Distribution transformers
CG Power Systems distribution transformers are manufactured in Mechelen (Belgium) and Cavan (Ireland).

The product range includes:

- Bio-SLIM® transformers
- SLIM® transformers
- Self-protected distribution transformers
- Steepwave distribution transformers
- Amorphous metal distribution transformers
- Three-phase pole/platform type transformers
- Liquid-filled three phase transformers
- Single phase transformers
- Compact substations
- Padmount units
The construction of a transformer comprises two active components: the ferromagnetic core and the windings. Within the transformer industry, the core and windings together are normally referred to as the “active part”. The passive part of a transformer is the cooling system, in case of liquid-immersed transformers consisting of the tank and the cooling liquid (mineral oil, silicone fluid, synthetic organic ester or natural ester).

The heart of the matter: the ferromagnetic core

The cut of the core sheets and the material of the ferromagnetic core are optimized according to the desired no-load characteristics and the specified noise level. Extensive rationalization of the shape and the clamping devices enables CG Power Systems to produce a core with minimum losses and dimensions. This methodology optimizes the consumption of both materials and energy, bringing benefits to the environment and to both the user and manufacturer.

The core has to be constructed in such a way as to limit the energy losses caused by eddy currents and hysteresis to a minimum. This is achieved by the use of silicon steel, a special soft steel with a 3.5% silicon content, which is characterized by low hysteresis losses and high resistivity. The reactive power dissipation can be lowered by limiting flux disturbances and minimizing air gaps in the joints between the core legs and the yokes.

Material

The core is constructed using thin sheets of cold-rolled grain-oriented magnetic silicon steel. Conventional grain oriented steel (CGO steel) is used for transformers with normal no-load loss characteristics, while transformers with reduced no-load losses are often built using higher-quality HiB steel, usually domain-refined (e.g. laser treated). These steel sheets are 0.23 to 0.35mm thick. Extremely low no-load losses can be achieved only by using amorphous metal. This ribbon of only 0.025mm thickness has very specific properties and therefore it requires a specially adapted design and use in wound cores only.
Cutting and stacking of the core sheets

Minimum magnetic flux distortion in the transition areas between yokes and core legs is achieved by optimizing the cut of the core sheets and the stacking pattern.

First of all, the core sheets are cut at an angle of 45°, thus allowing maximum flow of magnetic flux in the rolling direction which is the preferred flux path with lowest losses. Then the sheets are stacked in an overlap pattern of either single or multiple overlaps.

The multiple overlap or step-lap method offers additional benefits in terms of lower no-load losses and noise levels. Because they involve a more complicated production technology, step-lap cores are preferably made on fully automatic cutting and stacking machines.

Shape of core section

The vast majority of the distribution transformers built by CG Power Systems have an oval-shaped core section, formed by combining the traditional stepped round shape with a square mid-section. This gives great flexibility to the designers and allows them to select the ideal individual core section, while maintaining the use of standard materials and dimensions. This method combines the benefits of a rectangular core section (simplicity of production) with those of a round core section (excellent short-circuit withstand capability of the windings).

Clamping devices

By using simple profiled-steel yoke clamping systems and a number of metal tensioning straps, CG Power Systems has eliminated largely the need for either clamping bolts in the yokes (which distort the magnetic flux) or tie rods between the upper and lower yokes (which requires a larger tank).
Low voltage windings

Low voltage windings of distribution transformers are usually made of copper or aluminium sheet conductor (foil). The benefit of foil is that any high voltage ampere-turn asymmetry is compensated automatically by an appropriate internal current distribution in the low voltage foil. This reduces the axial stresses produced by short-circuits to a minimum (down to 10% of those for conventional windings), thus enabling the axial support construction to be greatly simplified.

Designs are adapted to the thermal, electrical and chemical characteristics of both conductor materials, thus ensuring that both versions are of equivalent quality and performance.

