



**TRANSFORMER-LIFE-MANAGEMENT
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Asset Management of Transformer fleets - An Overview

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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.





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Asset Management of Transformer fleets - An Overview

**Asset Management of Transformer Fleets
An Overview**

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Introduction

Transformer failures can lead to serious damages

- **Condition assessment is highly important**
 - In order to avoid outages
 - In order to spent the maintenance budget for the right transformers

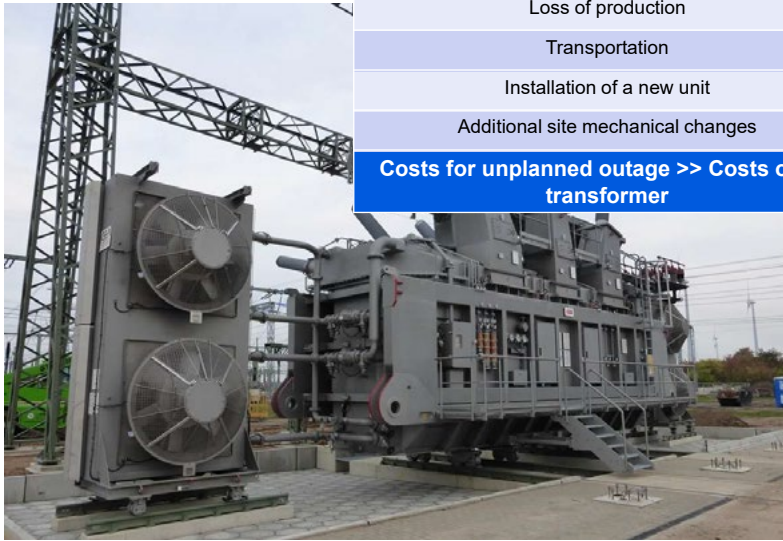




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Transformer Outages Costs of outages



What are costs of an unplanned outage?

Environmental impact

Loss of production

Transportation

Installation of a new unit

Additional site mechanical changes

Costs for unplanned outage >> Costs of the transformer

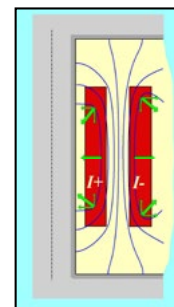


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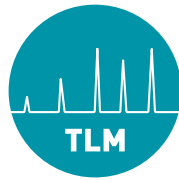
Transformer Fleets Typical Situation

- Majority of assets are > 30 years old
- Limited maintenance
- Assets have varied loading
 - Changing stresses
 - Mechanical
 - Thermal
 - Dielectric
- Spare reliability not always known
- High reliability must be maintained
- Need to make best use of the capital & resources



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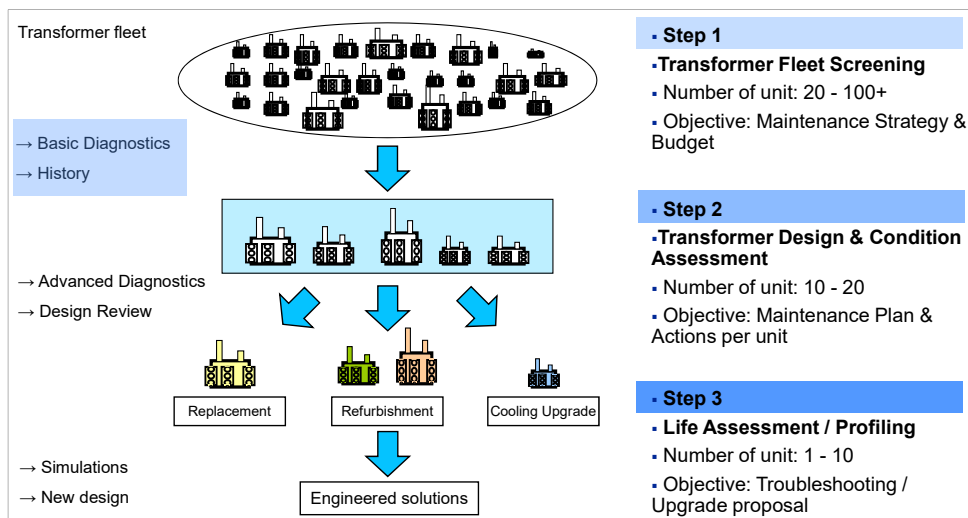




