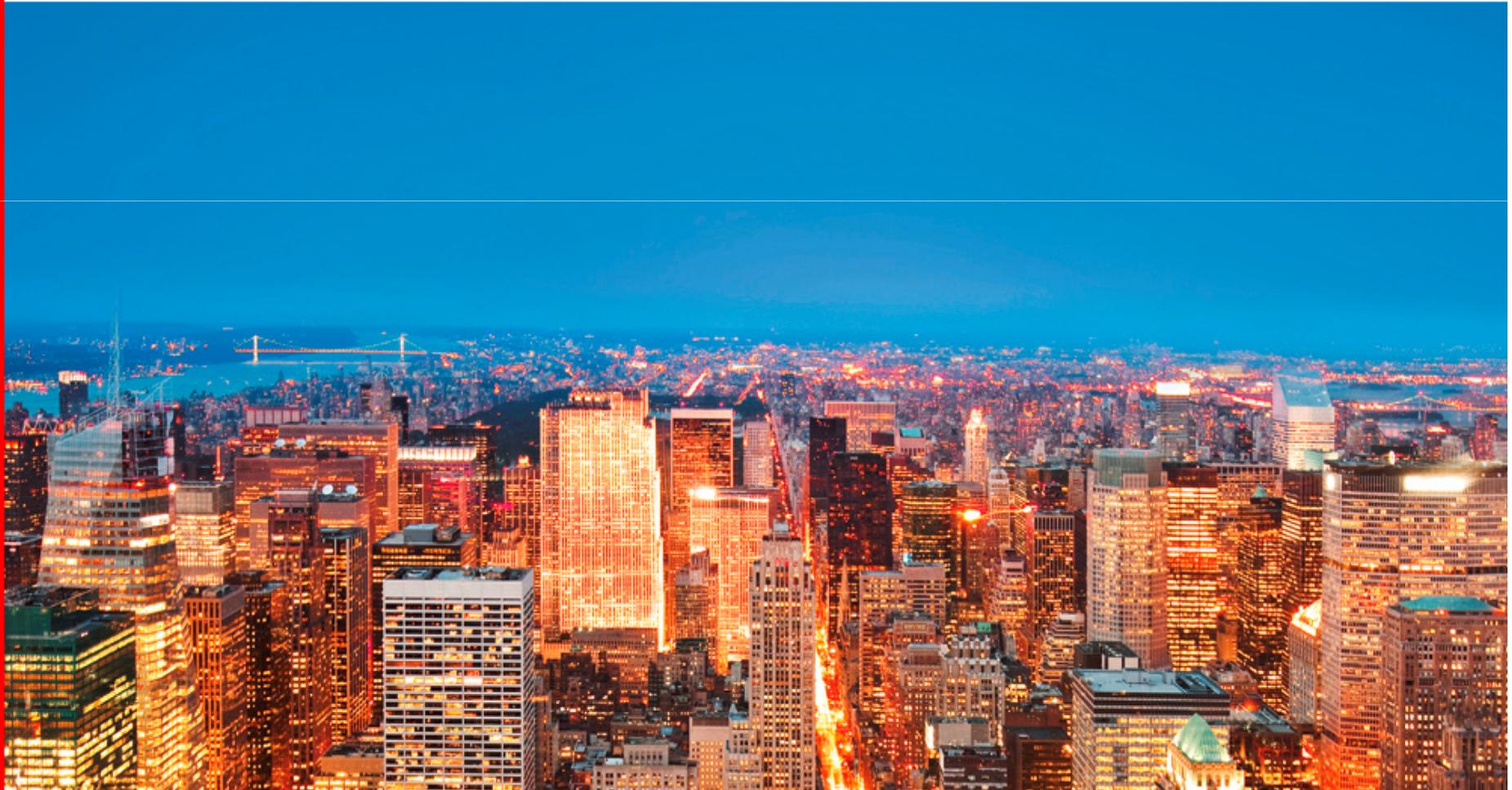


XIV. Szigetelésdiagnosztikai Konferencia  
Bambara Hotel – Felsőtárkány (Hungary)

**sebaKMT**  
A member of Megger Group

# Introduction into the Diagnostic World of Standards

## IEEE 400™ Series & VDE Recommendation





Power Networks



Communication Networks



Water Networks



TV Inspection of Sewers



Line and Object Location

**IEEE 400™ Series**

**VDE Recommendation**

*IEEE 400™ Series*

VDE Recommendation

- Institute of *Electrical & Electronics Engineers* (*IEEE*)
- *Professional association* founded on 1<sup>st</sup> of January in *1963* & with its corporate office in New York City & operations center in Piscataway (New Jersey)
- Today:  
*World's largest association of technical professionals* with more than *429,000 members* in chapters around the world