The maximum voltage between each turn is only a few tens of volts. This allows the insulation needed between the turns (foils) to be limited to 1 or 2 sheets of fine kraft paper or Nomex® (1). According to the design specification, this insulation may be coated with a thermo-hardening epoxy adhesive which cures and bonds during the drying process.

The structures forming the insulating space separating the low and high voltage windings, are fitted directly onto the low voltage foil winding, thus forming a part of it. These processes enhance the transformer’s short-circuit withstand capability.

Supplementary benefits of foil windings are:
- Greater simplicity in fitting cooling ducts.
- More even heat distribution through the windings.
- Semi-automatic winding techniques can be used.
High voltage windings

High voltage windings are almost exclusively of layered construction. The copper or aluminium conductors are made of one or more round or rectangular wires, either with an insulating enamel coating or wrapped in insulating paper or Nomex® (1).

The insulation between the layers consists of sheets of pre-coated kraft paper or Nomex® (1). The special epoxy adhesive coating in diamond pattern cures during the drying process, bonding the windings into a single structure and leaving channels for the oil impregnation.

The high voltage winding is wound directly onto the low voltage winding, over the structures forming the LV/HV insulation, giving maximum mechanical strength, rigidity and compactness.

This mechanical strength is of the utmost importance since, in the event of short-circuit, the windings have to sustain very high radial repellent forces. The mechanical effect of these forces is minimal in round windings, since these windings inherently have the ideal form to withstand radial stresses. The mechanical effect is much greater in rectangular windings. In order to combine the advantages of a rectangular core section (simplicity of production) with the benefits of round windings (excellent short-circuit withstand capability), CG Power Systems has developed the unique concept of oval-shaped cores and windings (see drawing above).

The main benefits of layered windings are:

> They form a simple winding, which allows continuous or semi-automatic winding.
> The impulse voltage distribution throughout the winding is predictable and controlled.
> Axial cooling ducts are simple to build and fit.
> Any taps required can be brought out anywhere in the winding through the layers.

(1) Nomex® high temperature insulation system is used in the ultra-compact and fire-safe SLIM® and Bio-SLIM® line transformers according to IEC 60076-14.
Assembly of cores and windings to build an active part may be carried out in either of the following two ways:

If the windings have been wound on a mandrel, the E-shaped cores and the windings are transported from their various construction locations to the assembly area where the windings are pushed over the core legs. The magnetic circuit is then completed by interleaving the laminations of the upper yoke with the laminations of the core legs.

If the windings have been wound directly onto the core legs (typically the range <1000kVA), the three core legs are positioned on a tilting table. The upper and lower yokes are then fitted highly accurately in the same way as described above.
Bushings are mounted on the cover, which is then fixed onto the assembled active part. The next step consists of connecting the windings to the bushings. The connection methods are durable and selected so as to ensure a solid, low-resistance connection between the linked conducting materials.

Transformers are often fitted with an off-circuit tap changer. This switch allows the increase or decrease of a certain number of turns while the transformer is disconnected from the circuit. Small variations in the supply voltage can be compensated by adjusting the tap changer to keep the output voltage at the required value.

The off-circuit tap changer is always fitted on the high voltage side of the transformer, since this is where the current is smallest. A second tap change switch is incorporated in transformers with dual high voltages in order to change the high voltage. Tap changers and tap switches are controlled either by cable or by a drive shaft.

The voltage ratio of the active part is then tested, and the assembly is dried for a specified time in an oven to remove the moisture from the insulating materials. This time depends on the quantity of insulating materials, which in turn depends on the transformer’s rating and voltages.
Construction

The vast majority of distribution transformer tanks are constructed with cooling fins. As with radiators, the purpose of cooling fins is to increase the available contact surface for the cooling air. However, in hermetically sealed designs the cooling fin design also enables a degree of flexibility which is needed to accommodate the expansion and contraction of the liquid as it heats and cools, due to load and ambient temperature. This allows the tank to be totally filled (and hermetically sealed), with the clear benefit of prolonging the transformer’s service life expectancy and reducing maintenance.

