



TRUST. WELL EARNED.

BRUSH Transformers

Unrivalled power delivery
from a name you trust





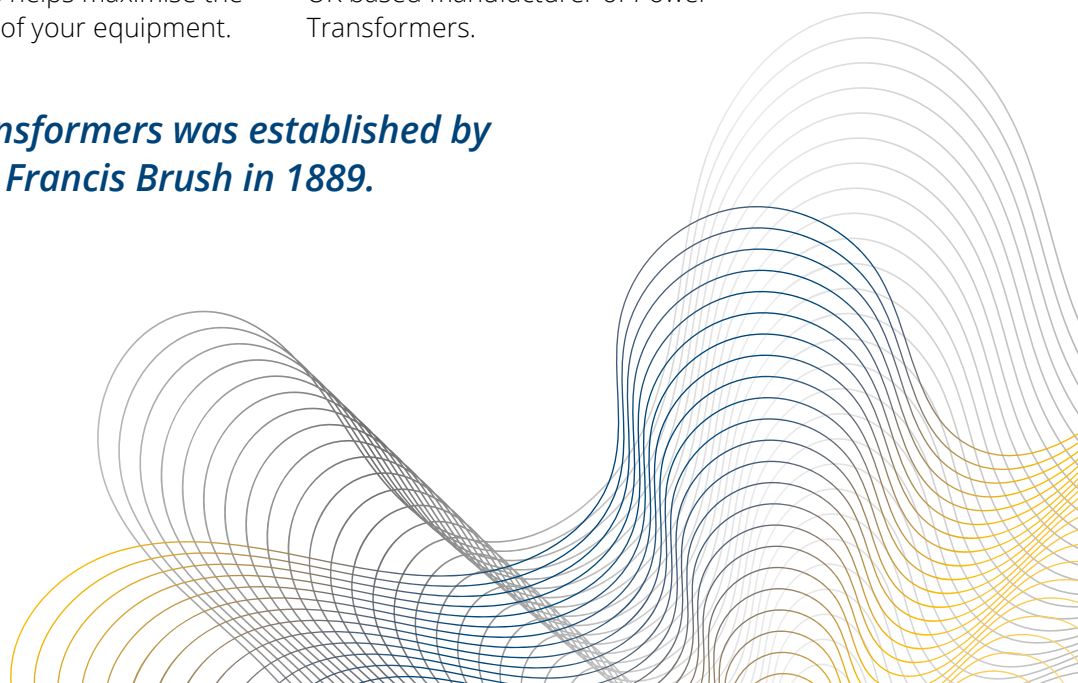
The Name Behind The Power

BRUSH products are manufactured to deliver high performance, year after year.

BRUSH services helps maximise the operational life of your equipment.

BRUSH Group offer Generators, Power Transformers, Switchgear, Diesel and Petrol Generator sets. BRUSH Transformers is the largest UK based manufacturer of Power Transformers.

BRUSH Transformers was established by Mr Charles Francis Brush in 1889.





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Energy Solutions For The Global Power Industry

BRUSH offers a comprehensive range of Power Transformers, Reactors, Tapchangers and Associated Services.

BRUSH are recognised as a leading independent transformer solutions provider, offering bespoke designed liquid-filled transformers from 6.6kV-145kV.

Continuing design innovation combined with over 125 years of consultative transformer expertise ensures the most technically demanding projects are supported by a comprehensive product range.

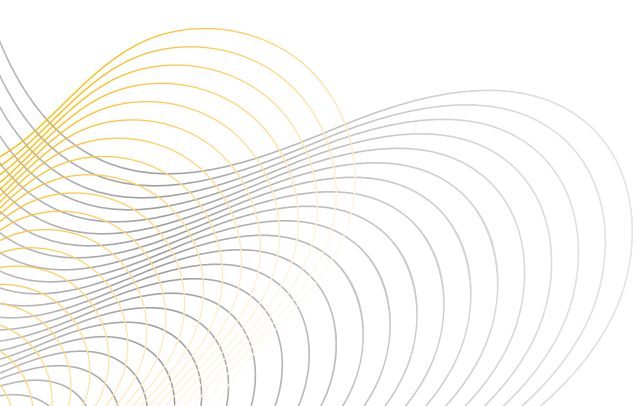
BRUSH Transformers is globally renowned for the quality of its products, innovation and service. Our worldwide market includes the utility, oil, petrochemical, coal, steel and rail industries.

