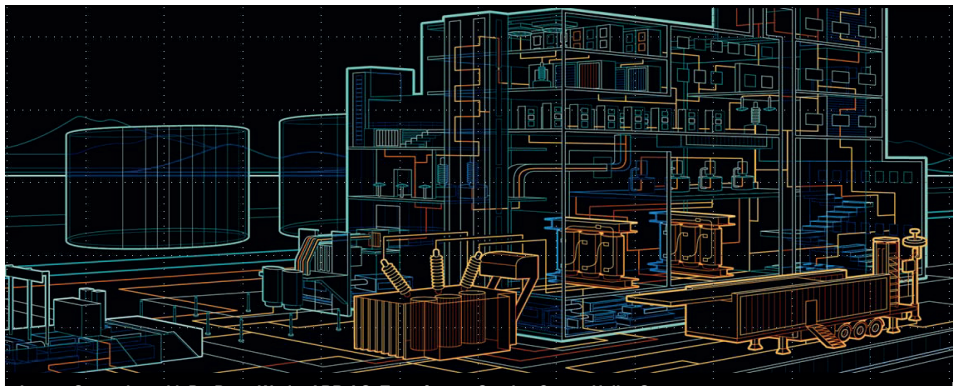
High Voltage Testing on Transformers On Site

Peter Werle
ABB Transformer Service

Dr.-Ing. Peter Werle has studied Electrical Engineering at the University of Hannover, where he afterwards received his Dr.-Ing. degree at the Schering-Institute for High Voltage Technique and Engineering.

Since 2003 he is with ABB AG, Transformer Service in Halle, Germany, where he has hold different national and international positions. Since 2010 he is the general manager of the Transformer Service Workshop in Halle with more than 200 employees. He is member of VDE, IEEE, DKE K 182 insulation liquids and CIGRÉ as liason officer A2 - IEC TC 10 and active in different working Groups. He is the author or co-author of more than 100 publications and owner of more than 20 patents in Asset Management, Diagnostic Methods, Monitoring and High Voltage Testing.

High Voltage Testing on Transformers On Site



Janusz Szczechowski, Dr. Peter Werle, ABB AG, Transformer Service Center Halle, Germany

Transformer Life Management 2014

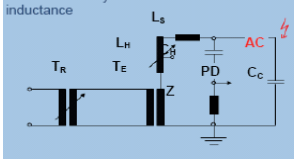
High Voltage Testing on Transformers on-site

Power and productivity for a better world™

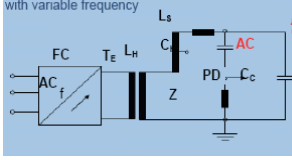
High Voltage Tests On-Site

- **Single phase tests on GIS and Cables**
  - **Before Commissioning**
  - **After Repair / Overhaul**

ACRL
Resonant test system with tuned inductance



ACRF
Resonant test system with variable frequency



High Voltage Testing on Transformers On Site

High Voltage Test on Power Transformers On-Site

- **Tendency: Increasing demand for HV tests on-site - TrafoSiteTesting™**

New Transformers, after transportation, before commissioning

After a certain incident – failure, sc. etc.

Old transformers in a new environment (spares in NPP)

After a repair on-site TrafoSiteRepair™

TrafoSiteTesting™ – Why ?

- **After Transportation, before commissioning**

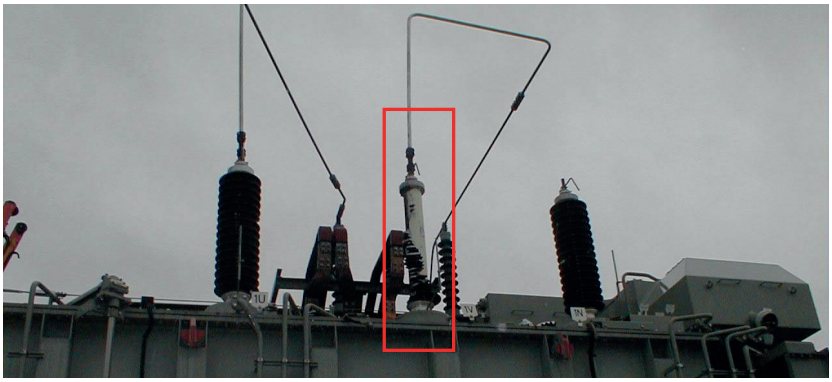
High Voltage Testing on Transformers On Site

TrafoSiteTesting™ – Why ?

