
Qualification of screen connections for cable systems, test methods, application, experiences and challenges

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ABSTRACT

This paper presents a combined test method based on CIRED WG 2017-1 and IEC standards to prove and qualify screen connections installed on a specific offshore cable. During the tests, several challenges have been encountered and will be discussed in this paper. The test procedure consisting of conductor and screen heating cycles without voltage, short circuit tests and periodic electrical resistance measurements. Before and thereafter, dielectric measurements have been performed and successfully passed. A final visual examination proved that three types of screen connections have successfully passed the qualification.

KEYWORDS

Electrical resistance measurement, cable connector, cable termination, high voltage cable, medium voltage cable, offshore, screen connection, screen current, short circuit test, thermal stability test.

INTRODUCTION

Cable systems in offshore wind farms are in most cases, due to safety reasons, at both ends grounded. With the increasing number of wind farms, some challenges become more and more obvious. In recent years, several service experiences have been gained, in particular issues with the screen connection of cable systems have been observed. Due to the both end grounded cable systems, a current is induced in the cable screen. If the screen connections are not able to carry these high currents or not installed properly, the induced current may cause in some instances overheating, which could lead to a failure during normal service condition. Therefore, the cable screens as well as their connections at the accessories shall be able to withstand the induced current.

This paper presents a combined test method based on CIRED WG 2017-1 "Test Recommendations for Ground Screen Power Cable Connections" [1] and IEC standards [2-4] for high voltage and medium voltage cable systems, respectively. The methodology is foremost based on the final approach of the CIRED WG 2017-1 [1] recommendations, whereas the defined values and parameters are based and extended on IEC standards [2-3], and internal requirements.

The aim of the test is to prove and qualify different types of screen connections installed on a specific cable. The type of cable used for the test is standard for connecting offshore wind farms. The screen of the cable consists of copper wires and is surrounded by a radial water barrier made of laminated aluminium foil, while the induced current flows through both sections. Therefore, the screen connection shall be able to connect both current carrying layers.

The test procedure consists of conductor and screen heating cycles without voltage, short circuit tests and

periodic electrical resistance measurements in order to investigate the current carrying capacity and ageing behaviour of the screen connections. Before and after the thermal stresses, dielectric measurements have been performed to validate the integrity of the insulation system of cable. The test program and its results will be shown and discussed in this paper.

During the tests, several challenges have been encountered, whereby the complexity of the test procedures increases. Following aspects will be discussed in this paper: length of the cable samples, connectivity for the contact resistance measurement, temperature measurement points and the short circuit current test.

TEST PROCEDURE AND SAMPLES

The test procedure for qualifying screen connections is not standardised. In 2021 CIRED published a working paper WG 2017-1 "Test Recommendations for Ground Screen Power Cable Connections" [1], which treats failures in case of induced currents into the screen in normal service operation. When using offshore cables, the current is not only induced in the screen wires of the cable but also in the laminated aluminium foil. To test the current carrying capability of such type of cable, the CIRED WG 2017-1 [1] provides some recommendations. Due to the lack of standardization, currently the test procedures are defined by agreements between cable accessories manufacturers, cable manufacturers and customers.

Current available test procedures are concentrating only on the screen connection. The complete cable accessory is foremost neglected and therefore not installed for testing. In this case, the thermal behaviour of connector will not influence the screen connection, which in reality could. However, the influence of the dielectric properties are also not investigated.

According to CIRED WG 2017-1 [1], several IEC standards [2-4] and customer requirements, we propose the test procedure shown in Table 1, which shall be performed to qualify screen connections.

In addition to Table 1, the electrical resistance measurement (based on IEC 61238-1-3 §6.2.2) will be performed periodically during the heating cycles test as well as before and after short circuit tests. Each test will be briefly described in paragraph A to D. Furthermore, the screen connections and the cable will be described in paragraph E and F.

A. Dielectric tests

The dielectric tests consist of partial discharge measurement, lightning impulse voltage test and power frequency voltage test. To investigate if damages occurred during lightning impulse voltage test, the partial discharge measurement shall be performed before and after them. The tests are based foremost on accessory and cable standards (e.g. IEC 60840 [2] or IEC 63026 [3]).