Transformer asset management – do more with less

Market pressures lead companies to reduce budgets for transformer maintenance and replacement – and ask more from existing assets. The ABB Ability Transformer Intelligence portfolio helps reduce transformer maintenance costs by optimizing transformer asset management and supporting units in service.

With an average age in industrial plants of 30 years and in utilities of 40 years, the world’s transformer fleet is aging – and is incurring associated increasing replacement and repair costs, and risk of failure. The economic pressures of deregulated and competitive markets, and the tendency to overload transformers, only exacerbates matters. Many transformers are now also operated beyond their recommended life span in order to smooth investment peaks.

These conditions make it imperative to adopt life-prolonging measures and to optimize transformer maintenance.

One significant maintenance optimization strategy is to replace simple time-based maintenance that mitigates risk by doing everything, every year, for all transformers, with a more sophisticated condition-based maintenance strategy – i.e., focusing maintenance on high-risk transformers. It is estimated that a life extension of 5 to 15 years can be achieved with properly focused preventive maintenance programs. The ABB Ability Transformer Intelligence portfolio supports this strategy shift by focusing on three elements: monitoring hardware, interpretation software and expert service →1.
The benefits of condition assessment

On a long-term and strategic level, a condition assessment study gives top management a clear picture of the maintenance and renewal investments that are required over the next 20 to 30 years to provide asset reliability and availability. This type of insight provides solid information to compare different asset management strategies and choose the approach that best supports the overall technical and financial strategy of the company.

In the medium term, a condition assessment gives asset managers the input necessary to make the best use of maintenance or replacement budgets. Funds can be allocated to units that show the best return on investment while reducing technical and environmental operation risks.

Abb offers transformer monitoring systems that help reduce repair, maintenance and running costs.

Key parameter monitoring gives early warning of faults developing in the main tank or accessories, allowing an operator to evaluate the severity of the situation.

Early warnings

- Mechanical faults
  - Short circuit
  - Winding displacement
  - Winding looseness
- Electrical faults
  - Partial discharge
  - Overvoltage through faults
  - Arcing
- Thermal faults
  - Cooling issues
  - Insulation aging
  - Overloading
  - Overheating (eg. improper connection)

Monitored parameters:

- Main Tank
- Accessories
- Mechanical faults
- Electrical faults
- Thermal faults

- Temperature
- Electrical
- Mechanical
- Chemical

- Early warning
- Short circuit
- Winding displacement
- Winding looseness
- Partial discharge
- Overvoltage through faults
- Arcing
- Cooling issues
- Insulation aging
- Overloading
- Overheating (eg. improper connection)
- Cooling system
- Bushings
- Tap changers
- Oil preservation system
And in the short term, the assessment can tell the maintenance manager how to apply the maintenance actions that secure the asset reliability required.

**Plug and play devices to unlock even more value from the transformer**

A CIGRE study has shown that transformer monitoring can reduce the risk of catastrophic failures by 50 percent [1] and that early problem detection can reduce repair costs by 75 percent and loss of revenue by 60 percent. Furthermore, annual cost savings can amount to 2 percent of the price of a new transformer – i.e., approximately $40,000 to $80,000 [2].

Transformer monitoring, then, makes good financial sense.

Transformer monitoring relies on temperature, electrical, mechanical and chemical sensors →2. ABB offers multiple sensors for these parameters, including the CoreSense™ family for dissolved gas analysis (DGA). CoreSense provides a nonintrusive, maintenance-free and easy-to-install solution that flags a potential fault with hydrogen measurement. Deeper analysis can be performed with the multigas version, the CoreSense M10 →3.
### CoreSense M10 multigas analyzer

The CoreSense M10 utilizes Fourier-transform infrared (FTIR) technology combined with solid-state hydrogen and moisture sensors to measure moisture and nine gases: hydrogen (H₂), methane (CH₄), acetylene (C₂H₂), ethylene (C₂H₄), ethane (C₂H₆), propene (C₃H₆), propane (C₃H₈), carbon monoxide (CO) and carbon dioxide (CO₂). The CoreSense M10 is also provided with a local (ie, non-cloud) version of ABB Ability Ellipse, ABB’s asset management solution.

### Tough and accurate enough for space

The gas-measuring FTIR module in the CoreSense M10 is based on the same ABB technology that is deployed in satellites to analyze greenhouse gases and meteorology in the Earth’s atmosphere. The first unit was launched more than 15 years ago and is still in service today. This technology is sought after for its outstanding reliability, accuracy and stability in harsh environments. In addition, the calibration-free nature of the technology provides significant savings in maintenance and replacement costs.

