EXPERIENCES FROM A ZERO CROSSING DAMPED TEMPORARY OVERVOLTAGE TEST ON A 525 KV 80 DEGREES RATED HVDC CABLE SYSTEM

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ABSTRACT

Understanding the reliability of XLPE DC cable system under temporary overvoltage is key to validate the robustness of future HVDC links. This study presents the results of a 525 kV DC system submitted to zero crossing damped oscillations waveforms at low and high frequencies – respectively 350 Hz and 5.7 kHz. The tests have been conducted on full size cable samples simulating four different steps of ageing. The successful completion of sequence proved viability of the XLPE cable system under such events during its whole lifetime.

KEYWORDS

HVDC cable; Qualification; Transient Over Voltage; Zero Crossing Damped Oscillation

INTRODUCTION

Reliable HVDC transmission infrastructure is essential for large scale renewable power implementation into our existing power grid. Cyclic mismatch between local supply and demand, caused by intermittency and geographic scattering, can be overcome with HVDC systems which allow reducing transmission bottlenecks. Faults occurring in HVDC cable links may generate new voltage shapes from the interplay between the cable system and its converter stations [1] [2] [3]. It is crucial to ensure robust cable performance under such voltage transients, and therefore dedicated HV tests have been designed and are now defined in the new technical brochure Cigré TB 852 [4].

This paper presents the experiences obtained from submitting a 525 kV, 80°C rated, extruded HVDC cable system to a sequence of zero crossing damped temporary overvoltage (DOV) tests, designed to demonstrate reliable cable performance in a suddenly grounded DC pole.

Transient overvoltage (TOV)

A fault occurring on one pole of a HVDC link results in a discharge of the faulty length with a damped oscillating waveform as shown in Figure 1. An undesirable consequence would be one or several other insulation faults occurring on this cable length. Since these waveforms are not covered by standard impulse shape required in Cigré TB 496 (2012) [5] or IEC 62895 (2017) [6], the Cigré TB 852 (2021) [4] has proposed a specific sequence to ensure the resilience of HVDC XLPE cable systems subjected to such events. The waveform characteristics depend on several system parameters, defined by the cable and the converter system. In this study, it was chosen to take typical 2 GW North Sea project configurations as a basis in order to define the oscillatory shapes. Figure 1, originating from Cigré TB 852 [4], shows an example of zero crossing damped temporary overvoltage waveform. The initial voltage prior to discharge can be raised up to a value of U_{DOV} (1.15 U_0 in this example). Then the discharge itself occurs with a frequency of f_4. A number of at least n_4 oscillations occurs before the peak drops below 0,05 U_0. Table 1 summarizes the parameters for DOV tests.

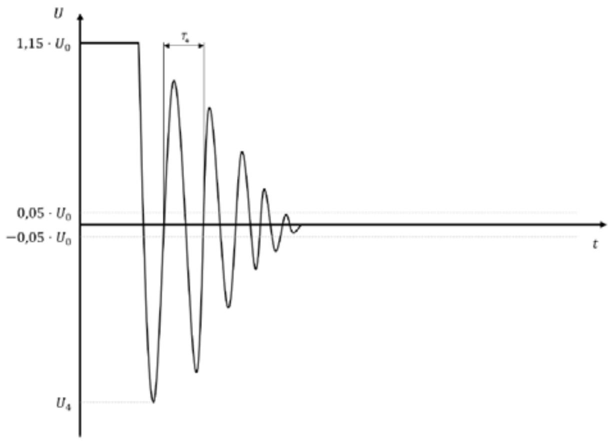

Figure 1: Example of Zero crossing damped temporary overvoltage waveform – Figure from Cigré TB 852 §12.2

Table 1: Parameters for DOV tests

Test parameter	Definition
First opposite oscillation peak value, U_4	Opposite polarity peak value of the first oscillation after sample discharge
Zero crossing damped temporary overvoltage period, T_4	Time period between two damped oscillations
Zero crossing damped temporary overvoltage frequency, f_4	Inverse of zero crossing damped temporary overvoltage period, T_4
Zero crossing damped temporary overvoltage oscillations, n_4	Number of zero crossing damped temporary overvoltage oscillations before peak voltage falls below 0.05 U_0
U_{DOV}	Initial voltage prior to discharge
U_0	Rated continuous DC voltage between conductor and core/insulation screen for which the cable system is designed