The changing power service landscape

Talented, young technicians are replacing retiring veterans. This new generation is more likely to rely on laptops than wrenches to make repairs. Scheduled maintenance and the break/fix approach are being replaced by predictive- and condition-based approaches. The service landscape is slowly, but significantly shifting. Embracing and adapting to the coming changes can reduce both costs and outages.

Hardware evolution

The 1960s and 1970s seem to have been a golden age of power-equipment design and manufacturing. Many of the transformers and high voltage oil circuit breakers, and even some switchgear, delivered during that period, remain in service today.

"The transformers and breakers that were weaker designs exhausted themselves early in life," says Randy Schrieber, head of ABB power services marketing and sales. "The remaining, vintage assets represent very robust equipment, designed to be repairable and constructed with conservative margins. With proper maintenance, most of them have parts that can be renewed to further extend their life. Of course, as they are used harder than ever and continue to grow older, the risk of failure becomes greater. That's driving the need for additional service for these old war horses."

In many cases, the utilities or industrial companies that own this gear would love to replace it. Replacement, however, typically comes with a big price tag and an extended outage. So, instead of buying new equipment, many owners are ramping up the frequency of service to extend their equipment life and ensure reliability.

"Eventually the page is going to turn and the bulk of this older equipment will be obsoleted or decommissioned," predicts Rick Gardner, ABB Sales & Marketing Manager for Medium Voltage Service. "Buyers will have to bite the bullet of short-term replacement costs, but in the long run the new assets are likely to reduce their maintenance efforts and costs."

New equipment

While capital cost is always a concern when buying new assets, those costs are declining.

Customers are benefitting greatly from competition between original equipment manufacturers (OEMs) and advancements in field-hardened monitoring systems," says Craig Stiegemeier, Technology Director for ABB Transformer Service in North America. "That's certainly the case in new transformers, which are able to take advantage of those systems. An important factor in the repair-versus-replace equation is transportation costs. Getting a very large transformer to the factory for a rebuild can cost upward of $1 million each way, and today's repair-on-site option takes both the transportation cost and risk away."

When you look at the new generation of power equipment, you will see that it has a lot in common with today's televisions. Compared to previous designs of both, the current models are more automated, reliable, and feature-rich. Automation and design features eliminate much of the traditional maintenance. Twenty years ago, everyone knew the location of a nearby TV repair shop. Try finding one today.

"Circuit breakers in a switchgear lineup are a good example of the design differences," according to Schrieber. "There are plenty of breakers with spring-stored energy mechanisms in use that include 300 moving parts. Today, a comparable breaker has only seven moving parts, so it requires significantly less maintenance."

Newer power-equipment designs also reflect an overall shift from electromechanical control to digital control, with fewer moving parts to replace and adjust. That's creating a shift toward maintenance-free assets. The maintenance still required is focused less on wrenches and screwdrivers and more on computers and software. That's driving a change in the skills and talents needed from the maintenance techs tasked with servicing this new equipment.

Technician turnover
Old hands and young guns

Just as you can broadly divide the installed equipment base into older, higher-maintenance assets and newer, minimal-maintenance assets, you can also divide the cadre of maintenance techs into the old hands and the young guns.

"Right now we are in the middle of the transition from mechanically focused to digitally focused maintenance," Schrieber says, "but there's still a big need for those veteran techs. Some organizations are faced with the problem of them retiring. Half of the baby boomers who make up this group are past retirement age. Additionally, some organizations are meeting headcount-reduction targets by providing buyouts to encourage pre-retirement-age techs to start collecting their pensions."

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In the short term, that trend has created an imbalance between customer service requirements for older equipment and the supply of skilled technicians able to do the job. Companies without the internal talent to maintain older

assets often outsource that service to the OEM.

"For new, microprocessor-based-technology power equipment, hand tools are giving way to computers loaded with control, monitoring, and analytical software," Gardner says. "The tea leaves tell us this is the direction the service business is moving. Service calls are less frequent and more focused on a digital, rather than mechanical, solution. Service providers are adjusting to support customers from this different angle."

Most routine maintenance can be handled internally by the customer. But, in addition to the major mechanical projects that require the resources of an outside service provider, there are a number of service assignments that make sense to outsource. One of them is asset analysis.

