

PD surveillance on cable installations while SOAK test

All new critical cable connections should be controlled for partial discharges (PD) when they are energized for the first time!

Poor workmanship, manufacturing defects, transport damage and excavation damage can generate insulation weaknesses which in turn cause partial discharges.

The PD activity will over time cause a breakdown!

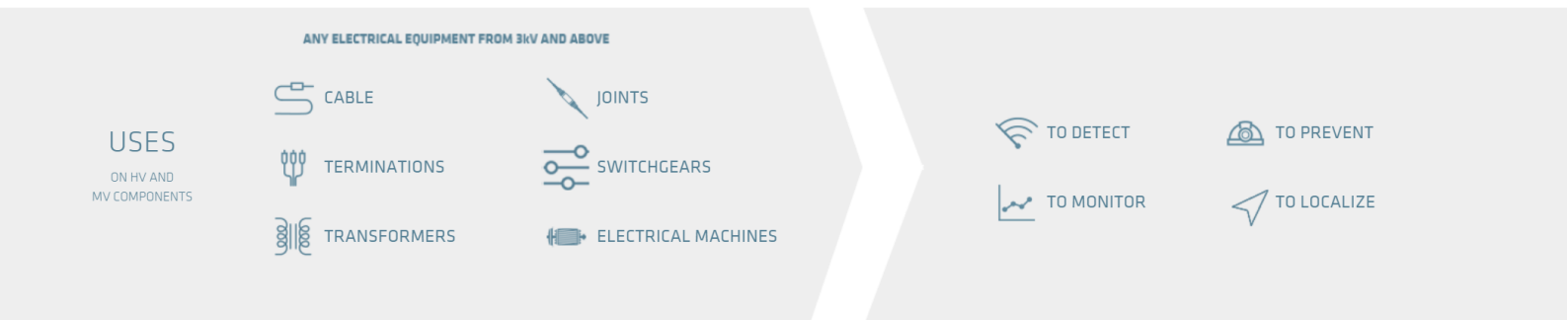


SOAK test with PD surveillance

- Data is collected during the first 4 hours under SOAK
- Data collected during the last 4 hours under SOAK
- Data is collected during the first 4 hours with load
- Total 2 days on site

A SOAK test it self will only reveal significant errors!

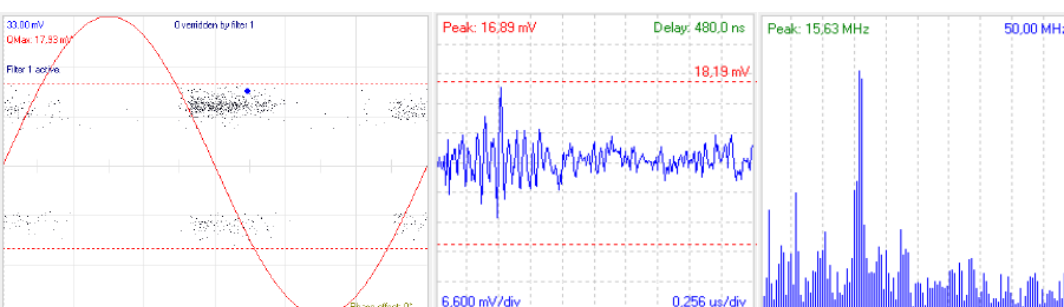
A SOAK test combined with PD surveillance will reveal small defects which over time will cause a breakdown!



PD surveillance SOAK test 220 kV joint



PD surveillance SOAK test 145 kV GIS termination



COMMISSIONING WITH VLF PD/TD



NEKA AS specializes in testing high voltage cables. We perform commissioning of new installations.

