



Transformer Service

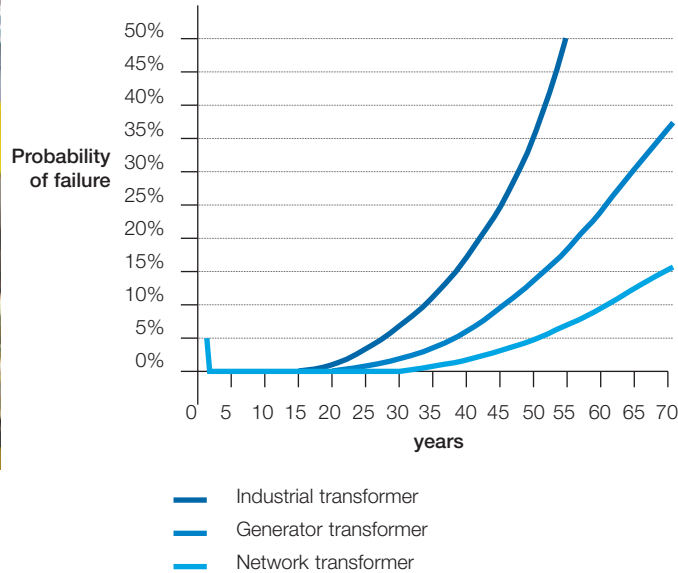
TrafoAsset Management™

ABB's solution for improved reliability and life extension of transformers

The Challenge – old transformer fleet loaded often near physical limits



Probability of failures of installed transformers increase with age*



A large proportion of the worldwide population is nearing the end of its lifetime, and means are urgently required to optimize transformer fleet performance through higher availability.

This has to be achieved at the lowest possible cost and with minimum environmental impact.

Transformers are often situated at strategically critical locations in power supply systems, and as a result the financial consequences of their failure can easily exceed their actual asset value.

The real challenge lies in implementing the right action at the right time. Here, a definite trend has emerged:

Asset managers are moving from Time-Based Maintenance to Condition-Based Maintenance, where decisions are no longer driven by an average timeframe defined by observations and past experience, but instead take into account the actual condition of the equipment and the level of reliability required to fulfil its function.

Given that the age of power transformers and industrial transformers in most countries is high and considering the increase of the typical failure probability with the transformer age, action clearly needs to be taken to ensure their continued reliability and functionality.

ABB – an important supplier of transformer services

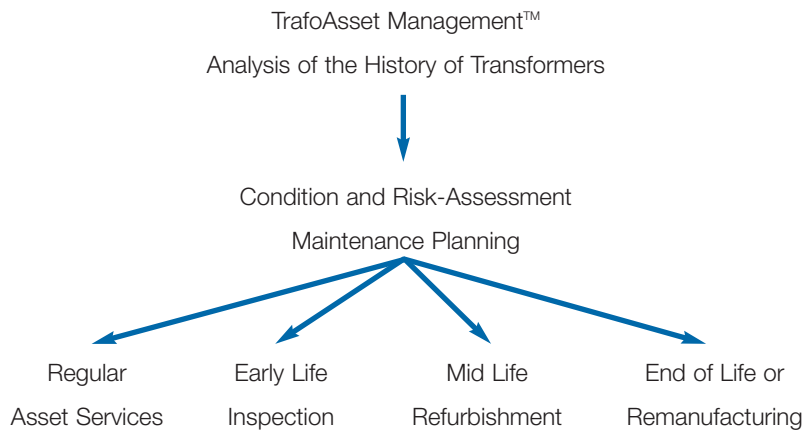
- ABB is the largest player in transformer services and
 - has more than 30 service centers worldwide
 - has more than 1000 service experts
 - benefits from expertise developed in over 50 factories producing new units
 - is backed up by ABB corporate research centers
 - has access to original design and OEM spare parts of more than 30 brands.