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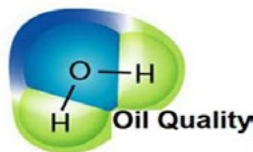
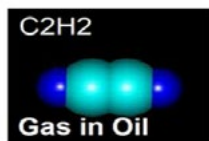
**Mature Transformer Condition Assessment (MTMP™)
Three steps approach**



**Condition Assessment
Basic Diagnostic**



Name Plate, Maintenance, Repairs, Overhauls, Faults

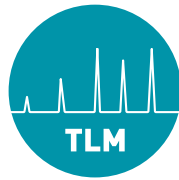


**Visuell
Inspection**



Standard electrical tests – insulation and winding resistance

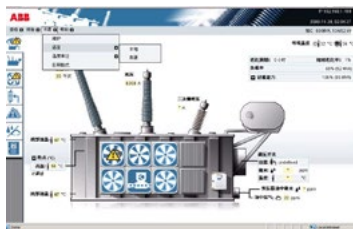




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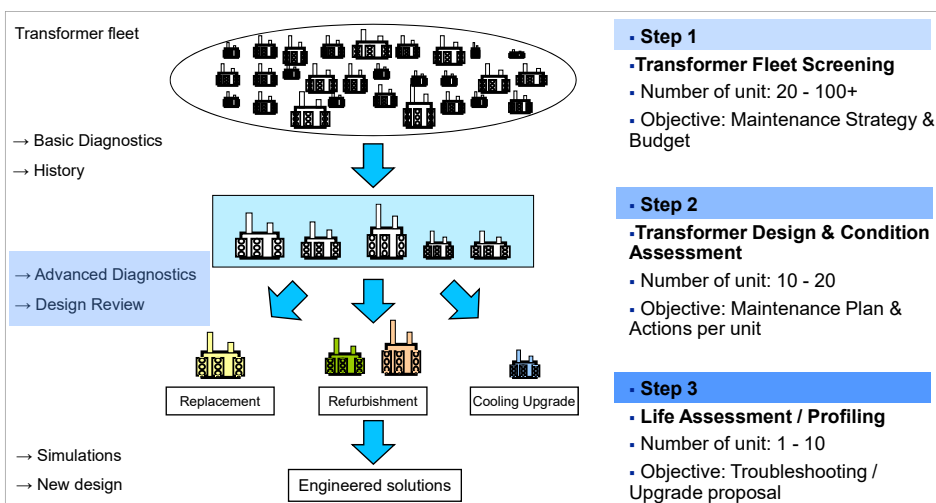
**Transformer Monitoring
Core-Tec**

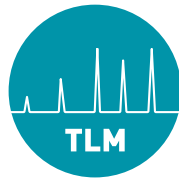


- ABB expertise to turn data into actionable recommendations to operate, maintain and manage transformer assets
- Modular platform to address low to high end applications
- User friendly web interface – no additional software needed on users computer
- Based on a microprocessor and Modular design, possible to add the sensors that the customer requests with additional hardware
- Very strong mechanical stability and temperature endurance => Long lifespan
- Reliable and proven technology (longest serving unit has >15 years in the field)
- Compact and easy to install
- Support for standard communication protocols, including IEC 61850 (certified by SGCC)
- 1'500 installed Worldwide



**Mature Transformer Condition Assessment (MTMP™)
Three steps approach**

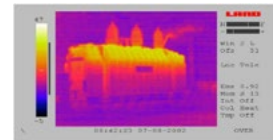
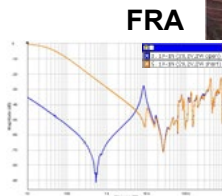
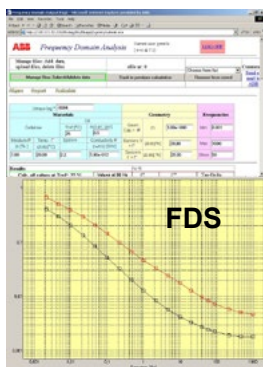




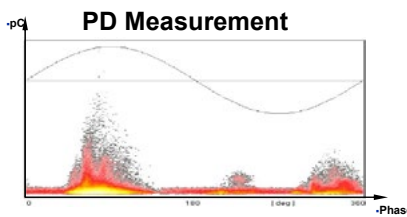
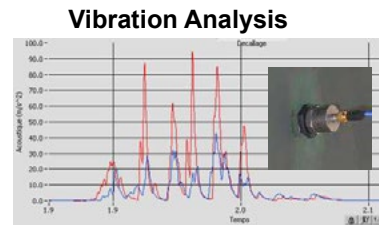
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Condition Assessment Advanced Diagnostic