On earth, ABB’s FTIR is also used in other applications such as refineries, semiconductor factories and chemical plants to measure chemical compounds in liquids because it can meet up to 99 percent reliability and provide stable measurements over extended periods of time, allowing identification of long-term trends.

Applying proven and robust FTIR technology to transformers assures that the DGA sensor is accurate, reliable and calibration-free.

### ABB Ability Ellipse Asset Performance Management

In the context of transformer health management, a major challenge for many industrial and utility customers is to analyze and keep track of the data generated by both online and offline measurements. Often, data exists in isolation and its interpretation relies heavily on transformer experts, many of whom are soon to retire.

ABB’s solution to these issues is ABB Ability Ellipse Asset Performance Management (APM). APM combines decades of subject-matter expertise in transformer manufacturing and maintenance with historical and real-time data analysis from transformer sensors. This continuous health and performance insight prevents critical asset failures while optimizing asset life cycle costs [3]. Each asset is also categorized according to its current health condition and expected life.

With all this actionable intelligence, utilities can optimize the operational and maintenance spend to maximize the capabilities of their assets and budgets and build business cases for repair/replace decisions.
ABB specialists interpret data from the transformer and provide services

Once APM triggers an alarm or recommends an action, for specific and complex cases, ABB experts can help make good use of the data collected by online monitoring sensors, as well as the output of asset management software, to analyze the condition of certain transformers or transformer fleets. The combination of this data with the design data, the information in ABB’s installed base system, the results of oil analysis, condition assessments and the maintenance history provides ABB with a 360-degree view of a transformer fleet. This insight plays a pivotal role for ABB in the condition assessment process [4].

ABB has access to design knowledge worldwide and original designs for more than 30 legacy brands. Also, all new ABB transformers are built using the same design concept, which incorporates standardized, service-proven components, thus ensuring an efficient service out in the field. Expert assessment is not only important for minimizing the risk of failure and extending lifetime but also for providing valuable information for initiating maintenance or repair work should a problem occur, resulting in shorter downtimes.

Historical review

ABB has a plethora of data on the transformer installed base. This data is continuously updated, e.g., current owner details and history. The system provides an important basis for the proactive detection of problems. For example, one analysis revealed a potential cooler problem in about 700 transformers in the installed base. The search focused on 10 to 600 MVA transformers that were over 20 years old and had oil- and water-type coolers. Some had failed due to leakages in these cooling systems and one such failure resulted in significant revenue loss for the operator. Using installed base data, operators were contacted proactively and advised to carry out regular checks.

Training and consultancy

ABB experts also provide on-site or off-site training in transformer technical specifications, design, manufacturing, quality and factory acceptance tests, testing, diagnosis, online monitoring and asset management systems as well as spare parts, maintenance, repair, upgrade and replacement – including safety, environmental aspects and economics.

Inspection robot

Troubleshooting sometimes involves draining the transformer oil so a specialist can gain access. This procedure involves a significant outage, risks and expense. However, ABB has now developed TXplore – a remotely controlled inspection “submarine” – to do this job →5. This automated inspection tool eliminates the need to put a human at risk and expose the transformer’s internal structure to external contaminants.
On-site repair
ABB’s on-site repair service [5] speeds up transformer repair and has, over the years, saved users millions of dollars by reducing downtime by four or more weeks. The on-site repair is achieved by bringing the transformer factory setup to the work site, which allows for any scope of work to be carried out, from refurbishment to full winding replacement – all performed to the same quality standards as in the ABB workshop [6]. Such repairs have been carried out worldwide on over 500 transformers, including ultrahigh-voltage transformers, converter transformers, industrial units and shunt reactors.

Due to significant progress in power electronics, ABB’s compact test systems can now perform most high-voltage tests on site, including applied and induced voltage, heat run and impulse tests.

Eco-friendly retrofit
The environmental impact of new plant or retrofits can be reduced by employing ABB eco-friendly solutions that combine component reuse, innovative materials (natural and synthetic ester oils, aramid fibers, amorphous steel) and modern technologies (dry bushings, vacuum tap changers, active noise control) [6].

These solutions reduce the risk of fire and pollution, minimize losses and noise, allow material recycling and reduce maintenance. They also allow capital investments to be deferred while providing extra overload capacity to cope with growing power demands.

The ABB Ability Transformer Intelligence portfolio is helping transformer operators around the world cope with ever-increasing commercial and regulatory constraints by allowing them to closely monitor equipment condition, analyze and interpret results to produce actionable intelligence and benefit from the long experience ABB has built up since it launched its first transformer over a century ago.