MT 26
International Conference on Magnet Technology
Vancouver, Canada | 2019

Contribution ID: **1720** Type: **Poster Presentation**

Thu-Mo-Po4.04-04 [27]: Design Optimization and Assessment of Fabrication of ITER Central Solenoid Twin Box Joints

Thursday 26 September 2019 08:45 (2 hours)

The ITER Central Solenoid (CS) will be one of the world's largest and most powerful pulsed superconducting electromagnet ever built; at an approximate weight of 1300 tons and a total height of 18 m consisting of a stack of six electrically independent 4.1 m diameter modules. In order to electrically connect the CS with the feeder busbars, 12 twin box joints are used to assure an efficient high current transfer while avoiding excessive losses.

The fabrication of the box entails a succession of steps: explosion bonding of the stainless steel and the copper, precision machining of the internal part of the box and the cover, introduction of the conductor bundle followed by a controlled compaction to achieve the required void fraction, closure welding the cover onto the box, and subsequent reaction heat treatment (HT) for the formation of the Nb3Sn superconductor. The combined effect of all these fabrication processes, if not optimized, can lead to significant residual stresses (before) and large localized plastic deformation during HT, which have empirically shown to result into microstructural heterogeneities and in the worst cases, cracking, and thereby component disqualification for use into a nuclear environment.

The paper summarises design optimizations that were investigated and could be implemented to remedy the present manufacturing fabrication technology process qualification failure(s). Various solutions have been realized by changing different design parameters whose effect on the response to the HT is studied. Dimensional metrology and residual stress measurements via hole - drilling method complemented with metallographic investigations were performed to assess the suitability of each of the solutions. Additionally, an innovative test bench is described, that was implemented for in –situ monitoring of one of the twin box mockups during HT.

Disclaimer: The views and opinions expressed herein do not necessarily reflect those of the ITER Organization.

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Session Classification: Thu-Mo-Po4.04 - Fusion VII: Joints and Terminations