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ON A FULL 3D THERMAL STRUCTURAL AND HYDRAULIC FINITE ELEMENT MODEL OF THE JT-60SA TOROIDAL FIELD COILS

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The JT-60SA Toroidal Field Coils (TFC) are currently being manufactured in Europe, and their assembly is progressing at full speed in QST, Naka. As part of their final acceptance, the coils are tested in working conditions and at full current in a dedicated facility in Europe. To help defining the cool down strategy for the testing of the TFCs, and also to anticipate their behavior during the cooling down of the JT-60SA tokamak, a fully 3D finite element model of a TFC has been created, which includes finite elements with both thermal-mechanical and hydraulic formulations, to simulate in real time the interaction between the Helium coolant flow and the structures. The model has been extensively used for predicting the behavior of the TFC during cool down and warm up, and the results have been benchmarked against the experimental evidence collected during the cold tests carried out in Europe. Several kind of analyses were carried out, from simple cool down simulations, to more sophisticated simulation of fast transient events, like the signature dynamic quench test which all TFCs have undergone. The model is built using the ANSYS commercial Finite Element code and is readily up-scalable to any size of similar magnets. This paper describes the rationale behind the definition of the model, and the results obtained in preparation of the first cold tests, and in view of the operation of the Tokamak. The associated modeling challenges are reviewed and critically discussed.

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