EXPERIENCE WITH THE DEPLOYMENT OF OFFSHORE RESONANT TESTING FOR 66 kV CABLES

Jack **HUNTER**, James **PILGRIM**, Ørsted Wind Power (United Kingdom), jachu@orsted.com, japil@orsted.com
Thomas **KVARTS**, Ørsted Wind Power (Denmark) thokv@orsted.com

ABSTRACT

Offshore wind farm array cable systems have increased in operating voltage to U=66kV. These systems feature many offshore constructed terminations, which must be tested prior to commissioning. Since the publication of the IEC 63026 standard, this has been achieved through either a near power frequency resonant test or a 24 hour soak test. The resonant test is often considered to be very challenging, but does deliver a lot of additional value compared to the soak test. This paper discusses some of the key factors needed to enable these tests, based on the experience of executing multiple such projects within Ørsted.

KEYWORDS

Submarine cables; site acceptance testing; resonant testing; cable terminations; offshore wind.

INTRODUCTION

As the array cable voltage has increased from U=33 kV to U=66 kV, the approach taken by Ørsted to testing of these cables has also changed. In the past, it was common practice to use Very Low Frequency (VLF) for site acceptance test on 33 kV array cables. The test would be conducted from the offshore substation (with all the cables in a string connected in series) as part of the hand-over test from the contractor. This test for 33 kV cables was carried out at 0.1Hz, 60kV for 60min according to the IEC 60502-2 [1]. With the move to 66kV array cables from 2020, projects began to use near power frequency resonant testing.

Reasons for Testing

A typical array string will consist of 4+ turbines, with the same number of discrete cable lengths forming the string. It is a common misconception that the purpose of the Site Acceptance Test is primarily to test the cable; however the cable will have been subject to routine tests in the factory (both before and after layup), culminating in a final near power frequency voltage test prior to loadout. Such tests will never be capable of identifying all potential defects in a cable, but these tests are typically at a higher voltage than those done on site. Therefore it can be reasonably expected that the cable itself would only fail the site acceptance test if damaged during installation. While this can never be ruled out, and a further offshore test helps to check the integrity of the cable, this is not the primary reason for the testing.

Each cable will be fitted with 6 terminations onto the junction box / switchgear unit at the WTG. These terminations have been completed on site, and hence it is essential to test their integrity before the termination contractor leaves site. Although great attention is paid to the cable termination process, including onshore “mock-up” trials where detailed procedures can be tested, there will always be the potential for issues to occur.

The number of terminations per string is 6 times the number of WTG, meaning that there will often be 30 or more terminations on a single string. This means that there are a large number of test objects. The cost of the lost generation incurred if a termination fails during operations can be very high, to the extent that a single outage can cost more in lost generation than the cost of testing multiple strings. This is especially true as the start of fault-finding activities may be constrained by vessel availability or weather conditions. Therefore there is a very clear benefit to testing each string thoroughly before the contractor leaves site in order to minimize the likelihood of failures occurring in service.

Guidance in Standards

In the past, testing of 33 kV cables was governed by IEC 60502-2 recommendations, while those at 66 kV would have fallen under the remit of IEC 60840 [2]. In 2020, a new IEC standard (IEC 63026 [3]) was issued which specifically covers submarine cables. This provides requirements for the electrical testing of submarine cables at voltages Um ≤ 72.5 kV. IEC 63026 §13.3 offers the following options for site acceptance testing:

- For Um < 36kV, test for 15 min with ac voltage of frequency 10-500Hz, or test for 15 min at 0.1 Hz at a voltage of 3 Uo.
- For Um > 36kV, test for 60 min with ac voltage of frequency 10-500Hz
- For all cases, an alternative is to test for 24hr with rated voltage Uo of the system (“soak test”).

Prior to the publication of IEC 63026, testing for submarine cables at U=66kV would typically be done according to IEC 60840, with the modification proposed by Cigre TB490 [4]; namely that it would be acceptable to use a reduced test voltage with a longer duration to overcome limitations of the test equipment available.

Objective of this Paper

This paper summarises experience gained from deploying resonant test equipment during the construction of 3 recent wind farm projects, identifying key lessons learned which will be valuable to the industry. The experience described in the paper will be valuable in demonstrating key enablers that must be in place at an early stage of the project, as well as discussing key factors affecting the logistics of the offshore works. The paper demonstrates how a well planned and carefully executed resonant test campaign can be used to detect potential issues early, and to minimise in service failures.