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DEMO Central Solenoid Design Based on the Use of HTS Sections at Highest Magnetic Field

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Previous studies indicated that the use of high-temperature superconductor (HTS) sections in the highest field allows maintaining the magnetic flux in the central solenoid (CS) reducing the outer diameter compared to the nominal size specified by EUROfusion. A reduced outer diameter of the CS coil would provide the possibility to reduce overall size and cost of DEMO. The proposed winding pack design of the CS1 module is based on 10 layer-wound sub-coils using HTS, react & wind Nb₃Sn and NbTi conductors in high, medium and low field sections, respectively. The design takes into account the hoop stress in a CS1 module with superconductor grading leading to different overall current densities in each of the 10 sub-coils. In addition, the vertical loads have been estimated for pre-magnetization, where the outer modules were pressed towards the central plane of the CS coil. Both, the hoop stress and the vertical loads have been taken into consideration for the determination of the required stainless steel cross-section in the winding pack. Due to the fact that the hoop stress decreases from the inner to the outer radius of the CS1 module, while the vertical stress depends only weakly on radial position a stainless steel grading is proposed.

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