- **After Transportation, before commissioning**

TrafoSiteTesting™ – Why ?

- **For diagnostic purposes after an incident**
  - **In case of a failure/breakdown/damage**



High Voltage Testing on Transformers On Site

TrafoSiteTesting™ – Why ?

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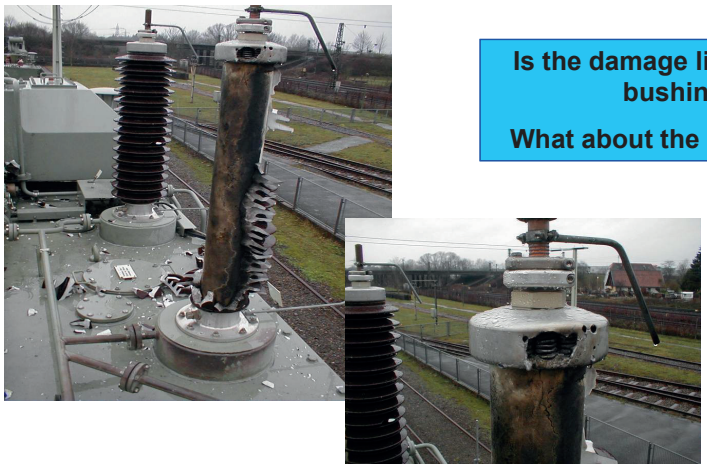

Is the damage limited to the bushing ?

What about the active part ?

TrafoSiteTesting™ after TrafoSiteRepair™

- After a repair/power upgrade on-site a FAT is necessary to verify the quality of the measure
  - Similar to a FAT after a repair in the workshop
- TrafoSiteRepair – Why ?
  - No risky transportation
  - Only possibility if transformer can not be transported to a factory
    - Rails do not longer exists
    - Roads are not longer useable
    - Bridges are not longer stable enough
  - Shorter outage time – no transportation needed
    - Shorten time of penalty for non delivering power
  - E.g cheaper – save costs for transportation

High Voltage Testing on Transformers On Site

TrafoSiteRepair™ – Economical Aspects

- 6 single phase GSU + 1 spare are installed in a NPP
- All transformers need new windings
  - Beside the savings in comparison to a new transformer (core reuse), there are no transportation costs

Transportation costs per GSU: 300k€ !

Total savings avoiding transportation costs: 2 Million Euro !

TrafoSiteRepair™

On-site Repair Categories	
Environmental Condition	**Available Facilities**
Category A Workshop with appropriate cleanness	**Category 1** Crane, oil conditioning system, drying systems High Voltage test possibilities
Category B Simple hall	**Category 2** Crane, oil conditioning system , drying systems
Category C No hall, but area with stable base plate / foundation	**Category 3** Crane available
Category D Free area	**Category 4** Power supply

Increasing Complexity

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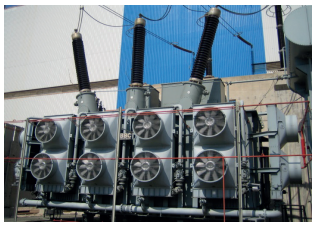

420kV / 520 MVA

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230kV / 50MVAr Reactor

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High Voltage Testing on Transformers On Site

TrafoSiteRepair™ – 400MVA Transformer

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HV Mobile Test Systems

- **Requirements**

HV Test to be performed

Easy to transport

Compactness

Low Costs

Mechanical Stability, Maintenance free

Easy Handling

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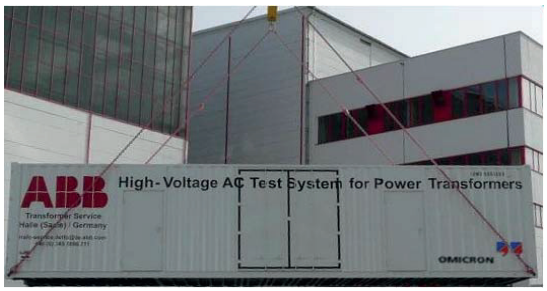
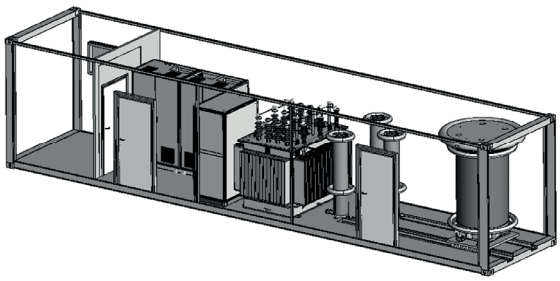
High Voltage Testing on Transformers On Site

