

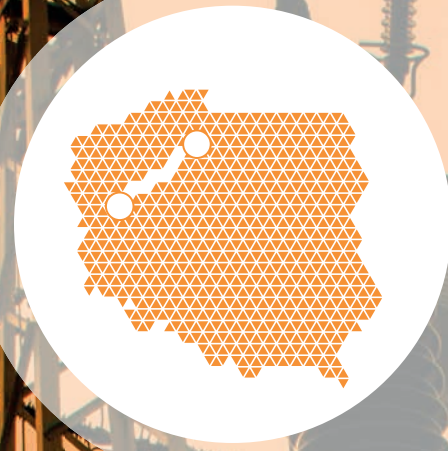


Measurements beyond standard!



Insulation quality analyzer
Sonel MIC-15k1

What did we do?



Power line
Jasieniec-Grudziadz



Rated voltage
400 kV



Operating voltage
220 kV

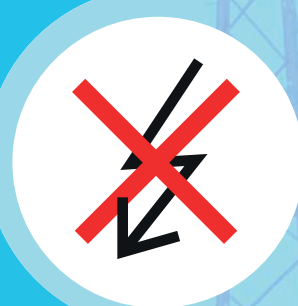


195 power line towers
73.6 km distance

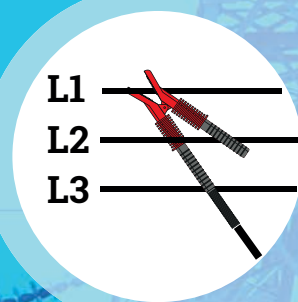
How did we do it?



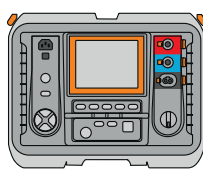
Tested ungrounded line



Tested unpowered line



Connection to phase conductors



Measurements

**Insulation quality analyzer
Sonel MIC-15k1**

**Remote control
Sonel MIC Mobile 2.0**

**Test voltage
15 kV**

Our results?

L1

$$R_{\text{ISO}} = 234 \text{ M}\Omega$$

$$I_L = 65.1 \text{ }\mu\text{A}$$

$$C = 1.47 \text{ }\mu\text{F}$$

L2

$$R_{\text{ISO}} = 220 \text{ M}\Omega$$

$$I_L = 69.4 \text{ }\mu\text{A}$$

$$C = 1.45 \text{ }\mu\text{F}$$

L3

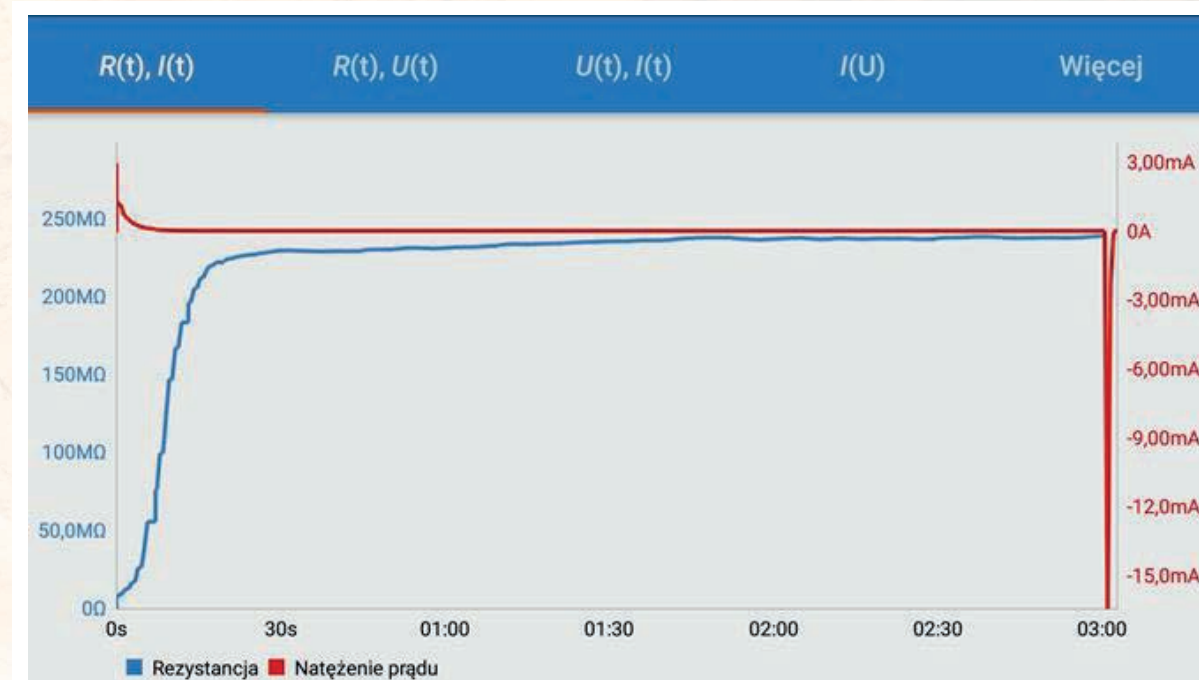
$$R_{\text{ISO}} = 240 \text{ M}\Omega$$

$$I_L = 63.7 \text{ }\mu\text{A}$$

$$C = 1.46 \text{ }\mu\text{F}$$



Results displayed
with Sonel MIC Mobile
2.0 mobile app



Voltage induced on the measured
line after ungrounding:

230-250 V

After reconnection, the power line worked correctly.

