EARTH RESISTANCE OF TRANSMISSION TOWERS

Transmission towers are solidly earthed at the base either directly by the buried leg structure or more commonly via a radial earthing strip. All these factors can contribute to a deterioration in the effective earthing of the transmission line and its ability to dissipate lightning strikes.

Additionally an overhead earthing conductor is placed above the live conductors bonding each tower of the transmission line to the earth grid at the origin and destination switchyards.

TRANSMISSION LINE EARTHING

Because of their height and location, transmission towers are extremely vulnerable to lightning strikes. When lightning strikes a tower or the overhead earth wire the current is safely dissipated to ground via all the towers bonded to the overhead earth BUT only if the earthing system is in good condition!

WHAT CAN GO WRONG?

When transmission lines are constructed they are expected to be in service for many years. Towers are frequently in remote areas and while out of sight should not be out of mind.

Steel is used for construction and although hot-dipped galvanised, corrosion may eventually occur, particularly if near the coast and often below ground level. The overhead earth wire bond at the top of the tower can corrode. The radial earthing strip can corrode in certain types of soil and if of copper is a magnet to thieves who can take advantage of remoteness to dig up the copper with little chance of detection.

TESTING TRANSMISSION TOWER EARTHING

Because a transmission tower typically has four legs and is, or should be, bonded to the other towers, it is not possible to measure the earth resistance by conventional methods. If a conventional earth tester is connected to the tower it will only measure the effective earth resistance of the complete line including the switchyard grids at either end.

It might be argued that provided the result is sufficiently low, adequate protection is provided. But this gives no indication if all, some or none of the towers are contributing to the effective earthing of the line. It is possible that the switchyard grids at either end are the only effective earth for the entire line! In this scenario a lightning strike could travel the complete length of the line before being dissipated.

CONVENTIONAL EARTH TESTERS UNSUITABLE

If a conventional earth tester is used to measure the earth resistance on an individual tower, it requires each tower to be climbed, the earth bond isolated, the resistance measured and the earth wire reconnected. Testing an entire transmission line by this method would be a lengthy and costly project not to mention the WHS issues and access permits required particularly if the line is in service.

COST EFFECTIVE ALTERNATIVE

Measuring the earth resistance of a tower in-service without disconnecting the overhead earth wire is achieved with the injection of an off-mains-frequency test current into the tower structure. The test current will flow to ground via the tower legs and the earth straps, but a significant proportion will escape via the overhead earth wire and flow to ground via all other towers and the switchyard grids. If the component of current flowing to earth via the legs and the earth straps is measured, the earth resistance of the individual tower can be calculated.

With the multitude of alternate paths to ground it is easy to understand that the injected test current needs to be sufficient so that the component flowing through the legs is sufficient for accurate measurement. The higher the test current, the better but for convenience and ease of portability into often rough terrain, the current needs to be supplied from light weight batteries. A 250mA test current is a good compromise between measurement accuracy and portability.

Measuring the current in tower legs was originally attempted with a large split iron-core CT with limited success because the CT would not universally fit all tower legs and between 4 and 12 measurements had to be manually summated as parallel resistances. The CT was heavy, brittle and expensive.

ROGOWSKI COILS TO THE RESCUE

The problem was solved by using four 5-metre Rogowski Coils. The 5-metre length can be wound up to four times around most tower legs increasing the sensitivity but are also sufficiently large enough to fit around tubular towers over 1.5m in diameter, an application way beyond the capability of iron-core CT's.

Rogowski Coil fitted around a typical tower leg. The green lead is injecting the test current and the black lead measures the voltage between the tower and the potential stake.

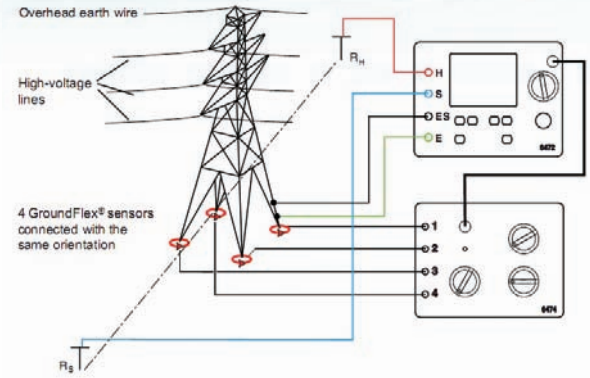
The AEMC GroundFlex

THE AEMC GROUNDFLEX

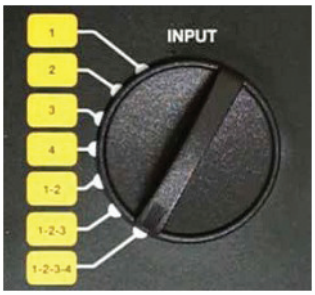
The AEMC 6472/6474 GroundFlex kit is the perfect solution for complete earth testing requirements. The 6472 (available separately) is a stand-alone multi-function earth tester which performs soil resistivity (without calculating it from a resistance measurement), earth resistance, leakage current and step potential measurements.

In earth resistance mode the 6472 measures both isolated and in-service earth grid resistance by either the selective or stakeless methods. When coupled to the 6474, the selective method is extended from a single clamp to four Rogowski coils for measuring the earth resistance of poles and towers with up to four legs.

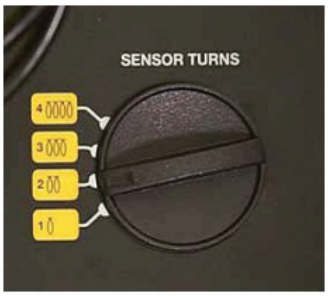
Once set up, the GroundFlex will measure the earth resistance of a tower in seconds! The tedious mathematics of summating four parallel resistance paths to ground is eliminated and is performed internally with the total resistance of the tower is displayed on the LCD.



Connecting the GroundFlex for Tower Testing
Rh is the Current Stake and Rs the Potential Stake

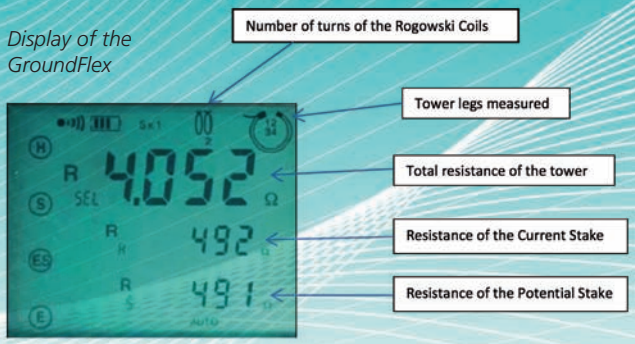


Selecting the legs to be tested



Selecting the turns of the Rogowski Coils

Display of the GroundFlex



In consultation with Australian users, the GroundFlex is supplied with a customised kit developed by Pacific Test Equipment. Because towers are frequently on tops of hills or mountains where the ground is rocky and the soil conditions poor, 100 and 50m test leads are included to improve the chance of the test stakes being placed outside the potential gradient area of the tower. For extreme conditions longer leads and longer stakes are optional.

The AEMC GroundFlex is exclusively available from Pacific Test Equipment or their authorised distributors across Australia and New Zealand.

See us at Down to Earth, Hunter Valley NSW
13-15 September 2016
www.downtoearthconf.com

For more information, please contact

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