

The image features a close-up, low-angle view of two large, cylindrical transformer windings. The winding on the right is a vibrant red, while the one on the left is a dark, almost black color. Both windings show the intricate, concentric layers of the transformer's core. The background is a soft, out-of-focus blue and white, suggesting an industrial or laboratory setting. In the top left corner, the Siemens logo is displayed in a white box.

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# Transforming know-how into top technology all round

GEAFOL cast-resin transformers

Answers for energy.

# The safe technology

## GEAFOL cast-resin transformers

Wherever distribution transformers have to assure the utmost safety in areas frequented by people, GEAFOL® cast-resin transformers are the ideal solution. With GEAFOL, the limitations of liquid-filled transformers are avoided, but the proven characteristics such as operating safety and service life are retained.

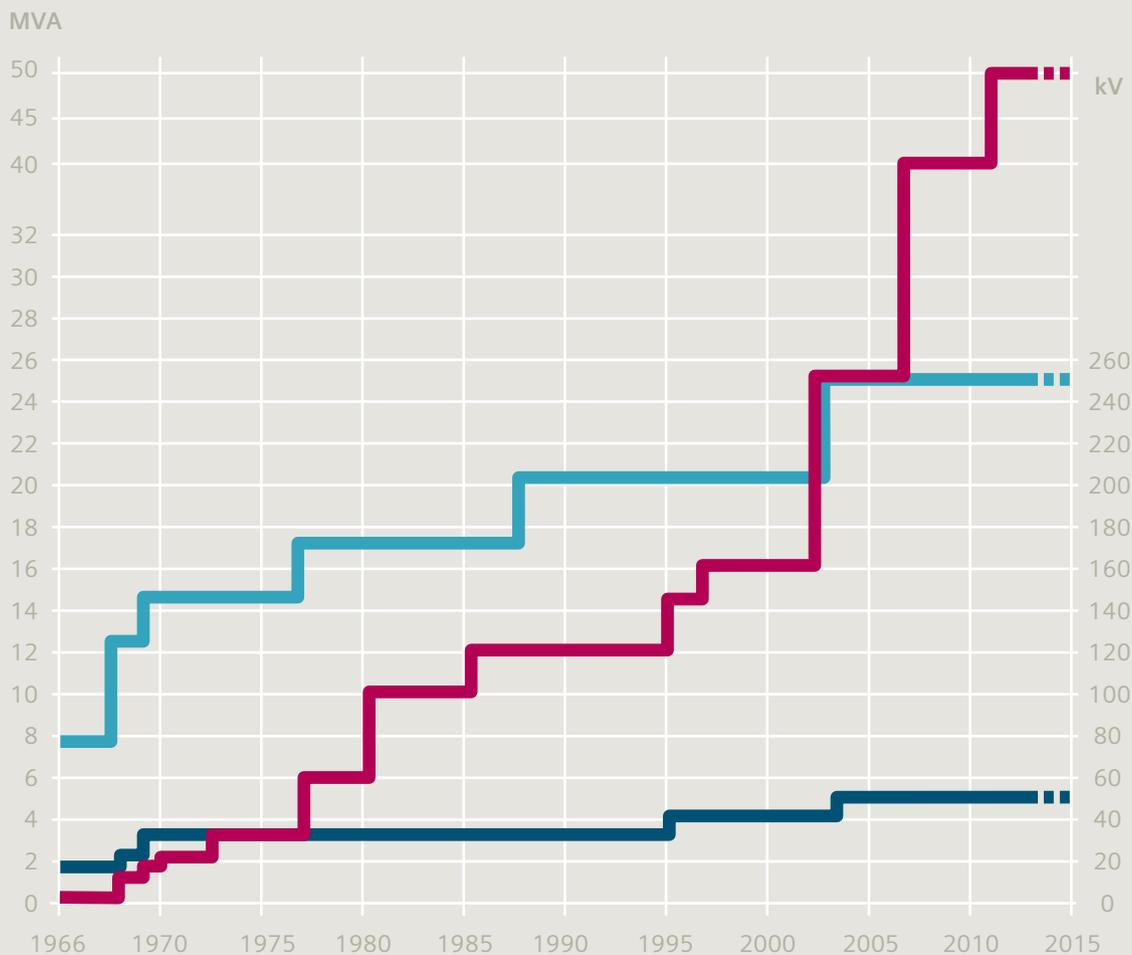
GEAFOL cast-resin transformers comply with IEC 60076-11 or EN 60076-11 as well as VDE 0532-76-11. However, they can also be designed to meet special national regulations or customer wishes. We offer tailored solutions that meet all requirements when it comes to operating mode, low noise and loss levels, connection technology, type of cooling, as well as transport and installation.

