DESIGN AND MANUFACTURING ASPECTS OF THE ITER CENTRAL SOLENOID PRE-COMPRESSION AND SUPPORT STRUCTURE

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The 1000 tons ITER Central Solenoid (CS) superconducting magnet has an overall diameter of 4.3 m and maximum height of 18 m. The magnet is made of 6 independent modules stacked above each other. The CS is designed to withstand very large electromagnetic forces. During operation, the modules develop vertical forces upward or downward, depending on the current flowing in each module and on the resulting magnetic field configuration. In order to maintain the modules in contact with each other, a mechanical structure preloads them with a 200 MN vertical compressive force. This force is applied using 9 sets of “belt like” inner and outer tie plates. The vertical net load applied to the CS in operation (+/- 60MN) is transferred to a support structure anchored to the Toroidal Field (TF) coils and designed to withstand a maximum vertical load of 180 MN. This load could appear in the case of a class IV fault (worst case : permanent distortion accepted; investment lost). In case of plasma disruption, side electromagnetic forces up to 2 MN have been identified between modules due to the induced current in the Vacuum Vessel. Therefore, the modules are linked with each other by centering rings, inserted in the inner bore of the magnet at the interface between two adjacent modules, and preventing horizontal offset. The net side force is supported by the lower supports and an upper centering device keeping the CS mechanical structure centered with respect to the TF coils, while allowing relative toroidal displacement of the TF coils. In operation the minimum radial clearance between the CS structure and the TF Coils is 10 mm.

After presenting the detailed features of the pre-compression and support structures, the paper reviews the different loading conditions and the requirements derived from the mechanical analyses performed using the normal and accidental operating conditions. Particularly enlightening is the way the conflicting requirements, arising from the desired flexibility with pulsed operation, have been addressed. The paper then focuses on the manufacturing methods for the different components of the structure, showing which critical issues are to be addressed in order to meet the requirements. A review is then presented of the possible manufacturing routes and of the required verifications to perform before moving to the production of large, full scale items. An assessment of the most promising solutions concludes the paper.