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M3Or2B-05: Calorimetric Measurements of YBCO Superconductor and Metallic Cables at High dB/dt in a Cryogenic Stator Machine Environment

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The U.S. Air Force Research Laboratory (AFRL) facility for the measurement of alternating-current (AC) loss in superconductors at high $B \cdot dB/dt$ has been recently tested and calibrated for operation. The test device has a spinning rotor consisting of permanent magnets arranged in a Halbach array; which exposes samples in a stator position with a peak radial field of 0.57 T, and with high rotation speeds up to 3600 rpm achieves a radial dB/dt is 543 T/s and tangential dB/dt is 249 T/s. Loss is measured by calorimetry at 77.2K using nitrogen boil-off from a double wall calorimeter feeding a gas flow meter, and the system was calibrated using power from a known resistor. For calibration, Cu-tape and Y-Ba-Cu-O (or YBCO) tape losses were measured and compared to results of a solenoidal magnet AC loss system measurement of the same samples but limited to a field of amplitude 0.1 T and a dB/dt of 100 T/s.

This work describes the use of this test facility to measure and compare AC losses of a variety of YBCO coated conductors and cable styles. In addition, Cu and Al metallic and non-metallic conductors (common- and hyper-conductors 99.999% Al, as well as carbon nanotube yarn) are measured and compared. Conductors of YBCO are provided by several manufacturers with different architectures including filamented, varying width, and different quench protection metal layers with varying thickness. The analysis and comparison among all samples is interesting, with unexpected differences and trends measured for (AC loss/cycle/meter) and (AC loss/cycle/volume) as a function of sweep rate $Bf = 0$ to 120 T/sec.

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