### Safety proven 100,000 times over

There are good reasons why GEAFOL cast-resin transformers are used wherever absolute safety is required. They can be found in high-rise buildings, hospitals, road and underground railway shafts, offshore installations, mines, wind turbines, nuclear power plants, and many other similar safety-critical environments. It is not surprising that the superior GEAFOL technology is produced under license by many transformer manufacturers all over the world.

Over 100,000 GEAFOL cast-resin transformers have proven themselves in power distribution all round the globe. The diagram below shows the power rating and voltage range developments achieved since 1966 as a result of continuous innovation.

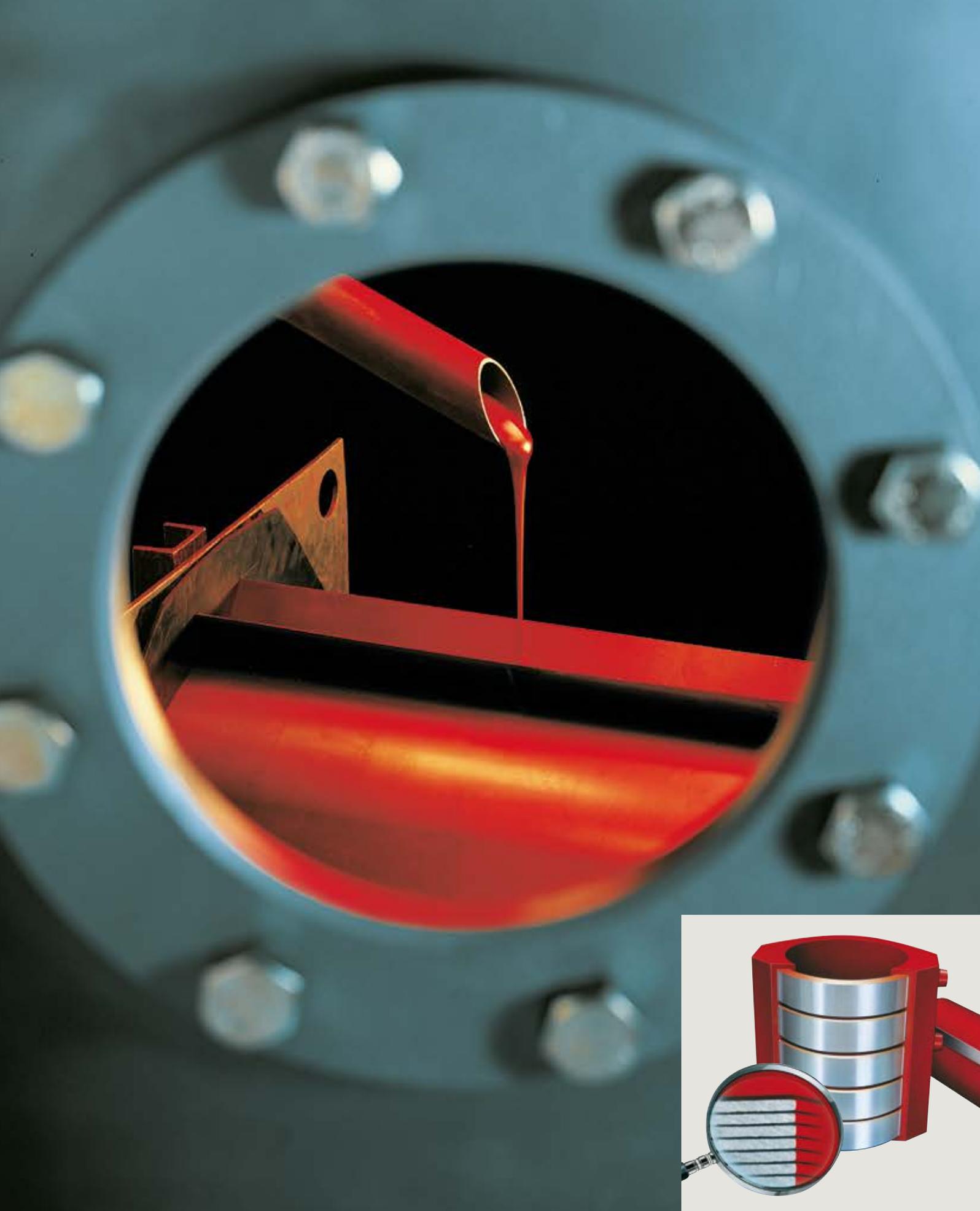
### Development of voltage and power ratings





GEAFOL transformers, with their environmentally sustainable technology and versatility, ensure efficient energy distribution at load centers.

