



DU PONT®

Nomex.

ABB's first 250 MVA, 400 kV fast-deployable transformer uses DuPont™ Nomex® insulation for high output and compactness

ABB's new fast-deployable transformer with hybrid insulation of DuPont™ Nomex® combines an exceptionally high power/voltage rating of 250 MVA, 400 kV with significant size and weight reduction for rapid transport mobility and fast deployment. *(Photo courtesy of ABB, All rights reserved).*

At a time of rising demand for energy, conventional fast-deployable transformers are falling short of the growing emergency power needs of electricity transmission grids and substations.

By definition, these transformers must be mobile, easily shipped, and quick to install and operate. That means they must be compact and relatively light, but this limits the output of such units and makes them incapable of delivering the required power in high voltage networks.

Now, in an advanced development, high voltage power transmission leader ABB has solved the power-to-size challenge by designing the first fast-deployable 1-phase HV network transformer with an exceptionally high power/voltage rating of 250 MVA, 400 kV. At the same time the company has achieved a reduction in size compared with standard substation transformers and conventional fast-deployable transformers, enabling rapid transit by standard truck, and fast set up as a quickly available emergency unit.

How was this possible?

Key to the breakthrough was the decision to use a high temperature class hybrid insulation system with DuPont™ Nomex® paper and pressboard, enabling ABB to design very compact transformer windings, yet achieve an unusually high power capacity compared with conventional cellulosic insulation.

As proof of its impressive power capabilities, the light and compact transformer has been operating successfully since 2012 at a power transmission grid in Spain, following extensive validation testing. The new 250 MVA unit can deliver 167% greater power capacity than an existing 150 MVA unit on site, despite significantly reduced dimensions.

The challenge

Mobile transformers play a vital role for many distribution grid operators in providing rapid emergency power in case of failure or downtime of the main HV unit. But typical mobile units are rated below 100 MVA to comply with shipping dimension and weight restrictions. This makes them incapable of supplying power in 220-400kV transmission grids.

The challenge for ABB was to develop a fast-deployable transformer rated at a minimum of 200 MVA to meet the substation's emergency power needs, but compact and light enough to allow the unit to be shipped easily by road.

The solution

ABB conducted a feasibility study to evaluate the technical challenges involved in developing a cost-effective fast-deployable transformer with the same output as considerably larger and less mobile units. The question was — how could the company achieve such seemingly conflicting objectives by combining the step-up in power capacity with outstanding mobility?

The study indicated that the only way to accomplish the two objectives successfully and simultaneously was to use high temperature hybrid insulation system instead of more traditional cellulose material, within a compact design. However, the project challenged engineers to develop the first hybrid insulation system designed for a voltage class as high as 400 kV. This required extensive evaluations in relation to designing and manufacturing of insulation components.

Working closely with DuPont, ABB chose high temperature class Nomex® paper and pressboard insulation that enabled winding conductors with reduced cross section and higher transformer winding temperatures — and safe, reliable performance above the operating temperature limits of cellulose and thermally upgraded cellulose. It was a decision that enabled a significant reduction in transformer size and weight, while still ensuring state-of-the-art insulating system performance at voltage as high as 400kV.

Furthermore, since the long time operating ceiling of 165°C hot spot temperature in high-temperature hybrid designs is significantly lower than the temperature limits of Nomex®, the lifetime of the insulation is expected to be considerably longer than cellulose-based insulation used in conventional designs. The heat resistant properties of Nomex® also give the transformer additional overload capacity for enhanced safety and reliability.

Key benefits to users

ABB's new 250 MVA, 400 kV, 1-phase fast-deployable transformer offers the following benefits to the final user:

- At 250 MVA, 400 kV, the rated power is 2.1 times that of a conventionally insulated fast-deployable transformer of similar dimensions.
- Compact size and reduced weight for easier shipping by standard truck, and reduced installation time.
- Extended service life due to the virtually non-ageing properties of Nomex® hybrid insulation operating at the design temperatures.
- High temperature ceiling of Nomex® insulation reduces risk of thermal failure, providing more reliable operation on the grid.
- Gains in cost effectiveness due to significant increase in available power rating.
- Validation by dielectric tests proves ABB capability to use Nomex® as a suitable hybrid insulation for highest voltages.
- Temperature rise tests, including overloading and direct temperature measurements by means of fiber optic probes, showed temperatures below the limits of IEC 60076-14, and without gas generation.

	Standard substation transformer	Conventional fast-deployable transformer	Hybrid insulation fast-deployable transformer
Rated Power (p.u.)	1	0.6	1.25
Load losses (p.u.)	1	0.87	1.74
No load losses @100% exc. (p.u.)	1	0.60	0.77
Shipping weight (p.u.)	1	0.53	0.62
Ratio Ton/MVA	0.57	0.51	0.28
Shipping dimensions L x W x H (p.u.)	1 x 1 x 1	1.17 x 0.68 x 0.75	1.32 x 0.69 x 0.71
Overall dimensions L x W x H (p.u.)	1 x 1 x 1	0.94 x 0.85 x 0.80	0.93 x 0.76 x 0.79

Table illustrates the key power, weight and dimensional advantages of ABB's new fast-deployable transformer design compared with standard substation transformers and conventional fast-deployable transformers, shown in relative values. (Table courtesy of ABB. ABB reserves all rights and takes no responsibility for the use of this information.)

About Nomex® papers and pressboards

DuPont™ Nomex® is a synthetic aromatic polyamide offering exceptional electrical, chemical and mechanical integrity, and resistance to high temperatures. It is widely specified as hybrid insulation for Class H transformers because of its upper temperature capability of 220°C, building in a safety margin that comfortably exceeds actual operating conditions. DuPont markets different types of Nomex® papers and pressboards in high, medium and low density, and in a range of thicknesses, for many insulation applications.

For more information, visit: www.nomexpaper.dupont.com or contact ABB at <http://new.abb.com/products/transformers/power>.