In certain cases, e.g. small ratings or severe dimensional limitations, the fins become so small that they are no longer flexible enough, necessitating the use of a gas cushion to allow the expansion of the liquid. This gas cushion keeps the internal pressure within the acceptable limits permitted by tank flexibility. Occasionally, some customers specify that a conservator must be fitted on top of the transformer tank to act as an expansion tank for the cooling liquid. The conservator is often fitted with a gauge glass, an air vent and an air dryer in an effort to ensure that only dry air can come into contact with the cooling liquid, and only at atmospheric pressure. If the air dryer is not properly maintained, it can lose its effectiveness and allow damp air to come in contact with the cooling liquid.

Functions of the transformer tank:

> It forms a container for the cooling liquid.
> It acts as a heat exchange surface for the dissipation of heat losses.
> It is a protective, earthed safety shell.
> It provides shielding against electromagnetic field leakage caused by current-carrying conductors.
Hermetically sealed transformers offer indisputable advantages compared with transformers fitted with a conservator, including:

> The insulating liquid cannot come into contact with the air, thus guaranteeing preservation of its dielectric integrity.
> Reduced maintenance, e.g. no checking required of the air dryer, no need to monitor the liquid for water ingress, etc.
> They are cheaper to buy.
> They occupy a smaller space, leaving more room for connections in compact installations.
> The protection equipment is often simpler than that fitted on transformers with a conservator.

The construction of these finned tanks is rather simple. The bottom, top frame, corrugated fin wall panels and plain wall panels are mounted on rotating welding tables and welded together. The ingenuity of our designers, the skill and craftsmanship of experienced welders, the robustness of the materials we use, individual leak tests during production and fatigue tests on typical designs all combine to ensure the long-term leak-free quality of our tanks.

Cooling

Heat is generated inside a transformer by the effects described by Joule’s law, hysteresis losses and eddy currents. This causes a rise in the temperature of the windings and core. The temperature will reach equilibrium when the quantity of generated heat is equal to the quantity of removed heat. Cooling is optimized in accordance with the maximum permissible temperature of the insulation system and the total quantity of heat to be dissipated, which depends on the transformer’s loss level.
Surface treatment and painting

After welding, the tank is shot-blasted to remove any surface impurities, leaving a clean prepared surface for maximum adhesion of the paint coating. Air-drying paint is then applied by spraying or flooding. An alternative painting technique is electrostatic powder coating, which is used for tank covers and cable boxes and also for complete tanks in some of the CG-factories. Where powder coating is employed, further chemical processes are needed before the powder coating is applied.

Several coats of paint are applied to a total thickness which guarantees adequate protection against corrosion for the pollution class of the locations where the transformer is installed. Tanks may be hot dip galvanised if requested by the customer.

Standard colours are RAL 7033 (green) or RAL (blue) for the Bio-SLIM® line.
State-of-the-art painting line

A state-of-the-art painting line, incorporating zinc phosphating, electrically applied liquid paint and powder coating has been installed in the Irish factory. This system is one of the most up-to-date developments in the field of finishing and the quality obtained is comparable with that required by today’s automotive industry for modern car bodies. Tests by independent laboratories have shown that transformer tanks treated in this way withstand more than 2,000 hours hot salt spray scribed test carried out in accordance with the relevant international standards.

Standard tanks are equipped with:

- **securing lugs** on the top frame of the tank to secure the transformer during transport
- **lifting lugs** on the cover to lift the complete transformer and/or the active part
- **underbase** welded to the bottom of the tank with bi-directional rollers (roller base)
- **filling hole** on the cover (can also be used to mount an overpressure valve)
- **earthing terminals** on tank cover and underbase or tank bottom
- **thermometer pocket** welded to the tank cover and filled with cooling liquid
- **drain valve** at the bottom of the tank (can also be used to take oil samples)

This standard package can be expanded to include other monitoring and protection instruments.
Mounting the active part in the tank

Once the active part has been oven-dried, it is given a final comprehensive quality inspection before being tanked. The top cover is then either bolted or welded onto the tank frame, in agreement with the customer. Both sealing methods are equally effective and performing. For silicone filled units we advise welded lids while for other liquids we have no preference.

