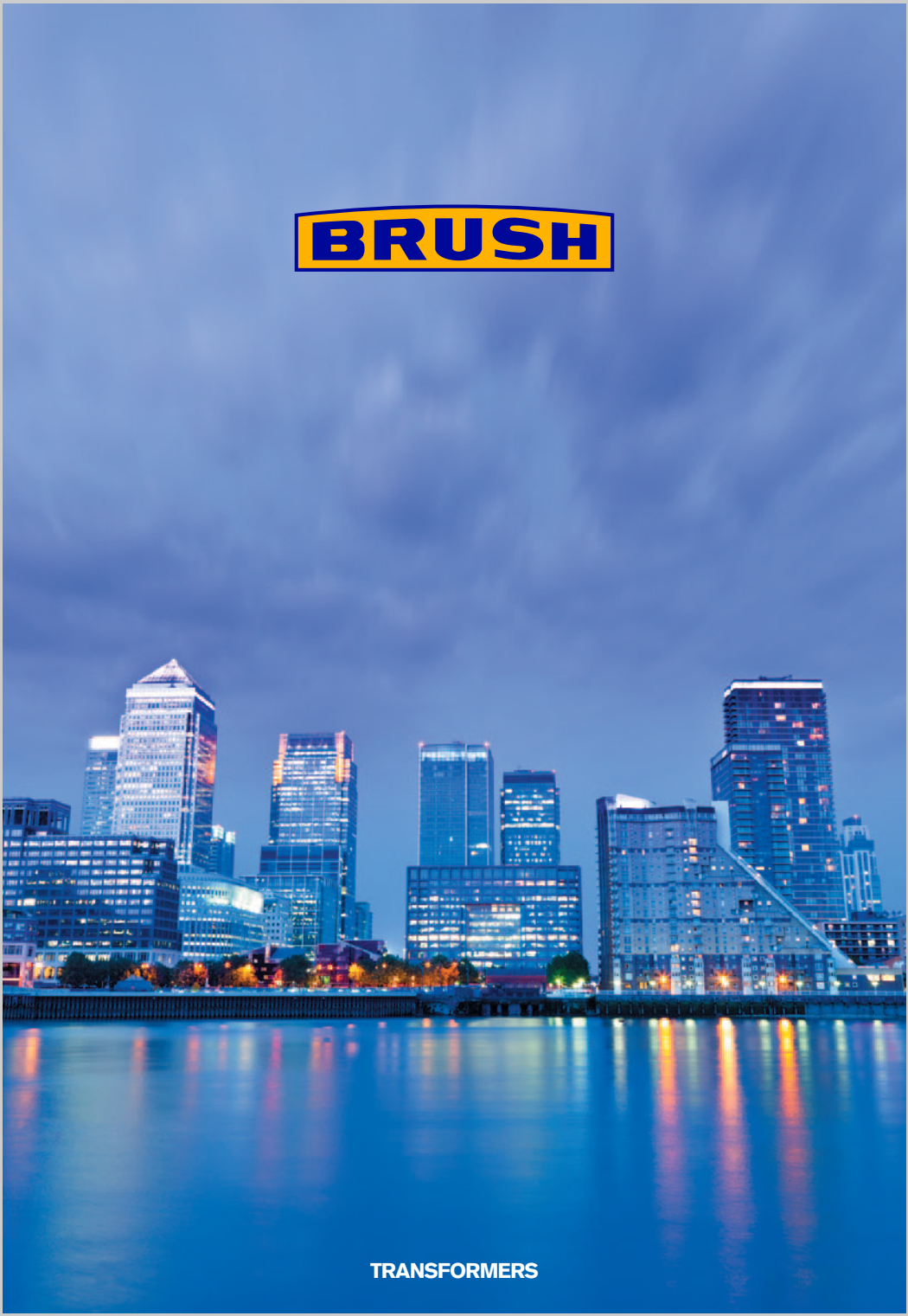
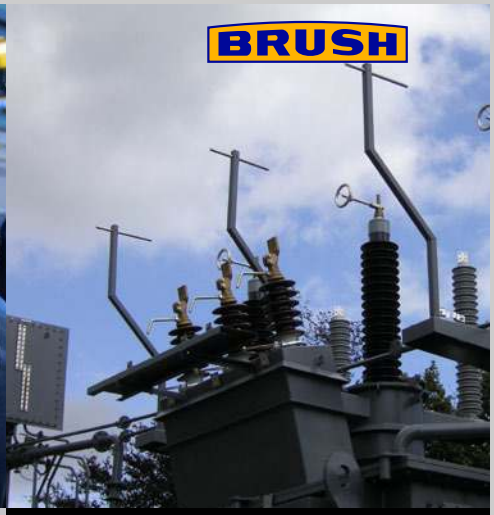
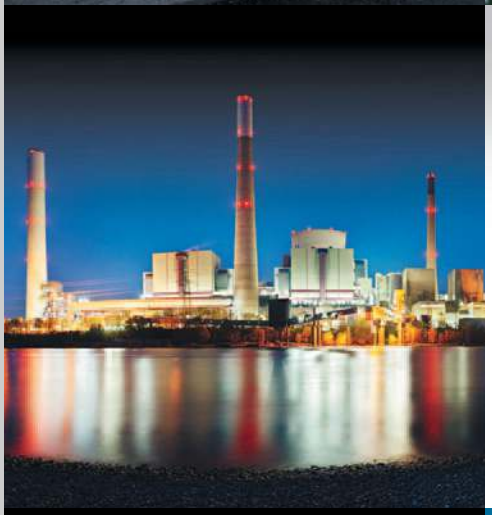
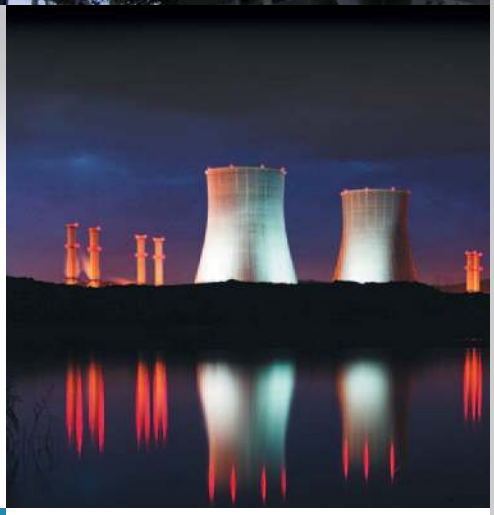