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 through research and product development to support our customers long term growth.

The company maintains ASTA third-party accreditation to quality standard ISO 9001:2015, environmental standard ISO 14001 and health and safety standard OHSAS 18001.

We design and manufacture to many British, European and International standards and have world class test facilities to ensure that the quality of the product is prevalent.



Transformers

With over a 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:

Power Transformers

- 6.6 kV, 11kV, 33kV, 66kV and 132kV – up to 160MVA
- Station service transformers
- Generator transformers
- Auto transformers

Special Transformers

- Traction transformers for EMU's
- Current limiting series reactors
- Rectifier transformers
12, 24 & 36 pulse
- Furnace transformers
- Transformers with dual secondary
- Trackside transformers
- System Inter-tie transformers
- Auto transformers for railway applications

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.



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Transformer Oil

BRUSH offers transformers with different types of oil as below:

- 1 Mineral oil
- 2 Natural esters equivalent to Midel, Envirotemp FR3
- 3 Synthetic oil

Traction Systems

For traction systems BRUSH are able to provide, 132/25kV traction supply transformers, 25-0-25kV auto transformers and 25kV 300Amp trackside booster transformers.

Short Circuit Test

BRUSH have successfully short circuit tested a 25kV, single phase track side transformer for Network Rail at KEMA Netherlands.

Partial Discharge Free Transformers

BRUSH offers PD free transformers. Ensuring our transformers are reliable with a longer life expectancy with less need for maintenance during service.

Noise Levels

BRUSH uses advanced core build technology that meets the most onerous operational requirements offering reduced noise levels.

By using this technology it helps in reducing the constructional costs on site, especially in residential areas as there is no need for noise enclosures around the transformers.

Variable Speed Fans

BRUSH offers transformers with variable speed fan technology. This helps with better temperature control, reduced noise levels and reduced auxiliary losses for the transformers during its service life.

No-Load Losses

Our optimised design offers reduced no load losses. The benefits of the step lap core build technology are low running costs and noise levels which reduces capitalisation costs of the transformer over its lifetime.

Direct Winding Temperature Measurement

To ensure our temperature measurement of the windings is high in accuracy, BRUSH can offer, on request, direct hot spot measurement in windings by the use of fibre optic sensors.

Compact Transformers

To help with reducing the overall substation size, BRUSH can offer optimised and compact designed transformers.



AT Tapchangers

Single compartment units



The AT range of single compartment units with high-speed resistor transition are 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.

Specification

- Compact
- Linear, reversing or coarse/fine versions
- Suitable for 52kV, star or delta windings
- 400A version (linear only)
- Suitable for 145kV star winding at neutral end
- 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

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

AE Tapchangers

On-load 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.

Specification

- 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

The AE also operates 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.

AE Tapchanger design has been further enhanced by the introduction of special barrier board material to improve its vacuum withstand capability.

Key Features

- 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



BRUSH Design

BRUSH has achieved a history of manufacturing spanning 125 years by refusing to compromise on performance, quality or reliability.

BRUSH Transformers strive to ensure that our products and services consistently provide the best value, and are suitable for each of our customers individual needs.

From the initial stage of any project, with a design department that employs 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 and 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 considering the changing customer requirements, material advances and technical design improvements.

All transformers are designed and modelled using latest 3D software. BRUSH Transformers utilise the latest CAD technology, investing in software packages including AutoDesk Inventor, ANSYS FEA and FEMM Electromagnetic FEA.

External fabrication facilities with full control on quality. All our transformer tanks are designed to withstand full vacuum.

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.

All fabrication designs are subjected to stress analysis. All structural components are stress analysed using "ANSYS" software.





