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Evolution of AC loss, inter-strand resistance and mechanical properties in prototype EU DEMO TF conductors during 30,000 load cycles

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Two prototype Nb3Sn cable-in-conduit (CICC) conductors were designed and manufactured for the Toroidal Field (TF) magnet system of the envisaged European DEMO fusion reactor. Though both conductors were designed to operate at 82 kA in a background magnetic field of 13.6 T, they reflect a different approach with respect to the magnet winding pack assembly. The first approach is based on React & Wind (RW) technology while the second approach is the more common Wind & React (WR) technology. Each conductor was tested first for AC loss in its virgin condition without any additional handling. The impact of Lorentz load during magnet operation was simulated using Twente Cryogenic Cable Press. The AC loss, contact resistance and mechanical properties of two sample conductors were tested in the press under cyclic load up to 30,000 cycles in LHe at 4.2 K. A summary of the results is presented for AC loss, contact resistance, conductor deformation, mechanical heat production and conductor stiffness evolution during cycling of the load. The results of cyclic load tests on DEMO TF conductors is compared with ITER TF samples tested previously. Both DEMO TF conductors showed similar mechanical behaviour show quite different AC losses. It is shown that in comparison with ITER TF samples, both DEMO TF conductors have much lower contact resistance, which results in high coupling loss. At the same time, load cycling has lower influence on DEMO TF conductors properties compared to ITER TF conductors.
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