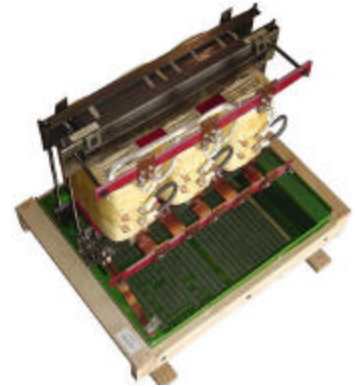


## Life Expectancy of Powersmiths Transformers

### Overview

The operational life of a Transformer is primarily determined by the life of its insulation system (materials used to insulate the conductors in the coils and the coils from the core) with abnormal conditions such as sustained short circuits, corona discharge from fast transients (e.g. lightning)\* and mechanical damage excepted; Copper, Aluminum and Steel are stable at well beyond the normal operating temperatures of the Transformer. It follows therefore that for longest life a superior insulation system must be employed. To this end Powersmiths exclusively uses a NOMEX® based UL Recognized Class 220 (220°C) insulation system in the manufacture of its transformers.



### NOMEX®

NOMEX® is a synthetic aromatic polyamide polymer that provides high levels of electrical, chemical and mechanical integrity. Used properly, NOMEX® paper products can extend the life of electrical equipment, reduce premature failures and repairs, and act as a safeguard in unforeseen electrical stress situations. The combination of properties of NOMEX® has been providing exceptional reliability to electrical equipment manufacturers for over 35 years and is used in the construction of all Powersmiths' Transformers

The unique properties of **NOMEX®** include:

#### ➤ Dielectric strength

The NOMEX® material used by Powersmiths can withstand short-term electrical stresses of > 800V/mil even without varnishes or resins. Powersmiths utilizes a minimum of 30 mils in at least 3 layers for a total short duration dielectric strength exceeding 24kV for fast transients and double that for sinusoidal voltages that is further enhanced by the Epoxy co-polymer impregnant.

#### ➤ Mechanical toughness

NOMEX® products are strong, resilient and flexible, with good resistance to tearing and abrasion. The mechanical structure of the coil is further enhanced by impregnation with an Epoxy co-polymer impregnant for a robust coil structure.

#### ➤ Thermal stability

Temperatures up to 200°C have little or no effect on the electrical and mechanical properties of NOMEX® products, and useful values are retained at considerably higher temperatures. Furthermore, these useful properties are maintained for at least 10 years of continuous exposure at 220°C

➤ **Chemical compatibility**

NOMEX® is essentially unaffected by most solvents, and is unusually resistant to attacks by acids and alkalis. It is compatible with all classes of varnishes and adhesives, transformer fluids, lubricating oils, and refrigerants. Also, since NOMEX® products are not digestible, they are not attacked by insects, fungi or mold and hence requires no special precautions for long-term storage.

➤ **Moisture insensitivity**

In equilibrium at 95 percent relative humidity, the NOMEX® materials used maintain 90 percent of their bone-dry dielectric strength while many mechanical properties are actually improved. Powersmiths also impregnate the Transformers with an epoxy based co-polymer resin that completes the protection to the extent that no special precautions or the use of desiccant dryers are required for long-term storage.

➤ **Nontoxic/flame resistance**

NOMEX® does not support combustion in air. In the case of a building fire, NOMEX® products do not produce significant amounts of toxic smoke or dangerous particles and will not produce any known toxic reactions in humans or animals. In addition Powersmiths utilizes a dry type Transformer construction, which does not have any fluids to spill, explode or burn.

**Transformer Useful Life**

The useful life of a Powersmiths Transformer is determined mainly by degradation of its dielectric strength of the NOMEX® insulating material (except for abnormal conditions previously listed), which as described above is related to its temperature of operation, and defined by the relationship:

$$**Time = 10 \exp \left[ \frac{8262}{^{\circ}C + 273} - 11.44 \right] \text{Hours}$$

As an example, Powersmiths Type E-Saver and T1000 transformers (both rated at 130°C rise) operating at 100% loading in a 35°C ambient (actual temperature of 195°C with hot spots factored in) would have a predicted insulation life of > 185 years.

*Notes:*

*\* Transformers may be externally protected from Transient Voltage Stresses by the use of suitably rated TVSS devices properly installed on the Bus feeders.*

*\*\* This prediction of aging behavior is the basis for the recognition of NOMEX® papers as a 220°C insulation by Underwriters Laboratories, the U.S. Navy, and others, and are confirmed by more than 35 years' commercial experience. Measurements show, for example, that NOMEX® paper Type 410 (used in Powersmiths Transformers) will maintain 12 kV/mm (300 V/mil) dielectric strength for several hours at 400°C, which is the performance predicted*

*Reference: <http://www.dupont.com/nomex/electapps/index.html>*