ABB family includes brands such as:

- ABB, Ansaldo, ASEA, BBC, Breda, CGE, Elektrisk Bureau, Elta, IEL, GE (>40 MVA), Gould, IEL, Italtrafo, ITE Indelve, Lepper, Marelli, MFO, Moloney, National Industri, Ocren, OEL, OTE, Richard Pfeiffer, Sécheron, Strömberg, Thrige, TIBB, Tyree Westinghouse.

* The probability of failure depends on age, type/intensity of usage as well as on external factors such as environmental conditions and how a transformer is maintained. Source of Failure Rate: CIGRE – International Council on large electric systems

ABB TrafoAsset Management™ is the solution for improved reliability, life extension and reduced outages of transformers



ABB's TrafoAsset Management™ defines and implements Condition Based Management in two pro-active steps:

- Condition and risk assessment to support asset managers decisions
- Four Asset Services Packages to improve the reliability of sick units

Analysis of the history of transformers

The analysis of the history of the transformer – including maintenance, operation, events, strategic importance is the basis for condition and risk-assessments.

Condition and risk-assessment

Condition and risk-assessment defines the maintenance plan based on the evaluation of risk of failure and importance of the transformers:

- transformer design and condition assessment to define the maintenance plan and actions per unit
- transformer life assessment/profiling to define troubleshooting actions/upgrade proposal

Four asset service packages

ABB's four asset service packages are the building blocks of condition based maintenance.

- Regular asset services
- Early life inspection
- Mid life refurbishment
- End of life or remanufacturing for life extension

ABB TrafoAsset Management™ delivers a safe and correct operation of your transformers, ensuring an optimal availability and reliability. By optimizing maintenance, including proactive and preventive, you will extend the lifetime of your transformer while reducing running costs.

Key benefits of ABB's TrafoAsset Management™

- Improved reliability
- Reduced major outages/failures and capital loss
- Life extension
- Heavy capital investments delayed
- Better utilization of maintenance budget (targeting of sick units)
- Increased power output
- Environmental solutions
- Detailed unit-by-unit maintenance plan

ABB TrafoAsset Management™: The Solution for you

Check list to assess your maintenance

What does your transformer fleet look like?

- What size are your transformers?
- What is the age of your transformers?
- How thorough is your maintenance program?
- When did you last have complete diagnostics?
- What is the cost of an outage?
- What is your process if a failure occurred - who would you call?

What is the overall condition of your transformer fleet?

- What are the most common failures?
- Do you know the condition of your transformers?
- Do you forecast and budget the transformer maintenance?
- How do you plan your maintenance work? (time based/condition based)
- Who carries out the maintenance and repair of the transformers?

Assess the following:

- Are there problems with on load tap changers?
- Is there a spare transformer?
- What is the condition and maintenance of the spare transformer?
- Is there a need for spare parts onsite?
- Are there any old water coolers?
- What is the situation regarding rust and leakages?

The solution

ABB's recommended services over the lifetime of a transformer

1. Regular Asset Services

Regular Asset Services

A maintenance package executed regularly, including:

- | | Yes | No |
|---|--------------------------|--------------------------|
| - Visual inspection (yearly) | <input type="checkbox"/> | <input type="checkbox"/> |
| - Dissolved gas and oil analysis at least every 1 - 3 years | <input type="checkbox"/> | <input type="checkbox"/> |
| - Functional check of accessories (yearly) | <input type="checkbox"/> | <input type="checkbox"/> |

2. Early Life Inspection

Early Life Inspection

A maintenance package executed typically in the first third of the lifetime of a transformer, including:

- | | Yes | No |
|---|--------------------------|--------------------------|
| - Visual inspection | <input type="checkbox"/> | <input type="checkbox"/> |
| - Dissolved gas - and oil analysis | <input type="checkbox"/> | <input type="checkbox"/> |
| - Functional check of accessories | <input type="checkbox"/> | <input type="checkbox"/> |
| - Analysis of events, maintenance and operation history | <input type="checkbox"/> | <input type="checkbox"/> |
| - On-load tap changer maintenance and overhaul | <input type="checkbox"/> | <input type="checkbox"/> |

**The lifetime of a transformer depends on type/intensity of usage as well as on external factors such as environmental conditions and how well it is maintained. A typical lifetime of a transformer used in Power Generation is about 30 - 40 years, in a Transmission Network about 40 - 50 years and in industrial applications about 20 - 30 years. Your ABB Service Partner will help you to assess the potential lifetime for your transformers.



