Development of a 145kV dry type plug-in GIS cable termination with standardized geometrical contour and connection interface

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ABSTRACT

The power industry is undergoing significant change driven by increased demand and legislation to incentivize green and sustainable energy sources. Among the numerous types of progress driven by various manufacturers, there is a clear demand and benefit with regards to standardized design, especially on geometrical dimensions and interfaces between different kinds of equipment. This paper presents a newly developed dry type cable termination, which is designed to provide a suitable cable sealing end to gas insulated switchgear (GIS) at 145kV with dimensions and interface designed according to IEC 62271-209 and CIGRE TB 784. The termination has been qualified for a cable with a maximum cross section of 1600 mm² according to IEC 60840 and launched with an embedded capacitive voltage indicator. The standardized contour provides the termination plug more possibilities to be used in various application areas, e.g., new concept of plug-in dry type outdoor cable termination.

KEYWORDS

Cable termination, plug-in, XLPE cable, dry type technology, GIS, green energy, silicone stress cone, standardized contour, connection system

INTRODUCTION

Before compact dry type plug-in terminations were developed, transformers and switchgear connections were made with air insulated, oil filled terminations. In the late 1970's the first accessories were realized with cable compartments that contained oil filled GIS or transformer terminations with pre-molded stress cones[1]. The GIS cable compartment had to be opened on site and the HV cable installer mounted the epoxy insulator and inserted the cable with the mounted stress cone and connector. Afterwards the insulator was evacuated and filled with oil. Once completed from a cable perspective, the GIS fitters closed the cable compartment and filled the GIS with SF6. For a transformer, the procedure was similar but instead of using SF6, the transformer oil needed to be pumped out of the cable compartment and re-filled again. That meant even greater effort for a transformer connection. The big advantage of these internal connections was the insulated and protected installation that could be situated in buildings rather than outdoors - with the associated huge demand for space.

Nowadays the dominating cable insulation material is cross-linked polyethylene (XLPE). In addition, the insulation material of cable and accessories has changed from impregnated paper and oil to solid materials such as insulation elastomers like silicone rubber (SiR).

There are several manufacturers of dry type plug-in terminations from 12kV to 550kV. While in medium voltage (MV) the interface contour of the inner cone system is standardized, it is not the case yet when it comes to the lower high voltage range from 52kV to 170kV. Here the manufacturer dependent insulator needs to be installed in the GIS or transformer before the installation is made on site with a plug from the same producer. That leads to logistic challenges as the end customer needs to accept the manufacturer for the whole plug-in termination and the GIS producer must then install the particular insulator in their compartment. With the development of SF6 free GIS switchgear, the insulators of new products must be compatible with these gases and withstand the higher pressures.

The main goals behind the development of an entirely new generation of dry type termination are:

- Satisfying increasing customer requirements for easier installation and greater cost efficiencies, whilst also maintaining all the advantages of the GIS and outdoor terminations currently in use.
- Enabling the option to disconnect on site without dismantling activities of the GIS or transformer.
- Environmentally safe – no risk of oil or gas leakage.
- No monitoring in service needed as is required for oil level, moisture content or gas pressure.

DRY TYPE TERMINATION TECHNOLOGIES

There are various design technologies for dry type terminations. [2] Among those designs, two major categories are referred to as either inner or outer cone type design as per IEC 62271-209. [3]

Figure 1 shows typical designs of inner cone and outer cone for cable connectors for GIS or transformers.

Figure 2 shows typical designs of inner cone and outer cone for outdoor cable terminations.

Today the most common products are inner cone systems with epoxy insulators and silicone stress relief cones. A few manufacturers use outer cones, but due to the more space that is needed and the mechanical disadvantages, the market tends to prefer the inner cone system.

Also the long reference period of more than 20 years proves that the inner cone system works.

In this paper, a new design concept of dry type GIS termination for 145kV system voltage in accordance to CIGRE TB 784 [4] is presented.