Meat and Potatoes Transformer Maintenance

With supply chain issues, long lead times, and the cost of being down due to an electrical failure, the need for maintaining and monitoring your power transformers is becoming increasingly more important. Developing a maintenance program, and implementing it on a scheduled basis, will help system operators monitor critical assets and deploy corrective actions before a failure may occur. With the tools at hand and the technology available, owners of these assets can develop comprehensive maintenance programs to determine the overall health of their units.

When developing a maintenance program for a transformer, we like to break it down into six main categories:

- Insulating fluid
- Physical and mechanical condition
- Auxiliary controls and indicators
- Winding construction
- Winding insulation
- Bushings

At the base of any good transformer maintenance program, is testing of the transformers insulating fluid. Abnormalities occurring within the transformer can almost always be detected early on via an analysis of the transformer oil. Oil sampling can be performed online without interruption to operation and the information gathered can be invaluable to catching potential problems at their inception. We typically recommend performing oil sampling, at minimum, on an annual basis. Regular sampling will help develop a trend of continuing transformer health. For high value units we also recommend considering an online oil monitoring system that can sample the oil on a continuous basis and alarm facility managers at the earliest onset of an issue. Similar to blood test results, transformer oil samples can give insight to many underline issues and testing should be completed on a routine and frequent basis.

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Verifying the physical and mechanical condition of the units is also a useful tool that can be completed on a frequent basis with little interruption to normal operation. Verifying positive pressure on gas blanketed transformers, inspecting for leaks, and assuring fans, coolers, and pumps are all operating, may seem routine but is an integral part of a transformer maintenance program. Most of these checks can be performed online and can be completed by site personnel with minimal training in transformer maintenance. So long as you know where to look and what to look for, regular physical and mechanical inspections can help detect the onset of potential issues before they become an emergency.

The final part of a comprehensive transformer maintenance program is to test the physical attributes of the windings, the insulation quality, and bushing conditions. All these tests are to be performed offline and are typically recommended to be performed every three to five years.

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The main tests recommended to be performed are the following:

- Power factor testing
- Winding Resistance testing
- Turns Ratio Testing
- Sweep Frequency Response Analysis
- Bushing power factor and Capacitance Tests

We tend to put special emphasis on the power factor testing of the winding insulation and bushing tests. Power factor testing is a test that can be used for trending and can give insight to deterioration of winding insulation. Bushings are sometimes considered the "weak point" of a transformer and power factor and capacitance test results can be compared to nameplate values. Deviation from expected results can allow system operators to plan for bushing replacements before a failure occurs and potentially compromise the entire unit. Similar to online oil monitors, online bushing monitoring systems exist and should be considered for high value assets.

No equipment will last forever but implementing and performing a comprehensive transformer maintenance plan can help prolong the life of your critical assets by catching and correcting issues at their inception. Investments in maintenance today will save costly unplanned outages in the future.

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Bradley Webb with over 16 years of hands-on experience in medium and high voltage electrical systems, Bradley Webb is the dedicated owner and operator of Substation Solutions, LLC. His career spans crucial roles in asset safety, strategic planning, and team leadership within high-stakes industries. As a seasoned professional, Bradley combines technical proficiency and business acumen to deliver exceptional substation maintenance, repair, and consulting services. Known for his meticulous approach to safety and quality, he has established Substation Solutions as a trusted provider for utility companies, industrial plants, and renewable energy facilities. Bradley's prior tenure at Pacific Gas & Electric as an Electric Standards & Work Methods Specialist solidified his expertise in asset management, maintenance standards, and safety protocols, enabling him to lead industry advancements at Substation Solutions. His commitment to client satisfaction, innovation, and strategic growth has driven his company's success, fostering long-term partnerships and a reputation for reliability.