Proposed Actions

Assess the status of your assets

- Applicable to fleet or specific transformers

Features

- Evaluate condition, remaining life time and risk of failure
- Define actions to mitigate the risks
- Modular analysis with 3 steps:
 - Transformer fleet screening
 - Transformer Design and Condition Assessment
 - Transformer Life Assessment/Profiling

Benefits

- Provide more visibility and “predictability” to the Asset Manager
- Decide on preventive maintenance actions
- Plan investments - invest in the right units
- Plan maintenance - optimize spending

3. Mid Life Refurbishment

Mid Life Refurbishment

Extensive overhaul of a transformer to extend remaining lifetime and increase reliability, typically performed after half of the expected lifetime:

	Yes	No
- Visual inspection of active part of transformer	<input type="checkbox"/>	<input type="checkbox"/>
- Dissolved gas and oil analysis	<input type="checkbox"/>	<input type="checkbox"/>
- Analysis of events, and maintenance and operation history	<input type="checkbox"/>	<input type="checkbox"/>
- Oil regeneration and drying	<input type="checkbox"/>	<input type="checkbox"/>
- Transformer and active part drying using hot oil spray or LFH process	<input type="checkbox"/>	<input type="checkbox"/>
- Advanced diagnostics to check mechanical, thermal and electrical condition	<input type="checkbox"/>	<input type="checkbox"/>
- New/refurbished accessories such as onload tap changers, bushings, pumps, temperature sensors, valves, gaskets, water coolers	<input type="checkbox"/>	<input type="checkbox"/>
- Refurbishment of the active part such as cleaning of active part, winding reclamping, connection retightening and new installation parts	<input type="checkbox"/>	<input type="checkbox"/>

Recommended solutions:

1. Regular Asset Services
2. Early Life Inspection
3. Mid Life Refurbishment
4. End of Life or Remanufacturing for Life Extension



4. End of Life or Re-manufacturing for Life Extension

End of Life Remanufacturing/Upgrade

Fixing a unit (failed or still in service but aged) by replacing parts using ABB's latest technology and new/refurbished material and accessories:

	Yes	No
- Remanufacturing: Higher reliability and efficiency are expected while keeping the same technical specification: nominal MVA and kV	<input type="checkbox"/>	<input type="checkbox"/>
- Upgrade: Higher reliability and efficiency are expected as well as higher MVA or overload capability and different kV	<input type="checkbox"/>	<input type="checkbox"/>
- Environmental upgrade: higher fire point, noise reduction	<input type="checkbox"/>	<input type="checkbox"/>
- TrafoSite Repair™	<input type="checkbox"/>	<input type="checkbox"/>



Transformer**

Mid Life Refurbishment

End of Life or Re-manufacturing for Life Extension

TrafoAsset Management™ – ABB’s recommended pro-active services

The following activities and intervals are indicative and should be applied depending on application, intensity, environmental and condition of the equipment