BRUSH
TRANSFORMERS










ENERGY SOLUTIONS FOR THE GLOBAL POWER INDUSTRY

BRUSH Transformers is globally renowned for the quality of its products, innovation and service. Our markets include the utility, oil, petrochemical, coal, steel and rail industries worldwide. We focus on working with our clients to provide solutions tailored to meet their exact requirements.

Our ongoing investment programme concentrates on the implementation of modern technology, research, product development and ensuring our facilities are of the calibre to support our plans for long-term growth.

We design and manufacture to many British, European and International standards and have first class test facilities to ensure that the quality of the product is prevalent. The company maintains ASTA third-party accreditation to quality standard ISO 9001:2008, environmental standard ISO 14001 and health and safety standard OHSAS 18001.

CONTENTS

POWER TRANSFORMERS

With over one hundred years of manufacturing experience in the transformer industry, BRUSH Transformers are the largest manufacturer of liquid filled power transformers based in the United Kingdom.

BRUSH Transformers supply a comprehensive range of transformers for a range of applications;

- **System transformers** for the UK, overseas utility network operators and many private network operators
- **Generator step up transformers** for use with; hydro-electric generation schemes, gas turbine generator stations and CHP plants
- **Grid connection transformers** for wind generation schemes
- **Power transformers** for industrial applications, traction systems, petrochemical projects, offshore oil and gas production facilities and special applications up to 132kV
- **Series current limiting reactors** for industrial applications
- **Motor unit transformers** for industrial applications and petrochemical plants
- **Rectifier transformers** for traction systems.

Where required, BRUSH are also able to supply transformers with alternative cooling systems such as forced air cooled/forced oil cooled and water cooled using heat exchangers.

For 33kV systems BRUSH manufacture transformers using alternative cooling fluids such as Midel and FR3, where transformers are either located inside buildings giving rise to issues related to increase fire risk or where there are environmental concerns. For traction systems BRUSH are able to provide; 132/25kV traction supply transformers, 25-0-25kV auto transformers, 25kV 300Amp trackside booster transformers.

