European Metrology Programme for Innovation and Research

Delivering Impact


# New instrument for high voltage tests

Electricity is transmitted from its point of generation at high voltages of 115 kV or above to minimise losses over long distances. Each element of the network requires testing to ensure sufficient robustness to withstand these levels as well as the environmental factors encountered during normal operation. System voltages are set to increase in the future and new measurement instruments are required to prevent power disruptions caused by component failure.

**Europe's National Measurement Institutes working together**

The European Metrology Programme for Innovation and Research (EMPIR) has been developed as part of Horizon 2020, the EU Framework Programme for Research and Innovation. EMPIR funding is drawn from 28 participating EURAMET member states to support collaborative research between Measurement Institutes, academia and industry both within and outside the Europe to address key metrology challenges and ensure that measurement science meets the future.

# Challenge

All elements of the high voltage (HV) transmission grid require testing to demonstrate tolerance to such voltages to prevent failure and disruption to electricity supplies. In addition, due to the height of HV lines lightning strikes are common and cause surges of power, or 'lightning impulses' (LI), reaching hundreds of kV in millionths of a second. Overhead line insulators, a common grid component, are 'puncture tested' to determine tolerance to such excessive voltages. Testing generally involves an electricity impulse generator and a voltage divider which reduces the high-voltage signal to 10 V, or levels compatible with recording equipment. The divider itself must have adequate insulation and physical dimensions large enough to withstand the full applied voltage and be able to scale-down HVs that are transient, lasting for micro- or nanoseconds in duration, in an accurate and linear fashion.

Methods for testing and calibrating such instruments are specified by the international standard IEC 60060-2, however HV levels in Europe are now increasing to higher than currently covered by this standard. New types of voltage dividers, with greater accuracy and more sensitivity to fast-rising voltages are required, alongside validated methodologies that would allow testing comparability, independent of test location.

# Solution

The EMPIR project *Metrology for the electrical power industry* developed a new voltage divider for puncture testing together with proof-of-performance established using newly developed calibration methodology. The design is based on ceramic disk resistors, which have low inductance, high mechanical strength and the ability to withstand high voltages. Non- linearity in results due to such things as temperature can be corrected for to give a scale factor, which is how much the input voltage is accurately reduced for recording on a data recorder, in this case of 100,000:1. The instrument can measure a maximum voltage of 600 kV for transient voltages shorter than 0.5 µs, an improvement on the 0.84 µs of existing instruments, and the full lighting impulse voltage it can withstand is 400 kV. Furthermore, the divider's rise time, the fastest rising pulse it can measure, is a mere 2 ns (0.002 µs).

# Impact

Veresence La Granja, a glass insulator manufacturer based in Spain, were one of the first to purchase the new voltage divider. The company has been making insulators for electrical networks since 1932 and believe that their experience and willingness to invest in technological developments has allowed them to offer products that have not been surpassed by any other manufacturer.

The company plan to use the new divider in their ISO 17025 accredited testing and calibration laboratory which collaborates with other independent laboratories to generate the test reports they provide with their products. La Granja consider the new divider instrument critical to this work and as HV levels continue to increase in the future, it will help improve the products that they can deliver to their clients, opening new markets in this field.

These upgraded setups for puncture tests on high-voltage line insulators will increase grid reliability, support the compatibility of testing between different test organisations and reduce the economic and social costs of disruptions caused by environmental factors.

## New instrument for high voltage tests

The EMPIR project *Metrology for the electrical power industry* sought to improve the measurement infrastructure surrounding the high voltage (HV) transmission grid. The project developed calibration procedures and measurements for determining power loss for industrial transformers, HV capacitors, HV reactors, and power cables, with an uncertainty 3 to 10 times better than previously possible. Novel instrumentation was built including a calorimetric measuring system, for the accurate determination of losses which occur when AC is converted to DC at network substations, and two phantom power sources rated for 100 kV and 1500 A for use in the calibration of transformer loss. The project produced new calibration facilities for the measurement of very fast transient voltages up to 500 kV and with 200 ns rise-time and measurement of fast surge currents down to 10 ns rise-time. Together these results will support the competitiveness of the European electrical power industry.


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