

## ALTERNATIVES FOR HV-AC TESTING OF LONG HV CABLES IN THE FACTORY AND ON-SITE

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### ABSTRACT

Manufacturers of HV test systems for the cable industry are faced with the request for testing XLPE-insulated power cables of several hundred kilometres, in the factory with power frequency of 50/60 Hz and on-site with AC-voltage in a frequency range of 20 to 300 Hz. This requires test systems with correspondingly high testing power often exceeding values of 100 MVA at 50 Hz which leads to large and heavy test systems being hardly manageable during manufacturing, shipment, installation and maintenance. Especially modified resonant test system arrangements show acceptable solutions for the factory with up to 80 MVA testing power and for on-site with more than 100 MVA equivalence power.

### KEYWORDS

HV-testing, ultra-long power cables, resonance circuit, variable frequency

### INTRODUCTION

There is a trend concerning the augmentation of the usage of cable routes with increasing transmission voltages up to 500 kV or to the usage of increasing cable routes for the connection of consumers to sources of energy like hydro power or offshore-wind parks. Furthermore, nowadays AC-voltage as well as DC-voltage are used. The consequence of the growing importance of HV cables results in very high requests regarding dependability as well as technical safety of these systems. Those may only be secured by comprehensive testing

both during manufacturing and commissioning.

### DIELECTRIC TESTING OF HV-CABLES

During manufacturing and after installation of XLPE-insulated cables these cables undergo stringent dielectrical tests. These tests mainly consist of a withstand voltage test in combination with partial discharge measurements.

For buried cables that are operated with AC-voltage the testing requirements are defined to corresponding standards, i. e. [1], [2] and [3] as described in column A of table 1. During factory tests, comparatively short lengths of cable are tested with mains frequency. For the withstand voltage tests there need to be correspondingly powerful resonance testing systems with variable inductivity according to the standardised test conditions. The partial discharge measurements may be done in shielded rooms with high measuring sensitivity to test the quality of the whole cable length. Due to the usage of cable drums with special dimensions that are used to enhance the winding volume and the delivery length correspondingly, there are consequentially higher demands on the capacities of the testing systems installed in the factory.

During the installation the separate lengths are connected to reach the system length by using joints and terminations. Preliminary to the commissioning of the system the quality of the installation of those components needs to be tested thoroughly through an AC-voltage test usually done in combination with a partial discharge measurement test directly at the joints.

Overview of principally cable manufacturing and testing technique for XLPE-insulated power cables

		A AC Landcable IEC standards e.g. 60840, 62067		B AC Seacable no IEC standards		C DC Seacable no IEC standards	
Manu- facturer's site	Technology	Cable drum	Hundreds of meters to few kilometers Pure cable (without joints)	Turntable, cage	Some ten kilometers Joints (splices) in factory	Turntable	Up to more than 100 kilometers Joints (splices) in factory
	HV Testing	HV withstand test	50/60 Hz power frequency 2.5U <sub>0</sub> for 30 min (60840) 2.5 to 2.0 U <sub>0</sub> for 30/60 min (62067)	HV withstand test	AC of 20 Hz to 50/60 Hz power frequency; Voltage level as A either factory or after laying	HV withstand test	HV -DC 1.85 U <sub>0</sub> for 15 min, additional HVAC (peak=DC) is recommended (CIGRE WG 21.01 02 2003)
		PD test	With AC 50/60 Hz (evaluation of delivery length)	PD test	With AC of 20 Hz to 50/60 Hz (evaluation of splices)	PD test	With AC of about 20 Hz (evaluation of splices)
Shipment		Cable drums on trailer		Turntable on vessel		Turntable on vessel	
Laying site	Technology	Laying and jointing on-site	Some ten kilometers	Laying only	Some ten kilometers	Laying only	Up to more than 100 kilometers
	HV Testing	HV withstand test	AC 20 to 40(300) Hz 2.0 to 1.7 U <sub>0</sub> for 60 min (60840) 1.4 to 1.1 U <sub>0</sub> (or 1.7) for 60 min (62067)	HV withstand test	Analogy with IEC for landcables A	HV withstand test	HV -DC 1.45 U <sub>0</sub> for 15 min (CIGRE WG 21.01 02 2003)
		PD test	On joints for cables of higher ratings	PD test	n.a.	PD test	n.a.

Table 1: Overview testing techniques