Noise levels

BRUSH offers Transformers that are capable of emitting low noise levels. By utilising the latest electrical steel material and manufacturing techniques, the noise levels can be attenuated to low levels, which is particularly important in built up areas.

No-Load Losses

The overall lifetime cost of a transformer is related to the losses generated by the unit. The no-load losses apply throughout the year and BRUSH has a wide range of electrical steels grades available to minimise the losses generated by the core to reduce the capitalised cost.

UK reference list:

UK Power Networks
Western Power Distribution
Northern Power Grid
Energy North West
Scottish Power
Scottish & Southern Energy
Tamesis
Network Rail
Green Frog
Eon

Overseas reference list:

Bermuda Electric Light Company (BELCO)
Abu Dhabi Water & Electricity Authority
Bahamas Electricity Corporation
Shell
Aramco
NIOC
ITS

AT TAPCHANGERS

The AT range of single compartment units with high-speed resistor transition is designed for three-phase systems with voltages of 44kV and 66kV line end or 132kV neutral end and nominal rated current of 300A.

A maximum of 17 tapping positions (16 steps) 15 possible for linear regulation and 33 tapping positions (32 steps) for reversing of coarse/fine regulation.

The AT tapchanger is designed such that power flow can be handled in either direction at full-rated current. The AT is a flange-mounted tapchanger where the oil in the switch compartment is kept separate at all times from the oil in the main transformer.

- Compact
- Linear, reversing or coarse/fine versions
- Suitable for 52kV, star or delta windings
- 400A version (linear only)
- Suitable for 145kV star winding (neutral end only)
- Single-phase version available
- Vertically-mounted option also available
- Manufactured in accordance with IEC 60214 and also complies with many other national and international standards.

Key features of AT and AE tapchangers

- Compact
- Bi-directional power flow
- High speed resistor on-load selector switch
- Ease of maintenance
- Low oil content
- Up to 17 positions (linear) or 33 positions (reverse or coarse/fine)
- Fully automatic or manual operation.

AE TAPCHANGERS

The AE series on-load tapchangers are built on the successful results of the design of the AT range. The AE uses many common parts from the AT including the complete drive mechanism. This range has a maximum of 17 tapping positions (16 steps) and is possible for linear regulation and 33 tapping positions (32 steps) for reverse or coarse/fine regulation.