The world`s largest professional association for the advancement  
of technology

Source: [www.IEEE.com](http://www.IEEE.com)

### IEEE 400-2012™

*“Field Testing & Evaluation of the Insulation of Shielded Power Cable Systems Rated 5 kV & above”*

- Various *field test methods* currently available or under development
- Covers shielded, insulated power cable systems rated 5 kV & above

### IEEE 400.1-2007™

*“Field Testing of Laminated Dielectric, Shielded Power Cable Systems Rated 5 kV & above with High Direct Current Voltage”*

- Includes recommended practices & procedures for direct voltage acceptance & maintenance testing of shielded, laminated dielectric insulated power cable systems rated 5 kV & above
- Applies to all types of laminated power cable systems such as paper insulated, lead covered, pipe-type & pressurized cables

### IEEE 400.2-2013™

*“Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF)”*

- Very low frequency (**VLF**) withstand & **Diagnostic Tests**
- Measurements performed in the field on shielded power cable systems

### IEEE 400.3-2006™

*“Partial Discharge Testing of Shielded Power Cable Systems in a Field Environment “*

- **Diagnostic Testing** of **new or service-aged** installed shielded power cable systems, which include cable, joints, and terminations, using **Partial Discharge** (PD) detection, measurement & location

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## 5.5 Partial discharge (PD) test with VLF sinusoidal waveform

### NOTE

- This subclause describes the *Partial Discharge* test with *VLF Sinusoidal* waveform *ONLY*
- *Partial Discharge Testing* is covered in detail in *IEEE Std 400.3*
- *VLF-PD tests* should be performed according to *IEEE Std 400.3*



### 5.5.1 Measurement and equipment

### 5.5.2 Method

### 5.5.3 Advantages

### 5.5.4 Disadvantages

## ■ 6. Voltage sources

The purpose of the test voltage is to produce partial discharges at locations where there are defects in the cable, terminations & splices

### 6.1 Sinusoidal Power-Frequency Voltage Sources

#### 6.1.1 Frequency Tuned Resonant Circuits (FTRC)

#### 6.1.2 Inductively Tuned Resonant Circuits (ITRC)

### 6.2 Alternative Voltage Sources

#### 6.2.1 Very Low Frequency Voltage (VLF)

#### 6.2.2 Damped Alternating Voltage

#### 6.2.3 Impulse Voltage

- IEEE Draft Guide for *Field-Testing of Shielded Power Cable* Systems Rated *5 kV & above* with *Damped Alternating Current Voltage*
- Working Group WG F05 of the IEEE Insulated Conductors Committee
- Status quo: October 2013
- Purpose of this guide:
  - ➔ Provide uniform practices & *procedures* for performing *DAC* off-line tests on installed shielded power cable systems in the field
  - ➔ Provide *guidelines for evaluation* of the test results
  - ➔ Presents the practices & procedures for testing & diagnosis of shielded power cable systems rated 5 kV & above using DAC
  - ➔ Applies to *all types of power cable* systems that are intended for the transmission or distribution of electric power

- **5. Damped AC Testing**
  - 5.1 General
  - 5.2 Types of Damped AC Voltage Testing
- **6. Damped AC Test Circuit & Parameters**
  - 6.1 DAC Test Voltage Circuit
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  - 7.1 General
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  - 7.3 DAC Evaluation Criteria
- **8. Partial Discharges (PD) Measurement Using DAC**
  - 8.1 General
  - 8.2 PD Parameters
  - 8.3 PD Evaluation Criteria
- **9. Dissipation Factor ( $\tan \delta$ ) Estimation Using DAC**