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All transformers supplied by BRUSH have the CE marking on the transformer rating plate as a sign of compliance. The no load and load losses are also indicated on our transformer rating plates.

Tier 2 is due to be enforced in July 2021 which will require all new transformers to be a further 10% efficient. However, BRUSH already supply transformers with Tier 2 efficiency to DNO's within a framework agreement. BRUSH Transformers met this requirement in 2016 in advance of its enforcement date of 2021.

BRUSH Transformers use high quality electrical steel with Hi-B material and efficient flux density to design transformer cores. This results in optimum no load loss and low noise level. We also design cores with 7 step lap joints which further reduces the losses and improves the transformer effectiveness.

Our windings are also designed with high grade electrolytic copper and minimum eddy current losses improving the energy efficiency.

Transformers with CER rating are compliant also at intermediate power rating.

Our transformers are EU directive compliant, aimed at reducing the amount of energy unnecessarily wasted through transformer losses.

Upon request, BRUSH Transformers are capable of supplying transformers with thermally upgraded paper.

The benefits of thermally upgraded paper are, extended lifespan of transformers especially in regions with high ambient temperatures increased reliability, reduced losses and reduced operational costs.

Winding designs can be optimised, based on current calculations, winding conductor types can be graded accordingly.

Our transformers are designed with CTC, bundle/bunch and PICC conductors based on the current in the windings, this reduces voltage stress levels. Thus giving enhanced short circuit withstand capability, reduced eddy current and load losses.

BRUSH offers transformers with optimised insulation structure. High quality insulation materials are used with various stage checks, helping in providing partial discharge free transformers. Special measures are taken to equalise the voltage potential over any joints.



This provides reduced site failure and a longer lasting insulation life which increases transformer life.

Transformer Manufacturing

BRUSH Transformers are manufactured to the highest standards in our computer controlled factories, with every step of the manufacturing process monitored and tested to guarantee quality.

Controlled Environment

A dust free shop floor provides a clean controlled environment for transformer assembly.

Air Cushion Transporters

The movement of core and coils and assembled units within the factory is performed using air cushion transporters on moving pallets.

The air cushion transporters and moving pallets are capable of handling weights of 100 tonnes and can be operated in tandem. Easy movement of heavy units within the shop provides stress free handling.

Windings and Insulation

All windings are made to strict dimensional tolerances using computer controlled winding machines.