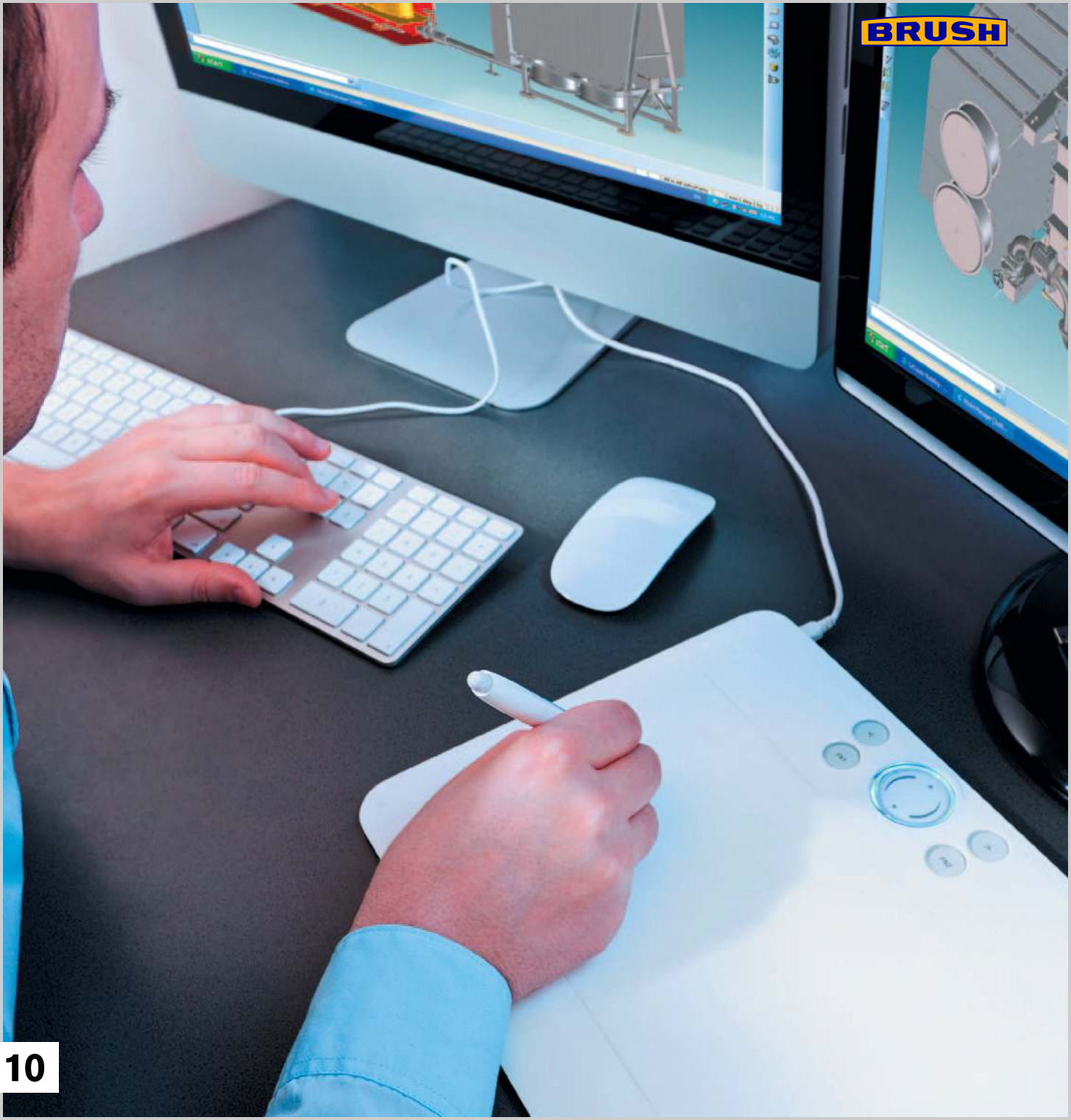
The equipment may be used to regulate three-phase transformers designed for system voltages of 33kV and 66kV at any position in the winding.

The AE may also operate on transformers designed for 132kV earthed neutral three-phase systems regulating at the neutral end of the winding. The maximum current rating is 500A, with overload capability in accordance with IEC 60354 and IEC 60076-7.

- 500A current rating
- Suitable for 33kV or 66kV systems, line or neutral end
- Suitable for 132kV systems (neutral end only)
- Maximum 650kVA breaking capacity
- Designed in accordance with IEC 60214 and also complies with many other national and international standards

Benefits of the AT, ATV, and AE on-load tapchangers

- Lower overall maintenance times and costs to the end user
- Separate tapchanger oil ensures 100% accurate D.G.A of transformers
- Can easily be housed in noise enclosures
- Retrofit tapchangers more easily accommodated
- Better for anti-tracking surfaces



DESIGN

BRUSH Transformers strive to ensure that our products and services consistently provide the best value, in the most cost-effective and suitable format for each of our customers individual needs.

From the initial stage of any project, the design department employ a wealth of experience to develop product specifications, combining a high degree of engineering integrity with the necessary commercial, practical design and quality considerations. This ensures that our customers receive the optimum design for their specific product requirements.