GEAFOL transformers cover an output range from 50 kVA to approx. 50 MVA with operating voltages up to 52 kV.



Potting of the winding in the vacuum furnace

Partially potted HV winding with magnified cross-section of coil

# The perfect technology

## GEAFOL cast-resin transformers

The GEAFOL principle has succeeded in producing transformers with excellent electrical, mechanical and thermal characteristics, which have also proved to be particularly compatible with the environment.

### Maintenance-free – environmentally friendly – rugged: The insulation

GEAFOL transformers are insulated with an epoxy resin/ quartz powder mixture. This is an environmentally friendly material that makes the windings maintenance-free, moisture-resistant, tropicalized, flame-retardant and self-extinguishing. This eliminates the need for additional flame-retardant chemicals, such as aluminum oxide trihydrate, which can negatively affect mechanical properties as well as aging. Even when the insulation is exposed to arcing, no toxic gases are generated. The windings are clamped between resilient spacers that provide effective vibration insulation both from the iron core and mutually between windings. The result: GEAFOL transformers are as quiet as oil-immersed types.

### Electrically safe: The aluminum foil winding

The coils of the high-voltage windings are made of aluminum foil. Why foil windings? Because foil windings combine a simple winding technique with a high degree of electrical safety. The insulation is subjected to less electrical stress than in other types of windings. In a conventional round-wire winding, the interturn voltages can add up to twice the interlayer voltage, while in a foil winding it never exceeds the plain voltage per turn because each layer consists of only one winding turn. The result: High power frequency and impulse voltage withstand capability.

Why aluminum? The thermal expansion coefficients of aluminum and the used cast resin are so similar that thermal stresses due to load changes are kept to a minimum.

### No gas inclusions: The epoxy resin casting process

The high voltage windings are potted with epoxy resin under vacuum at a high temperature. This procedure prevents undesirable gas inclusions. The quality of the potting combined with the electrical advantages of the foil winding plays a decisive role in providing freedom from partial discharges (up to twice the rated voltage). The low-voltage strip winding is also of aluminum. The width of the aluminum strip is equal to the length of the coil. This considerably reduces axial short-circuit forces in the transformer. The conductor strip and the insulation material are bonded together by heating and thus form a compact unit with sufficient strength to withstand radial forces reliably, for example in the case of short circuits.

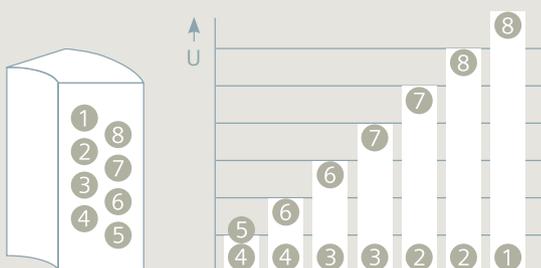
### Universal: The application areas

Dry-type transformers must be marked with proven environmental, climate and fire resistance ratings. Our GEAFOL cast-resin transformers are suitable for universal use and satisfy the requirements of the highest defined classes, as proven in comprehensive testing:

- Environmental class E2
- Climate category C2\*
- Fire resistance class F1

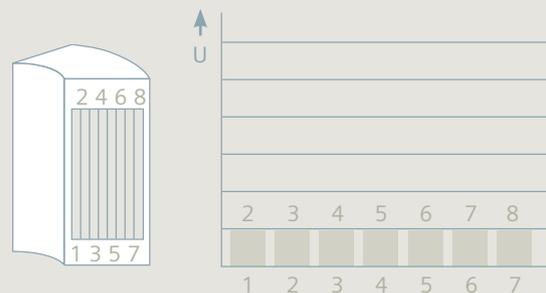
\* For outdoor installation, IP 23 degree of protection must be maintained.

