



Smart solutions.
Strong relationships.

Power Transformers

Our Journey Towards Excellence



ISO 9001
ISO 14001
OSHAS 18001
CERTIFIED

Expressions of Power



CG House, Mumbai

Crompton Greaves Ltd., established in 1937, has witnessed over seven decades of unparalleled growth to have current sales of over INR 138.5 Billion (US \$ 3 Billion approx). With an electrifying attitude, a fusion of experience and expertise in the field of applied energy, extensive R & D, advanced technology, dedicated workforce, superior manufacturing skills, exacting standards of quality and diverse and distinctive competencies that converge, Crompton Greaves offers a comprehensive portfolio of products and services for Generation, Transmission, Distribution and Utilization of power in various applications. Its presence is well established and widespread, notably in the Utilities, Industry, Agriculture, Transportation, Informatics, Telecommunication and Lifestyle Products sector.

Crompton Greaves promotes a high level of Research and Development activities to maintain a technological lead and competitive advantage.

R & D operations are structured to initiate a techno-active response right through the company, getting research out of the labs and in to the products. Numerous awards and ISO 9001, ISO 14001 and OSHAS 18001 certifications have accredited its exacting standards of quality management.

Today, Crompton Greaves International Operations are spread over all the continents in the world to become among the largest exporters from India in each segment of Transformers, Switchgear and Controlgear, Motors and Alternators, Pumps and Fans.

As the new millennium consumers plug-in to a switched-on future, Crompton Greaves, a flagship company of Thapar led Avantha Group will continue to play an electro-dynamic role ...engineering the right solutions ... making a difference to life and thriving in an increasingly wired world.

CG Group of Companies Worldwide

Crompton Greaves Power System (Acquisition of Pauwels Group, Belgium)

A Dream Accomplished

Crompton Greaves had a long cherished dream to become a formidable Indian Multinational. With the acquisition of the Belgium based Pauwels Group, CG has realized this most cherished dream.

This acquisition will give CG Transformer manufacturing facilities in 5 countries: Belgium, Ireland, Canada, USA and Indonesia. CG is perhaps the only Indian Company to conclude an acquisition of this complexity, magnitude and geographical spread.

Crompton Greaves is now in the prestigious position of being one of the top 10 Transformer manufacturers in the world.

With the acquisition of Pauwels, CG will have access to Pauwels network of sales agents and customers in over 135 countries. More than 600,000 Pauwels' Transformers are currently in use throughout the world.

Crompton Greaves Power Systems (Pauwels Transformers)

Since 1947, Pauwels group has stood for innovative, high-quality and reliable Transformers with due respect to the environment and service to customers around the world. By creating a dynamic and flexible company focused on these



Crompton Greaves Power Systems Transformer Plant, Belgium

key points, Pauwels continues to operate as a “full-line supplier” offering high performance and proven reliability with maximum return on investment for its customers.

Pauwels' full range of Transformers consists of:

- Liquid-filled Distribution Transformers for the distribution of electricity to consumers (15 kVA to 10 MVA/36 kV)
- Cast Resin Transformers (100 kVA to 10 MVA/36 kV) as an alternative to liquid-filled distribution transformers, with the emphasis on reduced environmental impact and increased fire safety
- Medium and Large Power Transformers (up to 575 MVA 525 kV) for the transmission of electrical energy
- Auto-Transformers (up to 700 MVA/525 kV)

- Phase-Shifting Transformers (up to 500 MVA/525 kV)
- HVDC Converter Transformers (up to 315 MVA/500 kV DC)
- Reactors up to 500 kV
- Mobile and Compact Substations (up to 500 MVA, 245 kV class)
- Special Application Transformers which include Traction Transformers, Testing Transformers and Slim Transformers



Distribution Transformer Plant Missouri, Washington, USA

CG Power Holding NV (Pauwels Contracting)

Since its formation in 1977, Pauwels Contracting, (now CG Power Holding NV) has grown to become a significant division within CG. The company specializes in electrical turnkey projects such as:

- A.I.S. and G.I.S. substations up to 500 kV.
- Mobile substations and mobile transformers up to 245 kV.
- Compact substations.



Slim Transformers

Its core activities include electrical projects for the wind energy industry. The success of Pauwels Contracting is also based on the energetic and consistent application of a complete range of professional project management services.