Filling

The transformers are placed in a vacuum chamber and filled with pre-treated liquid (filtered, dried and degassed) under deep vacuum. This ensures optimum impregnation of the insulation materials by the cooling liquid, giving the insulation structure maximum dielectric strength. Most transformers are filled with a high quality mineral oil which complies fully with the requirements of IEC standard 60296. In some cases, transformers are filled with silicone liquid (complying with IEC 60836) or synthetic organic esters (complying with IEC 61099). The liquid acts both as a coolant and as an insulating medium.
Testing
In the test bay, each transformer is subjected to a number of routine measurements and tests.

Fitting of protection equipment
Once routine testing is completed, the protection instruments and other accessories are mounted and the transformer is subjected to a final global inspection. Subsequently, the rating plate is fitted to the tank. The transformer is then ready for packing and transportation.

Packing and transport
For transport by road, timbers are attached to the U-shaped profiles of the roller base or skid, thus enabling the transformer to be secured to the load floor of the truck. A similar procedure is followed for container transport. When specifically requested by the customer, and mainly for transport by sea, the transformers are placed in strong wooden crates or boxes.

Routine measurements and tests
- Measurement of voltage ratios.
- Vector group test.
- Measurement of high voltage and low voltage winding resistances.
- Dielectric test of high voltage and low voltage winding(s) (1 minute at rated withstand voltage and nominal frequency). This test is also known as the "applied overvoltage test" and is intended to check the insulation of one winding from all other transformer components.
- Double voltage test (1 minute at double voltage and double frequency) induced via the low voltage winding. This is also known as the "induced overvoltage test" and is designed to check the insulation within each winding (turn to turn and layer to layer).
- Measurement of no-load losses and no-load current.
- Measurement of load losses and impedance voltage with the off-circuit tap changer in the nominal position.
- Measurement of the resistances of the insulating system between high voltage, low voltage and tank (Megger test).
In addition to standard transformer types for distribution applications, CG Power Systems also builds special transformers for industrial applications. These non-standard types in electrical and/or mechanical characteristics, are the result of extensive product development based on constant monitoring and evaluation of changing customer needs in the various market segments. In some cases, special customer requirements have also led to the development of a new product with its own characteristics.

Special transformer types

The CG Power Systems DT-business unit’s product range includes the following special distribution transformers, although this list is not exhaustive:

- single-phase transformers (used mainly in the US, Ireland and the UK)
- dual voltage transformers
- amorphous metal distribution transformers (AMDT)
- steep-wave transformers
- compact substations
- three-winding transformers
- auto-transformers
- converter transformers
- generator transformers
- earthing transformers
- substations with cable boxes and connectors for Ring Main Units (RMUs)
- phase shifters
- mono and tri-mono transformers
- transformers with special cable boxes (filled with air or oil)
- transformers with forced cooling (by means of fans and/or heat-exchanger)
- transformers with integrated protecting (fuses) and disconnecting equipment (as per IEC 60076-13)
- SLIM® and Bio-SLIM® transformers (very compact high temperature transformers) as per IEC 60076-14
- Small Power (up to 30 MVA)

Detailed information about our standard and special distribution transformers is available upon request.
Despite the fact that transformers are highly efficient electrical devices (>99%), inevitably some energy is lost during their long service life. This energy loss arises from the sum of no-load losses and load losses. These losses convert to heat which has to be removed during operation.

**No-load losses (P\(_0\)), also called iron losses (PF\(_I\))**

No-load losses occur in the core material due to hysteresis and eddy currents, and are present almost continuously while the transformer is connected to the electricity supply (i.e. 8,760 hours per year). The hysteresis losses are proportional to the frequency and the induction. Eddy current losses are also proportional to the frequency and the amplitude of induction but mainly also to the thickness of the magnetic steel.

