Close and Return



**B.7.1. Analyse des risques d'incendie sur les réseaux de câbles MT : le comportement des jonctions en cas de défauts**

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Le rapport présente une analyse du comportement des differentés types de joinctions installées à l'air libre, en cas d'incendie dû à un court-circuit interne.
Le comportament thermique des joinctions à l'air libre a été aussi étudié avec une camera à haute vitesse et avec un appareillage à thermovision, en donnant une attention particulière à l'auto-extinction et à la propagation du feu sur le joinction et le câble testé.
Après avoir etudié le comportement réel des différents types de joinctions, cet article analyse aussi les possibilités données par les différents types de protéctions resisténtes au feu.

**B.7.1. Fire risk analysis on MV cable networks : the behaviour of joints in case of fault**

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The paper presents an analysis of the behaviour of different kinds of joints installed in open air conditions, in case of fire due to internal short circuit.
Thermal behaviour of open air joints and cable bunches has also been investigated with high speed camera and thermovision assessment, focusing on self-extinction and fire propagation of the joints and cables tested.
After having focused on the real behaviour of different kinds of joints the paper describes the possibilities offered by different means of fire resistent coverings.

## Introduction

The length of the Enel MV network is about 300.000 km, 35 % of which is formed by underground cables. The MV cable distribution is mostly made up of impregnated lead sheath paper cables; in the past belted cables were layed until 15 kV while for 20 kV lines, three lead core cables under a single PVC sheath were used. Several kinds of joint of different technology were used and are still in service

The Enel harmonization makes provision for three single core paper cables pre-assembled type, with nominal voltage 12/20 kV, to be used on 20 kV lines as well as on lines with lower voltages.

In 1983 Enel harmonized the following kinds of unipolar joints for paper cables:

- paper tapes joint protected with injected resin;
- paper tapes joint with lead sleeve filled with poured compound and protected with cast resin.

In 1993 HEPR cables were harmonized and introduced in the MV network; shrinkable accessories (both heat and cold technology) were harmonized and introduced too.

As already mentioned the length of MV cable network is about 100.000 km; in most cases cables are buried and protected against damage using bent cement tiles or recycled PVC plates. However, cables can also be layed, especially in large towns, in tunnels, underground passages and so on; in such environments the brake out of fire and its propagation are possible as air is allowed to circulate.

Recently, in a tunnel coming out from a 150/20 kV substation the components of a joint caught fire as the consequence of an internal earth fault and the propagation of fire to the nearby cables caused temporary loss of service and damages.

Taking into account the above accident a research has been necessary to analyze the behaviour of joints in case of fault, to quantify the electrical parameters able to provoke their fire and to verify the efficiency of some of the fire resistent coverings available on the market.

## Test parameters

An urban underground cable network fed by an HV/MV substation can be l50-200 km long with an area of 15-20 $km^2$. The earth fault current of a network fed by the same transformer is given by the following formula:

$$I = [(0.003xL1) + (0.2xL2)]xV \qquad (1)$$

where:
$L_1$ = overhead lines length, (km);
$L_2$ = underground lines length, (km);
V = nominal voltage, $U_0$ (kV)

The typical values of the above current are comprised between 300 and 400 A. To evaluate the behaviour of the joints at the maximum stress conditions, a test current of 500 A was chosen.
According to the service and nominal voltage of the testing joints, the 12 kV value had been expected as test voltage. Moreover, due to the reasons later described, the tests were carried out at 15 kV.

## Test modality

The tests were carried out by means of MV paper cable bunches 10 metres long, with testing joints assembled in the middle and two indoor terminations assembled on the respective cable ends.

Each joint contained an "internal fault" made up of a tin wire 1 $mm^2$ cross section linking the connector with the screen. The sublimation of the tin wire, caused by the test current (500A), provoked the subsequent electrical arc causing in the joint the same effects of an earth fault due to internal short circuit. This method allowed the following advantages:

- repeatability and equivalence of the test conditions for all tested joints;
- negligible alteration of the joint kit, as all components were assembled.

The tests were carried out at CESI "Laboratorio Impianto Diretto 3000 MVA". The joints were tested at 15 kV and 500 A following the sequence:

C-0.5; O-0.3; C-0.5

applying at the same time both the voltage and the current test for a duration of 0.5 sec, test circuit switched off for a duration of 0.3 sec and applying again the voltage and the current test for a duration of 0.5 sec.

## Test materials

In this research the following cables, joints and terminations conforming to Enel's harmonization were used:

a) MV paper cable pre-assembled type, nominal voltage 12/20 kV, aluminium conductor 240$mm^2$ cross section;

b) Unipolar joints:
- paper tapes joints protected with injected resin;
- paper tapes joints with lead sleeve filled with poured compound and protected with cast resin;

c) Indoor teminations;

d) Fire resistent covering such as:
- silica textile;
- self expanding fire resistent resin, to be poured in a plastic sleeve;
- intumescent material, contained between two aluminium soldered sheets;
- heat shrinkable sleeve;
- ceramic fiber "carpet", thoroughly bonded to an aluminium sheet;
- sand, contained in a box without cover.

The fire resistent coverings described above have been available on the market for several years; they are used especially in industry as a barrier against fire and its propagation; however they are not expected to stand up to mechanical stress under normal working conditions.
In this research the coverings were tested to find out their effectiveness while assembled on a joint installed in open air conditions and put under stress by applying the test sequence described above. The capability to withstand the mechanical