	1st year operation		1 month	+ 1 years	+ 5 years	+ 10 years	+ 20 years	Relocation
	1/2 year	1 year ⁽¹⁾						
1. General								
1.1 – Visual inspection (painting, corrosion...)				M				
1.2 – Oil temp (with max. recording)	M		M					
1.3 – Winding temp (with max. recording)	M		M					
1.4 – Currents HV, LV (with max. recording)	M		M					
1.5 – Voltages VH, LV (with max. recording)	M		M					
2. Oil								
2.1 – Water in oil evolution		M		M				M
2.2 – DGA ⁽¹⁾ , physical-chemical	M			M				M
2.3 – Leakages, levels		M		M				M
2.4 – Filtering and degassing						M		M
2.5 – Drying and reconditioning/reclaiming							M	M
3. Active part assessment								
3.1 – Mechanical integrity						M		M
3.2 – Dielectric integrity						M		M
3.3 – Core integrity						M		M
3.4 – Internal inspection							M	
3.5 – Retightening							M	
4. Components								
4.1 – Core				M				M
4.2 – HV, LV bushings ⁽¹⁾				M				M
4.3 – O-rings, joints				M		M		M
4.4 – De-energized tap changer (DETC)								
4.4.1 – Visual inspection		M		M				M
4.4.2 – Internal verification					M		R	
4.5 – On load tap changer (OLTC) ⁽¹⁾								
4.5.1 – Visual inspection		M		M				M
4.5.2 – Internal verification ⁽²⁾					M		R	
4.6 – OLTC drive								
4.6.1 – Visual inspection		M		M				
4.6.2 – Internal verification					M		R	M
4.7 – Oil Pumps				M			R	M
4.8 – Coolers/Heat Exchangers				M				M
4.9 – Ambient temp	M		M					M
5. Accessories								
5.1 – Gas Relay, overpressure		M		M			R	M
5.2 – Desiccant		M		M			R	M
5.3 – Thermometers		M		M			R	M
5.4 – Valves		M		M			R	M
5.5 – Control cubicle		M		M			R	M
5.6 – Expansion tank		M		M			R	M

(*) Intermediate inspection (6 months) on critical units (GSU, Industrial, reactors...)

(**) Depends on model and operating life

Notes

(1) On-line monitoring possibility

M = Maintenance & Diagnostic; R = Replacement

Mid-life Refurbishment / Factory / TrafoSiteRepair™

Off line - Disconnected

Off line - Connected

On line



TrafoAsset Management™ – the service product portfolio



Engineering Solutions

ABB's Engineering Solutions provides a new level of "intelligent" services improving the performance, availability, efficiency, and predictability of a transformer fleet or single unit. Diagnostic testing, on-line monitoring, condition assessment, innovative solutions that meet environmental conditions, training courses and engineering and consulting services all form an integral part of our portfolio, supporting the needs of our various customers. Knowing the condition of a transformer fleet or unit is the key to success for an optimal maintenance program.

Factory Remanufacturing/Repair

ABB provides performance improvement and increased value to existing equipment due to full technical restoration, modernization and complete component check. ABB also has an effective service network across its range of transformer factories and dedicated facilities. Repairing a transformer, instead of replacing it, can in certain cases lower capital maintenance costs dramatically and provide quicker turnaround than buying new.

TrafoSiteRepair™

Power transformer factories and workshops are characterized by their orderliness, cleanliness, heavy lifting equipment, special tools and fixtures, specialist experienced teams in each process area, drying facilities and test bays. The ABB TrafoSiteRepair™ brings each of these capabilities to site and is tailored to meet the individual circumstances of each case. Combining more than 700 years of transformer manufacturing experience, TrafoSiteRepair™ is often the best solution when time or transport presents challenges due to expense, time and complexity.

TrafoSiteTesting™

ABB's latest development is a Mobile High-Voltage Test System or On-Site Testing of Power Transformers. Worldwide, it is the first 3-phase Mobile High-Voltage Test System for Power Transformers based on a static frequency converter which is especially designed for performing routine and special tests according to standards as IEC 60060-3, IEC 60076 and IEEE Std. C57.12.00.

Field Service

ABB provides condition enhancement, on site refurbishment, supply of original spare parts, tap changer rework, logistics and transportation 24 hours a day to guarantee the maximum availability of the installation. ABB are also your partner in the planning phase. Our professional management of the processes and site activity support you in finding the optimal solution. ABB offers: identification and traceability of equipment, periodic status assessment, condition based maintenance, repair and performance improvement, asset optimization, outdated material recycling and user training.

