S&C Electric Company
Electric Power Delivery Testing Feasibility Study

Project Fact Sheet

The electric power grid requires distribution and transmission switching, protection, and control equipment that isolates faults and automatically restores the system to meet the reliability expected of the future grid. It is impractical to test new switching equipment directly on the grid since this would risk events that could destabilize the grid leading to wide-spread outages. High-power laboratory test facilities within the United States are required to realistically simulate grid conditions to support the development programs of DOE and private industry.

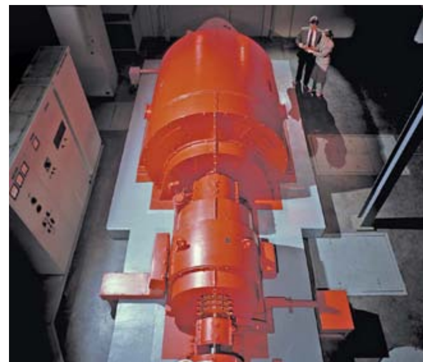
The National Energy Technology Laboratory (NETL) is managing this and other electric grid R&D projects on behalf of the DOE Office of Electricity Delivery and Energy Reliability (OE).

Goals

This project will research, engineer, and demonstrate high-power laboratory testing protocols to accurately reproduce the load conditions on the distribution grid and fault conditions on the transmission grid. The main deliverables will:

- Develop high-power testing protocols to simulate load conditions ranging from a maximum of 2000 A at 15 kV (50 MVA) to 1200 A at 38 kV (80 MVA), and procure the necessary resistive and reactor load components, and demonstrate testing protocols and circuits utilizing power directly supplied from laboratory short-circuit generators and demonstrate proper simulation of grid conditions.
- Develop high-power testing protocols to simulate fault conditions on the transmission grid up to 63 kA at 245 kV (25,000 MVA three-phase equivalent), procure the necessary energy storage capacitors, wave-shaping inductors, resistors and capacitors, and triggered spark gaps, and demonstrate combining high-voltage energy storage with the high-power short circuit currents from laboratory short-circuit generators to synthetically generate fault and transient recovery voltages typical of transmission grids.

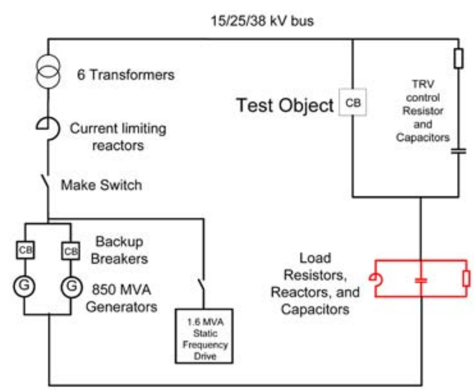
The demonstration of the testing protocols will be done with an existing small short-circuit generator (100 MVA) and the results will be used to plan and design a future high-power laboratory with two short-circuit generators each rated 850 MVA.



How Does it Work?

Basic Load Simulation Circuits

For load simulations, power is taken directly from the short circuit generators and the voltage and current are controlled by appropriate resistors and reactors to simulate the distribution load conditions.



Shown above, the 850 MVA short-circuit generators (future installation) supply the basic power through the closing switch, backup circuit breakers and step-up transformers to the Test Object. The focus of this project is to engineer and demonstrate the appropriate resistors and reactors (in red) to properly simulate the distribution loads ranging from 2 to 80 MVA at 15, 25, or 38 kV.

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Period of Performance:
6/27/06 – 9/26/07

Cumulative Project Funding:
Non-DOE: $950,000 (40.28%)

DOE: $1,408,625 (59.72%)

Total: $2,358,625 (100.00%)

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Office of Electricity Delivery and Energy Reliability:

http://www.oe.energy.gov

NETL:

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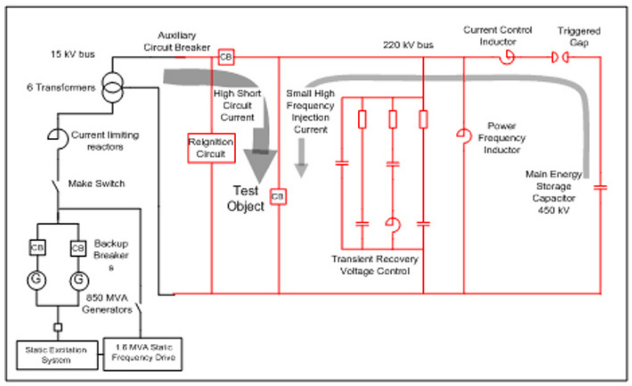
MGI:

www.netl.doe.gov/moderngrid

Transmission Fault Simulations

This load simulation circuit is simple but it cannot deliver the voltages or currents necessary for simulating short-circuit conditions on the transmission grid. Transmission voltages and currents are created "synthetically" and creatively by combining high current from the short circuit generators with the high-voltage of a large capacitor bank in a much more complex circuit.

The short-circuit generators (future installation) at medium voltages of 15 to 38 kV supply high fault currents up to 63 kA through the Test Object. At the critical point of circuit interruption, an auxiliary circuit breaker isolates the generators from the test object, and a large storage capacitor will provide the transmission-class recovery voltages. The high-voltage storage capacitor is precisely connected through a current-control inductor just as the test object interrupts the circuit and the auxiliary circuit breaker isolates the generator. The test object sees the high short circuit current seamlessly followed by the high voltages representative of the transmission grid. The circuit has a wide combination of resistors, capacitors and reactors to create the critical transient voltage conditions and one additional reactor to create an oscillating AC voltage representing the power system 60 Hz frequency. The work of this project is to develop the necessary circuits and components, including the controls necessary for precisely operating the auxiliary breaker and for discharging the main capacitor bank with just the right overlap with the high current for proper testing under transmission voltage short circuits.



Synthetic High-Power Laboratory Schematic

What are the Benefits?

These testing protocols and facilities will allow validation of new switching and protection devices developed by DOE and private industry research efforts to work reliably on the electric power grid. Having these specialized facilities available will speed up the research cycle resulting in faster delivery of new technologies needed to support modern grid requirements.

What are the Primary Applications?

These testing protocols would be used for testing switching and protective devices rated from 15 to 230 kV for load up to 2000 A and fault currents up to 63 kA. The facilities would also be used to validate performance of the switching and protection controls with full power transients – something that must be done to assure the reliability and security of new controls and the associated sensors.

What are the Status and Accomplishments to Date?

The cooperative development agreement was awarded and the Kickoff Meeting was held on in the summer of 2006. Design work selecting the testing protocols and developing the specifications for the circuit components and placing orders for the equipment was completed by end of December 2006. Equipment delivery and construction should allow demonstration testing in the third quarter of 2007.

What is the Market Potential?

This project provides some of the necessary infrastructure to support a viable research and development program in the United States. Development of new technologies requires the ability to properly test for normal and abnormal conditions such as high-power short circuits without risking the security and stability of the power grid. The market potential resides in the benefit of an accelerated R&D program and the associated benefits of the products critical to realizing the modern grid that they develop.