TrafoSiteTesting™

- Realisation
  - 2006 - Worldwide first three phase HV-Mobile Test System for power transformer based on SFC in a 40” container
  - Today – most powerful system on the market
    - 2006: 450kW
    - 2008: 1.35MW / 2MVA





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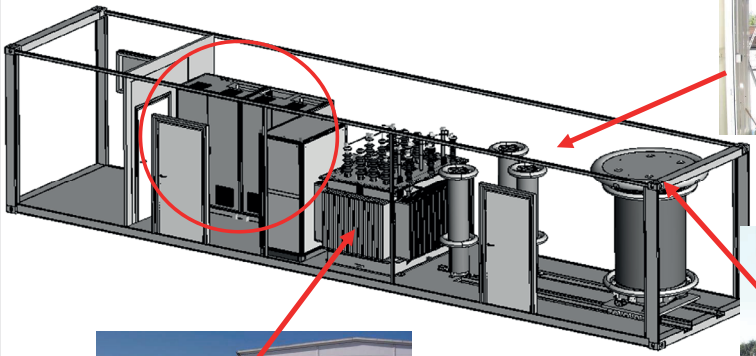
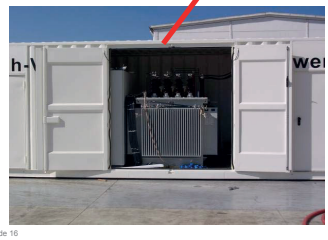
TrafoSiteTesting™

- Realization





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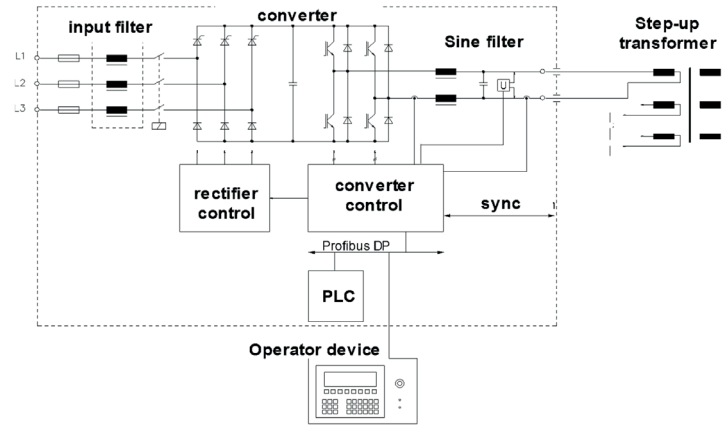
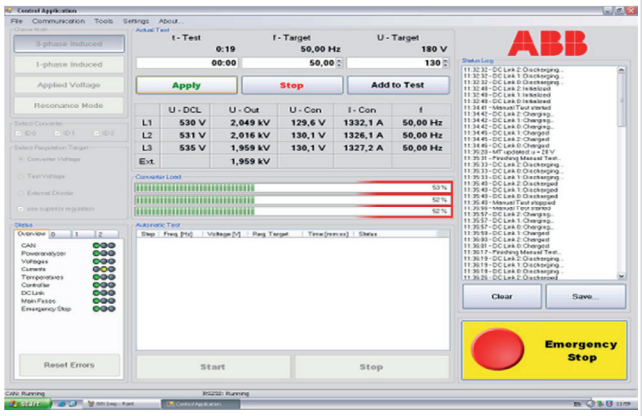


TrafoSiteTesting™



High Voltage Testing on Transformers On Site

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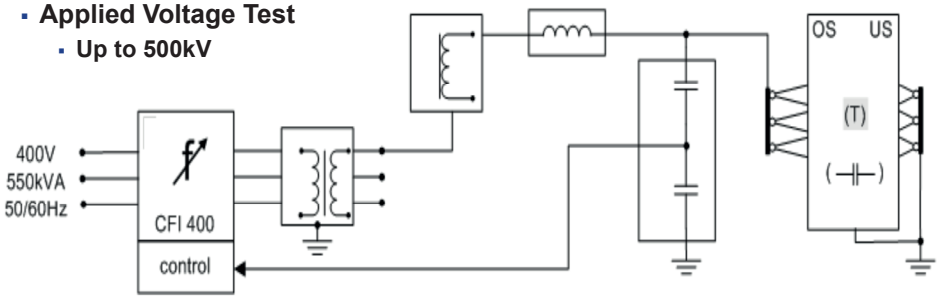
TrafoSiteTesting™

