



# Transforming perfect planning into outstanding performance. Siemens Transformers.

GEAFOL cast-resin transformers up to 40 MVA

Answers for energy.

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With the world's largest cast resin transformer, Siemens offers a safe, powerful, and environmentally safe alternative to liquid-filled transformers. This specially developed transformer, which weighs 50 tons, has some special features: to achieve such a high output, the high-voltage coils consist of six partial coils that are interconnected to create a winding. Excess heat is dissipated via special cooling channels in the windings.



The most up-to-date production technology: fully automatic punched core laying system.

Performance increase by about 25 percent thanks to fitting of cross-flow fans.

# GEAFOL Cast-Resin Transformers up to 40 MVA and 45 kV

## The Economical Alternative!

### **GEAFOL: Simply more efficient.**

Especially nowadays, when transformers are often loaded up to their maximum performance limits for extended periods, GEAFOL cast-resin transformers offer operators a lot of advantages. Firstly, they provide higher efficiency in that load range. Secondly, thanks to their special design, they have a clearly higher peak load capability which is frequently required above all in railway applications and rolling mills. They can easily handle peak loads up to three to five times the rating, even for several minutes on end.

### **GEAFOL: Simply faster.**

Not only our superbly organized and highly modern production facilities enable you generally to reach your goals faster with GEAFOL. Our simplified delivery, installation and commissioning procedures also save you valuable time, not to mention the construction work required, say, for oil sumps or additional fire protection measures in the case of oil-filled power transformers – none of which are necessary with the GEAFOL.

### **GEAFOL: Simply more power.**

Easy-to-retrofit fans allow the output of large GEAFOL transformers of 5 MVA and above to be boosted by about 25 to 40 percent – even during continuous operation. This makes sure you always have substantial power reserves at your disposal. Or, alternatively, the GEAFOL can be dimensioned to be smaller and lighter from the very beginning.

### **GEAFOL: Small despite its size.**

Industry in particular is attaching ever greater importance to the aspect of space requirements, above all when considering a long-term investment such as a transformer. The costs of the installation area add up over a lifetime of around 30 years. So, the smaller the space requirements, the more flexibly you can react to new demands.

### **GEAFOL: It pays off.**

For physical reasons, GEAFOL cast-resin transformers are designed differently to oil-insulated units as regards current density in the windings. This difference

manifests itself in considerably reduced winding losses and therefore in higher efficiency. In particular when the rated power is frequently utilized to the full, the GEAFOL performs more convincingly than oil-filled transformers when it comes to ensuring lower energy costs – an aspect which ultimately saves not only money but also resources.

And, since the maintenance requirement of the GEAFOL is very low throughout its entire service life, operating costs are also reduced. What's more, GEAFOL cast-resin transformers are often installed decentralized at the load center, so energy transport losses are correspondingly lower. Unlike oil-filled transformers, cast-resin transformers do not need costly fire protection measures or oil sumps.







## GEAFOL: A Strong Partner for Industry

### **GEAFOL: Just set it up ...**

... and put it to work! Once installed, the GEAFOL is connected and ready for operation. As it is virtually maintenance-free, you can basically forget about it for the next 30 years! However, should a repair ever be necessary because of extreme overloading, that's no problem either because the transformer is made of individual components which can be replaced quickly.

### **GEAFOL:**

#### **Simply environmentally friendly.**

The GEAFOL's insulation consists of an epoxy resin and quartz powder mixture with excellent properties. It makes the windings maintenance-free, suitable for the tropics, moisture-proof and self-extinguishing. No toxic gases are produced, not even under the effects of arcing. And the specially developed spacers of the coil support system ensure isolation of vibrations from the iron core, which leads to very low noise levels.

#### **Recycling with no ifs, ands or buts.**

When it comes to recycling, the GEAFOL offers clear advantages over the oil-filled transformer, too. All metal parts can be recycled by conventional methods. The aluminum foil and the insulating resin can be separated mechanically. The aluminum foil and the insulating resin can

be mechanically separated; the foil is returned to the aluminum cycle while the resin can, for example, be used as a filler.

