel and out-vessel structures and thin-walled components are simulated with the use of local FE models. In-time field sources can be described via a set of basic functions. As an alternative to direct integration over the entire operation scenario, a generalized solution for any scenario is obtained as a superposition of individual solutions. The mathematical formulation is implemented in terms of vector potentials or through a field vector. In the Cartesian coordinates, a separation of variables (vector components) is applicable. Parallel computations enable solving the problem in both formulations during the same runtime. An efficiency of these solutions is compared. Combined computations with different models provide cross-checking within common procedures. Integration with other computer codes is feasible that improves reliability of simulations. The proposed computational technique has been applied to EM analyses to support ITER design activities. The results have been included in the project documentation. Developed models enable cost-and time effective computations at further activity.

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