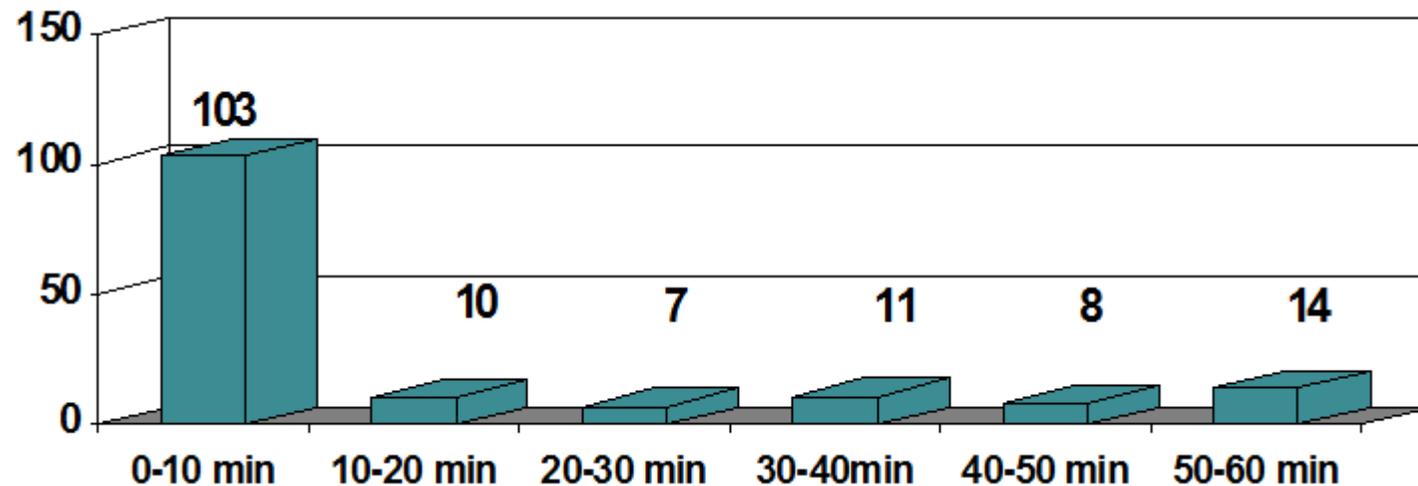
IEEE 400™ Series

***VDE Recommendation***

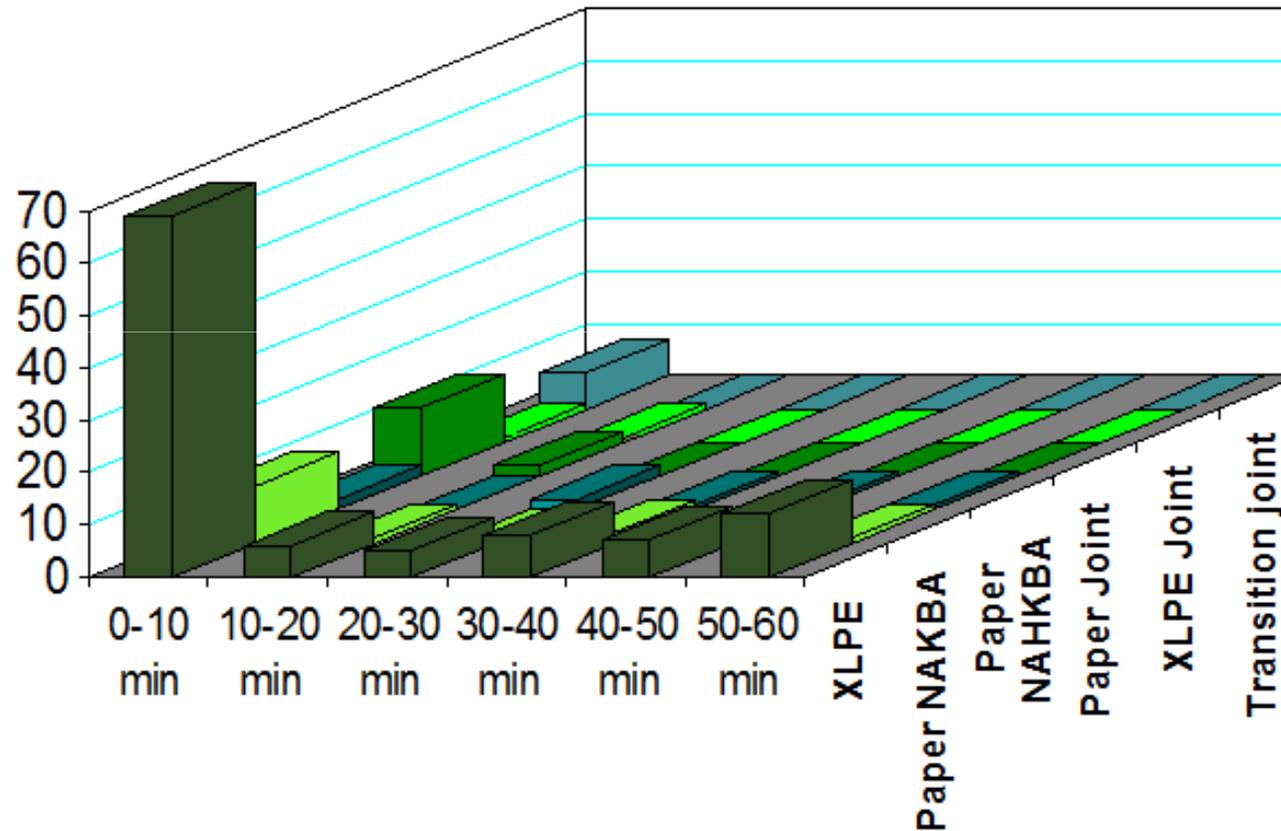
### “Dortmunder Energie und Wasser” - Experience Report

