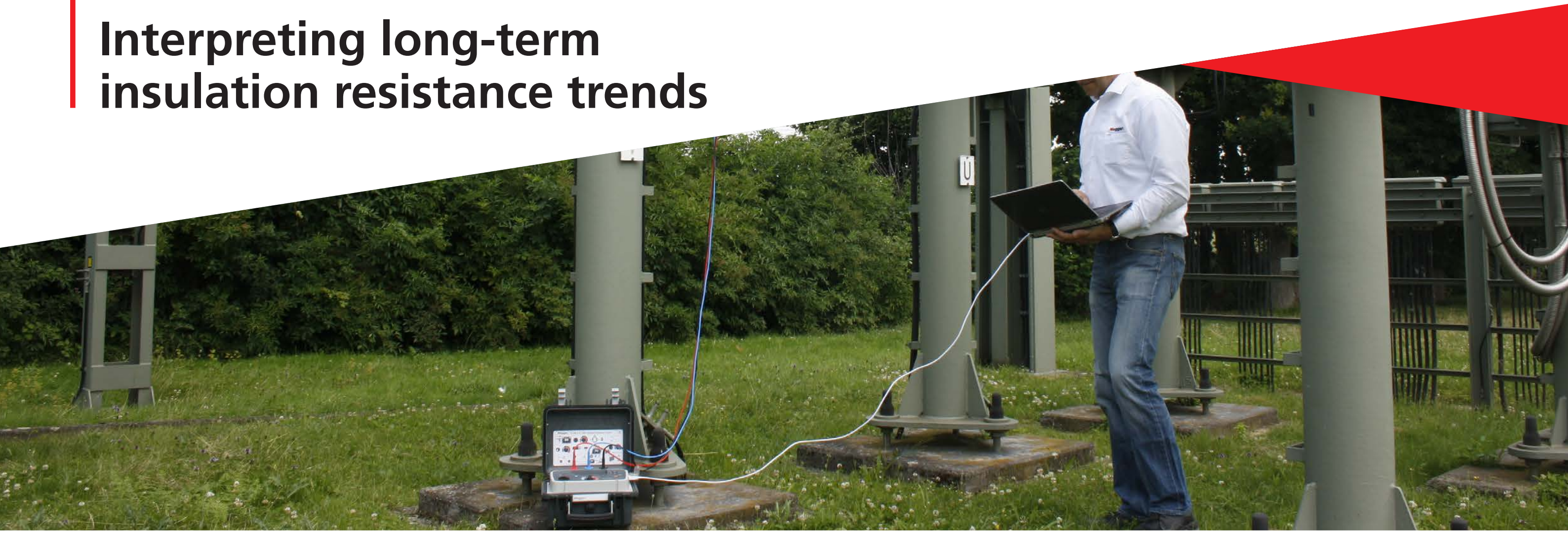
# Interpreting long-term insulation resistance trends



## Introduction

Just like the regular inspection of water tanks, the periodic checking of insulation throughout its working life is often overlooked. Yet the cost of implementing insulation testing as part of a routine maintenance schedule is very small in comparison with the huge costs of the failure it might prevent. Insulation testing is performed on electrical equipment at various stages in its life:

- **Immediately following manufacture**

Checking for errors or damage incurred during assembly

- **Before new equipment is put into service**

Checking for damage that happened during transportation and installation

- **Checking for wiring errors**
- **Periodically through its working life**

Checking for problems caused by mechanical stress - vibration, movement, impact

Checking for problems caused by chemical attack - dirt, oil, corrosive vapour

Checking for problems caused by thermal stress - hot/cold, machine starting/stopping

Checking for problems caused by environment - moisture, humidity, rodents

Checking for problems caused by electrical stress - spikes and over voltages

- **When it's put back into service after maintenance**

Checking for damage that happened during repair

Checking for wiring errors

- **After a prolonged shut down**

Mainly checking for environment damage - moisture, humidity, rodents, insects, spider webs, etc.

In most of these scenarios, insulation testing involves performing a simple "go/no-go" test, usually lasting for one minute to ensure that any capacitance on the test piece is properly charged. However, one scenario is different. When insulation is checked periodically during the working life of equipment, it's important not just to see whether the insulation resistance is "good" but also to see whether it is changing. A sudden downward change or degradation in insulation will warn of a possible impending failure. Once degradation in the insulation has been detected, further diagnostic tests can be called upon to help decide on the most appropriate form of remedial action. For the present time, let's turn our attention to performing the actual periodic insulation testing. Ideally when I venture into the loft to check my water tank I would take a nice bright torch – I certainly wouldn't rely on taking a tiny candle! In other words I would want make sure I was using the correct tool to do the job. Insulation testing is no different; it's essential to use an insulation tester that will give reliable, accurate and repeatable test results.

