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Fri-Af-Po.03-03: Development of a 36 kA LN2 Test Stand for Magnet Terminations

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The magnets of the SPARC tokamak as developed by Commonwealth Fusion Systems and the Massachusetts Institute of Technology include superconducting magnet termination cables that supply power to the winding pack. It is important to qualify these superconducting cables because they are epoxied into the cable magnets, making their removal extremely difficult, possibly scrapping a magnet. We present a test stand developed to determine the critical current of these terminating cables at 77 K. The test stand is capable of supplying up to 36kA to fully map the superconducting-normal transition of both poloidal field (PF) and central solenoid (CS) magnet terminations, as well as CS coils. A unique challenge is the complex shape of some of these cables, featuring 3D bends in some required to fit in a compact tokamak. In addition the design must account for manufacturing tolerances, so several features were developed to accommodate the wide variety of test article geometries: a gantry to support moveable busbars, flexible braided conductors, and continuously adjustable clamping mechanisms. A method for determining stresses induced by Lorentz forces on the irregularly-shaped test articles was developed taking into account the HTS tape allocated for each cable as well as sample geometry. Finite element analysis was also used to determine thermal loads induced by joule heating, allowing for the test stand to be tuned for pulsed operation and reduced costs. Finally, a boiler system is included to allow for quick test turn-around. The result is a test stand that ensures the magnet terminations perform up to specification before their permanent incorporation into the winding pack, derisking downstream integration.

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