### Voltage stress



#### Round-wire winding

The interturn voltages can add up to twice the interlayer voltage



#### Foil winding

The interlayer voltage is equal to the interturn voltage

# The flexible technology

## GEAFOL cast-resin transformers

### 50 % performance reserves – with radial-flow fans

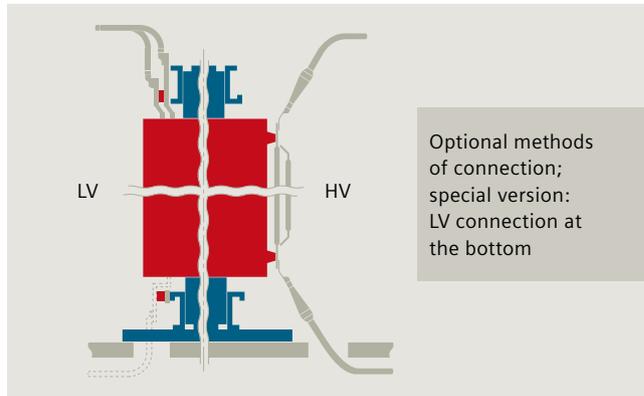
Radial-flow fans with temperature-dependent control can be installed to provide capacity reserves and to cover peak load periods. In this way, the transformer output can be raised by up to 50 %. To simplify installation and connection, the transformer is optionally available with connection on either the HV or LV side, top or bottom (note: LV connections are usually located on top, if fans are installed). Plug connections are also available.

### Uncomplicated: Planning with maximum freedom

Planning with GEAFOL does away with the limitations imposed by conventional transformer technology. Since these transformers can be installed without difficulty at load centers, optimum supply system concepts are possible. No special safety features are required (such as coolant-collecting troughs). Since the GEAFOL transformers often need less space than liquid-filled and gas-insulated transformers, a higher output can be accommodated in the same area. The modular design of the transformer is another economical feature. Windings, for instance, can be mounted and replaced on the spot.

### CO<sub>2</sub> balance

State-of-the-art transformers reduce the CO<sub>2</sub> balance because of their high efficiency and low transport losses. Thanks to environmentally friendly product design and the resulting reduction in materials and final weight, CO<sub>2</sub> is reduced during the manufacturing process as well.



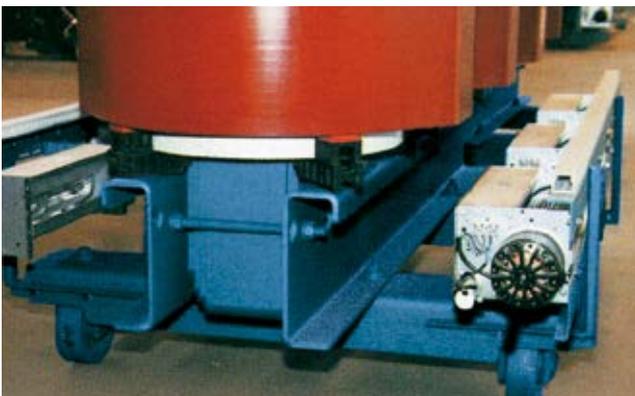
### Economical: No maintenance, no maintenance costs

GEAFOL transformers are practically maintenance-free. Once connected, in most cases they can be left to get on with their job. If the advantages of GEAFOL transformers are taken into consideration as early as at the planning stage, the overall costs of a power supply system can often be considerably reduced.