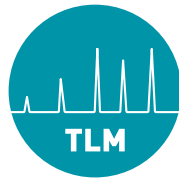


Thermovision-scan



Site Options and Actions Internal inspection





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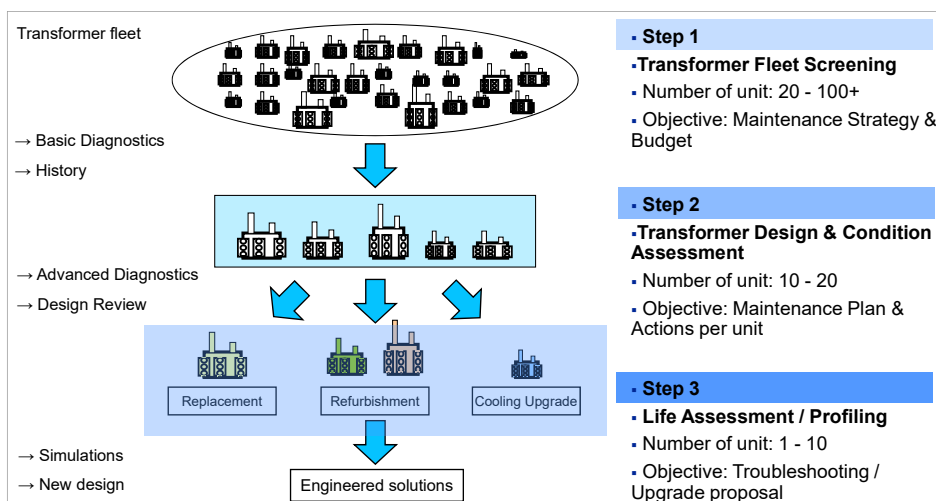
**Active Part Inspection
Patented High Tech**



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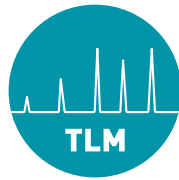


**Mature Transformer Condition Assessment (MTMP™)
Three steps approach**



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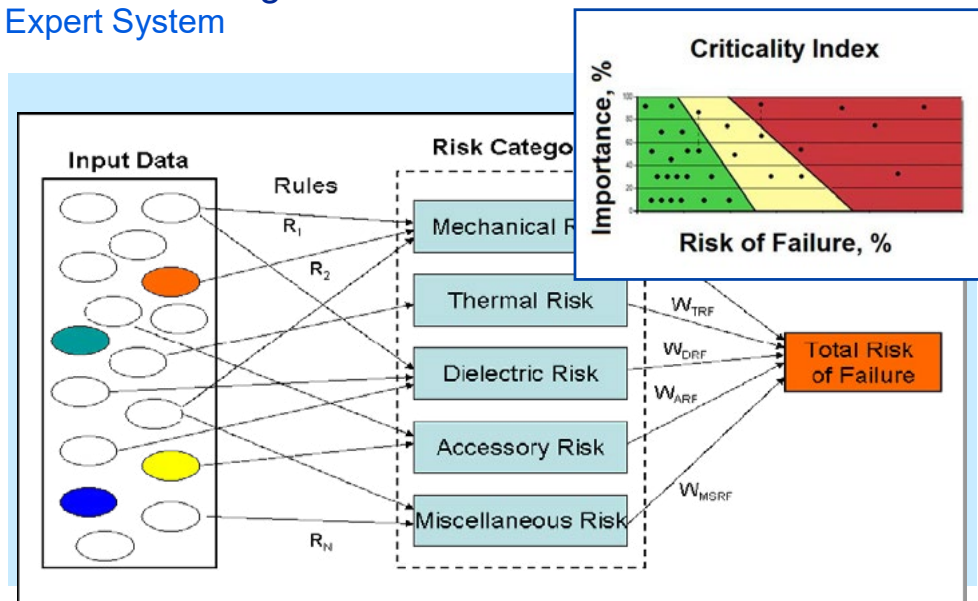




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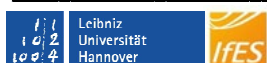
Fleet Screening
Expert System



Mature Transformer Condition Assessment (MTMP™)
Typical output and recommendations