CG Electric System Hungary Zrt. (Ganz)

In mid - 2006, Crompton Greaves have successfully completed another acquisition of two companies in Hungary i.e. **Ganz Transelektro Villamossagi Zrt.** Engaged in the business of **EHV Transformers, Gas Insulated Switchgear, Rotating Machines and Contracting** and an associate company of Ganz, **Transverticum Kft** engaged in the supporting areas of design, erection, commissioning and commercial activity with high-end engineering and substation capabilities.

CG Power Holding Ireland Limited (Microsol)

In 2007, Crompton Greaves acquired the **Microsol Group of Ireland**, with operations in Ireland, United States of America and United Kingdom, with expertise in the areas of sub-station automation for MV and HV sub-stations, with respect to both new sub-stations and retro-fitting for existing sub-stations.

CG Service Systems France SAS (SONOMATRA)

In 2008, Crompton Greaves completed the acquisition of **Societe Nouvelle de Maintenance Transformateurs SAS (SONOMATRA) in France**, a company which specialises in providing services of on-site maintenance/repair of power transformers and on-load tap changers, oil analysis, oil treatment and refilling.

MSE Power Systems

In 2008, Crompton Greaves acquired the **MSE Group based in USA**, which is engaged in Engineering, Procurement and Construction (EPC) of high voltage electric power systems. It is specialised in Conceptual Engineering, System Studies, EPC Engineering, Spanning, Relay/Control SCADA for Wind Parks, Electrical Substations and Transmission Lines up to 500 kV



Distribution Transformers



Smart solutions, Strong relationships

... for over 70 years



Mumbai Plant



Gwalior Plant



Bhopal Plant



Bhopal Plant - Distribution Transformers

Crompton Greaves kicked off the Transformers operation with their first supply to the US Army in 1937. Initial technology was from Brush Transformers and Hawker Siddeley Power Transformers, both from U.K. and then, from Westinghouse Electric Corporation, U.S.A. for Transformers and Reactors upto 500 kV to match growing volumes and changing international requirements. Development of 765 kV transformers was completed successfully in technical collaboration with Toshiba Japan. 2 units of 260 MVA, 765 kV Generator transformers have been manufactured, which were supplied to NTPC, Sipat. Several 765 kV auto transformers are under manufacturing for PGCIL. Having commissioned over 200 Million kVA in Transformers, Crompton Greaves is today the leading manufacturer of Transformers and Reactors, with a wide range, for all critical applications.

To sustain the growing demand of Transformers, Crompton Greaves commissioned a new integrated plant at Gwalior (T2), spread over 20,000-sq. m. in 1991 and yet another at Bhopal (T3), spread over 30,000-sq. m. in 1995. With the acquisition of the Pauwels group and Ganz, Crompton Greaves now produces a staggering 75,000 MVA of Transformers per annum in 10 plants across 3 continents. Of this, the indian operations produce over 30,000 MVA of Transformers annually. This has enabled CG to cater to the most demanding markets of the world.

Crompton Greaves have the capability to produce transformers from 5 kVA to 575,000 kVA (1.5 M kVA in a bank), 3.3 kV to 765 kV class for various applications and conforming to IS, IEC, EN, AS, BS, ANSI, CSA and other international standards.

POWER TRANSFORMERS

- Generator Transformers for Thermal, Nuclear, Hydro and Gas Generating Stations.
 - Upto 450 MVA, 500 kV class, three phase
 - Upto 810 MVA, 800 kV in a bank.
 - 900 MVA, 500 kV in a bank
- Auto Transformers for step-up and step-down
 - 500 MVA, 500 kV class, three phase
 - 1500 MVA, 800 kV in a bank.
- Reactors, Series and Shunt, upto 125 MVA, 800 kV class.
- 1200 kV Auto Transformer under development.



Unitised Substation

DISTRIBUTION TRANSFORMERS

- Oil Cooled Transformers, 5 kVA to 10,000 kVA, 38 kV.
- Dry Transformers, 100 kVA to 10,000 kVA, 36 kV
- Unitised Substations.



