

HIGH TC SUPERCONDUCTING CABLE PROJECT IN YOKOHAMA, JAPAN

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ABSTRACT

A High Tc Superconducting cable has been developed in order to be installed in the real grid in Yokohama, Japan. Purpose is to verify its reliability and stability of operation in the grid. The cable is designed for 66kV class and 200 MVA capacity with 3 cable cores configuration and 250m length. A 30m cable was also developed to confirm the validity of its design. Various tests and measurements, such as critical current measurement, voltage tests, and so on, were conducted successfully in FY 2009. The 250m cable was manufactured completely in FY 2010 and it will be installed and start to operate in the grid in the fall of 2011.

KEYWORDS

Superconducting cable, High TC superconductor, BSCCO wires, cooling system

INTRODUCTION

As underground space is almost unavailable and present space is already congested in populated urban areas in Japan, it will become highly difficult to construct new tunnels for underground power transmission cables. In addition to this problem, the need for replacement of over-aged larger capacity cables, such as oil-filled cables (OF cables) or pipe-type oil-filled cables (POF cables), is getting larger year by year. Replacing these cables with low-capacity cross-linked polyethylene vinyl sheath cables (XLPE cables), however, requires additional circuits, thereby causing impracticality due to the difficulties inherent in constructing new cable tunnels. High Temperature Superconducting (HTS) cable is one of the solutions for these problems because it is expected to transmit larger amounts of electric power having lower power loss despite smaller cable size due to the higher critical current density property of the HTS conductor.

The Tokyo Electric Power Company (TEPCO) and Sumitomo Electric Industries (SEI) have been conducting research and development of HTS cable systems since 1990. Based on these studies, a new HTS cable demonstration project was started in 2007, which is supported by Ministry of Economy, Trade and Industry (METI) and New Energy and Industrial Technology Development Organization (NEDO). A target of this project is to operate a 66kV, 200MVA HTS cable in the grid in order to demonstrate its reliability and stable operation (1)(2).

This paper reports the outline of the project and some results of studies and tests so far.

OUTLINE OF THE PROJECT

The HTS cable demonstration project, called as the Yokohama Project, has been conducted by TEPCO, SEI

and Mayekawa Mfg. Corporation (MYCOM). Target of this project is to operate a 66 kV, 200 MVA HTS cable system in the grid in order to demonstrate its reliability and stable operation.

TEPCO provides an actual power grid for demonstration tests and verifies system operation and maintenance techniques. TEPCO also studied what influences the connecting HTS cable had on the power grid. At the same time, SEI has developed element technologies for the HTS cable system, and is responsible for the manufacturing, construction and operation of the HTS cable system. Also, Mayekawa has designed and assembled a cooling system.

Time schedule

Fig.1 shows the time schedule of the Yokohama project. During the first two years, technologies were developed for all elements of the HTS cable system. The cable provides large current capacity with lower AC losses, and withstands short circuit currents. In this period, the demonstration site was determined and the grid condition was carefully scrutinized. In 2009, a 30 meter cable system was constructed and assessed at SEI's facility to verify its performance before manufacturing and constructing the HTS cable system at the demonstration site. Performance test of the cooling system was scheduled in 2010 in order to confirm system characteristics. Finally, the cable system will be installed and operated at the demonstration site over a one year period in 2011 through 2012.

FY	2007	2008	2009	2010	2011	2012
Cable system development	Design Cable, Joint, Termination Preliminary test AC loss, Fault current test, Mechanical test, etc.		Pre-performance test with 30m cable	Pre-performance test of cooling system		
Field test	Analysis of grid condition Decision of test code and test method		Cable manufacturing	Cooling system manufacturing	Install	Long term test

Fig.1 Time schedule of the Yokohama project

Cable system at the site

The demonstration site chose the Asahi substation, located in Yokohama, in consideration of space, current capacity and other factors. Asahi substation is an outdoor type, and has three set of 200 MVA, 154/66 kV step down transformers which connect 154 kV bus lines and 66 kV bus lines. Fig.2 shows the layout of the demonstration system at the Asahi substation. Installed are two HTS cables connected to each other with a cable-to-cable joint. Total HTS cable length is to be about 250 meters. A portion of the cable will be installed above ground and a portion remaining underground with multiple bends in both the vertical and horizontal planes.