

WEIDMANN DESIGNS AND BUILDS INSULATION SYSTEM FOR THE MOST ADVANCED FURNACE TRANSFORMER IN THE STEEL INDUSTRY

On Good Friday 2005, the NUCOR Steel Bar Division incurred a major Arc Furnace Transformer failure at its Kankakee facility bringing production to a halt. It was not a good day for NUCOR, but they were fortunate to have a spare available while the failed unit could be repaired.



The unit was built in 1989 by National Transformer of Norway and had originally been rated at 60 MVA. The addition of coolers in 1993 increased the rating to 72.8 MVA.

NUCOR selected Siemens Energy and Automation of Kansas City to assess the damage and propose a solution. It was discovered that the internal reactor had failed, but the main core and coil assembly showed signs of thermal aging and had been contaminated with copper and carbon from the failed reactor.

Siemens assessed the damage, and options for repair were considered. Instead of just restoring the transformer to its previous condition, Siemens proposed improvements including the possibility of an enhanced NOMEX[®] insulation system to provide increased reliability and lengthen service life. NUCOR recognized that the cost of an uprate at the same time as the repair was a good investment.

To determine what could be done to both repair and improve the reliability of the transformer, Siemens Transformer Specialist Dave Arnold contacted his long-time insulation partner, EHV-Weidmann.

Weidmann engineers also recommended an enhanced NOMEX[®] insulation system and, after evaluating data on the construction of the unit, provided an estimated uprate potential of 80 MVA. Unlike

core form units using Hybrid NOMEX[®] and Cellulose insulation systems, the shell form design requires almost exclusively NOMEX[®] Pressboard Components.

Increase Reliability - Since NOMEX[®] insulation withstands higher temperatures, failure due to thermal degradation of the insulation system is no longer an issue. An improvement in reliability combined with opportunity to increase load capability, in the same time frame as repair with conventional insulation, is a cost-effective alternative.

Extend Life Cycle - NOMEX[®] insulating materials contribute to the increased life of the transformer. This not only assures a greater up-time benefit for production and can mean virtually no unplanned downtime, it also spreads the investment pay back over more years essentially reducing production costs.

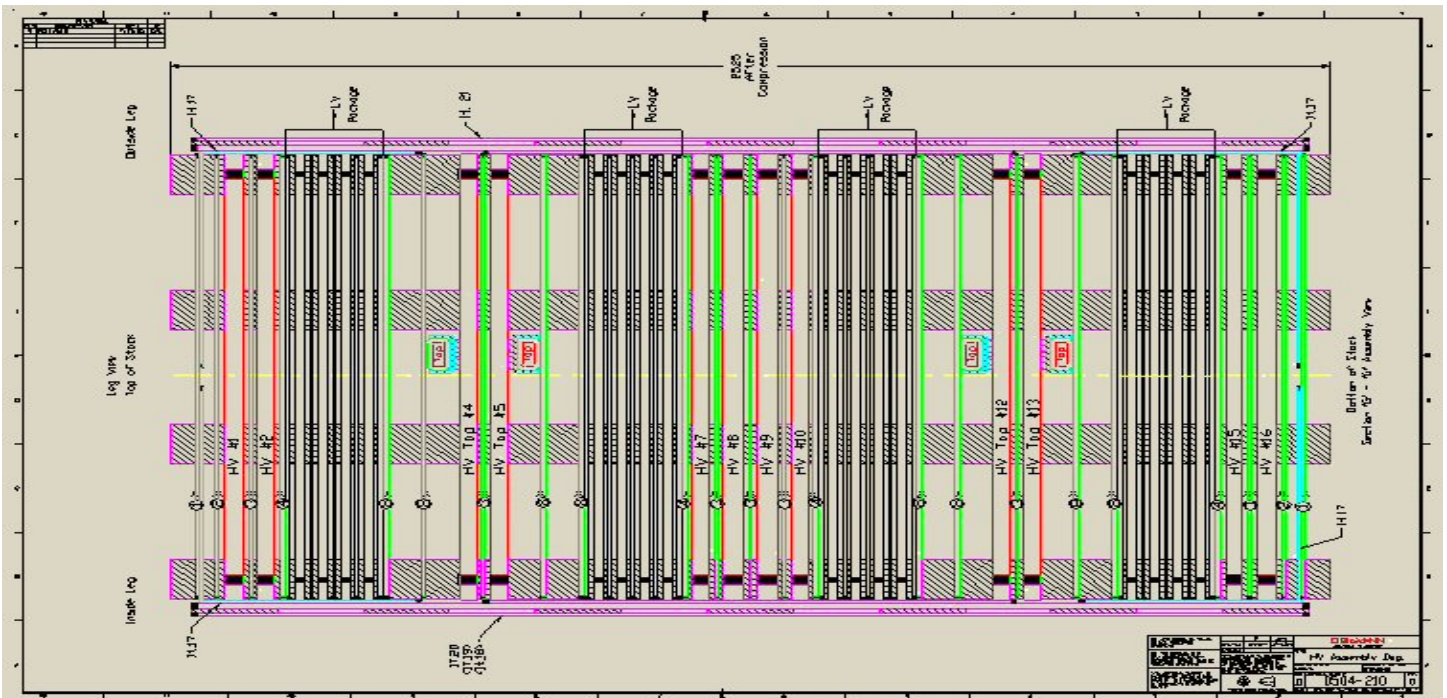
Prevent Failures - Since NOMEX[®] insulation does not lose its mechanical integrity with age, transformers remain tighter, less susceptible to internal movement due to mechanical short circuit forces and resistant to compromised dielectric clearances.