**Load losses (P\(_L\)), also called copper losses (PC\(_u\))**

Load losses occur in the windings, the connecting conductors and the tank. They are caused by the effects of Joule's law (Ohmic losses), eddy currents and flux leakages. Ohmic losses are equal to the product of the square of the current and the resistance of the conductor. These losses are proportional to the square of the load. In general lower losses always involve the use of a larger quantity of material and/or higher-cost materials, thus raising the price of the transformer. However, its energy consumption, and therefore running costs, will be lower. In order to make an economically valid comparison of transformers with different loss levels, a value reflecting the cost of the energy losses has to be introduced. This value, expressed in monetary units per watt, allows financial evaluation of the losses and is called “capitalization value”. The capitalization values for no-load losses (CP\(_0\)) are considerably higher than those for load losses (CP\(_L\)), which is logical because no-load losses occur continuously.
The Total Owning Cost (T.O.C.) of a transformer may be expressed by the following formula:

\[
T.O.C. = \text{purchase price} + (P_0 \times CP_0) + (P_k \times CP_k)
\]

Installation and maintenance costs may need to be added to this formula. Of course, the transformer with the lowest T.O.C. is the best economic choice in the long term. When a customer's price inquiry gives capitalization values, the optimum level of losses is calculated in the design department using specially developed software. Thus, it is often economically justifiable to replace older transformers with high loss levels by the new generation of low-loss transformers, since their lower losses ensure a significant return on investment after only a few years. If the no-load energy losses are capitalized at a very high level, then amorphous metal core transformers become an attractive alternative. The no-load losses of this type of transformer are some 75% lower than those of an equivalent transformer with a conventional magnetic steel core.

**Total Owning Cost (T.O.C.) = purchase price + (P_0\times CP_0) + (P_k\times CP_k)**

\[
T.O.C. = \text{Total Owning Cost}
\]

\[
P_0 = \text{guaranteed no-load losses (Watt)}
\]

\[
P_k = \text{guaranteed load losses (Watt)}
\]

\[
CP_0 = \text{capitalization value for no-load losses stated by the customer (euro/Watt)}
\]

\[
CP_k = \text{capitalization value for load losses stated by the customer (euro/Watt)}
\]

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**Evaluation of two distribution transformers, each with a nominal rating of 630 kVA but with different loss levels:**

<table>
<thead>
<tr>
<th></th>
<th>Tr. 1 630 kVA</th>
<th></th>
<th>Tr. 2 630 kVA</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P_0 Watt</td>
<td>P_k Watt</td>
<td>price euro</td>
<td>P_0 \times CP_0 euro</td>
<td>P_k \times CP_k euro</td>
<td>T.O.C. euro</td>
<td></td>
</tr>
<tr>
<td>Tr. 1</td>
<td>870</td>
<td>5,750</td>
<td>7,550</td>
<td>3,698</td>
<td>6,613</td>
<td>17,861</td>
<td></td>
</tr>
<tr>
<td>Tr. 2</td>
<td>1,150</td>
<td>8,400</td>
<td>7,000</td>
<td>4,888</td>
<td>9,660</td>
<td>21,548</td>
<td></td>
</tr>
</tbody>
</table>

This table clearly illustrates that the lowest purchase price does not necessarily reflect the best economic alternative.
A growing importance is attached to the negative aspects of technology on people and the environment in modern society. The potentially disturbing or hazardous aspects of transformers include:

- Noise pollution.
- Land pollution, due to escaping oil in case of leaks.
- The use of PCBs (polychlorinated biphenyls) in cooling liquids.
- Electromagnetic fields: the effects of such fields on humans, animals and instruments are not yet fully understood.
- Energy losses in transformers. This energy also has to be generated somewhere and this generation process has its own consequences, including a rise in emissions of harmful combustion gases.
- Visual pollution to the environment caused by the siting of transformers and substations without due consideration to the impact on the landscape.
- Safety of people and environment
Low-noise transformers

In many countries, there are strict limits on the noise levels which may be generated by transformers in both urban and rural locations. The primary source of the noise produced is the alternating magnetization of the core steel, while the current carrying windings contribute only a very limited amount in distribution transformers.

