

Superconductivity for Electric Systems 2006 Project Summary

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| YOUR ORGANIZATION: | SuperPower, Inc. |
| PROJECT TITLE: | Transmission Level High Temperature Superconducting Fault Current Limiter |
| PRESENTERS: | Roger A. Farrell |
| FY 2005 FUNDING: | \$2,650,000 |
| FY 2006 FUNDING: | \$500,000 |
| START/COMPLETION DATES: | May 27, 2002 / February 13, 2007 (to be extended) |

Overall Project Purpose and FY 2006 Objectives: The project purpose is to develop a superconducting fault current limiter (SFCL) for operation at transmission level voltage. The SFCL is a unique device in that it is transparent to the grid during normal operation but introduces impedance when needed during fault conditions. There is strong market pull for this device from U.S. utilities particularly at transmission level voltages.

The program includes the fabrication and test of three prototypes: a single phase proof-of-concept prototype, single phase alpha prototype and three phase beta prototype. The first two prototypes are tested off the grid and the beta prototype is to be installed and operated in the American Electric Power (AEP) grid. The proof-of-concept prototype was successfully tested at low voltages (up to 8.6 kV line to ground) in July 2004 but the reliability of the melt cast BSCCO-2212 elements were an issue.

Because of this as well as concerns about the slow pace of high voltage development and escalating cost, the project was placed on Reduced Effort Status (RES) for most of FY 2006 until the technical and financial risk issues could be addressed. The objectives for FY 2006 were to evaluate the feasibility of second generation (2G) HTS material in place of melt cast BSCCO and add a cost sharing industrial partner with high voltage expertise to the team.

SuperPower's partners on this project include AEP, the host utility for the beta prototype, and ORNL, cryogenic design and test support. LANL will also participate under a companion 2G feasibility demonstration program being conducted under the DOE's GridWorks program by assisting in the optimization of 2G for the SFCL application. SuperPower terminated its relationship with Nexans SuperConductors GmbH., the former supplier of melt cast BSCCO tubes. New partners added this year are Sumitomo Electric Industries, Ltd. (SEI) and The BOC Group, Inc. (BOC) as discussed in the next section.

FY 2006 Results and Accomplishments: The feasibility of using 2G in an SFCL application has been demonstrated through tests conducted: (i) on individual elements and modules (consisting of multiple elements) at low power at SuperPower and (ii) modules at power levels representative of what will be encountered at 138 kV voltages at the KEMA Test Facility. Although the 2G wire has not been optimized for the SFCL (purpose of the companion GridWorks Program), the preliminary testing conducted to date indicate 2G is a superior material to melt cast BSCCO with respect to the key performance parameters of response time to a fault, recovery time after a fault and energy absorbed during a fault.

SEI joined the project on June 30, 2006 with responsibility for the high voltage bushings and the cryostat electrical insulation system. The bushings provide the electrical transition from atmospheric to cryogenic conditions within the 2G matrix assembly while the cryostat insulation system isolates the matrix from the surrounding cryostat which is at ground potential. BOC joined the project at the point it entered RES with responsibility for the cryogenic system design, development, instrumentation and monitoring. However, the cryogenic system was not actively worked on during the RES period.

All objectives established for the RES period have been accomplished: 2G feasibility and addition of a high voltage partner. In addition we have added a cryogenic partner. As a result SuperPower and its team are poised to resume the SFCL project at full speed. SEI and BOC have successfully worked with SuperPower on the Albany Cable Project and are experienced in high voltage at cryogenic temperatures and cryogenics, respectively.

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FY 2007 Plans and Expectations: The plans for FY 2007 include:

1. Optimize 2G wire for alpha prototype (GridWorks).
2. Complete cryogenic and electrical insulation systems development for the alpha prototype.
3. Complete alpha prototype detail design of the 2G matrix, cryogenic and electrical insulation systems.
4. Conduct alpha prototype design review.

Key potential technical barriers include development of robust, high performing 2G modules and high voltage electrical insulation components. These are addressed by conducting extensive component testing and development prior to committing to a design.

Research Integration: There is a high level of research integration on this project, both within the broad expertise of the project team and in the forums created to review the program. The project team and responsibilities:

1. SuperPower – Project management; systems integration; 2G matrix design, optimization and supply; and prototype design, fabrication and test.
2. SEI – high voltage component design, development and manufacture; and support prototype design and test.
3. BOC – cryogenic system design, development and instrumentation; overall system monitoring; and support prototype design, assembly and test.
4. AEP – Select beta prototype site and provide specifications; substation design and engineering; procure beta prototype support equipment; support beta prototype system studies; and support beta prototype installation, commissioning and test.
5. ORNL – Design and test support of SFCL matrix component development; and cryogenic consulting
6. LANL (GridWorks) – 2G wire optimization and testing.

There are two forums for review of project progress:

1. Technical Advisory Board (TAB) – The program team formally meets periodically with the TAB to review program progress. The TAB consists of representatives from the project team, DOE, EPRI, representatives of five utilities (Consolidated Edison, New York Power Authority, AEP, Southern California Edison and Entergy) and academia (RPI). Some of these meetings are held concurrently with DOE Readiness Reviews. During the RES period no TAB meetings were held.
2. National Electric Energy Testing, Research & Applications Center (NEETRAC) – Several utilities participate in this program via their membership in NEETRAC: Baltimore Gas & Electric, Entergy, Exelon, Florida Power & light, and Southern Company, providing guidance to steer the SFCL performance and test requirements. Two teleconferences were held with the NEETRAC members in FY 2006.