OPERATION EXPERIENCE AND FURTHER DEVELOPMENT OF A HIGH TEMPERATURE SUPERCONDUCTING POWER CABLE IN THE LONG ISLAND POWER AUTHORITY GRID

Frank **SCHMIDT**, Rainer **SOIKA**, Nexans Deutschland GmbH, (Germany), frank.schmidt@nexans.com, rainer.soika@nexans.com

James **MAGUIRE**, Jie **YUAN**, American Superconductor Corp., (USA), jmaguire@amsc.com, jyuan@ams.com

Shawn **BRATT,** Air Liquide Advanced Technologies US LLC, (USA), shawn.bratt@airliquide.com

Tom **WELSH**, National Grid, (USA), Thomas.Welsh@us.ngrid.com

ABSTRACT

Underground high temperature Superconductor (HTS) power cables have attracted extensive interest in recent years due to their ability to transmit high power densities. Since the successful commissioning of the worlds first transmission voltage level HTS power cable in April 2008, three years of operation experience has been gained. Additional development aspects have been addressed in parallel to the grid operation to close the gap between the successful demonstration project and commercial availability of high voltage HTS cable systems. This paper describes the work and reviews experience gained during three years of in-grid operation.

KEYWORDS

HTS cable, Superconductor Cable, 2G HTS power cable, transmission level voltage

INTRODUCTION

All over the world, there is growing need for a reliable and sustainable electric power infrastructure. High voltage power cables using HTS wires have been developed to increase the power capacity in utility power networks while maintaining a relatively small footprint. Over the past decade, several HTS cable designs have been developed and demonstrated successfully [1]-[4]. All HTS cables have a much higher power density than copper-based cables at similar voltage levels. Moreover, because they are actively cooled and thermally independent of the surrounding environment, they can fit into much more compact installations than conventional copper cables, without concern for spacing or special thermal backfill materials to assure dissipation of heat. This advantage reduces environmental impacts and enables the installation of compact cable systems with three to five times more capacity than conventional circuits operating at the same voltage level. In addition, HTS cables exhibit much lower resistive losses than conventional copper or aluminum conductors.

With funding support from the United States Department of Energy (DOE), the world's first transmission voltage level HTS power cable using first generation HTS wires has been designed, fabricated and permanently installed in the Long Island Power Authority (LIPA) grid. The HTS cable was successfully commissioned on April 22, 2008. In 2007, a new DOE Superconductor Power Equipment (SPE) program to address the outstanding issues for integrating HTS cables into the utility grid was awarded to the current project team (LIPA II). The goal of the LIPA II project is to develop and install a replacement phase conductor manufactured using AMSC's second generation wire. This paper will report on the experience gained during the recent years of grid operation and on the progress and status of the LIPA II program.

PROJECT OVERVIEW

The LIPA I project is a Superconductivity Partnership Initiative (SPI) between the United States Department of Energy (DOE) and industry to develop a long length transmission voltage high temperature superconductor power cable. In 2007, a new DOE Superconductor Power Equipment (SPE) program to address the outstanding issues for integrating HTS cables into the utility grid was awarded to the current project team (LIPA II). American Superconductor Corporation is the prime contractor as well as the manufacturer of the high temperature superconducting wires. Nexans is providing the development and manufacturing of the cable, terminations and cryostat as well as site and installation support, and Air Liquide is providing the cryogenic refrigeration expertise, equipment, installation as well as operations monitoring and support. The host utility, LIPA, has provided the site, civil work, controls and protection, transmission planning and the operation of the HTS cable.

The cable system was designed to meet the specifications summarized in Tab. 1.

Voltage	**138 kV**
Current	2,400 A_{rms}
Total Power Carrying Capacity	574 MVA
Length	600 meters
Design Fault Current	51,000 A_{rms}

Tab. 1: Cable system specifications

LIPA II PROJECT

General description

In 2007 a program to address the outstanding issues for integrating HTS cables into the utility grid was awarded to the current project team. This project is addressing the following issues:

- Field Joint
- Field Repairable Cryostat
- Modular High Efficiency Refrigeration System Design
- Thermal Contraction Compensation within the Cable

While the LIPA I project was designed to demonstrate the technology, the goal of LIPA II is to demonstrate a commercial system. Within the LIPA II project, one of the