CG Power Systems uses a variety of techniques to limit noise levels drastically, the most important being to reduce the induction in the core, producing an appropriate core shape (e.g. the step-lap method), a special clamping construction and the use of low-resonance tanks, etc. This enables CG Power Systems to build transformers with extremely low noise levels, down to within what we refer to as “whispering level”. The building of 630kVAs with noise levels below 30 dB(A) sound pressure at 1 m is an illustration of this. CG Power Systems has also carried out pioneering work in the field of measurement of transformer-generated noise which lead to the official recognition of the noise intensity method in IEC 60076-10.

The sound intensity method allows more accurate measurement by eliminating disturbances due to the near-field effect and other nearby sources, and also enables the noise generated by the transformer to be measured when the ambient noise level is far in excess of the transformer noise. This clearly makes the noise measurement and evaluation process much simpler, while also allowing frequency analysis.

<table>
<thead>
<tr>
<th>Reference table dB(A)</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>20</td>
<td>rustling of leaves</td>
</tr>
<tr>
<td>30</td>
<td>whispering</td>
</tr>
<tr>
<td>40</td>
<td>library</td>
</tr>
<tr>
<td>60</td>
<td>normal conversation</td>
</tr>
<tr>
<td>70</td>
<td>traffic noise</td>
</tr>
<tr>
<td>100</td>
<td>heavy machine shop</td>
</tr>
<tr>
<td>120</td>
<td>rock concert</td>
</tr>
<tr>
<td>130</td>
<td>pain threshold</td>
</tr>
</tbody>
</table>
Land pollution: the importance of leakproof tanks and environmentally sound coolants

An escape of coolant from the tank can cause land pollution and possibly lead to the danger of fire when a spark or flame is present at the same time. The “Water Hazard Classification” of a liquid by the German Federal department of the environment (Umweltbundesamt) provides a measure of the threat posed by the liquid to underground and surface water. This classification is based on the biodegradability of the liquid. Most mineral oils and all silicone liquids are in category WGK 1 or 2, while esters are fully biodegradable and classified as “non-hazardous to water” (“nwg”, previously WGK 0). This class is normally specified only when the transformer is to be located in the vicinity of a water extraction area. But fire regulations and fire insurance policy conditions often also lead to the choice of these coolants. Their higher flash points and ignition temperatures (classified as K3 according to IEC 61100) enable the transformer to be operated without excessively stringent stipulations in respect of sprinkler installations or drip pans to catch leakages, thus yielding significant reductions in installation costs.

CG Power Systems also operates a consistent, stringent PCB (polychlorinated biphenyl) monitoring policy: the test certificate delivered with each transformer certifies that its PCB content is lower than the detection limit of 1 ppm (part per million). Oil deliveries or transformers returned for overhaul or servicing are never accepted before an oil sample analysis has provided conclusive proof that the liquid is PCB-free.

Recyclable materials

One of the central themes of the CG Power Systems corporate policy is the quest to reduce raw material consumption to a minimum. Waste materials from the production process are collected and carefully sorted for sale as scrap for recycling. A similar policy is followed by the specialist companies breaking old transformers for scrap. Today's CG Power Systems transformers are designed to facilitate the highest possible degree of recycling. Over 90% of the materials used can be recovered by simple procedures. Special attention is paid to environmental impact even in the choice of the smallest components.
Electromagnetic compatibility

All current-carrying conductors and machines create an electromagnetic field which can have an interfering effect on sensitive (e.g. electronic) equipment. Therefore all such products must be made with the highest possible electromagnetic compatibility (EMC): they may not produce a disruptive field or be affected by other fields in their vicinity. CG Power Systems liquid-filled transformers are ideal in this respect: their earthed tank acts as a natural electromagnetic screen, reducing the effect of external fields to negligible values.

