

# CABLE CONDITION ASSESSMENT: THE WHOLE PICTURE

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Most utilities and industrial plants make extensive use of medium voltage cable. Cable designs vary in many ways, including:

- Insulation Material
- Metallic shield or neutral condition
- Jacketing
- Operating Conditions

Powertech Labs offers an array of cable services for on-site condition assessment, laboratory evaluation and failure analysis.

## INSULATION CONDITION

Although insulation failure is usually the final breakdown mode in cables, it's rarely the primary cause. For example, polyethylene cables, which are made without defects, operated within temperature limits, and are kept dry, could last 40 years or more. PILC cables that have not suffered mechanical or corrosion damage have often outlived their designers.

Unfortunately, we do not live in a perfect world and cable insulation is often subjected to severe conditions including contaminated water, overheating, factory defects, damage during installation, and higher than rated voltage stresses. Any of these may, in time, lead to insulation breakdown. When assessing condition, look at what surrounds the insulation and how the cable was operated. Rely on the experience of the people doing the assessment.

Assessing insulation condition may be performed in the laboratory, on cable samples, or on-site, using one or more electrical tests. Laboratory assessment may be recommended after a failure has occurred. Lab assessment is made to determine whether cables of similar type and age should remain in service. Lab assessment may consist of dissection, water tree counts, and various small-sample chemical tests. If longer samples can be taken, AC breakdown tests are performed.

Laboratory tests tell the most accurate story of cable condition and cause of failure, but only tell the story on the sample examined. To understand the state of the insulation of the cable still in the ground, on-site condition assessment is needed.



## LABORATORY DISSECTION OF FAILED SAMPLES

During dissection the insulation is examined by taking wafer cross sections in solid dielectrical cable. The cable is checked for voids, protrusions, contaminants, water trees or other damage.

## LABORATORY AC BREAKDOWN TESTS

If a long sample can be removed from a cable installation, an AC breakdown test will give a good indication of the condition of the sample. The sample is terminated and subjected to increasing levels of AC voltage, until failure occurs. On new 15kV cable, AC breakdown may occur at over 150 kV. As the cable ages, the breakdown strength decreases. Cables nearing end of life will breakdown at or below three times operating voltage. For a 15 kV cable, this will be 25 kV line-to-ground or less.

## ON-SITE INSULATION CONDITION ASSESSMENT

On-site condition assessment involves some form of electrical test, usually performed on de-energized cable systems. At present, there are a number of tests available, including partial discharge, dissipation factor, voltage recovery and leakage current measurement, to name a few. Unfortunately, no single test will tell you the complete condition of your cable insulation.

Powertech has developed a low voltage DC test method – Leakage current (I) pico Ampere test (LIpATEST) – that has been used successfully to assess the condition of XLPE cables. The test voltage is less than half that of the recommended levels for aged cables using traditional DC hipot testing. The LIpATEST requires less than 10 minutes to perform and the maximum DC voltage is applied for only one minute. The LIpATEST is used for on-site insulation assessment, along with other tests to assess the condition of cable jackets and shields.



## HOW DOES LIPATEST WORK?

The LIpATEST on-site evaluation method involves applying a negative, step-DC voltage to a cable and measuring the leakage current for one minute at each voltage step. The leakage current is measured with a sensitive, highly filtered, DC pico-ammeter, which is fibre-optically coupled to the data acquisition system.

The test is computer controlled and the test duration is less than 10 minutes per cable. The equipment is suitcase-sized and easily transportable.

Cables with large and extensive water trees (characteristic of aged insulation) show significant departures in the linearity of leakage current vs. test voltage. AC breakdown voltage tests on these cables yield low breakdown voltages, confirming the effectiveness of LIpATEST.

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## THE WHOLE PICTURE

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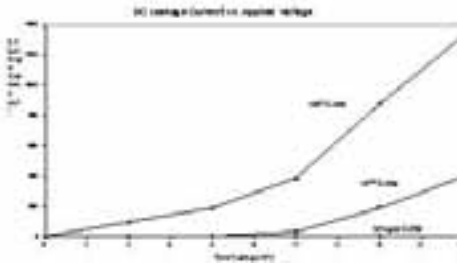
### METALLIC SHIELD OR NEUTRAL CONDITION

Cable metallic shields or neutrals may suffer mechanical damage during installation or over time from temperature cycling, particularly under cable clamps. Generally, the thinner the metallic shield, the more susceptible it is to damage or corrosion. Copper tape shields are particularly susceptible to damage and corrosion, even in fully jacketed cables. Metallic shield damage may result in heating of the underlying semi-con shield and insulation, which increases voltage stress and accelerates insulation failure. Damaged or corroded shields may be found in a dissection during failure analysis. In an on-site condition assessment, there are specific tests designed to examine the extent of metallic shield or neutral damage.

### ON-SITE NEUTRAL OR SHIELD CONDITION ASSESSMENT

An initial assessment of the cable neutral or shield is made with a DC resistance meter. If the resistance reading is high, Powertech uses Low Voltage Time Domain Reflectometry (LV TDR)

to locate the points along the cable where the neutral or shield is deteriorating. If the neutral or shield is corroded at many points along the length of the cable, a recommendation to replace the entire cable may be made. If the corrosion is isolated to only a few points, these locations may be cut out and new sections of cable spliced in place. This technique may save the cost of entire cable replacement, and gives you confidence that the remaining cable neutral or shield is in good condition and the cable is unlikely to fail suddenly. LV TDR is a very low-voltage technique (10 V pulse), and does not harm the cable in any way. The LV TDR test equipment is small and easily transportable.



### CABLE JACKET

Sometimes the cable jacket is compromised during installation or handling of the cables. A damaged jacket is often a first indication that further problems

may be encountered. Water ingress in the cable causes neutral or shield corrosion and water tree development, which eventually will lead to premature insulation failure.

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