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M2Or3A-03 [Invited]: Cost, weight, and AC Loss Minimization, for a Fully Superconducting 6.5 MVA Traction Transformer for High Speed Rail

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Electrification of transport is a growing trend. Air transportation presents some unique challenges for electrification and these challenges have driven the demand for faster electric rail transport. The CRRC Fuxing high speed train is one example of technology being developed, and tested, to be able to operate at 600 km/h. There is a demand to both increase speed, and number of passengers, for these high speed rail trains. The traction transformer is one of the most critical electrical devices on high-speed-trains. The use of HTS has been proposed to potentially deliver a 50% reduction in volume and mass whilst delivering a five-fold reduction in losses in a traction transformer. We have optimized the design for cryogenic overhead and cost and are currently building a 6.5 MVA superconducting traction transformer.
The transformer consists of four single-phase 25 kV/1.9 kV HTS windings, operating at 65 K, each of which drives a motor. The design incorporates Roebel cable in the LV windings to minimize AC loss. In this presentation we show the AC loss modelling results that identify the critical regions that contribute to AC loss. We then calculate the cryogenic system penalty, and weight, for design options and AC losses before optimizing the full system weight and volume. We demonstrate the benefit of hybrid windings, the use of high performance windings in only the AC loss critical regions, and examine the impact on cost and weight of the whole system. Finally we present the current design and report on the current implementation status.

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