#### **Strong output, reliable operation.**

For almost 50 years now, GEAFOL transformers with ratings in excess of 5 MVA have been operating successfully around the world. They are mainly used in industrial applications close to the load centers, in rolling mills, on offshore platforms and ships, in mining conveyors and in refineries, or wherever maximum power-to-volume ratio has to be achieved in buildings.

For instance, they are also installed in powerful wind generators because they are predestined for operation directly in the gondola. Operating reliability, fire protection and low maintenance are especially important here, above all in offshore installations.

#### **You can rely on Siemens.**

Thanks to our international organization, we are close to our customers the world over. Even if that's a foregone conclusion nowadays, it is a genuine advantage for our customers – and not only when they need service. Thanks to our strong world market position in the field of power transformers, we also possess the logistical expertise needed to get your GEAFOL swiftly and reliably to any given location.

#### **A long successful history.**

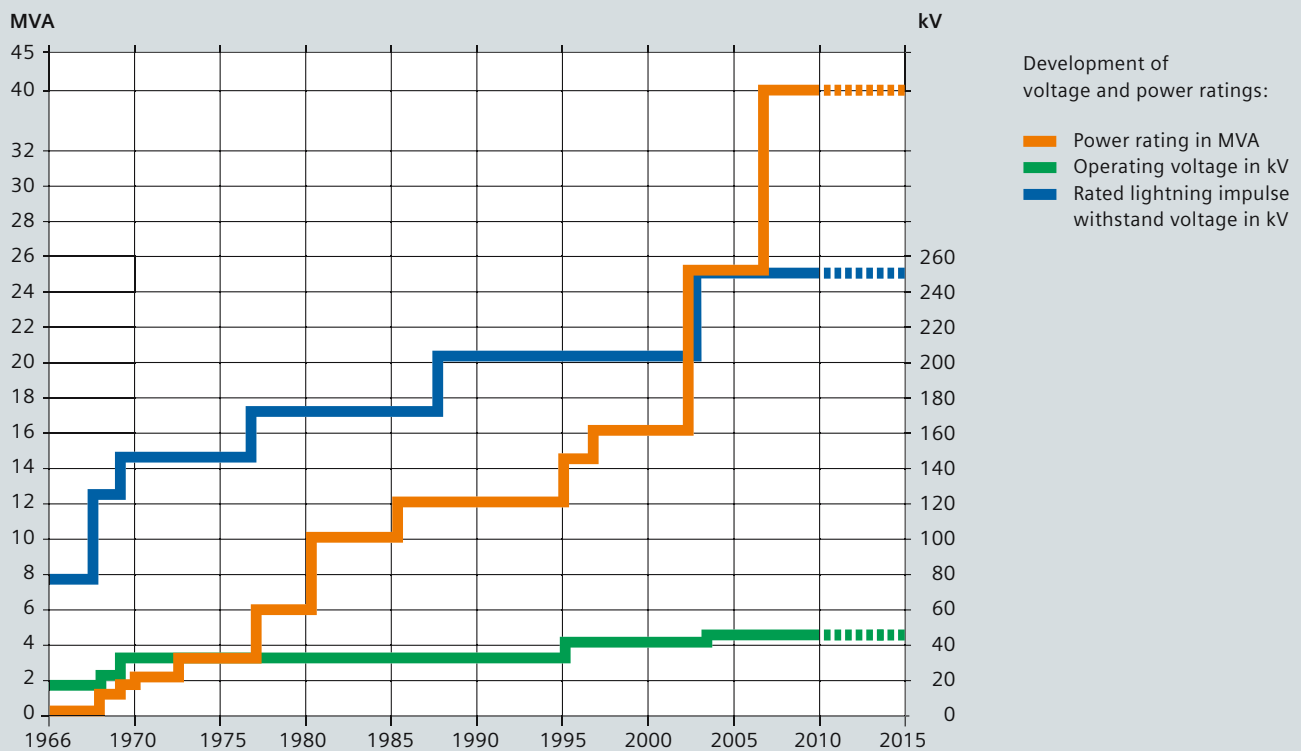
GEAFOL are able to look back on a long success story that started in 1966. More than 100,000 of our transformers worldwide are operating according to this principle – near the load, with low losses and practically maintenance-free. The decisive advantage: Continual increase of the GEAFOL transformer rating is not only based on our own experience but also on that gained from the construction of oil-filled power transformers in the same operating group. Despite differences in technology, there is plenty of know-how that can be transferred. In the design phase, our engineers rely on the most up-to-date IT systems.