Expected results?

$$\text{Icon of three towers} = \frac{\text{Icon of insulator} \times \text{Icon of } R_m/l}{\text{Icon of insulator} + \text{Icon of } R_m/l}$$

L1

R_{ISO}
805 MΩ

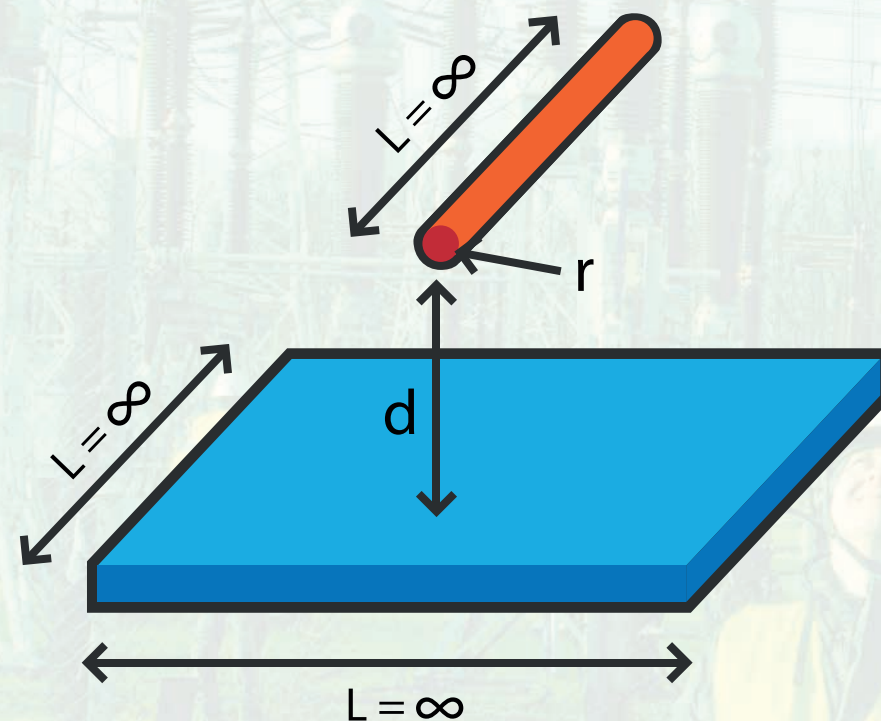
L2

R_{ISO}
805 MΩ

L3

R_{ISO}
805 MΩ

Simplified model line



$$R_m = \frac{\rho}{2\pi} \cosh^{-1} \frac{d}{r}$$

r

wire radius: 26.1 mm

d

distance from the center of the wire to the ground

ρ

resistivity of the surrounding medium: 71.4 TΩm

R_m

resistance of one meter of the system: 7.6 TΩ

l

power line length: 73.6 km

R_m/l

resultant resistance of the system 1.02 GΩ



number of insulators | 268 pieces



single insulator resistance | 1 TΩ



resultant resistance of all insulators | 3.7 GΩ

What does it mean?

Measured value

L1 $R_{ISO} = 234 \text{ M}\Omega$

L2 $R_{ISO} = 220 \text{ M}\Omega$

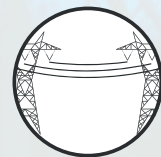
L3 $R_{ISO} = 240 \text{ M}\Omega$



Calculated value

$R_{ISO} = 805 \text{ M}\Omega$

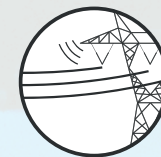
The line model did not include:



changes in
suspension
height and
ground clearance



influence of
the lattice post
supporting
structure



influence of other
conductors attached
to the tower



distance from
other over-
head lines



The assumed resistance of insulators is a guide value and does not take into account the impact of dirt on their surface

Approximate value of air conductivity around the line did not include:



space
radiation



emissions of
radioactive
compounds into
the atmosphere



air pollution



atmospheric
conditions

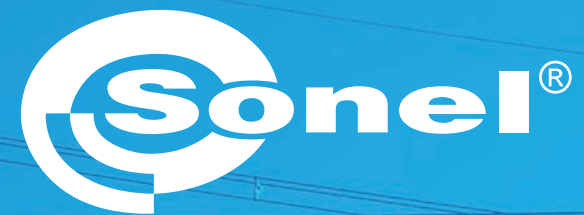


Challenges for the future

WHAT **CIGRE** STANDARDS DEFINE?

Insulation resistance of overhead power lines is not covered by any standards

- ❗ No minimum values of R_{ISO} .
- ❗ No defined test voltages
- ❗ No data on the recommended measurement time
- ❗ No guidelines regarding test environmental conditions
- ❗ Only insulators are tested, but this happens at the stage of their production



Overhead line insulation resistance is a mystery.

DISCOVER IT WITH SONEL S.A. METERS



If you had any experience with similiar measurements - share it. wt@sonel.pl