Advanced tools and services

Some of the most accurate and effective analysis tools are simply too expensive or complex for an individual utility or manufacturer to have on hand.

"Take a high voltage breaker in the substation," says Bob Stoner, ABB Sales & Marketing Manager for High Voltage Service. "Traditional maintenance practice dictated routine overhauls that meant removing the SF6 gas, opening the breaker, removing and replacing parts, reassembling the breaker and refilling the gas. That often meant a four-day outage. With radiography, the service organization can basically X-ray the interior of that breaker without removing anything. They have a literal picture of the breaker's health and can complete the job in four hours."

Dealing with SF6 gas is another service in increasing demand.

"Customers don't have this expertise because they never really needed it," explains Stoner. "They didn't worry much about gas releases. With the tighter environmental regulations on greenhouse gasses and stiff penalties for any SF6 releases, that changed. They are adding monitors to identify gas releases, and turning to qualified service providers to be sure any job that includes removing or refilling SF6 is done right."

Assessing transformer health is another job customers often rely on outside experts to do.

"Moisture in the winding paper insulation is one of the most important indicators of power transformer health," says Stiegemeier. "Swept frequency response analysis (SFRA) and dielectric frequency response (DFR) analysis are tests that can be conducted without taking the transformer apart. We inject a signal and analyze the internal activity, much like a heart EKG, to see what's going on in the windings.

An added benefit of these non-invasive, non-mechanical assessments is that they avoid the chance of the asset being reassembled incorrectly. The less often you open it up, the less chance that you will create a new problem."

Time-based vs. condition-based maintenance

In addition to the gradual transition from older, higher-maintenance to newer, lower-maintenance assets, the other major service shift is from time-based to condition-based maintenance.

We are accustomed to time-based maintenance. We were long told to change the oil in our car every 5,000 miles and rotate the tires every six months. This approach seemed to be based as much on generating revenue for the service provider as it was on extending vehicle life. A minivan used for daily stop-and-go deliveries in the heat of Phoenix clearly has different service needs than the same van used to run occasional errands in the moderate climate of San Diego.

For tires and transformers, people now recognize it makes more sense

The benefits of adding continuous monitoring continue to increase, while the cost of implementing the required technology continues to decrease.

to do maintenance only when required, based on the actual condition of the asset. But how do we assess asset health?

For some pieces of equipment, a simple hours or cycles recorder may provide the needed alert that maintenance is required. Still, that approach relies simply on comparing that metric with some arbitrary benchmark. The maintenance team has no information about the asset's actual health.

"The move toward condition-based maintenance is the biggest trend we see in high voltage circuit breakers," observes Stoner. "There are very few people doing five- and ten-year checks. Customers want to know the condition of a breaker so they know when it truly needs service. And they don't want to run out to the site to get that breaker data. They are adding sensors that transmit the data back to their operations area."

Gathering information

The ability to remotely gather asset health data is more affordable and easily acquired than ever. When purchasing new assets, the buyer can specify a range of data-gathering capabilities.

"With new switchgear, you have the option to add monitoring capabilities, and more and more people are taking advantage of that opportunity," says Quirin Hall, ABB Product Manager for Medium Voltage Service. "The sensors aren't fully integrated in the switchgear lineup yet. You buy the switchgear, install it and then upgrade it with the sensors. In the near future, though, the sensors will be built in during manufacturing."

Older, installed assets can be readily upgraded to add health monitors.

"It requires a relatively small investment and only about a half hour to upgrade a standard breaker to add monitors," explains Hall. "It doesn't require any sort of major redesign to be able to acquire up-to-the-minute data on the asset's health and status. Our customers can opt to monitor a variety of breaker parameters: number of operations, opening/closing time, number of false-current operations, contact wear, heat signature, inactivity timer, compartment temperature, auxiliary power quality, and more."

"In a transformer, the main things we monitor are cooling system performance and oil condition, including water percentage, dissolved gasses, and temperature," Stiegemeier says. "There have been big advancements in chemistry that help us understand the condition of the transformer based on analysis of the oil and gas. That information gives us an early and actionable warning of potential transformer issues. Many of these monitors are being specified for new power transformers and all of these monitors can be added to existing transformers."

