

## Benefits of an up-rate

With either of these approaches, failed transformers can be redesigned to current standards and up-rated to meet a variety of capacity needs. These options provide sound, economical alternatives that can be implemented in a much shorter turn-around time than the purchase of a new and larger transformer.

If the "Re-engineered with NOMEX®"™ option had not been available to NIMO, the unit could still have been repaired. However, the original capacity rating would have remained. With load growth over the past 30 years having already rendered the mobile unit too small for certain situations, its future performance and versatility would have been more limited.

It was NIMO's awareness and confidence in the up-rate with NOMEX® option that turned this story of failure into a startling success. That and Southwest's know-how and expertise in satisfying their customers' needs. The up-rate strategy has proved to be a wise investment and continues to provide dividends to NIMO and its customers.



## Southwest Electric Company Power Transformer—redesign and remanufacture

The Power Transformer Division of Southwest Electric redesigns and remanufactures failed or obsolete power transformers to current ANSI/IEEE standards, utilizing copper conductors and modern insulating materials.

A resident engineering staff performs computer-based short circuit analysis and redesigns the transformer, incorporating Southwest's coil-clamping system plus any needed reinforcements to structural members, to ensure compliance with ANSI/IEEE short circuit withstand requirements. Skilled, experienced craftsmen then remanufacture the transformers in accordance with documented procedures and under the controls of a comprehensive quality program to ensure compliance with customer requirements and Southwest Electric standards.

## Traditional cellulose vs. NOMEX® brand insulation

The major problem associated with cellulose as an insulation material is its thermal aging factor, which rapidly accelerates at temperatures not far above the accepted normal operating range for transformer conductors. As it ages, cellulose releases carbon monoxide, carbon dioxide and water. The water reduces oil quality and dielectric strength, which in turn leads to transformer failure.

Cellulose insulation poses two additional problems for transformers: moisture absorption and shrinkage. Over time, cellulose becomes spongy and compresses when mechanical forces are applied through normal and extreme use, allowing the winding conductors to move. This movement can often lead to failure. With mobile units that are normally hauled and jostled over all types of terrain, the situation is even more problematic.

In contrast, NOMEX® brand insulation maintains its integrity under the toughest conditions. Below 200°C, it has an infinitesimal thermal degradation factor that is far superior to cellulose. In addition, because of its remarkable tensile strength, NOMEX® brand insulation is exceptionally resistant to tearing. Also, it has compression characteristics that are far superior to cellulose. Consequently, transformer windings remain tight and far more resistant to ordinary and extraordinary stresses.

At the typical operating temperatures of electrical transformers, NOMEX® will not turn brittle. It outperforms cellulose at elevated temperatures and has a much longer lifespan. The superior mechanical toughness of NOMEX® paper and pressboard enables windings to withstand the most severe mechanical shocks.

Simply stated, NOMEX® brand insulation is the ideal material for high-performance electrical transformers of today and tomorrow.

## Another repair option with NOMEX® brand insulation

When a significant up-rate is not required, there's another, often overlooked, repair option available to operators that can provide a respectable 10–12% capacity increase at a very minimal cost.

## Two illustrations

In 1995 Southwest Electric redesigned a Federal Pacific Electric transformer for Union Electric Company of St. Louis, Missouri. The unit was originally rated 60/80/100/112 MVA, OA/FOA/FOA, 55°/65°C rise, 139.2 kV delta to 34.5 kV wye with LTC.

In this case, Union Electric did not require an increase in capacity. Instead, they requested that the BIL on the HV windings be raised from 450 kV to 550 kV, thus creating a unique problem for Southwest engineers: how to meet this requirement within the existing dimensions of the unit and still provide the required capacity. The problem was solved by using NOMEX® as the new insulation material on the conductor. This enabled the designer to increase dielectric clearances while obtaining a higher MVA rating due to the allowable temperature rise of 75°C.

In 1997 Southwest Electric received an order from another Midwest utility to up-rate an autotransformer. The unit had an original rating of 45/60/75/84 MVA, OA/FA/FA, 55°/65°C rise, 161 kV to 69 kV with a 13.8 kV tertiary. By insulating the conductors with NOMEX® brand insulation, Southwest was able to rebuild the transformer to a 75°C temperature rise with a top rating of 94 MVA.



For more information about retrofitting transformers, contact:

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## **NOMEX® brand insulation**

*Providing future solutions today*

NOMEX® brand insulation is used in many applications in addition to transformer repair, such as traction and industrial transformers and dry-type transformers (including resin-cast), as well as in new mobile transformers. Applications in motors and generators and other types of electrical apparatus are also widespread. Case histories are available describing the many applications. For more information about NOMEX® brand insulation, contact your local DuPont representative or one of these regional contacts:

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