

Capitalizing on a failure

Background

July 17, 1996, East Watertown, NY—As part of regularly scheduled maintenance, a Niagara Mohawk Power Corporation (NIMO) service crew had just de-energized the East Watertown substation's transformer and temporarily removed the unit from service. In its place, the crew had connected one of the power company's fleet of 21 mobile backups—a 9-MVA unit with a 30-year history of dependable service.

The procedure was routine. As soon as the maintenance work on the main unit was complete, the crew would put it back into service, and the mobile would have done its job once again. But what happened next was far from routine. At 9:53 a.m., just minutes after being put into service, the mobile failed.

The resulting outage put more than 6,000 NIMO customers out of electrical service for 37 minutes, the amount of time it took the crew to get the main transformer back into service. The failed mobile unit served as backup to 58 substations, and it was critical to NIMO's ability to provide dependable service.

According to Jim Carpenter, of NIMO's System Electric Operations Department, "It was like an insurance policy for us—and it had worked very well in the past."

Decision to up-rate

The situation had to be quickly addressed. NIMO faced three possible choices: repair in kind, repair with an up-rate or replace the unit with a new mobile. All three paths needed to be thoroughly analyzed and weighed against current and future needs.

NIMO was quite familiar with the up-rating strategy. Several of their transformers had been rewound and up-rated with DuPont NOMEX® brand paper and pressboard, and all of them continue to perform like new.

By up-rating from 9 MVA to 12 MVA, NIMO could increase not only the mobile's nameplate capacity but also its versatility. The mobile unit would be better able to cover a more complete array of emergency and scheduled maintenance situations. And with a vigilant eye always to holding down costs, NIMO could reap this benefit with a capital outlay of less than half the cost of a new unit. So NIMO decided to repair the unit and up-rate to 12 MVA, and the project was put out for bid.



**Southwest
Electric
Company**



CASE HISTORY

The up-rate process

The failed unit had been built by GE at its Pittsfield, Massachusetts, facility in 1966. Records indicated that it had never been overloaded. Recent diagnostic tests, including power factor, dissolved gas and oil quality, gave no indication there was an impending problem.

An analysis of the failure, which included an internal inspection, proved the culprit to be the cumulative effect of through-faults that had weakened the unit over time. The actual breakdown was a turn-to-turn dielectric failure in the high-voltage winding, a common type of failure.

The bidding process was quickly concluded. NIMO awarded the contract to Southwest Electric Company of Oklahoma City, Oklahoma.

Southwest Electric Company has been a leader in the electrical service industry for more than 50 years. With additional repair and service divisions in Ohio and Tennessee, Southwest specializes in motor redesign/rewind, switchgear redesign, repair and rebuilding, medium and large power transformer redesign/rewind, and field service for switchgear and transformers. NIMO had previous experience with Southwest Electric Company transformer redesign/rewinds.

As part of their strategy, NIMO wanted a contractor who was familiar with DuPont NOMEX® brand paper and pressboards and their integral role in up-rating. Southwest had already redesigned several units with NOMEX® to provide cost-effective solutions to their customers' requirements. Southwest was well aware of the benefits of using NOMEX®, especially the increased versatility it provided and the added reliability at a lower cost.

The work was completed by Southwest and the unit was returned and ready for service in May of 1997. See the "up-rate at a glance" on this page for information concerning before-and-after performance characteristics.

The mobile transformer was completely overhauled and refurbished and brought up to the most demanding ANSI/IEEE standards of performance. For example,

Niagara Mohawk up-rate at a glance

	Original	Up-rated transformer*	
		at 9 MVA	at 12 MVA
FOA rating	9 MVA	at 9 MVA	at 12 MVA
Load losses	189.2	177.8	316.0
No load losses	11.7	15.2	15.2
Total losses	200.9	193.0	331.2
Impedance	15.54%	16.12%	21.49%
Voltage—HV	110 kV	115 kV	115 kV
Voltage range—HV	107–119 kV	109.25–120.75 kV	
Voltages—LV	2520/4360Y/2520 × 5040 × 7970/13800Y/7970 Volts		

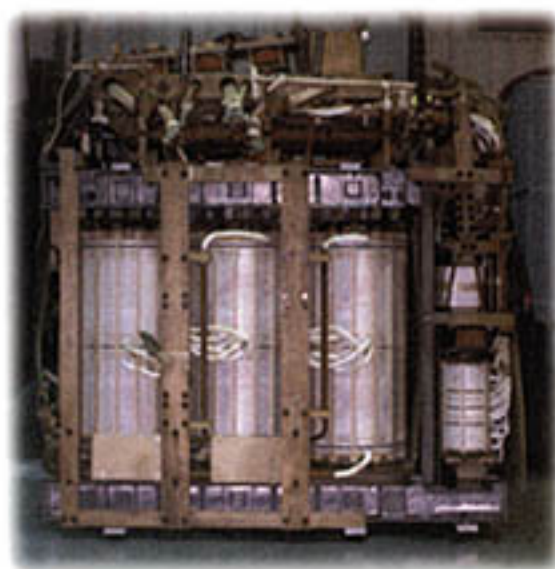
*Transformer is rated at 12 MVA, 95°C rise.
Data at 9 MVA is provided for comparison with original unit.
Core losses are higher on the same basis due to voltage changes in the HV winding.

the control power was originally supplied from a few independent turns wound on the main transformer. With the redesign by the engineers at Southwest, control power is now supplied by a separate control power transformer (CPT) mounted and connected externally to the main tank. Now if it were to fail, damage would be minimal and far less costly to repair.

Additionally, the aluminum tank itself, which had been damaged by the force of the failure, was repaired and strengthened. All controls were tested and verified. The unit was refitted with new gaskets, and the high-voltage bushings were replaced. Southwest Electric also improved the short circuit withstand rating of the transformer.

As part of its long-standing policy toward mobiles, Southwest specified the use of copper conductors wrapped with NOMEX® insulation. The repair company does this whenever possible, even when the customer doesn't require it. NOMEX® has a much higher tensile strength than cellulose insulation; thus it offers exceptional resistance to tearing and is far less prone to becoming brittle with use. By habitually going beyond what's expected, Southwest demonstrates a genuine commitment to providing clients with the highest quality and value.

In situations where the customer expresses a need for increased capacity, Southwest Electric recommends the use of NOMEX® insulation as a cost-effective solution.



In cases where a significant up-rate is required, Southwest offers a hybrid insulation system. In this option, the cooler areas in the transformer are insulated with traditional cellulose material, while NOMEX® brand insulation is applied to the hotter areas.

In a typical hybrid insulated core-form transformer repair, the hot areas requiring NOMEX® brand insulation are limited to conductor wrap, radial spacers and axial sticks, as is shown in the picture of the NIMO unit above. This usage results in a unit with a 95°C average winding rise. In another option, Southwest also has rebuilt transformers using NOMEX® as a conductor wrap only. This results in a 75°C rise unit with a smaller capacity increase (see "Another repair option" on the next page).