# Interpreting long-term insulation resistance trends

To demonstrate the impact the quality of an insulation tester can have on the ability to identify potential failures, some sample test result graphs are included in this article. Figure 1 shows the test results as taken by a particular test instrument, together with a dotted line representing the actual insulation resistance over time.

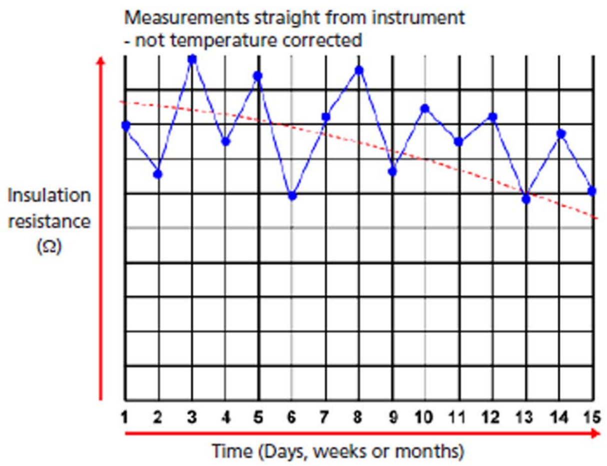



*Figure 1*

As they stand, the test results are erratic and it certainly is not possible to see the actual trend in insulation resistance.

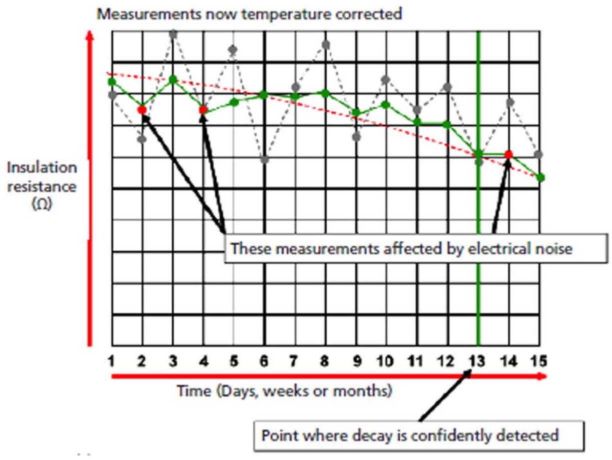



*Figure 2*

The first step is to temperature correct the test results. Figure 2 shows the temperature corrected results. Remember that insulation resistance values can change by a factor of two with a shift in temperature of 10 degrees centigrade. The resulting curve is getting closer to the true curve, but it is still difficult to identify the point where the insulation truly starts to degrade.

The first environmental issue likely to be encountered during insulation testing is electrical noise being picked up on the test circuit. This noise takes the form of a current induced into the circuit and can result in the test instrument reading incorrectly, usually lower than it should. In some cases, noise can mean that it's impossible to make measurements at all. When choosing an insulation tester, therefore, it is always essential to look for one that actually specifies its level of noise immunity. In Figure 3, errors due to the poor noise immunity of the instrument used to take make the measurements have been corrected.

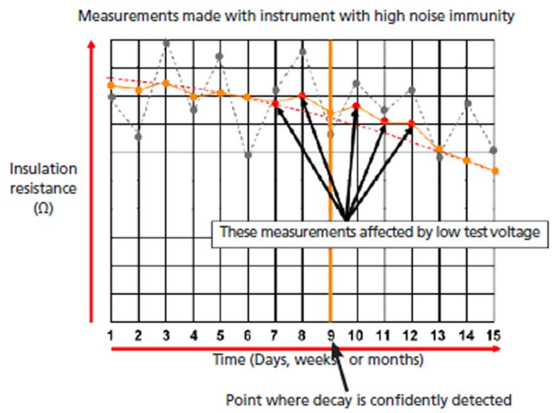



*Figure 3*

The next problem that may be experienced is maintaining test voltage repeatability. To ensure insulation test measurements are directly comparable it is important to use the same test voltage for each test. This involves a number of considerations. First, it help to know exactly what voltage the instrument is applying, so an instrument with a voltage meter that's operational during the test is strongly to be preferred. If the 5 kV test range is selected, it's good to know that the instrument is actually applying 5 kV to the equipment under test.

Megger Limited, Archcliffe Road, Dover, Kent, CT17 9EN, United Kingdom

T +44 (0)1304 502 100 F +44 (0)1304 207 342 E uksales@megger.com

# Interpreting long-term insulation resistance trends

Next, the instrument must be able to supply a reasonable amount of test current, usually specified in terms of current into a short circuit. For most applications, 3 mA is enough, although sometimes 5 mA may be beneficial. The reason for considering the instrument's current capability is that it will impact its ability to maintain the selected test voltage when it needs to supply high surface-leakage currents.