Oil Filled Distribution Transformer

SPECIAL TRANSFORMERS

- Arc and Induction Furnace Transformers Upto 60 MVA, 38 kV.
- Trackside Transformers 31.5 MVA, 25 kV AC, single phase.
- Locomotive Transformers upto 7500 kVA, 25 kV AC.
- Thyristor Duty Transformers.
- Package Substations upto 2000 kVA.
- Earthing and Auxiliary Transformers.
- HVDC Converter Transformers upto 300 MVA, 500 kV DC
- Mobile sub - stations upto 80MVA, 245 kV



Cast Resin Transformer

LIST OF SHORT CIRCUIT TEST ON TRANSFORMERS

Description of Type Test	Testing Authority	Type Test Report No.	Customer for whom Test was made	Year
Short Circuit Test 13.5/20 MVA, 132/27 kV Transformer	CPRI, Bhopal	87/STN-1/82	Railways, India	27.03.87
Short Circuit Test 10/16 MVA, 132/11 kV Transformer	CPRI, Bhopal	89/STN-1/272	PSEB,India	04.10.89
Short Circuit Test 21.6 MVA, 132/27 kV Transformer - Sr. No. T8282/1	CPRI, Bhopal	90/STN-1/170	Railways, India	27.09.90
Short Circuit Test 10 MVA, 33/11 kV Transformer -Sr. No. T8369/1	CPRI, Bhopal	92/STN-1/212	MEW, UAE	01.10.92
Short Circuit Test 12.5 MVA, 66/11 kV Transformer -Sr. No - M2000/1	CPRI, Bhopal	96/STN-1/407	PSEB,India	30.11.96
Short Circuit Test 20 MVA, 66/11 kV Transformer - Sr. No - T8551/3	CPRI, Bhopal	96/STN-1/411	PSEB,India	06.12.96
Short Circuit Test 21.6 MVA, 132/27 kV Transformer -Sr. No - T8704/1	CPRI, Bangalore	HPL99163	Western Railway, India	18.11.99
Short Circuit Test 15 MVA, 66/11.55 kV Transformer -Sr. No - M2651/1	CPRI, Bhopal	99/STN-1/316	GEB,India	08.12.99
Short Circuit Test 21.6 MVA, 220/27 kV Transformer -Sr. No. T8858/1	CPRI, Bangalore	HPL02091	Railway Electrification New Delhi, India	23.07.02
Short Circuit Test 70 MVA, 220/6.9/6.9/6.9 kV Transformer Sr. No - T8847/1	CPRI, Bangalore	HPL02147	NPC, India	30.11.02
Short Circuit Test 25/31.5 MVA, 132/33 kV Transformer Sr. No - T8931/1	CPRI, Bhopal	2003/STN-1/248	HPSEB, India	06.10.03
Short Circuit Test 21.6 MVA, 110/27 kV Transformer -Sr. No - T8947/1	CPRI, Bhopal	2003/STN-1/325	Central Railway, Mumbai, India	09.12.03
Short Circuit Test 25 MVA, 400 kV Transformer	CPRI, Bhopal	HPL09050	URI, NHPC	2008
Short Circuit Test 32 MVA, 220 kV Transformer	CPRI, Bhopal	HPL09051	CHAMERA, NHPC	2008
Short Circuit Test 102 MVA, 400 kV Transformer	KEMA Netherlands	159 - 08	SUBANSIRI, NHPC	2008
Short Circuit Test 80 MVA, 400/11.5/11.5 kV Station Transformer	CPRI, India	HPL09130	NTPC Simadri	2009
Short Circuit Test 315 MVA, 400 kV Transformer	KEMA Netherlands	72 - 09	POWERGRID	2009
Short Circuit Test 200 MVA, 400 kV Generator Transformer	KEMA Netherlands		NTPC	2009



315 MVA, 440/220/133 kV Auto Transformer at KEMA, Netherlands



102 MVA, 400 kV Single Phase Generator Transformer at KEMA Netherlands

A DOMINANT PLAYER IN UHV SEGMENT

Having supplied 750 kV transformers as early as in 1977, CG Electric Systems Hungary has been one of the early manufacturers of 800 kV class transformers. CG India has also become a dominant player in 800 kV transformers market in India. 260 MVA, 765 kV, Single Phase Generator Transformer supplied by CG India to NTPC was the first 765 kV transformer manufactured in India. At present, several 765 kV transformers are under manufacturing in CG India as well as CG Hungary.

