
Project Title:	Feasibility of Electric Power Transport by DC Superconducting Cables in Tennessee
Organization(s):	Tennessee Technological University
Presenters:	P. Chowdhuri
FY 2003 Funding:	\$96 K (over 18 months)

Project Purpose and Objectives: A dc superconducting cable has the following advantages over its ac counterpart: (i) AC superconducting cable has losses (hysteresis, eddy-current and dielectric); dc superconducting cable has none of these losses. (ii) Power transfer capability of an ac cable is constrained by the system stability limit; dc cable has no stability limit. (iii) Short-circuit current in ac can be as high as 10 times the full-load current; the dc short-circuit current can be limited to less than two times the full load. It will be impossible to find ac circuit breakers to handle such high short-circuit power; dc does not require a circuit breaker – the converters at either end of the line can interrupt the short-circuit current. (iv) three dc cables in bipolar mode is equivalent to six ac cables. The only disadvantage of a dc superconducting cable is the cost of converters at either end of the line. However, this disadvantage is disappearing because of new developments in converter design.

Tennessee Technological University proposed an eighteen-month project to study the feasibility of dc superconducting cables, emphasizing the following: (i) Preliminary cable design for monopolar/bipolar operation. (ii) Compatible converters at the cable terminals. (iii) Analysis of (a) short-circuit current, (b) losses due to harmonics, (c) transient overvoltages, and (d) reactive power compensation. (iv) Preliminary economic evaluation. (v) Future course of action. One distribution site and one transmission site in Tennessee were proposed for the study.

FY 2003 Results: One short distribution site in the Nashville Electric System and three transmission sites in the Tennessee Valley Authority region have been selected for the study. Preliminary designs of the cables for these four sites have been completed in collaboration with Oak Ridge National Laboratory (ORNL). Analyses of fault currents and current harmonics for these designs have been completed. Neither the fault-current magnitude nor the harmonic losses poses any threat to the operation of the dc cables according to ORNL. The basic design of the converter has been completed and sent to Asea Brown Boveri. Their comments are pending. Analysis of the transient voltages at different parts of the cable system has been initiated.

Recommended Next Steps: The behavior of the dielectric system of a dc cable is more complex than that of an ac cable. Therefore, the design of the dielectric system for the dc cable should be thoroughly investigated in a future project.