A.1.2.
Undergrounding the first 400 kV transmission line in Spain using 2 500 mm² XLPE cables in a ventilated tunnel: the Madrid « Barajas » airport project
GRANADINO R., PORTILLO M., Red Electrónica de España, Spain
PLANAS J., Pirelli Cables y Sistemas, Spain
SCHELL F., ABB Energiekabel, Germany

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.

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:
<table>
<thead>
<tr>
<th>Summer</th>
<th>Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ext maximum</td>
<td>+42 °C</td>
</tr>
<tr>
<td>Ext minimum</td>
<td>-10 °C</td>
</tr>
<tr>
<td>Ext max. avg.</td>
<td>+35 °C</td>
</tr>
<tr>
<td>Ext min. avg.</td>
<td>+50 °C</td>
</tr>
</tbody>
</table>