



## RECOMMENDATIONS FOR TESTS AFTER INSTALLATION ON XLPE MEDIUM VOLTAGE CABLES

### SCOPE

This technical informative applies to XLPE insulated cables with voltage ratings from 1.9/3.3 kV to 19/33 kV.

### ADVICE CONCERNING TESTS AFTER INSTALLATION

If a test after installation is carried out, note that:

- (a) The test is to detect defects caused during installation.
- (b) After installation, the test is applied to the cable and accessories.

### HIGH VOLTAGE D.C. TEST AFTER INSTALLATION

The D.C. testing of the primary insulation is not recommended. There are two important reasons for not using a High Voltage DC Test.

- 1) The DC field in the cable and accessories applies different electric stresses (both in magnitude and in physical location) to an AC field. So much different, that it is considered to be a poor process to find faults.
- 2) The application of HV DC leads to premature failure of aged and "wet" primary insulation. This has been proven in the Laboratory and has been proven repeatedly in the field.

### SAFETY REQUIREMENTS

As the voltages used in these tests are potentially lethal, appropriate safety measures must be employed to ensure that the safety of all people involved in the testing process is not compromised.

Cable ends to be isolated shall be disconnected from the supply and protected from contact to supply, or ground, or accidental contact.

Safety measures shall include, and shall not necessarily be limited to, earthing of cable under test prior to and after test voltages are applied, erection of safety barriers with warning signs, and an open communication channel between testing personnel.

The testing guidelines outlined in this document are Olex New Zealand Limited's recommendations only, and Olex New Zealand Limited can not be held responsible for ensuring the safe implementation of these recommendations.



## SHEATH INTEGRITY TEST

A sheath integrity test (e.g. 1000 V minimum insulation resistance tester) applied between the outer-most metallic layer and earth can identify after-installation damage to the non-metallic outer sheath.

The measured value should be read after application of the voltage for 1 minute. Ideally the measured value should be corrected for temperature to a standard value at 20°C if correction factors are available. A rough guide is that the insulation resistance decreases to one half of the value for a 10°C rise in temperature. The cable temperature should be recorded along with the measured values.

Measured values of Insulation Resistance for the sheath should be greater than calculated values. Calculated values for new cable range from 1.5 MΩ/km to 4.0 MΩ/km @ 20°C for PVC sheaths and from 120 MΩ/km to 300 MΩ/km @ 20°C for PE sheaths. Values are highest for small cables & thick sheaths and lowest for large cables & thin sheaths. (Factory tests show that measured values are up to an order of magnitude greater than the calculated values.)

Earth the screens after an Insulation Resistance Test on a sheath for at least 5 minutes before handling or performing other tests.

## INSULATION RESISTANCE TEST AFTER INSTALLATION

DC voltages up to 5 kV, used when performing Insulation Resistance Tests on Primary Insulation, are not considered to be a “High Voltage DC Test”.

An Insulation Resistance Test of the Primary Insulation should be carried out with an Insulation Resistance Tester, with a minimum DC voltage of 2.5 kV for 1.9/3.3 kV cables or 5 kV for cables above 1.9/3.3 kV and up to 19/33 kV. The Insulation Test should be carried out in the “Guarded Mode”, and the instrument should have a minimum full scale range of 500 GΩ. Guarding should be applied at both ends and a spare core used for the connection lead to the guard at the far end. Any conductor or cable core used as a guard lead must have a resistance to ground of greater than 10 kΩ. The measured value should be read after application of the voltage for 1 minute. Ideally the measured value should be corrected for temperature to a standard value at 20°C if correction factors are available. A rough guide is that the insulation resistance decreases to one half of the value for a 10°C rise in temperature. The cable temperature should be recorded along with the measured values.

Measured values of Insulation Resistance for the primary insulation should be greater than calculated values. Calculated values for new cable range from 2,400 MΩ/km to 18,000 MΩ/km @ 20°C. Values are highest for small conductors & higher voltages and lowest for large conductors & lower voltages. (Factory tests show that measured values are up to an order of magnitude greater than the calculated values.)



This test should be performed prior to any High Voltage Tests. Short the conductors to the screens after an Insulation Resistance Test on Primary Insulation for at least 10 minutes before handling or performing other tests.

If the instrument used for the above insulation resistance testing is a "Megger," Type BM 25, or equivalent, then the two following tests should be considered.

- A 10 Minute Polarisation Index Test. This test is commonly used as a replacement for the standard Insulation Resistance Test.
- A 5 Minute Step Voltage Test. The test should use five equal steps up to the maximum test voltage of 2.5 kV for 1.9/3.3 kV cables or 5 kV for cables greater than 1.9/3.3 kV up to 19/33 kV. This test is becoming increasingly used on cables of 6.35/11 kV and greater.

Both the above tests can be carried out automatically with the Megger, BM 25 unit, and guarding should be applied at both ends as above.

#### HIGH VOLTAGE A.C. TEST AFTER INSTALLATION

An A.C. voltage test at power frequency should be applied for 24 hours with the normal operating voltage of the system to the primary insulation.

Some customers have objected to a 24 hour test at only the operating voltage of the cable and would prefer a test using a higher voltage for a shorter time. This can be achieved by a Very Low Frequency (VLF) HV AC Test, and the equipment now exists for hire in New Zealand to perform this. The VLF HV AC Test is becoming recognised throughout the world as a replacement test for the old HV DC Test or the 24 hour AC test at normal operating voltage, although not many standards have details in them at this point in time. VLF Tests are carried out at a frequency in the band of 0.1 to 0.02 Hz. The VLF Test Set must be of adequate power to test the measured cable capacitance at the frequency chosen. The suggested maximum VLF test voltage for new cable is between 2.7 and 3.0 times the cable operating voltage ( $U_0$ ), for a minimum of 15 minutes. Where possible, a 30 minute testing time is now recommended as international research has shown this to give a higher confidence. Refer to the test procedure of IEEE-400-2, May 2004 draft.

For existing or aged cables being recommissioned after repair or alterations, the VLF Test Voltage should be a maximum of 2.3 times the cable operating voltage ( $U_0$ ), for 15 minutes.

#### DOCUMENTATION

All the values obtained in the above tests should be recorded in a cable log so that they are available for comparison purposes in the future.