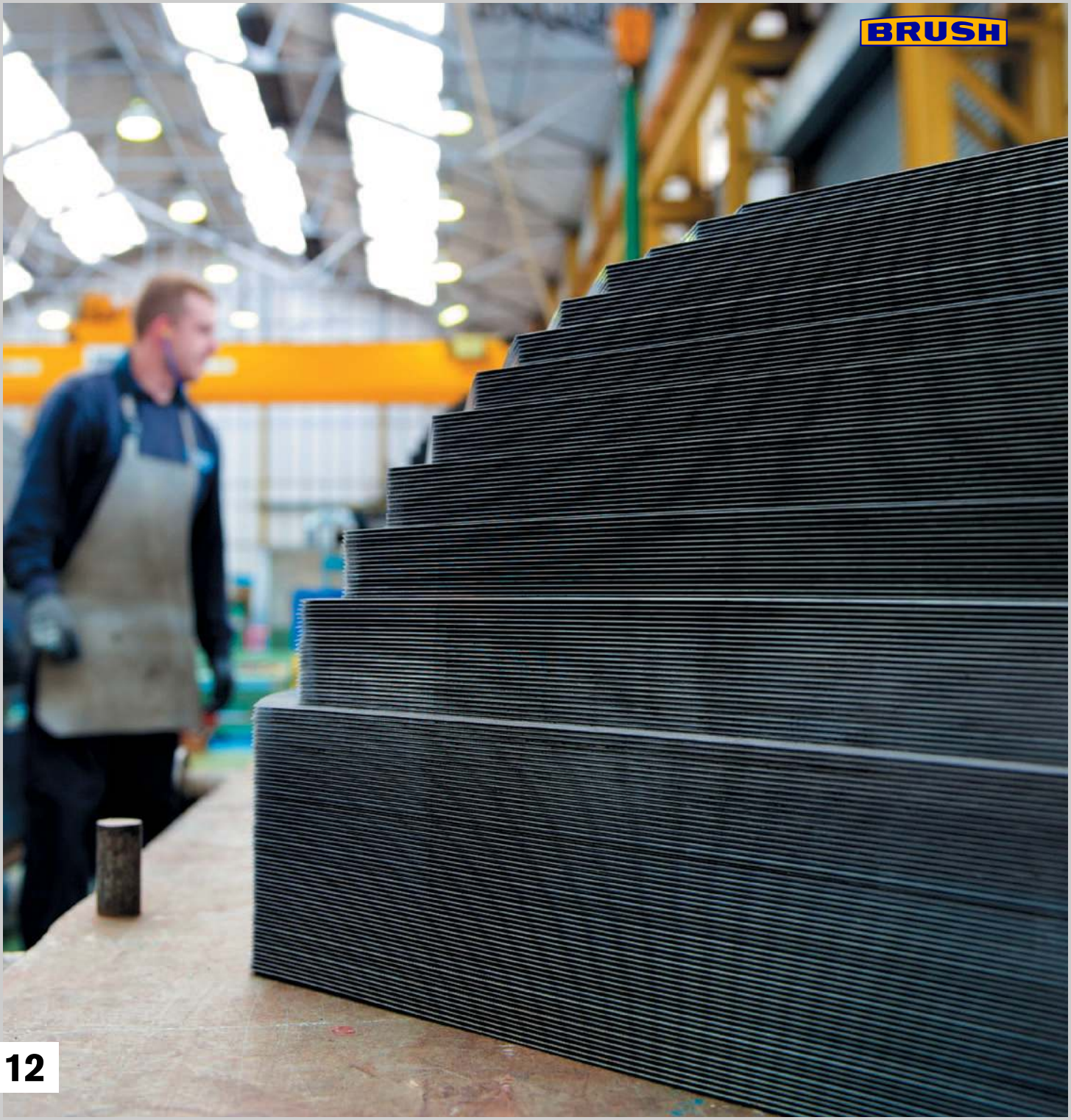
Sustained Design Excellence is achieved via a program of continuous improvement. The implementation of modern technology, research and product development, coupled with our long experience in the field, allows us to refine the design process whilst taking into account changing customer requirements, material advances and technical design improvements. When assessing any transformer design it is essential that critical performance values are accurately simulated.

BRUSH Transformer's design program suite is a knowledge-based system with capabilities for both 2D and 3D finite-element modelling. The design software suite effectively captures many years of transformer design knowledge and experience. Over recent years, the use of finite-element modelling methods for transformer design and analysis has proven to be an extremely powerful tool. We employ a fully integrated collection of software modules capable of the generation and solution of electrostatic and electromagnetic finite element models.

BRUSH have a large range of core steel grades available to optimise the design, allowing specific performance characteristics to be achieved. BRUSH also utilise proven coil designs to maximise the performance and minimise losses.

Bespoke design software derived from successfully established practices and techniques is combined with the sound numerical techniques encompassed within finite-element methodology to produce the optimum design for each customers requirement.

BRUSH Transformers utilise the latest in CAD technology, investing in software packages including AutoDesk Inventor, ANSYS FEA and Slim Electromagnetic FEA. This technology enables us to adopt a more streamlined approach to the process of planning, developing and manufacturing of products. This in turn creates an ideal platform for lean product development and achieving increased response rates with our customers.