### Disposal

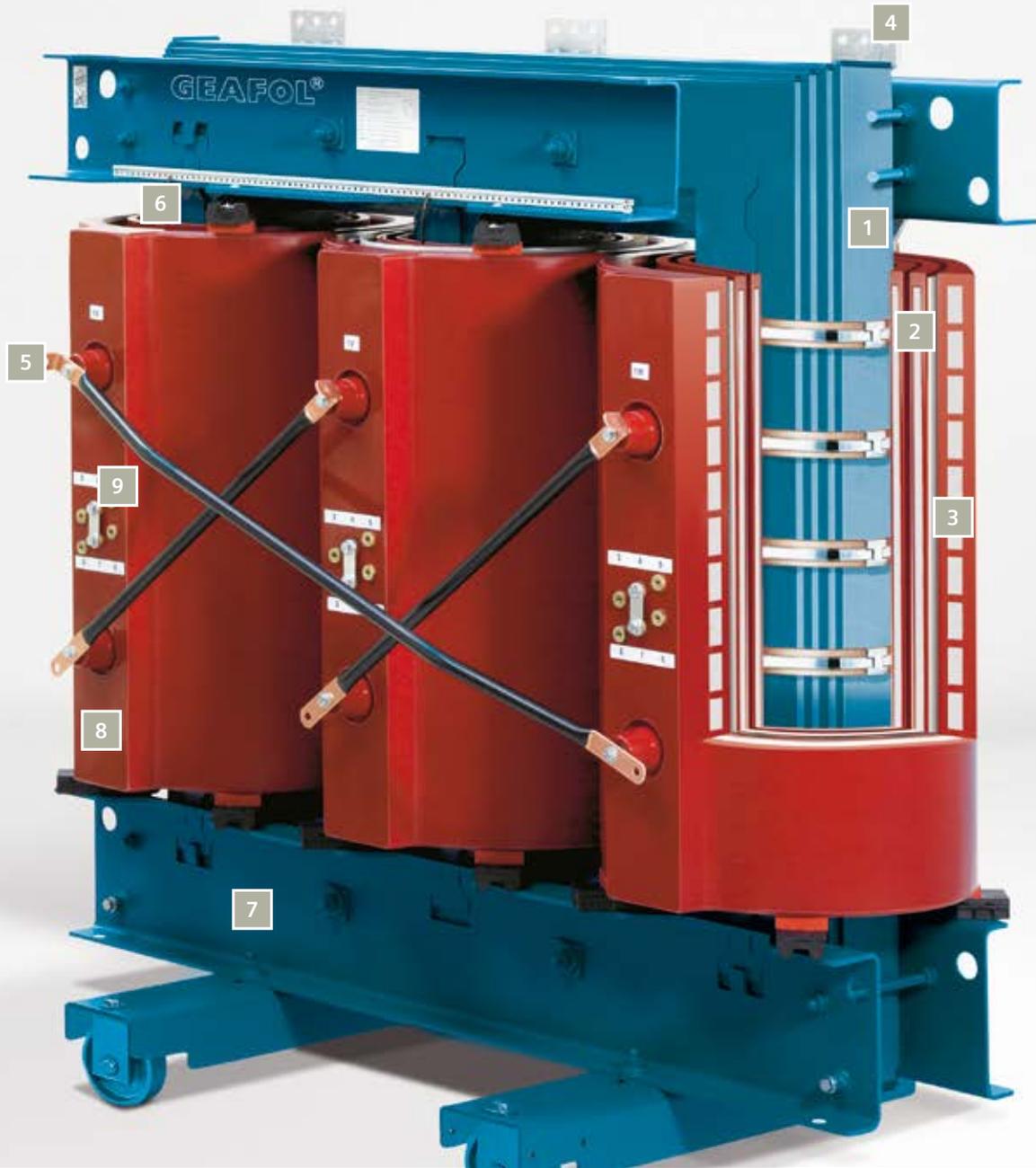
GEAFOL transformers are long-lasting investment goods with an economic lifetime of 30 or more years. Yet despite that, the time will come when the product will need to be replaced and disposed of. GEAFOL cast-resin transformers have a high recycling rate. On average, only 4 % of the material is used thermally, 2 % of the material can be disposed of in the landfill, and a full 94 % of the material can reenter the raw material cycle and be reused. It is conceivable that this material will be used again in your facility as a new transformer.

Radial-flow fans increase performance by up to 50 %



GEAFOL standard protective casings, e.g. to IP 20 degree of protection; optionally, modified housing designs are possible





## GEAFOL – Transformer technology at a glance:

- 1 Three-limb core** made of grain-oriented, low-loss electrolaminations insulated on both sides
- 2 LV winding** made of aluminum strip; turns firmly glued together by means of insulating sheet wrapper material (prepreg)
- 3 HV winding** consisting of vacuum-potted single foil-type aluminum coils; see also page 4
- 4 LV terminals**
- 5 Delta connection tubes with HV terminals**
- 6 Coil support system** to insulate core and windings from mechanical vibrations, resulting in low noise emissions as well

as allowing free expansion of the components in case of temperature fluctuations

- 7 Clamping frame and truck**  
Rollers can be turned around for lengthwise or sidewise travel
- 8 Insulation: Mixture of epoxy resin and quartz powder** makes the transformer nearly maintenance-free, moisture-proof, tropicalized, flame-resistant and self-extinguishing (aluminum oxide trihydrate not necessary)
- 9 HV tapping links  $\pm 2 \times 2,5\%$**  (on the HV terminal side) permitting adjustment to system conditions; can be reconnected in de-energized state

**Temperature monitoring** by PTC thermistor sensors in the LV winding (on request PT 100)

**Paint finish on steel parts**  
Thick-layer coating, RAL 5009, on request: Two-component varnish or galvanizing (for particularly aggressive environments)

**Modular design** e.g., windings can be individually mounted and replaced on site

**Ambient class E2**

**Climatic category C2**

(if the transformer is installed outdoors, degree of protection IP 23 must be assured)

**Fire resistance class F1**

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