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Development of a high temperature superconductivity power delivery system

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Résumé : Ce rapport décrit le projet tri annuel de Shouthwire Company de fabriquer un câble supra-conducteur à haute température (SCHT) pour alimenter en électricité deux grandes usines et un grand atelier de mécanique. Ce câble aura trois phases, de 30 mètres chacune, qui fonctionneront à 12.5 kV et 1250 Ampères. Il est prévu que cette liaison entre en service à la fin de 1999. Ce rapport comprend aussi un bref exposé du développement des SCHT et de la situation actuelle des matériaux supra-conducteurs. Le projet de Southwire est co-financé par le Département de l'Energie des Etats-Unis.

Abstract: This paper will describe the 3 year project by Southwire Company to build a High Temperature Superconductor (HTSC) cable project to supply power to two major manufacturing plants and a large machine shop. There will be three phases, each 30 meters long, that will operate at 12.5 Kv and 1250 amps. The Southwire project is being cost shared by the United States Department of Energy.

I. INTRODUCTION

Southwire Company started closely monitoring the developments on superconductivity since materials were discovered that could be cooled with inexpensive and readily available liquid nitrogen. These new materials not only offered promise of being environmentally friendly, with high current capabilities, but are capable of longer underground runs than conventional cables. The higher current capabilities might allow replacing existing underground cables in conduits with cables having 3 to 5 times the capacity.

Higher current capability might eventually mean power could be transmitted at generator voltage without the expense of transforming to higher voltages. Also, the difficulty of acquiring new right-of-ways might be addressed by installing these higher capacity lines in existing right-of-ways.

Superconductivity Materials

Superconductivity is not a new discovery. In 1911, a Dutch physicist, Heike Kamerlingh Onnes discovered that virtually all electrical resistance disappears if you cool mercury to a very low temperature. Onnes called this lack of electrical resistance superconductivity.

Subsequently scientists learned that three conditions must exist for the materials to remain superconducting, otherwise they become resistive. The material must not exceed its critical temperature, critical current or be placed in a magnetic field. The first commercial superconducting wire was produced in 1961 and was made from niobium and tin. Niobium-titanium was produced closely behind that. These materials were superconducting when cooled with liquid helium, which boils at minus 459 Fahrenheit. Superconducting materials that require cooling with liquid helium are generically called Low Temperature Superconductors (LTSC).

There was limited commercial success of helium cooled superconductors, with two notable exceptions. The major commercial (LTSC) use has been in magnetic resonance imaging (MRI) devices and powerful research magnets. These devices have been commercially available for about 20 years now.