INSTALLATION AND COMMISSIONING OF TRIAX HTS CABLE

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ABSTRACT

A Tri-Axial high temperature superconducting cable system was installed by Southwire and nkt cables in the American Electric Power (AEP) grid in Columbus, OH in the United States. The cable is rated 13.2 kV and 3.0 kA for 69 MVA. The cable was installed underground with a cable-to-cable joint and serves as the connection between the step-down transformer and the distribution station bus. The cable was tested prior to being placed in service to verify performance parameters. The cable was placed in service on 8 August 2006 with load reaching 2,400 Amps (55 MW) on the first day of operation.

KEYWORDS

High temperature superconductor, superconducting, cryogenics, dielectric, cable, installation, underground.

INTRODUCTION

High temperature superconducting (HTS) cables have been under development around the world for many years. Superconductors offer the advantage of significantly higher power density and higher efficiencies as compared to conventional copper or aluminum cables. Current projects have addressed performance, reliability and economics of the technology in live utility grid demonstration projects. An innovative Triaxial cable design has been installed and placed in service at the Bixby Substation of American Electric Power in Columbus, Ohio USA. The cable operates at 13.2 kV with a continuous service rating of 3,000 Amps for 69 MVA. Design and testing of the cable and terminations has been discussed in detail by Sauers, et al [1].

The HTS cable connects a 84 MVA 138/13 kV transformer to the 13 kV distribution bus at the Bixby station. The cable provides 100% of the power to the 13 kV bus and all residential, commercial and light industrial customers served in the community around the station. Approximately 8,600 customers are connected to the station.

The Triaxial cable design places all three electrical phases concentric on a common cable core. The phases are made of BSCCO-2223 superconducting wires. A common copper concentric neutral is located outside the three phases. The cable design is shown in Figure 1. The HTS cable is placed inside a thermal envelope called a cryostat and the entire structure is flooded with liquid nitrogen (LN) to maintain an operating temperature of -202° C. Details of the cryogenic cooling system are outside the scope of this paper and have been discussed in detail by Lynch, et al [2].

The HTS cable is manufactured on a reel-to-reel process similar to conventional cables. The final cable was packaged on a 3 meter reel and shipped using standard methods from Cologne Germany to Columbus, OH in the United States.

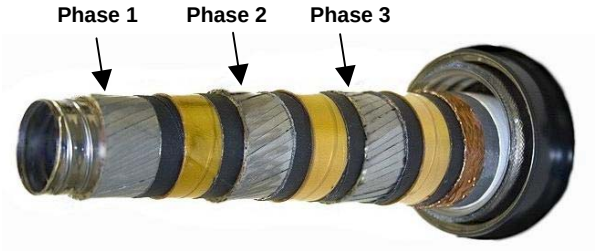

Figure 1: Triax superconducting cable.

Motivations for the Triax design include reduced material usage and reduced operating costs. The concentric phase arrangement allows for reduction by one half the quantity of HTS wires as compared to other cold dielectric HTS cable designs. The single core arrangements results in reduced AC losses and a smaller cold surface area – both factors to reduce cryogenic operating costs. These factors help bring the Triax cable to economic viability for certain applications.

INSTALLATION

General Layout

The cable circuit is 200 meters in length. Termination points are located at the North and South ends of the route. An underground vault for the cable joint is located approximately half way between the terminations. A joint was not required for 200 meter circuit, but was included to demonstrate field assembly and techniques for joining HTS cables.

A portion of the 200 meter cable was placed above ground in cable tray while the majority was pulled into an underground duct. The section was placed above ground to provide site visitors a visual reference for the cable. This section includes a 90 degree bend. The underground duct is located at a depth of approximately 2 meters and includes multiple 45 and 90 degree bends and is approximately 200 mm inside diameter.