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Undergrounding the first 400 kV transmission line in Spain using 2 500 mm² XLPE cables in a ventilated tunnel: *the Madrid « Barajas » airport project*

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Abstract: This paper describes general features of the project involving the undergrounding of a double circuit 400 kV line, rated 1720 MVA in winter, along a route of nearly 13 km in the surroundings of the Madrid Barajas airport.

A major re-development of the airport including two new runways and a new terminal and satellite buildings are being constructed with operational EMF interferences with existing overhead lines that need to be under grounded.

Underground cables will be laid in a prefabricated tunnel along the whole route, requiring the installation of a forced cooling system to extract the heat generated by cable losses due to the high power rating demanded to the circuits.

Keywords: XLPE insulated cable, cable rating, ventilated tunnel, fiber optic temperature sensing, real time circuit thermal rating.

1. Introduction

The Madrid Barajas airport is being re-developed with the construction of two new runways and terminal and satellite areas. Interferences of overhead lines with airport operations are regulated by law and caused by the presence of towers and conductors in the take-off and landing routes and radio electric interference with automatic navigation systems (LLZ, GP and ILS). A double circuit 400 kV overhead line rated 1390/1720 MVA (summer/winter) is being undergrounded along a route of nearly 13 km in order to eliminate such future interferences.

Cable and GIL solutions were compared having finally selected the XLPE cable solution being this more competitive for the project. Underground route is 12.800 m, having adopted the solution of installing two circuits, one cable per phase, inside the same tunnel, equipped with a forced cooling system.

Résumé : Ce rapport décrit les caractéristiques générales du projet impliquant l'enterrement d'une ligne double circuit à 400 kV, 1720 MVA de capacité de transport en hiver, de presque 13 km à l'aéroport Madrid-Barajas.

Un élargissement de l'aéroport incluant deux nouvelles pistes d'atterrissage et un nouveau terminal et des bâtiments satellites sont en cours de construction, donc il y a des interférences avec les lignes aériennes existantes.

Les câbles souterrains seront installés dans une galerie préfabriquée le long de l'itinéraire entier, exigeant l'installation d'un système de refroidissement forcée pour extraire la chaleur produite par les pertes des câbles.

Mots clés : câble isolé XLPE, capacité de transport, tunnel de ventilation, senseurs de température, capacité de transport du circuit en temps réel.

2. Basic Project data

Nominal System Voltage U:	400 kV
Maximum System Voltage Um:	420 kV
Minimum System Voltage:	380 kV
Winter Rating:	2 x 1720 MVA
Summer Rating:	2 x 1390 MVA
Short circuit current:	50 KA, 0.5 s
Impulse Levels:	
• Switching:	1050 kV
• Lightning:	1425 kV
Installation Type:	Tunnel
Height above sea level:	up to 1000 m
Air Temperatures:	

	Summer	Winter
Ext maximum	+42 °C	+25 °C
Ext minimum		-10 °C
Ext max. avg.	+35 °C	+22 °C
Ext min. avg.		-3.5 °C
Tunnel maximum	+50 °C	
Maximum air velocity in the tunnel:		5 m/s