Optimized use of raw materials and of primary energy sources

Extensive optimization has enabled CG Power Systems to succeed in building very compact and low loss transformers. Today’s 1,000 kVA model is the size of the 630 kVA transformer of just a few years ago, for example. This optimization and rationalization have simultaneously yielded significant savings in raw materials (copper, aluminium, magnetic steel, metal, etc.) and coolants.

CG Power Systems also contributes to a cleaner and safer environment by offering low-loss transformers which require lower consumption of primary energy sources (coal, gas and oil), thus reducing emissions of the harmful combustion gases which cause phenomena such as acid rain and depletion of the atmospheric ozone layer.

SLIM® and Bio-SLIM®: the nec-plus-ultra

Since 2001, CG Power Systems offers transformers with the SLIM® and Bio-SLIM® line. Thanks to the use of K3 class liquids and homogeneous insulation as per IEC 60076-14 based on the DuPont high temperature NOMEX® insulation systems, these transformers are very compact and offer low noise and low loss in combination with high fire safety, bio-friendliness and increased reliability. The compactness also represents a reduced use of materials and ECO-footprint.

This type of transformers is very popular in market segments where space is limited and safety is a priority (wind turbines, buildings, tunnels, subway, …).
Design specifications and standards

CG Power Systems transformers are designed to meet the most recent national and international standards such as IEC, ANSI/IEEE, CEN/CENELEC, BS, DIN/VDE, NEMA and CSA, etc. The R&D department is responsible for managing and updating the internal standards database. Engineers from this department also play an active role in international standards committees and working groups, where they are able to keep up-to-date with the latest developments in technical standards.

CG Power Systems has designed standard transformer models for a large number of markets, each fully meeting the local requirements. Other transformers are built to the individual specifications of customers such as electricity utilities, large contractors and heavy industrial companies. Another group of transformers, mainly in the renewable sector, are tailor-made to meet the customer’s specific requirements and needs.

This approach has enabled CG Power Systems to achieve a high degree of automation in the design and construction areas, leading directly to an ability to offer attractive prices and fast delivery. The high level of customer satisfaction and the numerous accreditations achieved after stringent approval procedures illustrate the success of the CG Power Systems product development strategy.
The complex chain of processes, from initial offer through to final delivery, is managed by the logistics department. In view of the strongly international character of the CG Power Systems Group's business, this requires flawless organization and extensive experience.

Quality logistics management produces fast delivery times, punctual and complete delivery, and correct and rapid handling of administrative procedures. Careful construction of the Group's computer network and information systems has built a superbly efficient information flow system connecting all the various departments of the CG Power Systems organization. The group operates a Just-In-Time material flow system, optimized using specialized computer software, automated warehousing systems and firm contracts with accredited suppliers.

CG Power Systems supplies transformers to customers in over 135 countries around the world. This requires the assistance of specialist transporters with wide experience in multi-mode transportation. In addition to the complexities specific to long-distance destinations, complicated logistical problems can arise when transformers have to be installed in locations where access is difficult.
Quality assurance certified to ISO 9001 and based on self-assessment

All non-conformities found during the complete process are documented and a root cause analysis is carried out.

Since end of 2010 FMEA evaluation has been introduced as part of the quality risk assessment, and this for design, production and product. This commitment to quality runs throughout the company: R&D, Design, Production, Quality Control, Logistics and Administrative Services. Additionally the Human Resources department maintains an ongoing programme of quality consciousness and quality enhancement training for all the company’s employees.

Operating a certified quality system to ISO 9001 standards is merely a precondition for achieving consistent quality. Within the CG Power Systems organization, quality control is carried out at each design and production phase through a self-assessment system.