CG has also made a foray into 800 kV class Shunt Reactors and 1200 kV class transformers.

CG's UHV product range includes :

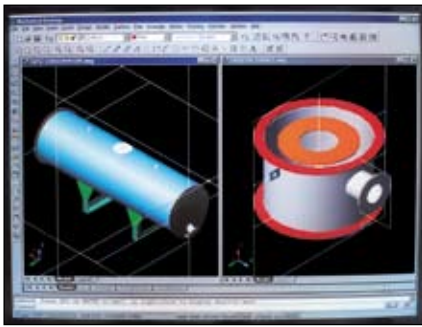
- 800 kV Class Generator Transformer
- 800 kV Class Auto Transformer
- 800 kV Class Shunt Reactors
- 1200 kV Class Auto Transformer (Under development)



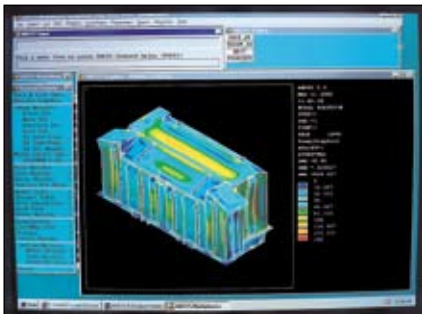
367 MVA, 750 kV Single Phase Auto Transformer, Albertissa, Hungary.



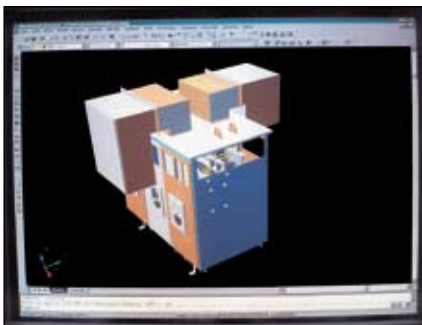
260 MVA, 765 kV Single Phase Generator Transformer supplied to NTPC Sipat



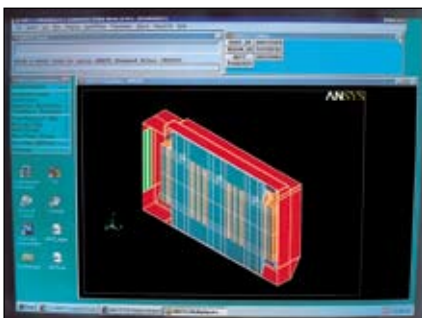
3D View of Transformer components



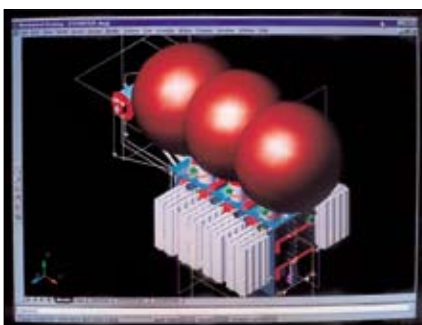
Tank under simulation test for vacuum withstand



Layout of Dry Type Transformer



FEM analysis of core assembly



Clearance Sphere - design verification

TRANSFORMERS, TECHNOLOGY

Crompton Greaves have absorbed world class technologies through collaborations for built-in total reliability.

- Brush Transformers, U.K.
- Hawker Siddeley Power Transformers, U.K.
- Westinghouse, U.S.A. for Foil Technology, Distribution and Power Transformers and Shunt Reactors upto 500 kV class.
- GE, U.S.A. for Amorphous Core Transformers
- ABB, Sweden for Locomotive Transformers.
- Toshiba, Japan for 765 kV Generator and Auto Transformers
- Pauwels Trafo, Belgium
- Ganz Hungary

Design technology incorporates the following state of the art techniques and software to comply with the ever demanding customer and system integration needs and the latest manufacturing techniques.

- 2D and 3D Finite Element Method (FEM) analysis for electrostatic and electromagnetic distribution
- MAGNET for electromagnetics.
- VOLNA for Impulse Distribution
- IDEAS and ANSYS for structural designs.

- ANSYS for seismic analysis.
- ELECTRO for 2D Electrostatic Stress Analysis.
- ED MAG for Circulating current.
- ELDINST for Short Circuit Behaviour current.
- Unigraphics and special add-on software for components, parts and their quick integration in to the final Product.
- Simulation techniques for noise vibration, thermal, hot spot, seismic analysis and short circuit.



