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DESIGN OF LOAD-TO-FAILURE TESTS OF HIGH-VOLTAGE ELECTRIC INSULATION BREAKS FOR ITER'S CRYOGENIC NETWORK.

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The development of new generation superconducting magnets for fusion research, such as the ITER experiment, is largely based on coils wound with so-called 'cable-in-conduit'conductors. These cable-in-conduit conductors consist of various types of stainless steel jackets, densely filled with superconducting strands based on either Nb3Sn or NbTi, and subsequently compacted. The concept of the cable-in-conduit conductor is based on a direct cooling principle, by supercritical helium, flowing through the central region of the conductor, in close contact with the superconducting strands.
Originating from this principle is a direct connection between the electrically grounded helium coolant supply line and the highly energized magnet windings. Various insulated regions, constructed out of high-voltage insulation breaks, are put in place to isolate sectors with different electrical potential. These axial insulation breaks are essentially build up from stainless steel end fittings, hermetically connected via a glass-reinforced resin composite body, of sufficient length, to prevent electrical breakdown during magnet operation.
In addition to high voltages and significant internal helium pressure, the insulation breaks will experience various mechanical forces resulting from differential thermal contraction phenomena and electro-magnetic loads. Special test equipment was designed, prepared and employed to assess the insulator breaks'mechanical reliability.
A binary test setup is proposed, where mechanical failure is assumed when permeability to gaseous helium exceeds 10-9 Pa*m3/s. The test consists of a load-to-failure insulation break charging, in tension, while immersed in liquid nitrogen at the temperature of 77 K. Leak tightness during the test is monitored by measuring the permeability of gaseous helium directly surrounding the insulation break, with respect to the existing vacuum inside the insulation break. The experimental setup is proven effective, and various insulation breaks performed beyond expectations.

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