Project Title:	Design and Development of a 100 MVA HTS Generator
Organization(s):	**Oak Ridge National Laboratory and Los Alamos National Laboratory**
Presenters:	Jim Bray (General Electric Company), Jonathan Demko (ORNL), Joe Waynert (LANL)
FY 2003 Funding:	$150 K (DOE to ORNL); $430 K (DOE to LANL)

Project Purpose and FY 2003 Objectives: General Electric's Global Research in Niskayuna, New York, will design and develop a 100 MVA class high temperature superconducting generator, with designs through 250 MVA. The HTS rotor will be capable of retrofitting into existing generators. ORNL and LANL have entered into Cooperative Research and Development Agreements (CRADAs) with GE in FY 2003 to provide assistance in several technology areas.

For FY03 ORNL will: design, fabricate and assemble test rig to measure total hemispherical emissivity of specified surfaces at 20 K; modify existing apparatus to support quench protection studies for HTS conductors down to 20 K; measure dielectric performance and partial discharge of coil samples; and conduct room temperature mechanical property measurements of sample coils using the resonant ultrasonic spectroscopy (RUS) method.

For FY03 LANL will: provide excitation system design and testing assistance; measure outgassing properties of materials supplied by GE and evaluate the gas species present as needed to develop methods of long term vacuum retention without active pumping; evaluate the potential application of rotating heat pipes for cooling the rotor; and assist in analytical and experimental evaluation of AC losses in the HTS conductor which affect the heat loads of the rotor windings.

FY 2003 Performance and FY 2004 Plans: In FY 2003, ORNL and LANL began working with GE to research and improve the overall design and capabilities of the HTS generator system.

For FY03, ORNL designed, fabricated and assembled a test rig to measure total hemispherical emissivity of specified surfaces at 20 K; conducted preliminary measurements on selected surfaces; initiated modifications to an existing apparatus to support quench protection studies for HTS conductors down to 20 K; initiated design and conducted preliminary experiments to measure dielectric performance and partial discharge of coil samples; and conducted room temperature mechanical property measurements of sample coils using the RUS method.

In FY03, LANL submitted an excitation system design and a testing plan; established a vacuum outgassing measurement system and measured the properties of several GE samples; designed a modification to the vacuum system to allow outgassing and getter/adsorber measurements at low temperatures; developed a thermal-fluidic model of a rotating heat pipe and a design of a room temperature model validation experiment, adapted a model to evaluate AC losses in the HTS conductor, and consulted on how to measure those AC losses.

ORNL Plans for FY 2004

1. Complete measurements of the total hemispherical emissivity of specified surfaces at temperatures between 20 K – 80 K including surface contamination. Submit final report.
2. Modify existing HTS test apparatus to support quench protection studies for HTS conductors down to 20 K. Submit final report.
3. Measure dielectric performance and partial discharge of prototype coil samples. Submit final report.
4. Conduct room temperature mechanical property measurements of sample coils using the RUS method. Submit final report.

LANL Plans for FY 2004

1. Complete outgassing material characterization measurements; submit final report
2. Complete getter material evaluation; submit final report
3. Complete rotating heat pipe assessment; submit final report
4. Complete AC loss evaluation; submit final report
5. Complete next generation HTS conductor impact report

FY 2003 Results: Significant progress has been made during the year.

ORNL FY03 Results

Emissivity test rig - The heat meter and warm source were designed and fabricated. After some initial calibration of the heat meter, some design modifications were made and initial tests were made on a copper plate

Dielectric testing - Samples of single tapes and sample coils were provided to ORNL by GE for measurement of partial discharge.

Quench Protection - Modifications to existing test apparatus are being made to accommodate overcurrent testing of BSCCO-2223 tapes down to 20 K. At these temperatures, the critical current of the tape can be several times higher than at 77 K, so existing equipment, that is capable of 330 A current pulses, is being modified to be capable of taking 1000 A current pulses.

Mechanical Properties - Room temperature measurements of the mechanical properties of HTS prototype coils were made.

LANL FY03 Results

Excitation System Design - LANL submitted the design of a novel generator excitation system and a suggested testing plan which utilized the 1430 MVA generator at LANL.

Outgassing Material Characterization - A vacuum system was designed and built for outgassing characterization. The outgassing properties of several material samples received from GE were measured.

Getter Material Characterization - A design has been developed to modify the vacuum system to incorporate a cryocooler to allow the evaluation of the gettering properties of materials. All the necessary materials are in-house.

Heat Pipe Assessment - A heat pipe model that incorporates the GE performance requirements has been developed and three detailed technical reports were submitted to GE. A room temperature experiment that will validate the model predictions has been designed and costed and is being fabricated.

AC Losses - A model was developed of the AC losses in the HTS conductor and silver stabilizer. A report describing the preliminary results was submitted to GE.

Research Integration: ORNL has regular teleconferences to ensure that direction, efforts, and results are in accord with the needs of GE. The results are reviewed by GE staff. One technical paper on the emissivity measurements is planned for the *Cryogenic Engineering Conference* in September 2003. Material properties characterization is coordinated with the Metals and Ceramics Division staff at ORNL.

LANL has regular teleconferences with GE to ensure that our direction, efforts, and results are in accord with the needs of GE. In addition, GE scientific and engineering staff are working closely with LANL staff to verify calculations and experimental results. There have been numerous interactions with internal LANL experts, Dr. Campuzano at the University of Illinois-Chicago, and industry experts in vacuum science. LANL has also been consulting Dr. Razani of University of New Mexico and internal experts on the heat pipe performance modeling and details of the experimental setup and data acquisition.