The cable diagnosis is a three-part commissioning that ensures that the quality of the installation is satisfactory

Commissioning and cable diagnostics

VLF COMMISSIONING WITHSTAND TESTING Service aged XLPE cables IEEE 400.2-2013:

System voltage	Test voltage (phase/earth)	Test time
24 kV	24 kV _(rms)	30 min
36 kV	33 kV _(rms)	30 min
69 kV	63 kV _(rms)	30 min

VLF COMMISSIONING WITHSTAND TESTING New XLPE cables IEEE 400.2-2013:

System voltage	Test voltage (phase/earth)	Test time
24 kV	32 kV _(rms)	60 min
36 kV	44 kV _(rms)	60 min
69 kV	84 kV _(rms)	60 min

TAN DELTA (TD) DIAGNOSTIC TEST

At 1,5 U₀ for 66 kV kabel
To determine the quality of complete cable's insulation.

PARTIAL DISCHARGE (PD) TEST

At 1,5 U₀ for 66 kV kabel
To indicate and localise points of weakness and insulation imperfections

TDR 'FINGERPRINTING'

To identify joint positions along the cable

Commissioning according to; IEEE 400.2 or IEC 60502-2

- Good insulation will be unaffected
- Reveals; Production deviations, poor workmanship, and aging
- Uses sinusoidal, 0.1Hz HV waveform
- Up to 30 km cable can be tested



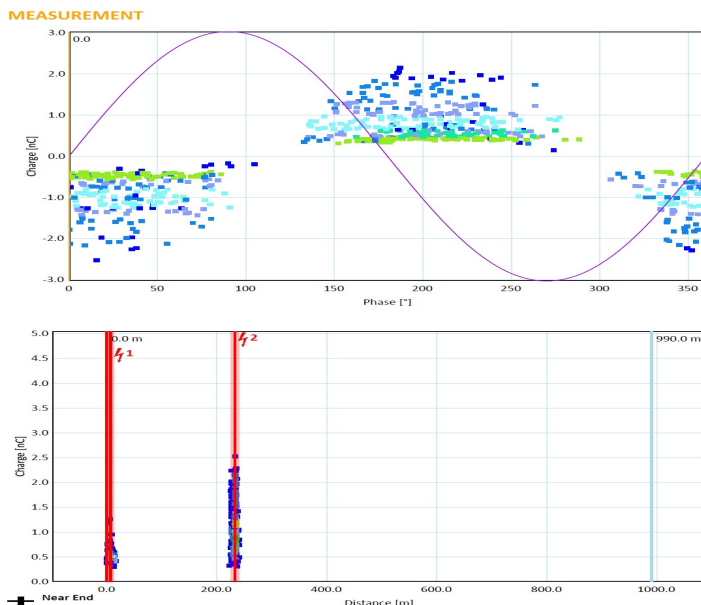
COMMISSIONING WITH VLF PD/TD

Benefits of VLF PD & TD Diagnostic Testing

- Complete assessment of the quality of the cablesystem. This helps to ensure that the installation is satisfactory and does not have weaknesses present that will fail at a later date
- Commissioning with VLF PD / TD verifies the installation and gives the owner a fingerprint of the cable installation for future control
- VLF partial Discharge (PD) reveals cable faults and the fault location.
- VLF Tandelta (TD) uncovers the general aging of the insulation and creates a fingerprint of the insulation system



PD mapping with PRPD and location on cable



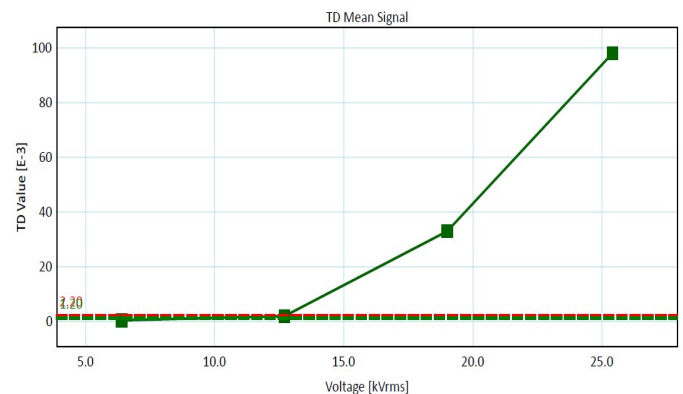
Defects in cable, joints and terminations are uncovered along the entire cable. The test also provides information about the type of fault, inception voltage and severity.