Each workstation has a description of the tasks to be carried out and the accompanying quality control procedures. A component is passed on to the next workstation only after the worker concerned has carried out the specified quality control procedures and approved the component. Any material or component failing a quality test is rejected immediately.

Thus each worker checks his/her own production and regards the next workstation as his/her customer. The quality department monitors all quality control documents and carries out additional inspections at strategic points in the production process. This allows immediate action to be taken and any modifications to be made as required.

Materials purchased from approved suppliers are subject to goods inwards checking which can vary from simple identification to comprehensive testing in the physical chemistry laboratory. All raw material and component suppliers must meet ISO standards.
Sales

The CG Power Systems Group sales organization is structured to ensure the shortest possible lines of communication between customers and Group companies. This goal is achieved by working through a network of small, efficient sales offices and specialist representatives with an expert knowledge of local conditions and of the customer’s requirements.

Customer service

Orders are handled by a multi-disciplinary customer service team, where technical, commercial and administrative skills are blended to deliver what each different customer type demands: the right product at the right time at the right price.

The Customer Service team is specialized in processing orders with very specific characteristics in terms of customer requirements and/or transformer types. This results in a high degree of overall customer responsiveness and fast information exchange throughout the contract period ensuring well informed customers. The EMEA customer service team works closely together with the departments Logistics, Planning, Production, Transport and Invoicing, and After-Sales of the business units in Belgium and Ireland in order to guarantee the highest possible levels of customer satisfaction.
After-sales service

The CG Power Systems organization offers an extensive range of support services to customers after delivery of their transformers, including:

- a 24-hour helpline, with teams on permanent standby to carry out all possible urgent repairs, etc.
- maintenance and repairs to transformers either on-site or in our well-equipped workshops
- oil sampling - to assess the insulating condition of the liquid
  - to analyze dissolved gases
  - to determine PCB content
- drying, degassing and filtration of the coolant
- supply of spare parts
- provision of replacement transformers
- modifications such as:
  - connections (e.g. bottom entry or top entry cables)
  - replacement or conversion of accessories such as Buchholz relays, liquid level indicator gauges, pressure relays, etc.
- overhaul and replacement of the off-circuit tap changer
- increasing transformer power capacity by converting to forced cooling (installation of fans, etc.)
- training for customers’ maintenance staff
- advice to customers on how to operate and maintain their transformers
The most frequently fitted protection instruments may be divided into seven groups:

1. Temperature monitoring

1.1. Monitoring the temperature of the cooling liquid
> Indicator thermometer with maximum pointer without electrical contacts
> Indicator thermometer with maximum pointer and two electrical contacts
> Remote thermometer with maximum pointer and two electrical contacts
> Thermostat with one or two electrical contacts
> PT 100 resistance-type thermometer

1.2. Monitoring the temperature of the windings
> Winding temperature indicator with maximum pointer and two electrical contacts

2. Liquid level monitoring

2.1. Liquid level monitoring in integrally filled and hermetically sealed transformers
> Vertical magnetic oil level gauge

2.2. Monitoring the liquid level in hermetically sealed transformers with gas cushion
> Float oil level indicator
> Oil level sensor with one electrical contact and optional gas sampling valve

2.3. Monitoring the liquid level in transformers fitted with a conservator
> Gauge glass
> Prismatic oil level gauge
> Horizontal magnetic oil level indicator without or with electrical contacts
3. Internal overpressure protection
   - Pressure relief device without indicator
   - Pressure relief device with indicator flag
   - Overpressure relay with two electrical contacts

4. Protection of the liquid against moisture ingress
   - Silica gel air dryer

5. Multi-purpose protection
   - Buchholz relay with two normal (NO) contacts
   - DGPT2 relay with four electrical contacts

6. Protection against physical contact
   - Plug-in bushings and connectors (inside cone and outside cone model)
   - Standard and special cable boxes

7. Overvoltage protection
   - Arcing horns
   - Surge arresters

For a more detailed description, ask our marketing communication department to send you the separate brochure on protection equipment.