Tests performed out of doors in particular can be expected to involve high surface- leakage currents due to surface contamination, the effect of which will vary with climatic conditions. Using the instrument's guard terminal should eliminate the effect of the surface leakage itself on the measurement, but it will not compensate for errors resulting from variations in test voltage. This variation will also affect the graphing of test results as highlighted in figure 3. In figure 4 the effects of test voltage variation have been removed

Earlier, the use of the guard terminal to eliminate the effects of surface leakage was mentioned, but what many users forget is that the guard terminal can itself introduce errors into the measurement. The challenge for today's insulation tester manufacturers is to provide excellent measuring performance combined with the highest possible level of safety.

However, the additional protection against 8 kV transients needed for a CAT IV 600 V safety rating can, unless the instrument is very well designed, compromise the performance of the guard terminal. It is therefore necessary when choosing or specifying insulation testers to look for models where guard terminal performance is explicitly stated.

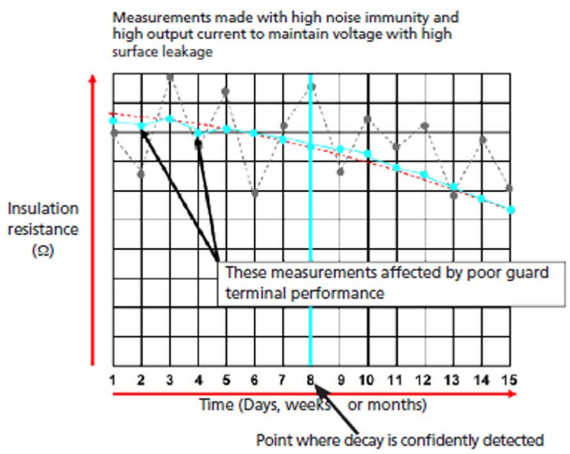



*Figure 4*

In figure 5 the measurements have been taken with an instrument that has good noise immunity, voltage stability, current capacity and guard terminal performance. It will be seen that they closely reflect the true insulation degradation curve of the insulation under test.

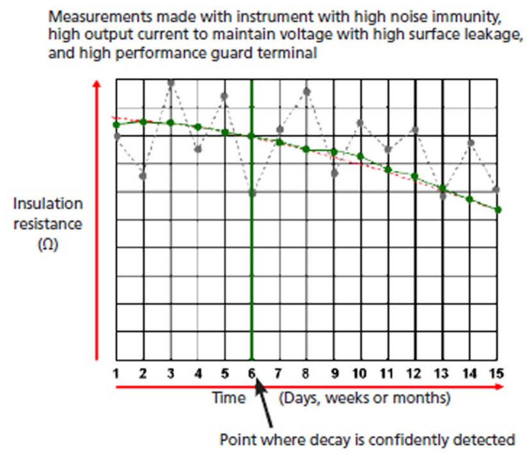



*Figure 5*

It can also be seen that the point at which insulation degradation can be confidently detected is now much earlier, making it easier to plan for downtime and to take remedial action before the degradation develops into a costly and disruptive full-blown failure. Figure 6 highlights this difference and makes the contrast between a good insulation tester and a poor one very clear.

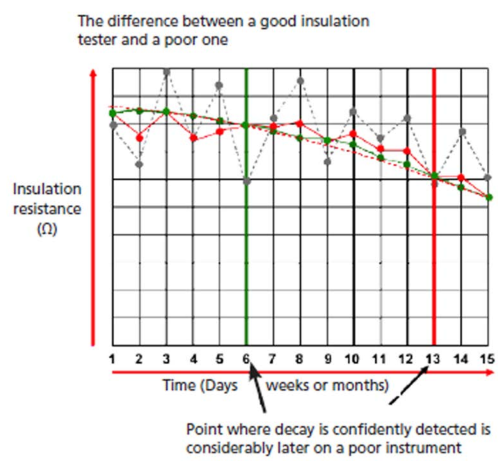



*Figure 6*

# Interpreting long-term insulation resistance trends

**TITLE:** Interpreting long-term insulation resistance trends.

**AUTHOR:** Paul Swinerd.

**DATE:** July 2011

**KEYWORDS:** Guard terminal, electrical noise, insulation resistance, transients.

**ABSTRACT:** Having good insulation on electrical equipment is rather like having a water tank in your loft that's actually watertight. In both cases, the cost of repairing an actual fault – whether it's poor insulation or a leaking tank – is likely to be much less than the cost of repairing the damage caused by the fault. Nevertheless, how many people actually take the trouble to look occasionally at their water tanks to check that they are in good order? Not many, I suspect, even though doing so could potentially save a lot of money and heart-ache.

**EMAIL:** paul.swinerd@megger.com