ROI for sensors

"The cost of sensors for a transformer, as an example, depends on their sophistication," Stiegemeier says. "For a large power transformer worth millions of dollars, it makes sense to pay the $30,000 to $50,000 to add sensors. The investment in sensors makes even more sense for critical applications where you need to do everything you can do avoid an unplanned outage."

The benefits of adding continuous monitoring continue to increase, while the cost of implementing the required technology continues to decrease. Over time, more and more assets, both old and new, will have sensors and be able to transmit a continuous stream of health data to maintenance managers.

Making sense of the data

Data from sensors on assets can be used for something as simple as sending an alarm when a device crosses a temperature or pressure threshold. The trend, though, is for maintenance managers to acquire analytical tools to convert the continuous stream of data into a holistic, on-going health profile of the device.

Adapting to the shift

Next steps for navigating the changing service landscape

- Capture knowledge from current veteran technicians.
- Backfill for lost service capacity and knowledge with third-party services.
- Aggregate data from inspections and tests to enable data-driven decision making.
- Transition from traditional, time-based to a condition-based maintenance strategy, reducing service calls to healthy assets and focusing attention where issues exist.
- Identify critical, existing assets and incorporate appropriate sensors in them to automatically detect potential problems.
- Include appropriate sensor options in new asset specifications, enabling a transition to condition-based maintenance.
- Deploy analytical software for asset health data, automating service response and providing rich performance-trend information.

"We have created software to integrate and analyze this mass of information collected from sensors, as well as test and inspection data," according to Stiegemeier. "We have tested and proven this software on more than 10,000 transformers over the last two decades. Armed with all this information, the system can assess the risk of failure of an asset and detect an emerging problem long before it poses a major risk."

Rate of adoption

The highest rate of condition-based monitoring implementation is in the more expensive and critical high voltage assets, especially in utilities that are more accustomed to monitoring their devices.

"For distribution level applications, utilities have been slow to adopt the condition-based approach," Gardner says. But he predicts that "it's only a matter of time before they manage their entire networks via this method."

One thing driving the addition of intelligence to utility power equipment is the new set of outage-related regulations.

"North American Electric Reliability Corporation (NERC) regulations have driven an increased desire to highlight emerging risks because of the fines utilities face for unplanned outages," explains Stiegemeier. "Avoiding a single fine could offset the cost of adding a full complement of sensors to a transformer."

Condition-based monitoring is seeing even slower adoption with industrial users.

"Unlike utilities," Gardner continues, "most industrial power users don't have anyone in their facility really familiar with the concept of condition-based monitoring for power equipment, so they hesitate to install it. Transformers and switchgear just sit there in a factory or substation; and since they have few moving parts, maintenance managers don't see the need to add sensors."

Risk-based maintenance

A further refinement of condition-based maintenance is risk-based maintenance. This approach has been used in some industrial equipment applications, but is only now beginning to take hold for power equipment.

"In addition to gathering health-status information being reported back by the sensors, you also dispatch techs to go onsite and gather as much information on the asset as you can," Stiegemeier says. "That includes operator interviews, visual inspections, maintenance records, and any other resources that could provide insight into current health, expected longevity, environmental conditions, and the asset criticality. All of the data is processed to develop a risk factor for that asset."

With this approach, maintenance managers can allocate their attention and budget to the most vital assets. They can use their precious maintenance dollars most effectively to ensure reliability and predictability of operations.

These risk assessments are available from some OEMs and service companies. While there is an up-front investment required, no approach does a better job of prioritizing maintenance resources and ensuring asset reliability.

Summary

Maintenance managers must adapt to the shifting power service landscape. Rather than preparing for a tsunami that will suddenly disrupt their maintenance methods, they need to adjust to the slower, but no less significant, tidal changes now underway.

For both older-but-serviceable assets and the most-current power equipment, capturing all the data available in one place will allow a more comprehensive understanding of asset risks. Using software to leverage that data by highlighting and prioritizing risks is both efficient and effective.

Maintenance managers should carefully consider the many benefits of incorporating additional sensors into transformers, switchgear and breakers. Having a steady stream of real-time asset status and health data reduces the likelihood of unexpected issues and downtime. More importantly, it facilitates the ongoing shift to a more condition-based maintenance approach.

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