#### ■ Distribution of Cable Faults over Time:

- ➔ **66%** Faults occurred in first **10 min**
- ➔ **75%** Faults occurred in first **30 min**
- ➔ **25%** Faults occurred in **last half an hour**



## “Dortmunder Energie und Wasser” - Experience Report



- In Germany recently a recommendation has been published
  - ➔ „**VDE Recommendation for commissioning testing of MV cables**“  
(Nov 2011)
  - ➔ Describes PD diagnosis as an **important test** for commissioning testing

### **VDE** Dresden

- Members of this working group were specialists of:
  - ➔ **18 Power Utilities**
  - ➔ **4 Universities**
  - ➔ **4 Service providers for testing and diagnosis**
  - ➔ **1 Armature manufacturer**
  - ➔ **1 Cable consulting company**
  - ➔ **4 Manufacturers of PD measuring systems**

### Recommendation VDE

- Experiences of 20 years commissioning tests with **0,1 Hz VLF** test voltage indicate, that by a voltage test, **only the very serious installation errors are detected**
- There is a **large variety of installation errors**, which pass the commissioning tests, and **fail only after several years of operation**
- **Target**
  - ➔ Fulfillment of the **statutory requirements** of the Operation Safety Act, **DIN VDE 0105** in respect to the commissioning test of new installed resp. modified electrical systems.
  - ➔ Quality control of new installed armatures by PD testing
  - ➔ Gaining of information for the condition assessment of cable systems

## 1. Cable Sheath testing

### ■ Table 1: Test voltage levels and requirements

Sheath Material	PE	PVC
Identification	2Y	Y
Cable types (examples)	NA2XS(F)2Y	NA2XSY
Test voltage type	DC	DC
Test voltage level	< 5 kV	< 3 kV
Test duration	< 5 min	< 5 min
Typical leakage current	< 100 $\mu$ A/km	< 800 $\mu$ A/km @ 3 kV

### 2 Testing of the cable insulation after new installation of pure XLPE Cables

- **Field test statistics** indicated that **test faults appear within 15 to 30 minutes of operation**
- Test durations of **60 minutes** produced **no additional information or results**
  - ➔ Therefore: **test duration of 30 minutes** is considered as **sufficient**
- **Significant amount of the faults**, that are probably **not detected** during the voltage tests can be detected & **localized by an additional partial discharge measurement.**

### 3. Partial discharge measurements for commissioning tests

- **PD Measurement allows to control:**
  - ➡ Cable quality
  - ➡ Condition of the complete system installation
  - ➡ Potential fault spots can be detected early
  - ➡ Evaluation of the system & budgeting of the required investments can be made
  
- **A fundamental rule:** PD occurring at  $U_0$  indicate a high risk for operating faults
  
- **PD test systems with the following voltages are available:**
  - ➡ 0,1 Hz VLF (Very Low Frequency)
  - ➡ 20 – 300 Hz AC
  - ➡ 100 – 500 Hz DAC



## Köszönöm a figyelmet!

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