TD analysis according to IEEE 400.2

Phase P2 Overview

	6.4 kV	12.7 kV	19.0 kV	25.4 kV
Mean TD [E-3]	0.46	2.00	33.0	98.0
Standard Deviation TD [E-3]	< 0.1	0.22	0.24	0.27
Mean RMS Voltage	6.4 kV	12.7 kV	19.0 kV	25.4 kV
Mean RMS Current	10.1 μA	18.6 μA	27.8 μA	37.3 μA
Mean Load C	2.3 nF	2.3 nF	2.3 nF	2.3 nF

TD PHASE DIAGRAMM



TD analysis reveals the general aging of the insulation system in cable, joints and terminations. The values are checked against the requirements of IEEE 400.2.

ON-LINE CONDITION ASSESSMENT ON ELECTRICAL ASSETS

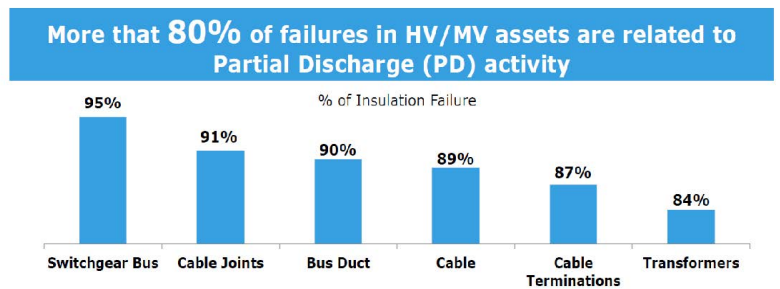


Partial discharge occurs in weaknesses within the insulation system of high voltage components.

The phenomenon breaks down the insulation until a breakdown occurs!

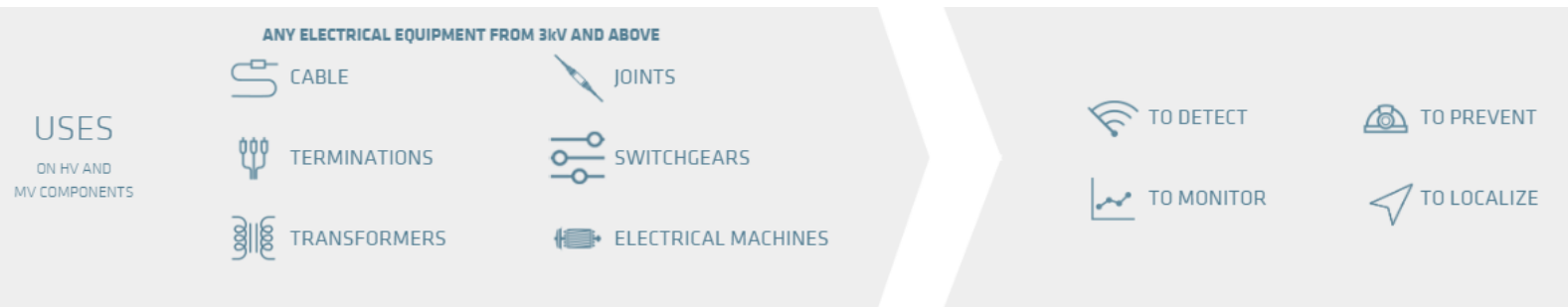
Installation error, manufacturing defects, mechanical damage or aging lead to partial discharges.

With strategic measurements through the grid, the source of the PD activity is located.