- **Applied Voltage Test**
  - **Up to 500kV**



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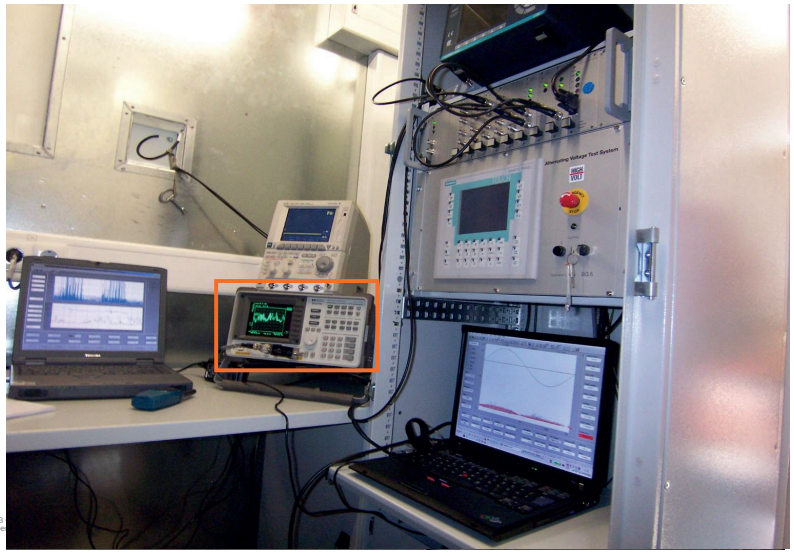
High Voltage Testing on Transformers On Site

TrafoSiteTesting™ - Examples

- Test 433MVA/400kV Single Phase GSU in a NPP

TrafoSiteTesting™ - Examples

- 400MVA GENERATOR STEP-UP TRANSFORMER
  - Induced Voltage Test with PD - measurement



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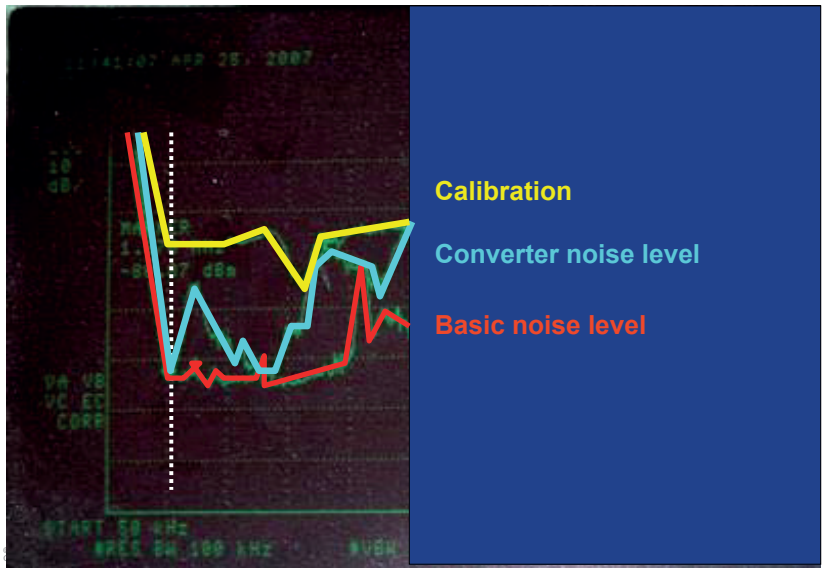
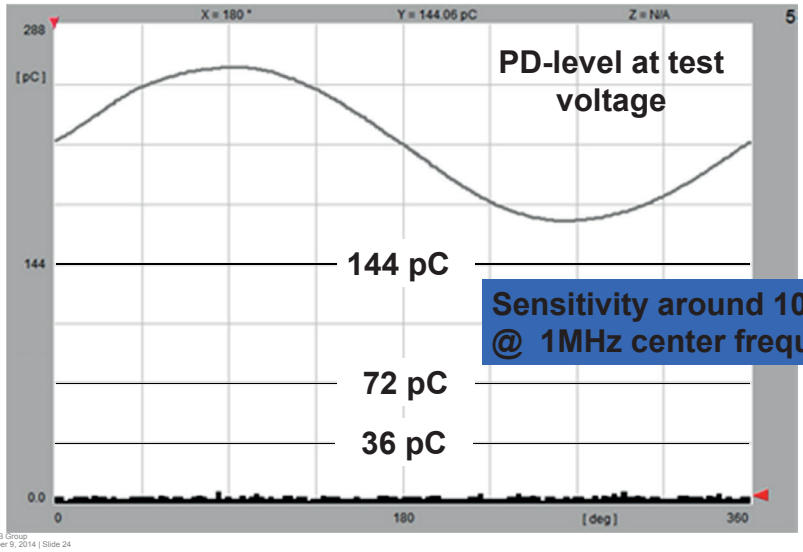
TrafoSiteTesting™ - Examples

