University of California
ciee

ELECTRIC GRID RESEARCH

Project Summary

Development of Fault Current Controller Technology

Context

Due to ever-increasing loading on the electric system, fault currents have been approaching, and in some cases, exceeding, the ability of circuit breakers to safely interrupt the fault currents and protect vulnerable substation equipment.

Upgrading to larger breakers is one option, but an expensive one, and utilities are already seeing fault currents exceeding the capability of the largest breakers available today. Commercial replacement breaker technology for these higher currents is based on sulfur hexafluoride (SF_6), a strong greenhouse gas.

Reconfiguring lines and substations will also limit fault currents, but at the expense of system reliability and transfer capability. Insertion of reactors into the substation neutral is another option, with serious drawbacks as well.

Advances in both high-power electronics and high-temperature superconductivity (HTSC) offer the prospect of fault current controllers (FCCs) which can directly limit maximum current flows and have led to the development of prototype FCCs at the 15 kilovolt (kV) level.

Goals and Objectives

Research objectives include assessment of the technical feasibility of fault current controller technologies, comparison of active and passive technologies, and the acquisition of field data and understanding necessary for the successful integration of these new devices into the existing grid. One specific objective is the development of test protocols and design specifications to guide further development of these technologies, including devices for higher transmission voltage levels.

Description

This project is the first phase of a multiphase program. Overall, this phase will consist of four major tasks: development of an FCC test protocol and test plan; controlled testing in the lab or factory; long-term field testing at a Southern California Edison substation; and a comprehensive technology evaluation that will include assessment of the potential of the technologies for further development to higher voltage levels.

Prototype devices will be developed by the Electric Power Research Institute (EPRI), using solid-state high-power electronics technology with active current sensing and switching, and by Zenergy, Inc., using a passive design that is a hybrid of HTSC and conventional iron-core transformer technologies will be tested. A third device, from American Superconductor, Inc., will be tested in a subsequent Phase II project. Each uses a different technology.

Current Status (3/2010)

An initial technical assessment of available and emerging FCC technologies has been conducted.

Zenergy constructed, factory tested, and subsequently re-designed their 15kV HTSC FCL. The refined unit was then successfully factory tested and cleared for field testing. It is currently operating in actual distribution system conditions. Fault and performance data are being collected for later evaluation. This work has produced factory and field test protocols to guide the design and testing of fault current controller technology.

Simulations of the EPRI solid-state prototype showed that, to meet target criteria, the unit would need to be re-designed, and would cost more than originally estimated. By mutual agreement of EPRI and the Energy Commission, the EPRI project was stopped. A new project proposal will be developed for consideration, based on design refinements. EPRI issued a final report detailing its design and development approach.

Why It Matters

The successful development of FCC technology could provide a cost effective solution to the problem of maintaining electric system reliability under continual stress from the steadily increasing power requirements of California.

FCCs potentially represent an environmentally attractive alternative to high-power circuit breakers, which currently use SF_6, an extremely potent greenhouse gas, as the insulating medium, and for which there is no viable alternative insulating medium available.

Since one FCC in a substation can protect multiple breakers, transformers, and other components in that substation, a single FCC installation can avoid or defer

the replacement of several expensive components.

{More details}

ELECTRIC GRID RESEARCH

Project Summary

Development of Fault Current Controller Technology (Pg 2)

Participating Organizations

Principal Investigator:

University of California, Irvine

Research Partners:

Southern California Edison Co.
Electric Power Research Institute
Zenergy, Inc.

Project Start Date: September 1, 2007

Project End Date: June 30, 2011

CIEE Contract No.: MTX-07-02A

CEC Contract No.: 500-02-004

CEC Work Authorization No: MR-064

Reports

Technical Report on the Current State of Development of Fault Current Controller Technology, Dr. Keyue Smedley, UC-Irvine, February 2008.

Test Protocol for FCL 15kV, 1.2kA, 3 Phase High Temperature Superconductor Fault Current Limiter, Francisco De La Rosa, Zenergy, Inc., May 2008.

Test Plan for 15kV, 1200A Solid State Fault Current Limiter (SSCL) for Field Evaluation Testing, Dr. Mahesh Gandhi, Silicon Power, Inc., August 2008.

Development of a 15kV Class Solid-State Current Limiter, Dr. Mahesh Gandhi, Silicon Power, Inc., November 2009.

Publications and Related Materials

{Link}

Funding

Funds for this project came from a $1,175,000 award by the California Energy Commission (CEC) through the Public Interest Energy Research program (PIER).

For More Information, Contact

Dr. Merwin Brown,
CIEE Electric Grid Research Program Director
(916) 551-1871
merwin.brown@uc-ciee.org