HV withstand test for a 500kV Power Cable Project Using 8 modular variable Frequency Resonant Test Systems

ChuanQiang XIAO, FengXi ZHANG, HongBin DAI, XianKun ZUO

SINDIA Instruments Co Ltd, China. xiao@sindia.cn

ABSTRACT

The paper introduced the acceptance test in a 500kV long cable project. Based on the initial test parameters calculation, eight modular type of AC resonant test systems made in Germany were used with connection of two in series to reach higher voltage, followed by four in parallel to reach bigger currents. The test project was completed based on China State Grid Standard.

The tests were successfully performed in Dec. 2017 by SINDIA Instruments Co Ltd ("SINDIA"). One cable joint in phase A had broken down during test.

KEYWORDS: HV resonant test system, Series & parallel connection technology, Voltage withstand Test, Breakdown, Corona monitoring

INTRODUCTION

China's transmission and distribution networks were developed rapidly in the last 30 years, with 500kV substations built in the core areas of first-tier cities including Beijing, Shanghai and Guangzhou. In order to transmit 500kV power into the core areas, 500kV extra-long power cable transmission lines were built in the last 10 years or have been planned for deployment over the next 5 years.

China State Grid had published a test standard Q/GDW 11316-2014 for HV power cable test up to 500kV. This standard specified $1.7U_0$ 60min for 500kV cable acceptance test as table 1:

Table 1: Q/GDW 11316-2014 Test codes for power cables

Rated voltage U0/U kV	Test Voltage 20~300Hz		Test Time min
	New cable lines or operated less than 3 years	Old cable lines	
18/30 and below	$2.5U_0(2U_0)$	$2U_0(1.6U_0)$	5(60)
21/35-64/110	$2U_0$	$1.6U_0$	60
127/220	$1.7U_0$	$1.36U_0$	
190/330			
290/550			
For cable lines with rated voltage 66kV and above, partial discharge monitored voltage withstand test is a must			

This test standard for power cable lines were stricter than related IEC standards. It provided technical basis for each provincial power companies including test voltage and test time. In addition, partial discharge measurement was also specified as basic requirement for power cable test of rated voltage 66kV and above.

"Alternatively, a voltage of U_0 may be applied for 24h", which is specified in the related IEC standard, is removed from China State Grid's test codes for power cable lines Q/GDW 11316-2014, as a result of the fact that many break downs of HV power cable lines happened within 6 months operation after performing the above mentioned 24h U_0 test.

SINDIA completed Beijing 500kV 6.7km cable line acceptance test in 2014 with 4 resonant test systems connected in series & parallel working mode [1].

The second 500kV long power cable test performed and introduced in this paper deployed cable line with length up to 15.3km, with 8 resonant test systems connected in series & parallel working mode.

Acceptance test proposals were under discussion for a future project of 20km with 10-12 resonant test systems connected in series & parallel working mode. This might be a technical challenge to control up to 12 systems in one test.

As 500kV substation allocated in the urban area or right in the core areas of the metropolitan cities, 500kV cables are the only choice for power transmission. Hundreds of MVA of test power were required and 3 major problems came out that were big test systems, large test area and large feeding power.

No single test equipment can provide such huge test power, and tests based on modular type systems were proofed as the best option. In order to minimize the feeding power, higher quality factor Q value greater than 120 was required by minimizing corona activities.

PROJECT PARAMETERS

This 500kV cable line project had two circuits with circuit length of 15.3km. One circuit was made with local manufactured cable and accessories; the other one was imported from Europe. Cable conductor cross section was 2,500mm^2. Cable line was installed under cable tunnel conditions as shown in figure 1. Eight cross bonding sections were used for grounding system as figure 1. Each phase had 23 cable joints in the middle, 1 GIS termination and 1 outdoor termination.

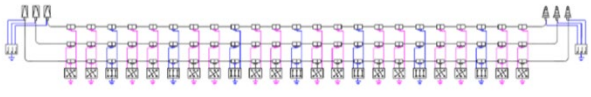

Figure 1: 8 sections of cross bonding system

The rated cable capacitance was 0.203 μ F/km provided by