Structural seismic analysis of Transformers

With deployment of well qualified Engineers and Technocrats, Crompton Greaves have fully harnessed long experience in Design and Software, a core strength of India, to offer innovative, reliable and efficient Transformer solutions. Advanced computer systems, design techniques and simulation of the field conditions contribute to fast product development and ensure enhanced reliability – so very critical for the Transformers.



Transformer Engineering Centre at Mumbai Plant

POWER TRANSFORMERS, CORE BUILDING

Transformer Cores are built with CRGO, low loss silicon steel laminations. Use of Hi-B grade and laser scribed laminations for the core significantly reduces no load losses and noise levels as committed.

New high speed “GEORG” CNC machines for core slitting and cropping offer stress free laminations without burrs for fully aligned core building. Special dimpled sheets provide space between laminations for most effective cooling.

The laminations forming the magnetic circuit are assembled on a special core building fixture. The Step-Lap or Mitred joints at the core corners ensure a streamlined magnetic flux path.

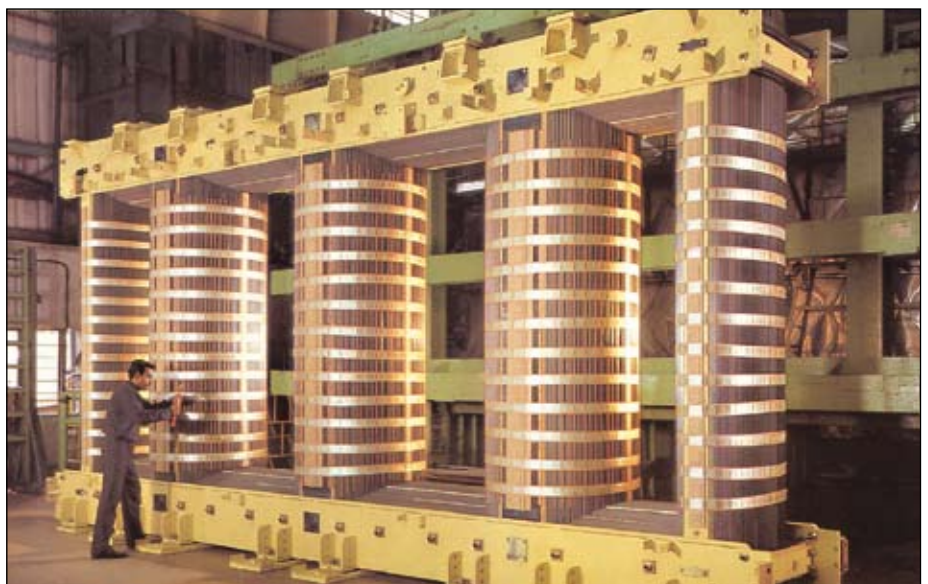
The core limbs are held with resin bonded glass bands to eliminate limb bolts. Yokes are clamped by solid mild steel plates with yoke studs, ensuring high rigidity for withstanding mechanical shocks during transportation and short circuits. For logistics, five limb core construction offers reduced height for large Power Transformers.



Assembly Area Mandideep Plant, Bhopal



High Speed 'GEORG' CNC Machine



5-Limb Core assembly of 250MVA Generator Transformer

POWER TRANSFORMERS, WINDING

Electrolytic Grade Copper or Epoxy Bonded Continuously Transposed Conductors (CTC) are used to the design requirements. Windings are made on the vertical or horizontal winding machines with great care by well-experienced techno-craftsmen in a clean environment, (5 microns max.) with positive pressure for superior reliability. High quality pre-compressed insulation, pre shrunk by a specially designed process, ensures long service stability. Thermally upgraded paper enables emergency overloading beyond nameplate rating, wherever desired.

The winding has axial and radial cooling ducts to ensure effective heat dissipation in to the oil and eliminating the hot spots.

For high voltage windings, disc coils with excellent mechanical strength are used to take the stresses due to voltage level. A special interleaved or shielded construction offers most uniform voltage distribution despite system transients. Finished coils are compressed by predetermined clamping force in a 200 tons, Isostatic Hydraulic Press, for retaining the designed geometrical position of the individual winding.