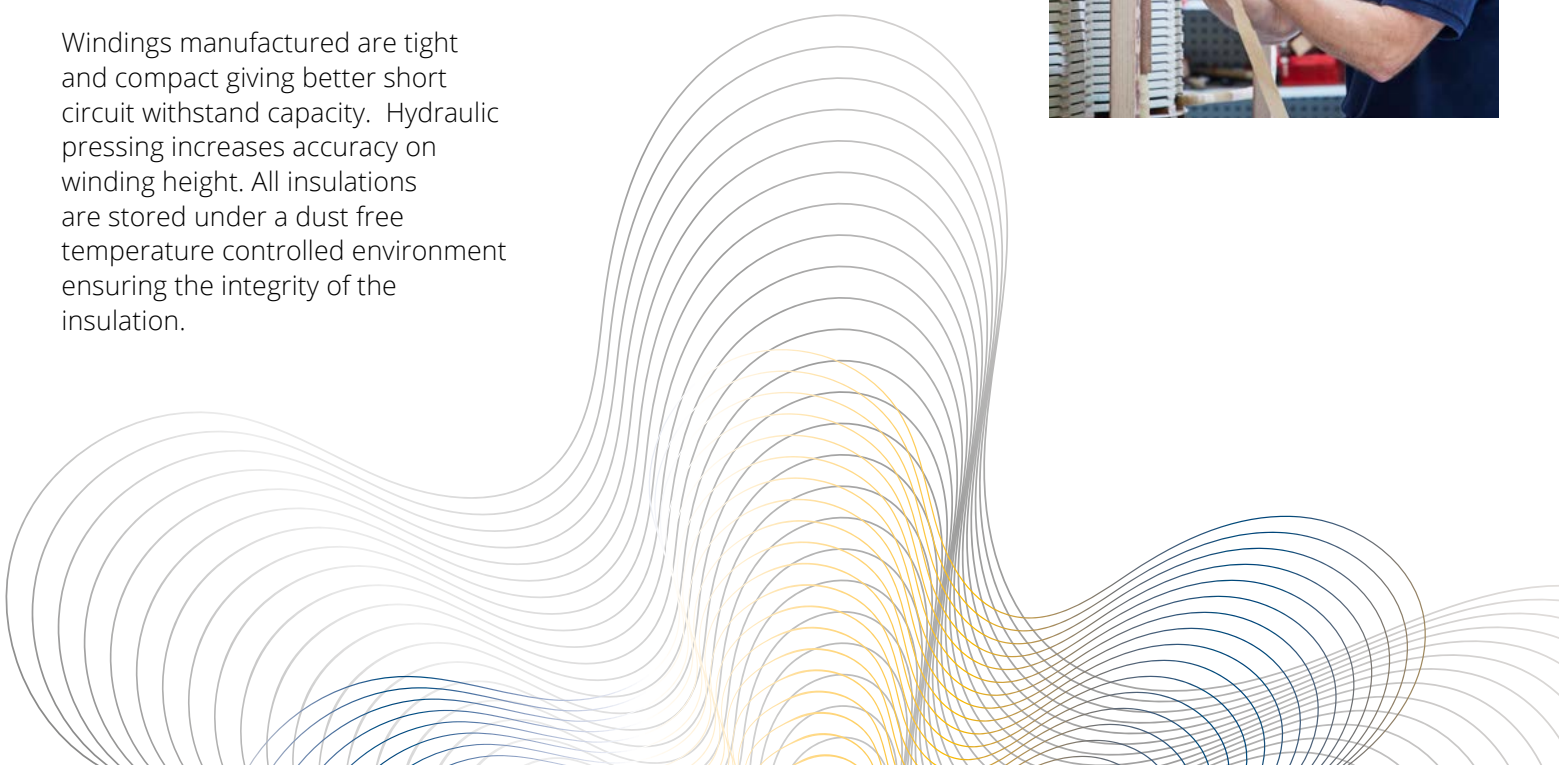
Windings manufactured are tight and compact giving better short circuit withstand capacity. Hydraulic pressing increases accuracy on winding height. All insulations are stored under a dust free temperature controlled environment ensuring the integrity of the insulation.

Core-coil Assembly

The connections on the core and coil assembly are made using the latest crimping technology providing carbon free connections and PD free transformers.

The core clamps are designed to press the active part using the hydraulic jacks and power packs with correct pressures on the windings.

The pressing of the active part with correct pressure gives good mechanical stability and greater short circuit withstand capability.





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Drying of Core and Coils

The core and coils are dried in the vacuum drying oven, using an advance computer system that records all processes and curves, controls the temperature, vacuum degree and drying time.

Compared to conventional ovens, our vacuum oven ensures uniform drying of the active part to achieve a designated level of 0.6mbar vacuum (0.5% Moisture).

Final Assembly

Upon completion the fully assembled core and coils are dried in the vacuum oven, 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.

Tanks

Our tanks are painted with C5-M protection for corrosive environments. All tanks are designed to withstand full vacuum, pressure tested and stress analysed.

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.

Optimum dielectric strength is achieved via processing in accordance with rigorous in-house quality procedures.

Testing Facilities

BRUSH Transformers test facility can carry out all routine, type and special tests as per the International Standards IEC, ANSI and as per BS, ENATS specifications.

Dedicated test facility for testing 11kV, 33kV, 66kV and 132kV.

Special sound enclosure for testing low noise transformers with a background noise level as low as 30dB within the enclosure.

Latest test instruments for carrying out ratio tests, winding resistance, loss measurements, capacitance and tan delta with automated recording of all results and printing of test reports.