MANUFACTURING

THE CORE

Each transformer core is produced using a computer-controlled Georg cutting line. Using interleaved laminations of cold rolled, grain orientated, low loss electrical sheet steel conforming to BSEN 10107. The core employs a mitred step-lap design ensuring minimum noise and loss levels with uniform flux distribution throughout the magnetic circuit.

WINDINGS AND INSULATION

All windings are manufactured to exacting standards in order to maintain strict dimensional tolerances. Clamping to a pre-determined load pressure during manufacture ensures that each winding is able to withstand the excessive axial forces, which may result from external sources.

All principal components of insulation are pre-fabricated from electrical grade insulating board; processed to ensure electrical and mechanical stability throughout the temperatures found in operational service.

CORE-COIL ASSEMBLY

Each core-coil assembly is rigidly braced using steel frames. Optimum dielectric strength is achieved via processing in accordance with rigorous in-house quality procedures.

TANK CONSTRUCTION AND FINISH

Transformer tanks are manufactured using mild steel, which is electrically welded. Cooling is effected by pressed plate radiators, electrically welded and independently pressure tested. Metal is pre-treated by shot blasting, then immediately covered with a high performance industrial paint finish, suitable for highly corrosive environments. This finish is designed to give maximum world-wide, long term protection in coastal, industrial, and general environments with suitable heat and oil resistance.

FINAL ASSEMBLY

Completed core-coils are dried in thermostatically controlled vacuum ovens, fitted into the transformer tank and filled with oil under a vacuum. This is followed by an oil processing system using de-aerated oil. After the tanking process is complete the transformer is prepared for test.

SHORT CIRCUIT CAPABILITY

In order to prevent deformation when subjected to short circuit forces, solid block end insulation, backed-up by substantial supporting frames is utilised. The axial end thrust under fault conditions is minimised by the suitable distribution of ampere turns over the length of the windings, and by ensuring that the design dimensions are closely adhered to during manufacture. Transformers designed and constructed in this way are capable of withstanding the effect of short-circuit forces.

TEST SERVICES

At BRUSH Transformers every transformer is subject to a comprehensive series of tests in compliance with the latest requirements contained in all relevant specifications. All the testing is carried out on site within one of BRUSH's fully equipped test areas.

The test facilities include a 7.8MVA generator driven by a 2500HP motor, a 2.8MVA power regulator used in conjunction with capacitor banks (60 MVAr currently installed). These ratings can provide sufficient power for short circuit temperature rise testing at full ratings, for transformers up to 100MVA.