#### **Tried and tested quality.**

It goes without saying that we possess our own, highly modern test lab to test transformers, even with these high ratings, directly at the factory. Therefore, the GEAFOL dispenses with time-consuming and work-intensive transport operations and the related costs. The freedom of our transformers from partial discharges is tested up to twice the rated voltage – in other words, far beyond the amount specified in the standard.



The coil support system compensates thermal expansion of the coils by means of spring pressure.



**1** Three-limb core made of grain oriented low-loss electrolaminations insulated on both sides

**2** LV winding of aluminum strip; Windings fully covered with bonded insulating sheet

**3** HV winding consisting of individual vacuum-potted coils of aluminum foil

**4** LV terminals

**5** HV terminals HV tapping links permitting adjustment to system conditions; can be reconnected in de-energized state

**6** Coil support system or separation of core and winding vibrations; low noise values

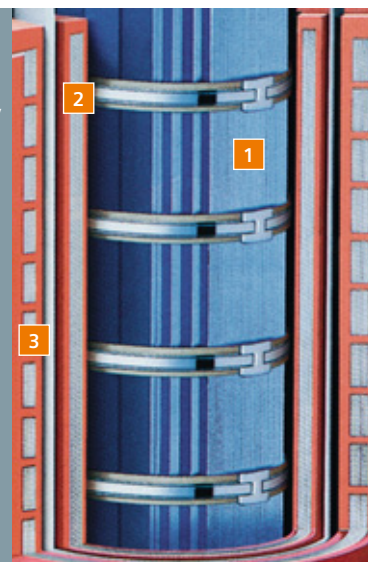
**7** Yoke clamping frame and truck Rollers can be swung round for lengthways and sideways travel

**8** Insulation made of an epoxy-resin and quartz-powder mixture makes the transformer practically maintenance-free, moisture-proof and suitable for tropical climates, poorly combustible and self-extinguishing

**9** Cross-flow fans to boost performance

**Temperature monitoring** by PTC thermistor sensor or PT100 in the low-voltage winding

**Paint finish of steel parts** Thick film paint coating, on request: two-component paint coating or galvanization (particularly aggressive environments)



## GEAFOL: Superior Technology

### Development continues.

The performance data of GEAFOL transformers has developed continuously in terms of rated power, operating voltage and rated lightning impulse withstand voltage. Since as early as 1977, distribution transformers have been manufactured and GEAFOL transformers above 5 MVA developed to meet customers' specific requirements.

### New technology for new quantities.

The thermal load on the transformer represents a particular challenge in the power range from 20 MVA. Therefore, for the new GEAFOL transformers in this rating class, we have developed a highly efficient cooling method which operates with novel cooling ducts.

What is new about it is that special cooling ducts are now used in the higher-voltage winding and the core to dissipate heat losses. Besides that, by means of the new coil support system we absorb the high axial forces that arise in the event of a short-circuit. In this system, the coils are fixed with spring pressure and, at the same time, the increased thermal expansion of the larger coils is compensated.

### GEAFOL: Suitable for universal use.

Dry transformers must be marked in conformity with the verified ambient, climate and fire categories. Extensive testing is required for certification. GEAFOL cast-resin transformers conform to the highest defined categories and can therefore be used anywhere:

- Ambient category E2
- Climate category C2
- Fire category F1

We produce these units in accordance with VDE 0532-76-11, IEC 60076-11, EN 60076-11 or to special national specifications or customers' wishes.

We offer customized problem solutions which do justice to all requirements in terms of operating mode, freedom from noise and losses, connection, type of cooling, as well as transport and installation.

# GEAFOL: In Use Worldwide

Since their introduction, GEAFOL cast resin transformers have proven outstanding in reliably and safely supplying power directly to consumers around the world. Major advantages include high operating safety, practically maintenance-free operation, and extensive power reserves. They also offer compactness and the assurance that the flame-retarding, self-extinguishing insulation will not release toxic gases in the event of a malfunction, even if electrical arcing occurs. Today, GEAFOL is synonymous with reliable performance under the widest range of operating conditions!

