TYPE TESTING OF A 13.2 KV, 69 MVA TRIAX HTS CABLE

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ABSTRACT

A Tri-Axial high-temperature superconducting cable system was type tested in preparation for installation in the utility grid in Columbus, OH, in the United States. The cable and accessories were designed for a 15 kV-class voltage with a nominal current of 3000 A. The testing procedure was compiled from applicable parts of existing norms for XLPE cables and oil-filled, paper-insulated cables and approved by the utility customer, American Electric Power Co., AEP. Additional procedures were added for the cryogenic components of the system. This article describes in detail the testing procedure that led to the approval of this cable design.

KEYWORDS

High temperature superconductor, superconducting, cryogenic, dielectric, cable, type testing, underground.

INTRODUCTION

Several installations worldwide are now demonstrating high-temperature superconducting cables. This article describes the type-testing in preparation of a 2-year test installation of a 13.2 kV, 69 MVA Triax cable for the American Electric Power Co (AEP) in Columbus, Ohio.

High-Temperature Superconducting power cables (HTS cables, “supercables”) can carry three to five times more power at every voltage level with lower energy losses and less voltage drop than conventional copper- or aluminum power cables. This allows for new system solutions in urban areas.

The practical reach of MV (10-35 kV) is extended from 1-10 km to 10-200 km. This allows for a reduction of the number of substations in a meshed network. What is today transmission and sub-transmission at 50-400 kV can be carried out at lower voltage levels.

Since the HTS technology is now at its entry-stage with small manufacturing volumes, the costs are initially high compared to the conventional alternatives. Therefore, the first uses will be where large civil-engineering and environmental savings can be made. Such early uses include the retrofit of cables in existing ducts and tunnels, upgrading of the power rating in a narrow rights-of-way, and the out-localization of HV substations away from sensitive or congested areas.

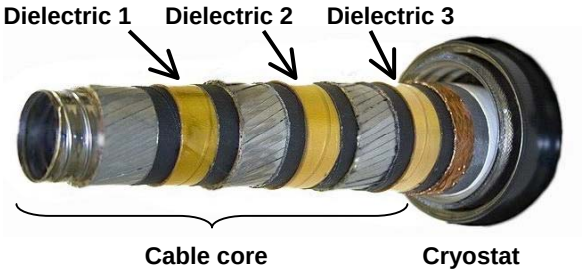

Figure 1: Triax superconducting cable.

TYPE TESTING

Background

There is not yet an established norm for the type testing of HTS cables. A test procedure was compiled based on applicable parts of existing norms [1-7] and additional tests based on the experiences of previous HTS cable installations [8, 9]. The type tests were carried out on 3-5 m long samples in preparation for a 200 m long pilot installation [10-13].

The electrical insulation consists of a lapped polymer ribbon (Cryoflex™) in multiple layers impregnated by liquid nitrogen at a temperature of 68 K to 83 K (-205 C to -190 C) and pressurized to 3-6 barg. This means that high-voltage tests of practical cables longer than a few meters require a complete system consisting of cable conductor, thermal insulation and pressure containment (“cryostat”), terminations and a cooling system.

The type tests were separated in three different parts as follows:

1) Type tests on a 5 m cable system;
2) Fault-current tests on 3 m cable and splice samples;
3) HV tests on 3 m splice samples.

Type tests on a 5 m cable system

Many of the testing procedures were carried out on a 5-m test system consisting of a flexible 5 m cable, terminations and a cooling system. The tests were carried out at ORNL.