Assessment and Evolution of HV and E-HV Dry-Type Outdoor Cable Terminations

Panagiotis **TSAKONAS**, Riccardo **BODEGA**, Prysmian Group, (Netherlands), panos.tsakonas@prysmiangroup.com , riccardo.bodega@prysmiangroup.com
Paolo **BOFFI**, Mammeri **MOHAMMED**, Andrea **IADANZA**, Prysmian Group, (Italy), paolo.boffi@prysmiangroup.com , mammeri.mohamed@prysmiangroup.com, andrea.iadanza@prysmiangroup.com

ABSTRACT

Outdoor cable terminations have always been an irreplaceable part of high voltage cable systems. So far the evolution of their technology has been more or less in line with the evolution of the cable technology. A most common feature of these terminations is that they are built around the cable itself and that they rely on dielectric fluids (wet type termination) to sustain the electrical stresses inside them. Nevertheless, the challenges set by the utilities is pushing this technology to its limits. For this reason, new technologies of outdoor cable terminations have emerged. This paper will elaborate on the design criteria for developing the future generation of cable terminations and the qualification program to be followed. Practical field applications of such terminations are also presented.

KEYWORDS

outdoor cable termination, composite housing, porcelain housing, dry type, plug-in, slip-on, self-supporting, retrofitting, universal cable end, AIS substation, quick replacement, energy transition

INTRODUCTION

Since the first cable systems were installed more than a century ago, the outdoor cable terminations or outdoor sealing ends, have always been an irreplaceable part of them. They are vital components in the HV and EHV networks facilitating the transition between the cable system and an overhead line from a transmission tower or a busbar line of an AIS substation.

Outdoor cable terminations can be classified depending on:

- The insulation technology of the HV cable:
  - Extruded plastic (e.g. XLPE, EPR)
  - Impregnated paper (e.g. LPP)
- The insulator tube housing:
  - Porcelain.
  - Composite.
- Type of insulating medium:
  - Wet (e.g. Silicon oil, PIB oil)
  - Dry/Solid (e.g. LSR, epoxy)
  - Gas (e.g SF6)
- The structural capacity:
  - Self-supporting.
  - Flexible.
- The pollution class.
- Special features:
  - Slip on.
  - Plug in.
  - Seismic proof.
  - Explosion proof.

CONVENTIONAL OUTDOOR CABLE TERMINATIONS

For the past decades the majority of the installed population of cable terminations in the HV/EHV grids are of wet type with either porcelain or composite housing. At figure 1 the main components and their functionalities are briefly described.

1. Prepared cable: Continuation of the HV cable's insulated core towards the top of the termination.
2. Stress cone: To control the electrical field at the cut of the outer semiconductive layer and steer the equipotential lines inside and outside the termination
3. Dielectric fluid: To steer the equipotential lines and withstand the electrical stresses around the stress cone area.
4. Insulator tube: To contain and provide an environmental protection of the insulating fluid inside the termination while maintaining a creepage resistance along the interface with outside air.
5. Top connector: To provide a low resistance path for the current to flow from the cable's conductor to the clamp of the overhead line.

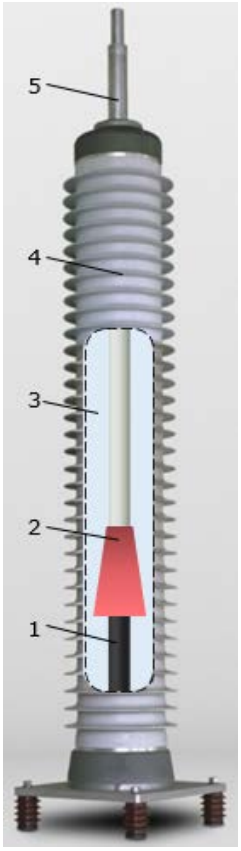

Figure 1. Typical construction of a conventional terination.

These type of cable terminations have been a very cost effective solution and have proven to be very robust during qualification testing of HV/EHV cable systems. Nevertheless, the so far onsite experiences have revealed that by design these terminations present a number of limitations :

A. **Cable preparation:** A long section of the cable has to be manually prepared onsite. The preparation length increases with voltage class (up to 5-6 meters for EHV terminations!) since the cable extends until the top of the termination. This cable section needs to be straightened, cut in precision, peeled from the outer sheath, sanded and polished. This process becomes more demanding for more complex cable