Micafil VPD Facility



Isostatic Press



Autoclave



Winding Bay Mumbai Plant

POWER TRANSFORMERS, CORE-COIL ASSEMBLY

The winding is rigidly supported by a common pressure ring of densified wood at the top and bottom, for precise alignment. Well profiled angled rings are placed between HV and LV windings to reduce voltage stress levels. The ends and tapping leads of all the windings are connected by special extra flexible, insulated copper cables, which are rigidly braced in position. In oil forced units, oil is circulated inside the winding by specially designed pipes of insulated materials.

The core coil assembly is dried to less than 0.5% moisture content, by the automated Vapour Phase Drying (VPD) plant of MICAFIL. High mechanical rigidity is achieved by hydraulic pressing at calculated force and tightening all pressure screws. The core-coil assembly is put into the tank with proper locating arrangements. The tank is then filled with hot oil, filtrated by High Vacuum Oil Filtration Plant to max. 5 PPM moisture content, free of particles above 5 microns size and with very low gas content, under vacuum to ensure least exposure to atmosphere.

POWER TRANSFORMERS, TANKS

Tanks are built with mild steel plates to withstand full vacuum, conforming to the International standards. The welder's qualification is done as per ASME Section IX. Tanks are designed to roll and skid in specified directions.

Lugs for jacking, lifting and hauling are routinely tested for dye penetration. Tanks have welded or bolted top cover. For large units above 50 MVA, bell type construction is available. Tanks are shot blasted to get a surface finish of SA 2.5, coated with zinc rich primer and then painted. Epoxy or polyurethane painting and spray galvanising are optionally offered to specific requirements for surface finish of the Tank.

The transformer is made ready for final inspection after assembly of bushings, conservator, radiators etc.

POWER TRANSFORMERS, QUALITY ASSURANCE

High standards set for procurement and inputs go a long way to ensure reliable Transformers. Quality is ensured at source for standard materials, with a qualified and dedicated Supplier base. Continuous upgradation of Suppliers and close



Impulse Generator 2000 kVP, 200 Kilo-Joules from High Volt, Germany.

inspection of incoming materials, controlling in-process parameters and thorough inspection and testing of the Transformers ensure consistent high-quality standards that Customers have come to expect from Crompton Greaves

TEST FACILITIES

In addition to the normal routine test facilities, the following major type test facilities are available in-house for type testing the Transformers to all major international standards.

1. Switching and Lightning Impulse Test System.
2. Partial Discharge and Radio Interference Measurement Facilities.
3. Noise Level Measurement Setup.
4. Temperature Rise Test Plant
5. Dissolved Gas Analyser (DGA) for oil.
6. Harmonic Measurement and Analysis
7. Linearity Test Set for HV Reactors
8. Vibration Test Plant
9. SFRA Test

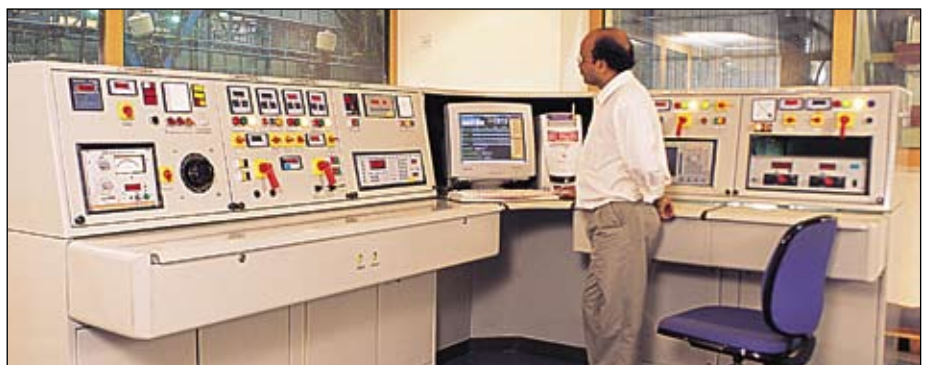
The Transformer designs are proven for dead short circuits by tests conducted at independent, accredited Short Circuit Laboratories.

CGL has successfully completed the short-circuit test on the following Transformers at KEMA, Netherlands.

- 1 102 MVA, 16/400 kV, 1 phase generator transformer.
- 2 315 MVA, 400/220/33 kV, 3 phase Auto transformer.