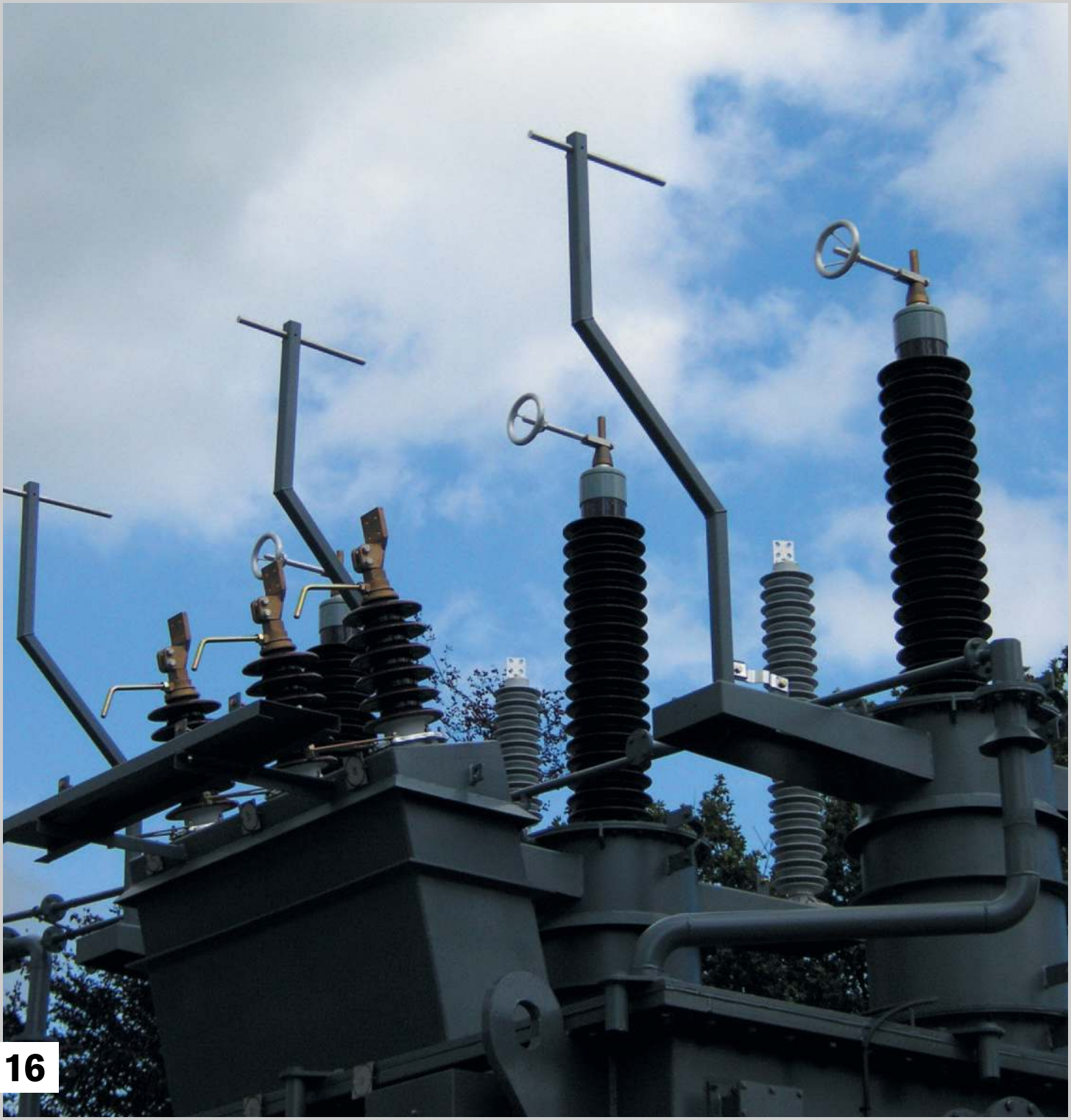
BRUSH also has two multi-ratio plant transformers of 38MVA and 14MVA, a 2MVA 200Hz alternator for induced over-voltage testing and a Haefely SG A 1200-120 impulse testing system comprising of:

- 1200kV, 120kJ per stage generator
- 2000kV voltage divider IEC 60060 – 1
- 1200kV multiple chopping device
- Hias 743 high resolution impulse analysing system
- 600kV overshoot compensation filter.

Test area is equipped with:

- High voltage capacitance dividers and AC peak voltmeters used for measurements up to 600kV
- Capacitance and tan delta bridge for measurement of capacitance and loss angles
- Three phase AC power analysers used in conjunction with precision current and potential transformers for the accurate measurement of transformer losses
- Bruel Kjaer sound level measuring equipment used for the measurement of transformer noise and spectrum frequency analysis
- Partial discharge measurements can be made in pico-coulombs or micro-volts
- Sweep Frequency response analysis.

All the instrumentation is of a high standard and is calibrated and checked at regular intervals.



TRANSFORMER SERVICES

INSTALLATION

We can offer a complete installation service or alternatively supply a supervisor to oversee and guide the installation, testing and commissioning of your equipment. We offer complete method statements and risk assessments in accordance with our ISO9001 accreditation. Dedicated site quality plans are compiled for every site contract.

BRUSH Transformers has a worldwide reputation for the supply and installation of a varied range of electrical power transformers and tapchangers covering various applications and locations. These include land-based industrial facilities, marine and the oil and gas sectors both onshore and offshore.

Our Aftermarket support team are able to provide an unrivalled degree of professionalism, reliability and efficiency when undertaking all manner of service activities involved with equipment installations

COMMISSIONING

To complement its market-leading position for supplying and installing transformers, we can provide highly qualified and competent commissioning engineers, who are able to undertake the complete electrical testing and commissioning of transformers and ancillary equipment.

SAFETY

All personnel are supplied with and trained in the correct use of PPE. All work is pre-planned and method statements and risk assessments issued. Each team has one member trained in first aid.