Advanced Field Service

LFH - ABB's Low Frequency Heat drying method heats a transformer core with an electrical pulse, creating a vapor action that effectively pushes moisture from the insulation into the oil, extending the life time of a transformer by 33% compared to conventional drying.

Oil reclaiming - Water, acids and sludge are the oxidation products that cause the most concern for oil ageing. Reclaiming of transformer oil restores the oil properties to very near those of new oil.

Spare Parts

Having critical parts on hand can significantly reduce the downtime associated with transformer maintenance and failure. Some of these parts can be purchased quickly off-the-shelf from the manufacturer. ABB has access to the original design documents for the impressive number of transformers installed worldwide, which belong to the ABB family.

ABB's 1000 service experts offer you the industry's broadest service portfolio worldwide

Reference Cases

Condition Assessment and On-line Monitoring Reference – Aluminium Smelter



Customer Needs

- Increase aluminium production by 10 %
- Ensure that the eight 20-year old industrial rectifier transformers are able to handle the new operating conditions.

ABB's Response

- Power increase feasibility study
- Condition/Life and Risk assessments including action plan
- Revision/Repair at site
- Supply, Installation and Commissioning of an On-line Monitoring system
- Quarterly report to the customer and interpretation of the monitoring data with an action plan

Customer Benefit

- The customer increased the production of aluminium with their old transformers without any loss of production

Risk-of-failure assessment study Reference – Transmission Utility



Customer Needs

- Determine the risk of failure of transformers in the entire fleet
- Prioritization of follow-up corrective actions
- Optimize yearly maintenance budget of 1280 kUSD

ABB's Response

- Assessment of risks of failure and Importance of transformers
- Proposal for maintenance actions and budget

Customer Benefits

- ABB optimized solution provides 1st year (24%) savings = 306'000 USD
- Maintenance budget spent on correct units resulting in increased overall reliability of the fleet

Distribution of Maintenance Budget (MB):

Units	Before ABB Study	After ABB Study
11 High Risk Transformers	110 kUSD = 9% of MB	245 kUSD = 25% of MB
47 Med Risk Transformers	470 kUSD = 37%	434 kUSD = 45%
70 Low Risk Transformers	700 kUSD = 54%	294 kUSD = 30%
Total: 188 Transformers	Total Maintenance Budget: 1,280 kUSD	Total Maintenance: Budget: 973 kUSD

Mid Life Refurbishment Reference – Pump Station



Customer Needs

- A new lease of life
- Minimum down time
- Quick response
- Life extension

ABB's Response

- Extensive workshop facilities including:
 - vapour phase dry-out
 - High end process and testing
 - World class work quality

Customer Benefits

- Short lead time
- Deferred capital investment
- Reduced maintenance costs
- Updated components
- Increased reliability
- Reduced risks
- Improved environmental effects

Remanufacturing/Upgrade Reference – Utility Brazil



Customer Needs

- Needed more power and overload capability on a 26 year old, 15 MVA ONAF/145 kV transformer
- Same footprint to limit civil work and save time
- Reduce risk of fire

ABB's Response

- Nomex® insulation on conductors and board
- BioTemp fluid to replace mineral oil

Customer Benefits

- Upgrading to 25 MVA (+66%)
- Overload during 4 hours up to 43 MVA (+70%)
- Biodegradable fluid reduces contamination and clean-up costs in case of oil leaks
- Risk of fire and toxicity of fumes reduced

Contact Us

ABB Ltd. - Transformer Services

Affolternstrasse 44
8050 Zürich
Switzerland

www.abb.com/transformers

© Copyright 2008 ABB. All rights reserved

No part of this publication may be reproduced or transmitted in any form or by means, electronic, mechanical, photocopying, recording or otherwise without prior written permission of ABB.