— EARTHING — THE GREAT UNKNOWN

Earthing is one of the most important fundamentals of an electrical distribution system but is the least understood, particularly how to test and measure it.

AEMC 6471 Multi-function Earth Tester Australian Kit

There is frequent confusion between Resistivity and Resistance but they are completely different parameters and are measured for different reasons. The fact that earth testers supplied with 10 and 15 metre test leads are actually purchased and expected to give meaningful measurements in Australian soil conditions confirms the lack of understanding!

The purpose of the earthing system and the importance of it to be effective and well maintained is generally understood, but when it comes to conducting tests to measure the earth resistance or soil resistivity then many mistakes are made and many results are questionable!

There are three situations where earth measurements are required:

1. Design of the earthing system when soil resistivity measurements should be made to determine position, number and depth of electrodes. The myth that belting electrodes as deep as possible will give the best result is not always correct and could be a significant waste of copper. The only way to determine the correct design is to conduct a comprehensive soil resistivity survey of the site.
2. Measurement of the earth resistance after installation to prove the installed system meets the design specification before it is commissioned.
3. Regular in-service earth resistance measurements to confirm the system is maintained in good condition.

It is conceivable that in a large organisation such as an electricity utility, each type of test is conducted by a different person or crew which could mean using a different instrument for each.

SOIL RESISTIVITY

Soil resistivity is measured in Ohm-metres and requires the minimum of a 4-pole earth tester. In simple terms four electrodes are placed a distances equal to the depth at which the soil resistivity is to be measured. From these results the optimum depth can be determined and the number of stakes required to achieve the desired earth resistance.

To fully survey a site in both area and depth, a large number measurements are required and an instrument with a memory is almost essential. While most 4-pole earth testers can be used for soil resistivity, many will not read directly in Ohm-metres and resistivity has to be derived mathematically from a resistance (Ohms) reading for each measurement using the formula 2π x Resistance x stake spacing. With some hundreds of measurements needed for a complete survey, the calculations will be tedious.

More sophisticated instruments will display the readings in Ohm-meters and save them to memory with the operator only having to enter the stake spacings.

The next consideration is the test current that can be generated. For Australian soil conditions anything below 200mA is inadequate but for serious measurements instruments with test currents up to 2.5 Amps will produce far better results.

Most, if not all earth testers, are manufactured in the northern hemisphere where soil is generally more fertile than in southern hemisphere countries such as Australia, South Africa and South America where they are required to work under more arduous conditions.

EARTH RESISTANCE

Measuring the earth resistance of a new installation prior to connection and commissioning is reasonably straight forward provided the right instrument is used for the conditions. This is where the el-cheapo instrument with a whopping 10mA test current and 10 and 15 metre leads can give misleading results. As with soil resistivity, a decent test current will produce more reliable results in varying soil conditions.

The length of the test leads is determined by the soil resistivity, not what the manufacturer supplies to keep the cost and weight down!

AEMC GroundFlex used to measure the earth resistance of a structure

In reasonable soil conditions, 50 and 25m leads are an absolute minimum and for worsening conditions 100 and 50m or even longer are required!

There is an obvious limitation with this measurement. Not all earthing systems are situated where there is 100m or more of clear space to run test leads away from interference from other earthing or buried metal. Making accurate measurements under these conditions is possible but requires more skill and a higher grade of instrument.

While it may be argued that an instrument supplied with inadequate leads could be upgraded with longer leads, it is inevitable that if the manufacturer has compromised where it is obvious, there will be other compromises and as always you only get what you pay for!

IN-SERVICE EARTH RESISTANCE

Maintaining an earthing system in top condition is probably the most important part of earth testing. In the past the substation would have been taken out of service, the earthing disconnected and measured in the same way as prior to commissioning.

Unfortunately taking a substation out of service is seldom an option, particularly in rural areas where there is no alternative supply.

In-service measurement is now possible with new generation multi-method earth testers which utilise Selective and Stakeless test methods.

The Selective method is where one electrode or group of electrodes can be measured independently of any other earths connected to the same network. When using the Selective method a test current >200mA is essential. The reason for this is that the test current dissipates throughout the earth network and has to be of significant magnitude through the section under test to give an accurate measurement.

The Stakeless method, as the name implies, measures the earth resistance without test stakes and long leads. The stakeless method is a "non-contact" method where the test current is induced and measured by a clamp-on probes. This can solve the problem when there is insufficient space to run out long leads.

The obvious question is why not use Stakeless measurement for all earth resistance measurement?

The answer is that Stakeless works best in some situations and Selective works best in other situations and it is the skill of the operator to know which method to use and where!

NEW GENERATION EARTH TESTERS

The good news is that all of the above tests can be performed with a single instrument. The AEMC 6471-A kit is unique to Australia and comprises all accessories necessary for in-service testing of all types of Australian distribution substations. The major benefit of a multifunction tester is that with three different test methods there is always a method to suit the conditions.

Also in the same range is the AEMC 6472/6474 GroundFlex kit which applies the selective method for in-service testing of transmission and communication towers.

For serious earthing designers, the Syscal range of Soil Resistivity instruments are the best choice. Syscal offer various models with test currents of 500mA, 1 Amp and 2.5 Amps.

Syscal's Soil Resistivity instrument

TRAINING

Pacific Test Equipment is highly experienced in the use and application of earth testers and offer training on how to get the best from their instrument to customers who purchase earth testers from Pacific Test Equipment or one of their authorised distributors.

Training can be customised to suit user's requirements and can include any or all of the following:

- Soil resistivity
- 4-pole earth resistance
- Selective earth resistance
- Stakeless earth resistance
- In-service SWER measurement
- Earth resistance of towers and structures

More importantly users are taught where to use each method and the traps and errors which can occur if the wrong method is used.

For more information about these products or others on our website please contact:

PACIFIC TEST equipment

Pacific Test Equipment Pty Ltd

Sydney Melbourne or your State Distributor

T +61 2 9659 2300 • F +61 2 9659 2311

E sales@pacifictest.com.au

www.pacifictest.com.au