SOLUTION:

The Weidmann organization has decades of experience and expertise designing and building insulation systems for all types of transformers, but this shell form furnace transformer would be the first of its type to be upgraded with a new NOMEX® insulation system.

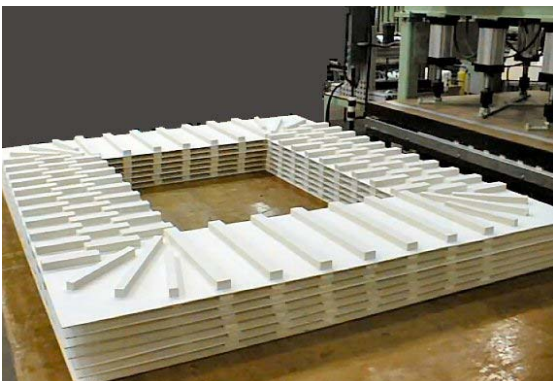
Bill Phelps, Senior Technical Service Engineer at EHV-Weidmann stated that, "Designing a new NOMEX® insulation system for this transformer was a huge undertaking, but the greatest challenge was in manufacturing. We had to develop everything. The project required the development of new manufacturing processes. It was even necessary that we design and build specialized equipment. The design was the easy part. Identifying the right materials and developing the manufacturing processes were the hard part."

THE INSULATION DESIGN



"These were new techniques for Weidmann and we also helped Siemens with some of their processes. Here at Weidmann, we have many years of experience in the design and manufacture of transformer insulation but this was the first time that we utilized NOMEX® insulation in a shell form transformer."

"As far as we know, this is the first hybrid insulation system for a shell form furnace transformer using NOMEX® materials that has ever been successfully built."



The Weidmann team examined and investigated the many challenges:

- Identifying and Sourcing Appropriate Materials
- Forming NOMEX® Pressboard Channels and Angles.
- Selecting a High-Temperature Adhesive.
- Developing Manufacturing Processes for Bonding the Barriers and Spacers
- Minimizing Cost of Materials and Labor



Weidmann worked on ways to maximize the yield of NOMEX[®] pressboard and eliminate the waste of off-cuts. In the end, 98% of off-cuts were used for fabrication of spacers and other components. All costs associated with this project were monitored and documented.

An extensive search for high temperature adhesives was conducted. Many adhesives were examined including a test series for adhesives in the EHV-Weidmann R&D lab. An adhesive system for the shell form washers and blocks was developed.

Alternate procedures for applying high temperature, pre-mixed adhesives were investigated and put in place. A high-temperature press for the manufacture of washers was designed and built, and a press for bonding the washers and blocks was developed.

Insulation:	Application:
410 NOMEX [®] Paper	Inner Conductor Wrap
410 NOMEX [®] Paper Specially Coated with B Stage	Outer Conductor Wrap & Bonding
T993 NOMEX [®] Pressboard	Coil Barriers, Spacers, Blocks, Contoured Insulation Pieces
T994 NOMEX [®] Pressboard	Lead Separation and Reinforcement
Creped NOMEX [®] Paper Tapes	Intercoil Connections, High Voltage Lead Insulation, Cable Wrap
Res-I-Glas Tape by Fibertek	Securing the Outer Layer of the Reactor Winding
Res-I-Glas String by Fibertek	Securing Leads and Conductor Tapes

As the insulation system design was being completed, NOMEX[®] insulation board and paper requirements were estimated so that Weidmann could order early, avoiding any potential delay in this time critical repair cycle.

All of these activities were completed and the manufacture of the insulation package began. The complete insulation package was ready for shipment within the month.

Siemens produced the windings and made the necessary changes to the auxiliary equipment. They assembled, processed, tested and painted the unit. Weidmann representatives visited Siemens to review the assembly of the first phase. The new HV coils were wound first; then the LV bar coils were assembled. After all phases were completed and assembled, they were placed into the tank and the core was stacked around the phases. New cables were installed and the tap changer was reworked. The remanufacture was completed, the unit passed all Standard ANSI tests and Siemens shipped the transformer.



RESULT:

This new 80 MVA shell form transformer with the first NOMEX[®] insulation system was energized and returned to service. The NOMEX[®] insulation system upgrade has increased the load capacity by 20%.

NUCOR Steel representative Curt Shoaf stated, "We are not using the increased MVA of this unit since we are limited by available power. We were not so much interested in a greater MVA capacity as we were in the increased reliability and longevity of this transformer."

"We have the best possible insulation system and double the protection. We run at the same power, and the unit runs much cooler now. We know it won't deteriorate if we heat it up."

"A side benefit of running cooler is energy savings, which means saving money. A little savings today could mean a lot more in the future."

"The cost for the NOMEX[®] Insulation System upgrade was only incrementally more than a rewind in-kind. The unit runs significantly cooler than it did previously, but the biggest value is in the long-term reliability."

Reliability has become even more important since replacement is a long process. There are few manufacturers of furnace transformers in the US. Recently some transformers have been imported, but the delivery cycle is extensive.

WEIDMANN CAPABILITY - WEIDMANN SOLUTIONS:

With the ability to increase the capacity through high temperature insulation systems, a host of benefits are available:

- Improved Life at Normal Service
- Significant Reduction of Insulation Aging
- Increased Power Density; Reduced Size and Weight of All Materials
- Lower No Load Losses
- Safer and More Environmentally Acceptable

Remanufacture of existing transformers has become, in many ways, a preferable alternative to replacement since re-use of electrical and structural steel are important cost considerations, and no modification to buss structure or site is required. The use of NOMEX[®] insulation materials can provide enhanced performance, long-term life and improved reliability.



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