- **PD-Measurement**



TrafoSiteTesting™ - Examples

- **PD-measurement - SENSITIVITY**



High Voltage Testing on Transformers On Site

TrafoSiteTesting™
Mobile Impulse Test System

- Are AC tests enough ?
- Not in any case…
  - TrafoSiteRepair™
  - Change of insulation liquid
  - Problems with transients
  - Etc.…

- Charging Voltage 2MV
- LI - 1.8MV
- SI - 1.3MV
- Energy 300kJ

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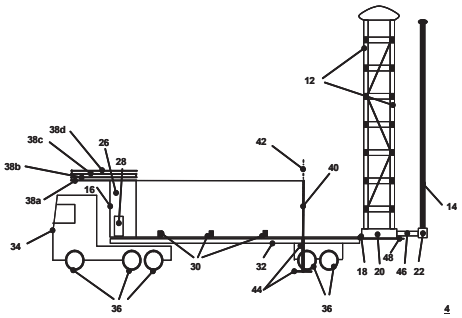

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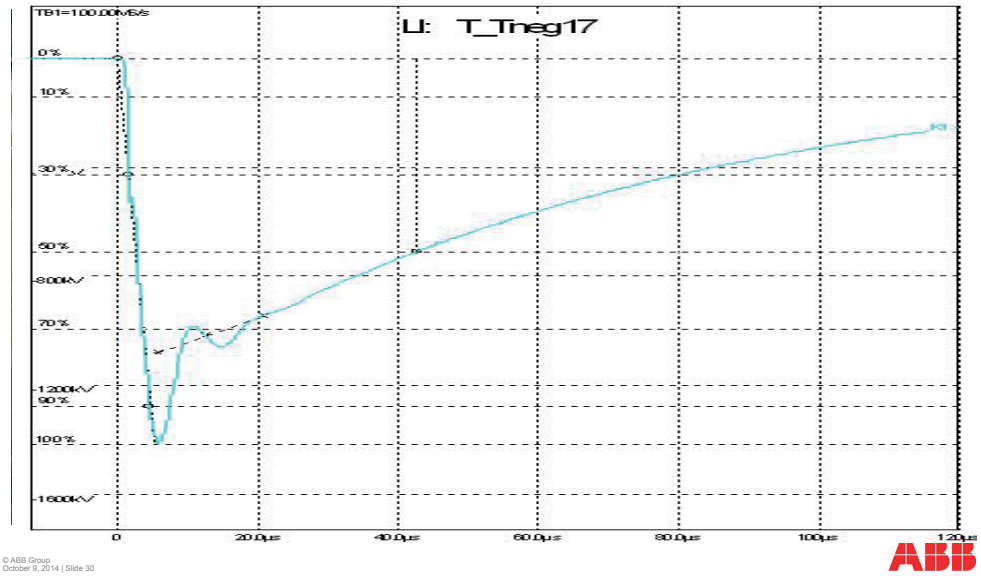

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High Voltage Testing on Transformers On Site

Conclusion and Outlook

- HV Test on-site on power transformers become more an more important
  - Different reasons – especially the number of on-site repairs is increasing
- Requirements concerning the HV tests to be performed on-site are increasing
  - CIGRE A2-34 work on a recommendation
  - Today: Induced and applied voltage tests
  - Short-term: Impulse tests
  - Long-term: Heat run test on-site
- New HV mobile test systems from ABB made in Germany fulfill even strong requirements and can be bought or rented for performing these tests
- Outlook: In the future the old MG-sets installed in HV test labs will be replaced by frequency converter technique – Halle is working on a 5MW / 12MVA system which will be ready end of 2010

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