INSPECTIONS

As part of a comprehensive maintenance programme, BRUSH Transformers offers a structured inspection scheme, which can be tailored to meet the operational needs of the installed equipment and facility. These inspections are available for all BRUSH Transformers products in addition to third party equipment. By following a structured inspection programme, the equipment outage time is reduced to a known minimum period. It also provides a continuous appraisal of the equipment's current condition. As a result of each inspection, potential problems arising can be addressed prior to them causing serious failure.

MAINTENANCE

The notion that prevention is better than cure lies at the heart of any maintenance programme. BRUSH Transformers Aftermarket support services are fully equipped to provide all existing operators with a customised support package. This may be adapted to suit each and every individual operator's need, wherever the installation is situated.

TRANSFORMER SERVICES

MAINTENANCE CONTRACTS

BRUSH Transformers can provide short and long term maintenance contracts. These support operators by:

- Enabling a continuous mode of operation. The use of long-term maintenance and health care contracts may be developed to suit the customer's needs
- Enabling designation of inspection points, spare parts and recommendations for continued equipment performance
- Assist in reducing operating costs associated with unplanned outages as a result of equipment failures.

FIELD REPAIR

To complement the inspection capabilities, we can offer a wide range of repair services. These are performed in the field where we have considerable experience working in vastly differing environments, including both onshore and offshore installations, worldwide.

TRANSFORMERS

Typical transformers field repair services offered include:

- Transformer refurbishment
- Radiator repair or replacement
- Cooler equipment replacement
- Cable box replacement
- Oil processing
- Oil replacement
- Tapping switch modification/replacement
- Gasket seal replacement
- Transformer relocation
- Transformer up-rating.

CONTROL SYSTEMS

Typical power management and cooler control systems services offered include:

- Automatic Voltage Regulator fault finding and calibration
- Cooler Control System fault finding and calibration
- Transformer protection relay testing.

TRANSFORMER SERVICES

FACTORY REPAIRS

When it is not possible to repair equipment in the field due to constraints such as space, environment or lack of suitable resources then BRUSH offer a factory based solution. BRUSH possesses comprehensive manufacturing facilities manned by professional personnel for repairing and overhauling equipment. These facilities are supported by technical and project functions to achieve complete customer satisfaction.

Typical transformer factory repair services offered include:

- Tank replacement
- Winding rewind
- Core replacement
- Tapchanger overhaul
- Transformer uprating
- High voltage testing facilities

BRUSH have factory-based Aftermarket support facilities which include:

- Workshops with cleaning facilities and vacuum drying ovens
- Modern machining and fabrication facilities
- Coil manufacturing and core manufacturing facilities
- Assembly workshops including large capacity craneage
- High voltage test facility

SPARES

Using the latest technology available, our data capture system enables us to identify component parts and provide necessary spares for either pre-commissioning or operational requirements.

TAPCHANGER SERVICES

BRUSH offers a team of fully skilled service engineers to provide full Aftermarket service available to tapchangers, 24/7/365. Within the business we have a fully dedicated spares/repairs department and team of fitters.

SPARES

Spare parts are available for all modern and obsolete models of on-load tapchangers and off-circuit tap selectors. All spare parts are genuine parts manufactured to the highest degree of quality, from original drawings, materials and tooling.

In addition to manufacturing a full range of modern on-load tapchangers and off-circuit tap selectors.

Associated tapchangers have a fully equipped repairs department, which specialises in the repair and refurbishment of old tapchangers. We will arrange to remove the faulty equipment from site, return it to the factory, repair or refurbish as required, return to site and install, test and commission as requested.

Main features include:

- Maintenance training
- Routine maintenance
- Engineers site visit for assessment, inspection and reports on the tapchanger
- Emergency repairs
- Spare parts for tapchangers
- Minor repair or overhaul
- Complete tapchanger overhaul and repair at our factory
- Retrofitting modern units to replace older tapchangers allowing reduced maintenance costs for the future.

ENERGY SOLUTIONS FOR THE GLOBAL POWER INDUSTRY

BRUSH
NOTTINGHAM ROAD,
LOUGHBOROUGH,
LEICESTERSHIRE,
LE11 1EX, UNITED KINGDOM
T + 44 (0) 1509 611511
F + 44 (0) 1509 612009
E SALESUK@BRUSH.EU

www.brush.eu