Plant 1 - Results of condition assessment and action plan

	Mechanical	Electrical	Thermal	Accessories	Overall	Risk Mitigation - Actions
TFO 2	Winding	Arcing	Heating		95	Visual Inspection and repair in factory / rewinding
TFO 5	Tank			OLTC heating	80	Repair on site and OLTC overhaul
TFO 1			Aged oil	Bushing	70	Oil regeneration / filtration and advanced diagnosis / change HV bushing
TFO 6		Arcing		Thermometer	50	Exchange TopOil - thermometer / on line monitoring of DGA
TFO 3				Silicagel	40	Exchange Silicagel
TFO 7					25	Standard maintenance actions and controls
TFO 8					15	Standard maintenance actions and controls / 10 % overload capabilities
TFO 4					10	Standard maintenance actions and controls / 15 % overload capabilities





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Recommendations

Site Actions

- Site internal repairs/upgrades
- Cooling and Control Systems upgrade
- Bushing and OLTC Maintenance or replacement

- Oil Reprocessing
- Transformer Active Part Drying
- Biodegradable fluid retro fills



Recommendations

Contingency Planing

What to do in case of a
long repair on-site or
in the workshop ?



ABB response: World's first hybrid insulated 400kV mobile transformer





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Mature Transformer Condition Assessment (MTMP™) Example – US Utility



Customer need:

- Prioritization corrective **actions on a fleet of 128 units**
- Optimize yearly maintenance budget of 1.3 MUSD

ABB response:

- Assessment of the condition and risks of failure with MTMP™
- **Determine the individual risk of failure**
- Proposal for maintenance actions and budget

Customer benefits:

- The maintenance **budget was reduced by 24%** the first year
- The maintenance budget is now spent on the right units, resulting in an increased overall reliability of the fleet at a lower cost:
 - 11 risky units: budget increased from 9% to 25%
 - 47 medium risks: budget increased from 37% to 45%
 - 70 low risks: budget decreased from 54% to 30%

ID	Asset	Condition	Risk	Priority	Cost	Impact
1	1001	Good	Low	Low	1000	Low
2	1002	Good	Low	Low	1000	Low
3	1003	Good	Low	Low	1000	Low
4	1004	Good	Low	Low	1000	Low
5	1005	Good	Low	Low	1000	Low
6	1006	Good	Low	Low	1000	Low
7	1007	Good	Low	Low	1000	Low
8	1008	Good	Low	Low	1000	Low
9	1009	Good	Low	Low	1000	Low
10	1010	Good	Low	Low	1000	Low
11	1011	Good	Low	Low	1000	Low
12	1012	Good	Low	Low	1000	Low
13	1013	Good	Low	Low	1000	Low
14	1014	Good	Low	Low	1000	Low
15	1015	Good	Low	Low	1000	Low
16	1016	Good	Low	Low	1000	Low
17	1017	Good	Low	Low	1000	Low
18	1018	Good	Low	Low	1000	Low
19	1019	Good	Low	Low	1000	Low
20	1020	Good	Low	Low	1000	Low
21	1021	Good	Low	Low	1000	Low
22	1022	Good	Low	Low	1000	Low
23	1023	Good	Low	Low	1000	Low
24	1024	Good	Low	Low	1000	Low
25	1025	Good	Low	Low	1000	Low
26	1026	Good	Low	Low	1000	Low
27	1027	Good	Low	Low	1000	Low
28	1028	Good	Low	Low	1000	Low
29	1029	Good	Low	Low	1000	Low
30	1030	Good	Low	Low	1000	Low
31	1031	Good	Low	Low	1000	Low
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37	1037	Good	Low	Low	1000	Low
38	1038	Good	Low	Low	1000	Low
39	1039	Good	Low	Low	1000	Low
40	1040	Good	Low	Low	1000	Low
41	1041	Good	Low	Low	1000	Low
42	1042	Good	Low	Low	1000	Low
43	1043	Good	Low	Low	1000	Low
44	1044	Good	Low	Low	1000	Low
45	1045	Good	Low	Low	1000	Low
46	1046	Good	Low	Low	1000	Low
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95	1095	Good	Low	Low	1000	Low
96	1096	Good	Low	Low	1000	Low
97	1097	Good	Low	Low	1000	Low
98	1098	Good	Low	Low	1000	Low
99	1099	Good	Low	Low	1000	Low
100	1100	Good	Low	Low	1000	Low



Asset Management Conclusion

- **Asset management strategies need to be based on excellent condition assessment methods**
- **The more precise the condition is known the more efficient actions can be taken**
- **Hightech like robotic applications or on-site testing optimize condition assessment methods and MTMP**
- **ABB offer a variety of technical sophisticated solutions already approved for different fleets**
- **Continuous research and development ensure that condition assessment methods getting better and better leading to optimized asset management strategies**





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