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400 kV XLPE cables for the extension of Cleuson-Dixence Hydro power plants

WYLER C., BIOLLEY C., HEIZMANN T., MARRO A., Alcatel Cable Suisse SA, Cortaillod, Switzerland
NICOLET A., Aménagement Cleuxon-Dixence, Sion, Switzerland

Résumé

La première installation de câbles 400 kV en XLPE en Suisse a été mise en service en octobre 1998. Trois circuits câblés d'une longueur d'environ 400 m relient les transformateurs situés dans la caverne de l'usine hydoélectrique 1200 MVA de «Bieudron» à une sous-station 400/220 kV sur l'autre rive du Rhône. Les câbles ont un conducteur en cuivre de 800 mm^2 et une gaine ondulée en aluminium extrudé. Les extémités et les câbles sont remplis de SF_6.

Abstract

The first commercial installation of 400 kV XLPE cables in Switzerland has been in industrial service since October 1998. Three cable circuits of lengths of 400 m link the transformers of the 1200 MVA underground hydro power plant « Bieudron » with a 400/220 kV substation located across the Rhone river. The cables have a conductor cross-section of 800 mm^2 copper and a metallic sheath made of seamless extruded corrugated aluminium. The cables as well as the terminations are filled with SF_6 gas.

1. Introduction

The system of hydro-power plants of the «Aménagement Cleuson-Dixence SA» uses the 400 mio m^3 of water stored in the «Lac des Dix», which is located in Valais, Switzerland. The three existing power stations «Chandoline», «Fionnay» and «Nendaz» use the head of 1745 m to produce some 780 MVA of electric power (see figure 1). To enable a better response to the strongly fluctuating demand, the peak power production has been increased by the construction of the 1200 MVA power station «Bieudron». This power station comprises the following components :

- a new water intake bored in the «Grande Dixence» gravity dam
- a headrace gallery of 15.5 km
- a surge tank
- a steel lined inclined shaft of 4.3 km
- a power station with three hydroelectric groups (Pelton turbine 423 MW, generator 465 MVA).

The power station is installed underground in three caverns with a total volume of 155'000 m^3 (see also [1] for more information on the installation).

With a head of 1883 m, a power of the Pelton turbines of 423 MW, and a power per pole of 35.7 MVA of the generators, the new hydro power plant Bieudron sets three world records.

2. Electrical conception of power plant «Bieudron»

Figure 2 shows a schematic of the electrical installations. Each of the three groups has a 423 MW Pelton turbine with 5 injectors running at 428 rpm. The generators have 7 pairs of poles and are cooled by purified water. The energy produced by the generators is lead to the transformers by means of a system of coaxially shielded air insulated busbars at a nominal voltage of 21 kV and a current of 15'000 A. The busbars have an aluminium cross-section of 21'000 mm^2. Each group is provided with a three-phase 21/410 kV transformer of 500 MVA which is also installed in the cavern. There is no circuit breaker between the generators and the transformers. Three systems of 400 kV cables link the transformers with a 400 kV gas-insulated substation (GIS), where also the circuit breakers are installed. From there, the energy produced is evacuated by a 400 kV overhead line and, by means of a group of single-phased 400/220 kV transformers of 600 MVA, by the 220 kV grid.

The basic characteristics of the 400 kV grid are given in table 1.

Table 1 : Specifications of the 400 kV grid.

Max. operating voltage	435 kV
BIL	1550 kV
Short circuit current	55 kA / 3 s