Wide band digital power analysers used for high measuring accuracy (0.1%) even at low power factors.

New high accuracy CT's and VT's (manufactured by Epro):

- V.T's – Voltage Error – $\pm 0.010\%$
- C.T.'s – Accuracy $\pm 0.005\%$, $\pm 0.5\text{Min.}$

Guaranteed loss measurements are carried out with great accuracy. Separate dedicated customer suite with Wi-fi.

Dedicated high voltage laboratory for carrying out routine, type and special testing on 132kV transformers.

This test facility houses a BRUSH designed / manufacture 40 MVA, 450kVp, 3.3-2.5 kV to 115kV test transformer. Taps on HV for HV variation in 45 steps to vary test voltage from 2.5kV to 115kV in steps of 2.5kV.

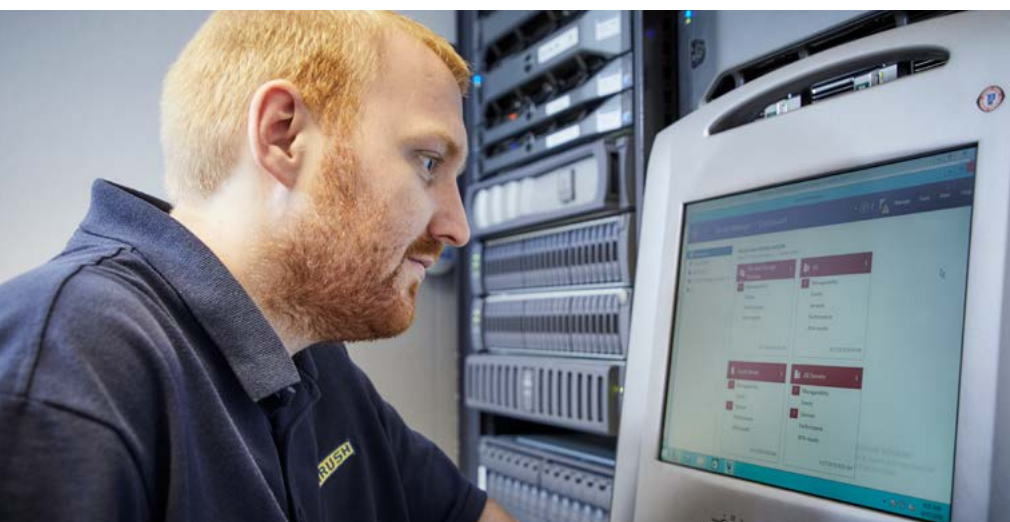
Multi Coarse fine tap arrangement transformer specially designed for variable loading conditions with frequent switching cycles for test purposes.

5 MVA power regulator used in conjunction with capacitor banks (60 MVar currently installed).

Impulse test with digital control and data acquisition system from Haefely.

Rating of Impulse System

- Generator type Haefely SGD1200-120:
- No of Stages – 12
- Total Gen voltage : 1200kV
- Energy – 120kJ
- Capacitive Voltage dividers
- Haefely CZ2000 @ 2MV and Haefely CS800 @ 800kV
- Chopping Gaps : 6 of 200kV per stage.
- High resolution digital recording system enabling the comparison of wave shapes to be made, saved and printed.





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Partial Discharge Measurement

4 Channel Digital Partial Discharge equipment from Omicron is used to measure partial discharges on the transformer. The background PD levels attained in the test lab is of 10–20 pC.

Digital equipment with excellent tools which separates the smallest PD pulses from interference and helps in analysis.

Global Quality Standards

- BRUSH Transformers hold ISO 9001-2015, ISO14001, and ISO18001 certification
- Certified and approved to supply to Network Rail
- 8D approach to problem solving
- In-process check/process control plans at various stages of manufacturing to reduce errors
- Stringent final inspections prior to dispatch of every transformer by standard quality inspection process

Benefits to Customer

- Highest quality product
- Customer quality management system in place
- Operational excellence of the product
- Reliability of the transformer



Transformer Services

24 hour service support

Installation

We 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 Service 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 our market-leading position for supplying and installing transformers, we provide highly qualified and competent commissioning engineers, who undertake the complete electrical testing and commissioning of transformers and ancillary equipment.

