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Engineering and Structural Assessment for the updated design of the DTT Central Solenoid

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The "Divertor Tokamak Test"(DTT) is an experimental fusion reactor being built in Frascati (IT) in the framework of the European Fusion Roadmap. The DTT Central Solenoid, used to drive the current in the magnetically coupled plasma, comprises six Nb3Sn layer-wound independently energized modules. Each module is made of three sub-modules: High Field (HF), Medium Field (MF) and Low Field (LF) grades. Each sub-module includes a different CICC, optimized for the specific operative values of magnetic field and current density. Each of the three CICCs relies on a design with rectangular geometry, constant steel jacket thickness. Owing to the limited hydraulic lengths, no pressure relief channel is used, which contributes to the improvement of the coil engineering current density. In order to meet all goals of the DTT scientific program, a variety of plasma scenarios have been designed. These cause intense and heterogeneous loading conditions for the CS stack; from the mechanical point of view, each module is subjected to a vertical expansion or compression and to a huge radial action, whereas the current variations cause relevant heat loads due to AC losses, with impact on the coil temperature margin. To ensure the structural integrity of the magnet, an external system is defined for the application of the required vertical preload to the CS modules. The precompression structure prevents axial repulsion and follows the shrinking of the stack preventing any detachment between modules during all scenarios. This system consists of nine sets of inner and outer Tie Rods, one upper block and one lower anchor block for the rod, as well as nine sets of six superbolt pretensioners for the preload application. This work presents the details of the updated design of the CS stack and the precompression system, and the static and fatigue structural analyses of the main components.

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