
Project Title:	Matrix Fault Current Limiter: SuperPower, Inc., CRADA
Organization(s):	Oak Ridge National Laboratory, Los Alamos National Laboratory
Presenters:	L. Kovalsky (SuperPower), J. Bock (Nexans), S.W. Schwenterly (ORNL)
FY 2004 Funding:	\$115 K (DOE to ORNL), \$20 K (DOE to LANL)

Project Purpose and FY 2004 Objectives: The purpose of this project is to conduct R&D on specified components and provide technical design support to a SuperPower, Inc. (SP) team developing high temperature superconducting (HTS) technology for a Matrix Fault Current Limiter (MFCL). This device incorporates a series-parallel array of bulk HTS elements and inductors in a subcooled liquid nitrogen (LN) bath. Transition of the HTS elements into the normal state during a fault drives most of the current into the inductors and leads to a sudden increase in impedance that limits the fault current. ORNL's FY 2004 objectives are to:

- ◆ Assist with cryogenic subsystem R&D, design, fabrication, and testing
- ◆ Assist with high voltage subsystem R&D, design, fabrication, and testing
- ◆ Participate in conceptual and detailed design reviews
- ◆ Guide commercialization by participation on the Technical Advisory Board

FY 2004 Performance and FY 2005 Plans: The MFCL Project is broken into three major tasks, the Pre-Prototype/Alpha Prototype, Beta Prototype, and the Beta Field Evaluation. The pre-prototype is single phase and is rated at 8 kV/800 Arms. The Alpha prototype is single phase rated at 138 kV, with a current rating to be determined by the target application. The Beta prototype is a full 138kV three-phase system that will meet all of the host utility's requirements. The Pre-Prototype/Alpha Prototype development task runs for approximately 2.5 years. The Beta unit will be designed to meet a specific utility application requirement, and will be tested on the transmission grid at a utility host site to be determined. During FY 2004, ORNL carried out tests to simulate SP's cooling concept in an existing cryostat. ORNL personnel attended all project review and Technical Advisory Board meetings. In the summer of 2004, the cryostat will be modified to accept a SP-provided bushing for combined cooling and high-voltage tests in late FY 2004 and in FY 2005. Material testing will also be carried out on samples provided by SP.

FY 2004 Results: Preliminary cooling tests in sub-cooled LN were performed using an existing pressure cryostat. Liquid nitrogen at 77 K and 1 atm was circulated through a coil of copper tubing at the bottom of a bath of pressurized supercritical nitrogen. This coil simulates the cooling ring that is attached to the cryocooler in SP's design. Foam discs were placed above the coil to simulate the vacuum above the pressurized tank that would surround the MFCL array. A disc heater mounted below the coil simulated the array heat load. Two temperature sensors were mounted above and below a G-10 plate attached just above the coil. Initial tests at 3 atm and 5 atm supercritical nitrogen pressure indicated that the lower sensor (which is closer to the heater) stayed about 2 K warmer than the one above the plate for power inputs up to 300 W. Good temperature stability was obtained with no venting from the pressurized bath. Further tests were run with more sensors in this cryostat to give a more detailed temperature profile. A copper plate replaced the original G-10 plate. At power levels up to 300 W, temperatures were maintained between 83 K and 86 K below the copper plate, and ranged up to 93 K in the bath above the plate. A new cover flange has been made for this cryostat, to accept a 52-kV bushing that will be provided by SP. This bushing will have a high-current lead similar to that of the Pre-Prototype MFCL unit, allowing a realistic simulation of conditions in the MFCL cryostat. A CRADA between ORNL and SP is in the final stages of development and is expected to be approved by July 2004.

Research Integration: ORNL team members attended project review meetings in October 2003 and May 2004. Frequent contact was maintained with SP personnel by telephone and E-mail. Because the current collaboration between ORNL and SP is informal with limited budget, SP has supplied some of the hardware for the cryostat modifications.