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CICC performance evaluation by numerical modelling of electromagnetic-mechanical properties in ITER Nb3Sn strand

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Aiming for a better quantitative description of superconducting strand degradation in large ITER Cable In Conduit Conductors (CICC), the electromagnetic-mechanical modeling of strain-sensitive Nb3Sn strands and full-size CICCs is essential. A numerical strand model is built based on accurate intra-strand resistance data, computed spatial filament strain distribution and experimentally obtained filament crack allocation. It consists of a 3D network of resistors including superconducting filaments, normal matrix elements, and an outer stabilising shell or inner core when present. With the ITER-Twente Nb3Sn strain scaling law based on measured strand data, the model calculates the corresponding spatial electrical potential distribution. The critical current and n-value of a strand element in a CICC varies with the local magnet field, temperature, uniform axial strain, peak bending strain and crack density. Implementation of the local strand properties in the cable model JackPot remains manageable in terms of computation time by the use of simplified analytical functions produced with the strand model.
The relations allow an accurate description of the electromagnetic-mechanical properties of each strand element subjected to the complex axial and bending strain pattern, even with cracks, in CICCs with the Twente cable model JackPot for cable performance analysis and predictions.

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