## Directly at the load in the rolling mill.

In Novolipetzki in the CIS, 16 GEAFOL transformers (6.1 MVA each) are operating directly at the load center in a cold rolling mill in the electronic power converter mode for the roll stand and for driving a cold wide-band line. Effortlessly, they cope with the extreme thermal and dynamic loads resulting from the quickly changing load cycles.

6.1 MVA







### Stable conditions in China.

A fast-growing infrastructure such as in China can lead to voltage problems in the medium-voltage network. GEAFOLE 22-MVA transformers are used nonetheless to supply a stable voltage to ultra-modern and sensitive installations, for example, in the semiconductor production sector. The fitted stepping switches make it possible to switch even under load. These transformers featuring closed-loop voltage control are connected between the medium-voltage network and distribution transformers to ensure a reliable power supply even in sensitive areas such as these.

# 22 MVA

### Two 40-MVA GEAFOLE for HVDC PLUS

The two largest cast resin transformers in the world are being used for the test setup of the new Siemens HVDC PLUS system. The two converters are being placed in a back-to-back configuration and connected to the GEAFOLE transformers on the three-phase side. The system setup will allow the new converter topology in the HVDC PLUS system to be thoroughly tested under realistic conditions. A number of new solutions, as well as some previously patented ones such as new cooling channels in the high-voltage coils and the core, were used in these high-output cast resin transformers. This ensured that energy transmission would be environmentally friendly, safe, and efficient. The system will also be used for updates and refinements of this technology.

# 40 MVA





### On the high seas and GEAFOLE's on board.

Weighing in at 835,000 t and 110 m high, it was the world's largest drilling platform in 1984 and had a power supply equivalent to that of a city with 30,000 inhabitants. That's the Norwegian drilling platform Statfjord C, equipped with 17 cast-resin transformers. Following the positive experience gained in that project, the Oseberg platform was then equipped with GEAFOLE units in 1988.

The 23 transformers on board have a total output of more than 65 MVA, which corresponds to the power requirement of a city with a population of 40,000. In the meantime, many more drilling platforms have been built with GEAFOLE, and a large number of them are still under construction.

5,000 kVA

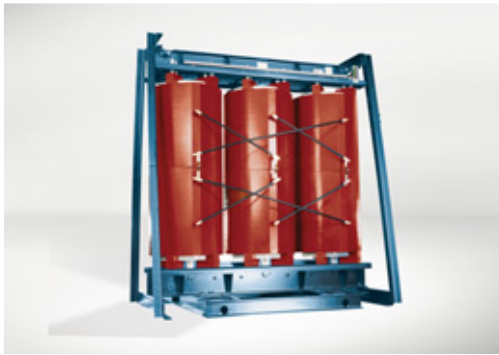
### Really "cool": the GEAFOLE on the "Grand Princess".

Eight GEAFOLE transformers featuring a special cooling system ensure a smooth power supply on one of the largest cruise liners in the world, the "Grand Princess", with its 2,600 passengers and 1,100 crew members. Installed in an enclosure to degree of protection IP 44, each transformer has a rating of 9.15 MVA.



9.15 MVA





### The GEAFOLE that went out into the cold.

We built these 7.5-MVA double-tier electronic power converter transformers ( $35 \pm 2 \times 2.5 \% / 2 \times 2.2 \text{ kV}$ ) for use in the Priobskoye oil field. They are designed for an ambient temperature down to  $-55^\circ\text{C}$ . Transformer certification conforms to the Gost standard. They were set up on a platform supported by a pile foundation.

# 7.5 MVA

**23-MVA GEAFOLE double-tier converter/cast resin transformers for the Moorburg coal-fired power plant.** Generating about 12 billion kilowatt-hours annually, the new Moorburg power plant is almost able to cover the city's entire power requirement, while also supplying hundreds of thousands of households with district heating. The four transformers with a capacity of 23 MVA and a weight of 42 tons each will be used for the power supply of the controlled feedwater pump drives of the Moorburg coal-fired power plant located in Hamburg. A particular feature of these double-tier transformers is their two secondary windings that are  $30^\circ$  phase shifted to each other. This phase shift reduces system perturbations caused by the converter when controlling the speed and torque of the pump drive. As a result, supply grids are less burdened by harmonics and making expensive filter systems unnecessary.

# 23 MVA



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