Dissolved Gas Analyser for oil



Test Bench

PROCESS CERTIFICATION

All the three manufacturing Plants are certified to ISO 9001-2000. Our Mumbai, Gwalior and Bhopal plants are additionally certified to ISO 14001 standards by BVQI, U.K. Mumbai and Bhopal plants are also certified for OHSAS: 18000. A structured TQM programme is in place ensuring continuous improvement towards world class quality standards. The quality assurance systems are backed by a strong in-house R & D continuously working to upgrade and ensure total system reliability.

With SAP/R4 and PLM implementation, the internal processes are further sharpened to provide effective Transformer solutions, all over the world.

TRANSFORMER FINISH

With concealed wiring in rigid Conduits, Junction Boxes, Elbows etc. to the NEC guidelines, a neat wiring layout is offered. Great care is taken for using thin, minimum width jointless gaskets having minimal exposure and constrained sealing system, to the international practices for absolutely no leakage of the oil.



Painting and finishing

The paint system, epoxy and acrylic based polyurethane, are compatible to the specified corrosive environment and have a good aesthetic finish.

TRANSFORMER PACKING

While the main Tank is transported as per the planned design and logistics, the accessories and tools, first packed in polyethylene, are shipped in standardised seaworthy wooden packing boxes, with shipping marks and contents specified for damage free shipment.

TECHNICAL DOCUMENTATION

All the drawings are in CAD, for quick review while getting approved and thereafter the final drawings can be submitted on a CD alongwith a print copy as required.

The Transformer Installation, Commissioning and Maintenance Manual is in fully searchable electronic format (PDF) on a CD for easy and quick access to the exhaustive technical instructions.

POWER TRANSFORMERS, EXPORTS ALL OVER THE WORLD!

Today over 600 units of Crompton Greaves Transformers up to 320 MVA and 500 kV are installed in over 75 countries around the world.

Power Transformer shipping calls for a specialised skillset and meticulous planning through study of product specifications, Port capabilities and shipping logistics to ensure safe, reliable, timely and cost effective passage till installation site in the destination country. Critical aspects of Power Transformer logistics and shipment are planned and taken care of at the design stage itself and the Crompton Greaves in-built expertise make a significant contribution there.



3 x 250, 550/275/33 kV, Single Phase Auto Transformer, Kapar Substation, TNB Malaysia

Smart solutions, Strong relationships

... for over 70 years



Loading on Ship

KEMA

Type test Certificate of short-circuit performance

Crompton Greaves Limited
Mumbai, India

has successfully passed the type test sequence on a

Generator power transformer

Type: GSU Transformer
Rating: 102 MVA – 400kV ± 7.5% -2.5% / 16 kV – single-phase – 50 Hz

The test object passed the specification of test duties of

IEC 60076-5

The test results are recorded in Certificate No. **159-08**

This Certificate is issued on 17 March 2009

KEMA Nederland B.V.

P.G.A. Bus
KEMA T&D Testing Services
Managing Director

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KEMA

Type test Certificate of short-circuit performance

Crompton Greaves Ltd
Mumbai, India

has successfully passed the type test sequence on a

Test object

Type: 315MVA, CGL Auto
Rating: 315 MVA – 400 kV±8x1.25%/220 kV/33 kV – Yna0d11 – 50 Hz

The test object passed the specification of test duties of

IEC 60076-5

The test results are recorded in Certificate No. **72-09**

This Certificate is issued on 9 September 2005

KEMA Nederland B.V.

P.G.A. Bus
KEMA T&D Testing Services
Managing Director

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Crompton Greaves Limited

Transformer Exports,
Kanjurmarg (East),
Mumbai - 400 042.(INDIA)
Telephones : +91-22-2579 6902
Direct : +91-22-6755 8368
Fax : +91-22-2578 0456
Email : nitin.naik@cgglobal.com

Transformer Domestic,
Kanjurmarg (East),
Mumbai - 400 042.(INDIA)
Telephones : +91-22-6755 8000
Direct : +91-22-6755 8372
Fax : +91-22-2578 3271
Email : ukil.biswaroop@cgglobal.com

Registered Office :
CG House, 6th Floor, Dr. Annie Besant Road, Worli, Mumbai 400 030, India
W: www.cgglobal.com