Subject: I, T, R, V & Q vs.t for Cases 1, 2 & 3
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Dear Kirk et al.,

Attached are three graphs, ITRVQ1t.doc, ITRVQ2t.doc and ITRVQ3t.doc. These give the current, temperature rise, resistance, resistive voltage and heat dissipated in E951 magnets Cases 1, 2 and 3. Cases 1 and 2 each have 16 layers of wire of 75 turns per layer; the outer radius is 30 cm. Case 3 employs an addition 8 layers (for a total of 24), again with 75 turns per layer; its outer radius is 40 cm. Because of the extra turns, Case 3 can generate 14.5 T at the same 7.2 kA at which Case 2 generates 10.1 T.

Case 1 employs one power supply, of 150 volts and 3.6 kA peak current, which is sufficient to generate 5.0 T. Starting from an initial temperature is 84 K, it can reach 3.6 kA in 8.2 seconds, at which point the resistive voltage across the coil is 123 volts. Reversing the voltage from the power supply (which Ioannis Marneris says requires only the removal of a diode from the power supply) drives the current to zero after a total pulse length of 11 s. The peak temperature rise is 5.7 K; the total heat dissipated in the coil is 2.6 MJ. During the pulse the magnet resistance rises from 30.4 milliohms to 34.5 milliohms at 9 s, after which it falls slightly (to 34.2 milliohms), despite additional heating, because of the decline in magnetoresistance with declining current.

Cases 2 and 3 require four power supplies in series/parallel--i.e., 7.2 kA at 300 V. Case 2, if pulsed from 74 K, has a pulse length of 6.2 + ~2.8 = ~9 s. The peak temperature rise is 17.1 K, which raises the resistance from 23.9 to 34.4 milliohms, with a peak resistive voltage of 234 V. The total dissipation is 7.0 MJ.

Case 3, with its 50% greater number of turns, requires precooling with hydrogen. If pulsed from 30 K, the pulse length is 15.15 + ~7.85 = ~23 s. The peak temperature rise is 43.8 K. The resistance ranges from 11.3 to 35.4 milliohms; the peak resistive voltage is 219 V. The total dissipation is 12.9 MJ.

Bob Weggel