This is **WHY** we are strongly committed to **on-line, accurate & reliable PD testing**

Source: 493-1997 - IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems (Gold Book)



CRITICAL DEFECTS DETECTED ON HV AND MV



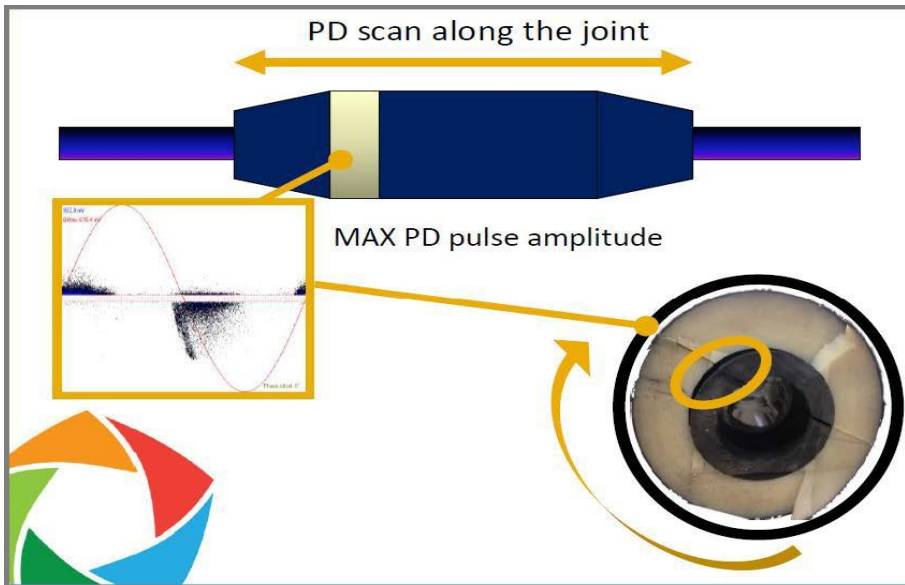
AVOIDED FAULTS



ON-LINE TESTING WITHOUT SERVICE INTERRUPTION



HIGHEST PERFORMANCE FOR COMPLEX PD DIAGNOSIS AND DEFECT LOCALIZATION



PD scan along the joint

MAX PD pulse amplitude

- HV joint
- PD scan along and around the joint by simply moving the Pry-Cam

Results with Pry-Cam:

- Accurate defect localization
- Total cost saving



- OF Termination having high levels of dissolved gas
- Potential loss of generation and explosion risk

Results with Pry-Cam:

- Internal PDs found on phase B in few minutes
- Faults prevention

Investigation showed that papers were loose/unwinding



- 6 HV terminations investigated

Results with Pry-Cam:

- Accurate and reliable diagnosis
- Detection of 4 PDs on 2 terminations
- Faults prevention

LINE RESONANCE ANALYSIS (LIRA)



Sensitive to small changes of wire electric parameters, mainly the insulation permittivity, that are a significant condition indicator of the cable state (thermal and radiation aging, humidity, insulation defects, mechanical damage).

Cable diagnostics with LIRA

LIRA can detect:

All types of changes affecting the insulation capacitance

Dimensional changes as cable joints or splices between different cable types, areas influenced by extensive heating, radiation, water intrusion, corrosion, bends, scratches, mechanical impacts, fatigue, etc.

Global or local insulation material degradation (XLPE, PILC and others).