Safety

All personnel are equipped 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.

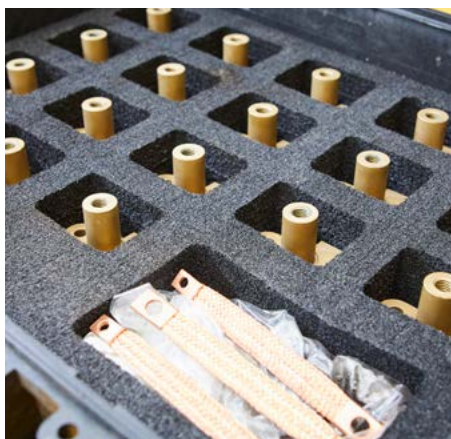
It also provides a continuous appraisal of the equipment's current condition. As a result of each inspection, potential problems arising can be addressed prior to them causing serious failure.

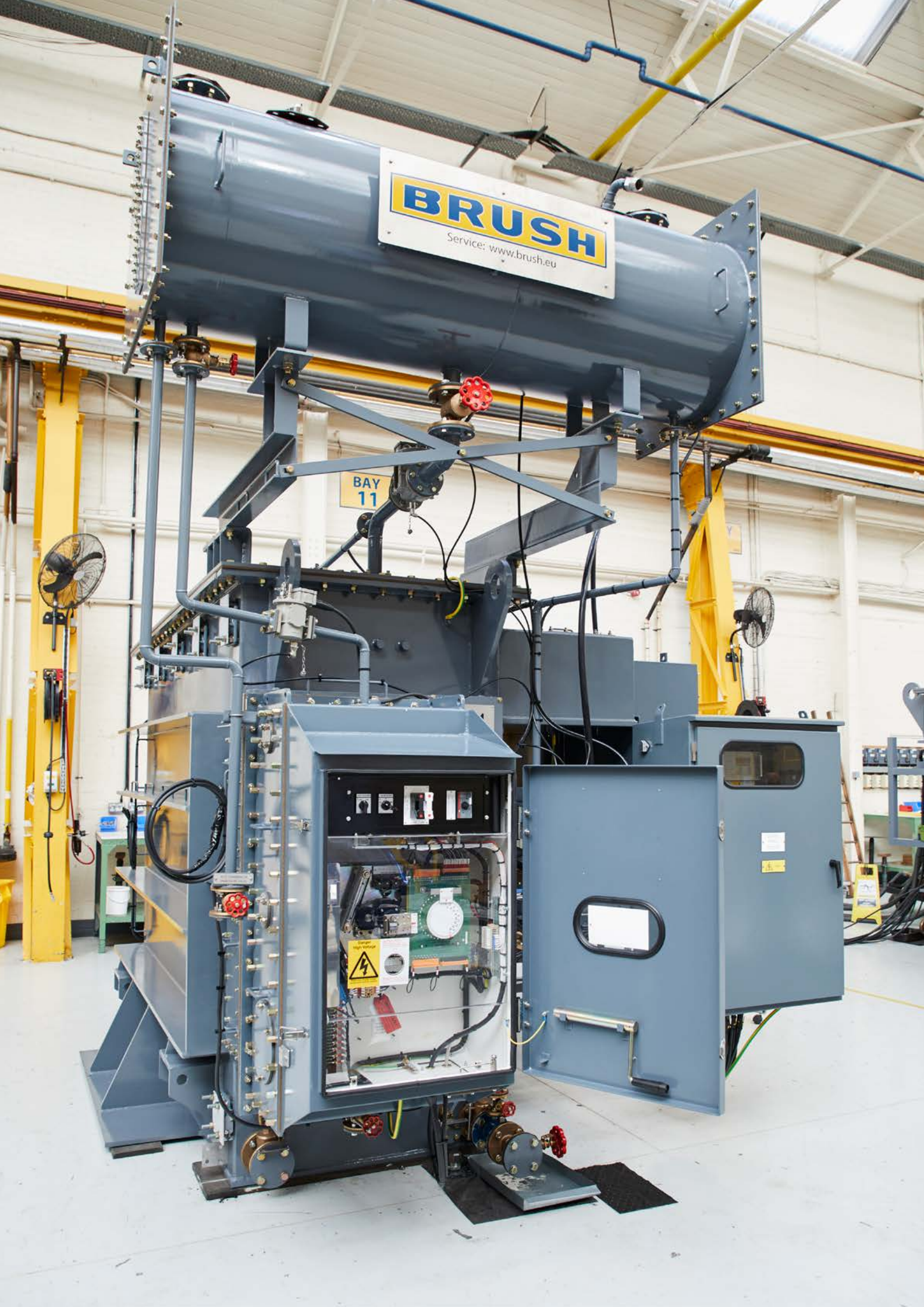
Maintenance

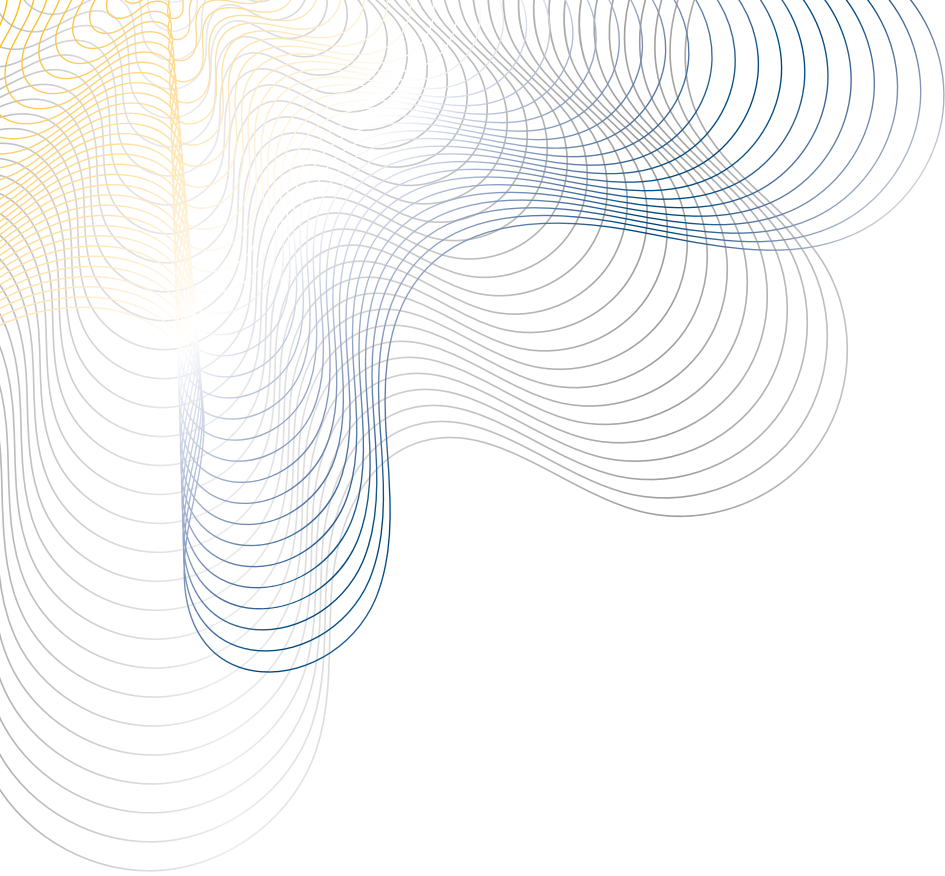
The notion that prevention is better than cure lies at the heart of any maintenance programme.

BRUSH Transformers Services are fully equipped to provide a customised support package which can be adapted to suit each and every individual operator's needs, wherever the installation is located worldwide.

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.







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For more information please contact us at www.brush.eu/contact