All types of changes affecting the insulation capacitance

LIRA might detect:

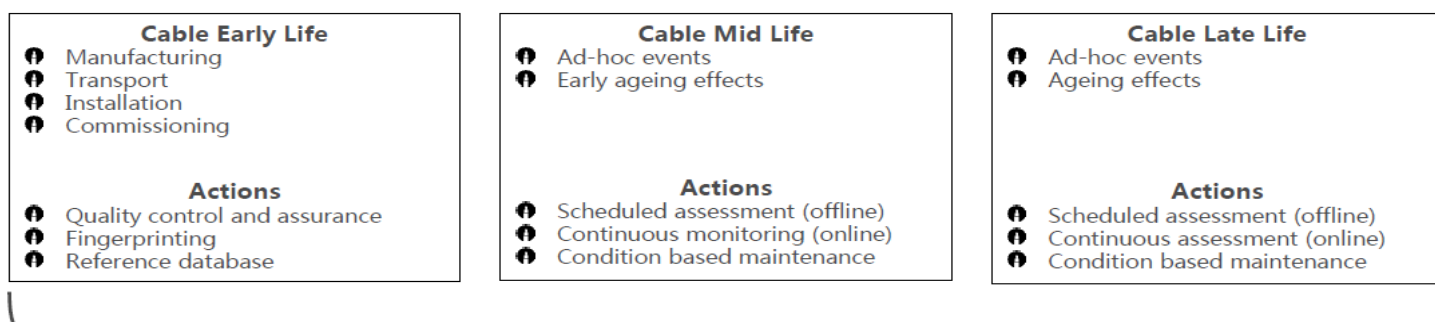
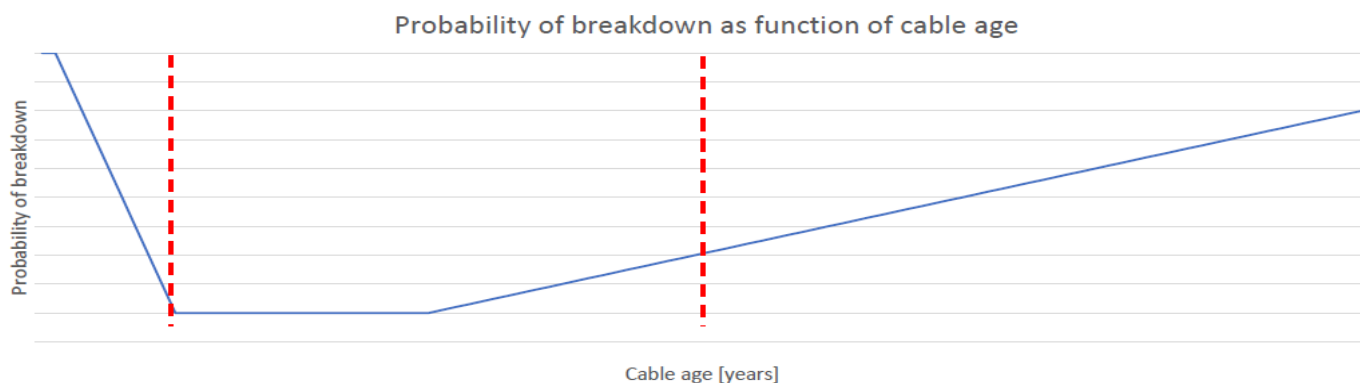
Damages in outer sheath only if water/humidity or other factors directly or indirectly affects the capacitance of the insulation/screen system.

High resistance failure depending on extent of change and size.

LIRA cannot estimate the cable residual life time:

One measurement will give information of the cable condition at the time of measurement. Repeated measurements will generate increased information for a more accurately prediction of the cable status.

In most cases the LIRA system will detect consistent but in-significant features or global degradation along the cable. Repeated measurements will generate increased information of the development of these features/degradations.



LIRA Benefits

Accurate and fast location of defects, complementing existing tools

Reduced repair down time

Early warning of degradation facilitates preventive maintenance and prevents cable breakdown and the cost and hassle associated with power or signal outage

Extension of operational life time beyond initial design objectives
Reduced insurance cost due to less risks

Provides more than ten cable condition related results from one measurement

Provides information on global and local condition

More sensitive to changes in cable parameters compared to other solutions
Detects fault localization with accuracy 0.1 – 0.3% of cable length

Has excellent length capabilities, ranging from 30 m to 300 km

Is non-destructive