



BRUSH
AFTERMARKET



REPLACEMENT GENERATORS

ENERGY SOLUTIONS FOR THE GLOBAL POWER INDUSTRY

BRUSH has been at the forefront of the power generation industry for over 130 years, manufacturing world class turbogenerators, transformers, control systems and switchgear. BRUSH is the largest independent manufacturer of turbogenerators in the world, combining the resources of three major manufacturers of generators for gas turbine, steam turbine and hydro-turbine drive.

With manufacturing plants in the UK, the Netherlands and the Czech Republic, and with customers across all continents, BRUSH has a truly global presence. Each manufacturing plant has been designated as a Centre of Excellence for the design and manufacture of high voltage generators, power management systems, excitation systems and motors (including synchronous, submersible and other special types). Together with Hawker Siddeley Switchgear and Harrington Generators, BRUSH offers a comprehensive range of products and services for the power generation industry. BRUSH offers a comprehensive service with rapid response times to all customers, anywhere around the globe.

BRUSH Aftermarket operate and are represented in the following locations:

- Loughborough, UK
- Houston, USA
- Singapore, Malaysia
- Ridderkerk, NL
- Tokyo, Japan
- Mumbai, India
- Plzen, CZ
- Kuala Lumpur, Malaysia
- Seoul, Korea
- Aberdeen, UK
- Lagos, Nigeria
- Pittsburgh, USA
- Abu Dhabi, UAE

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REPLACEMENT GENERATORS

BRUSH has proven its internal ventilation design with comprehensive testing programs and a history in power generation across the globe.

Some manufacturer's generators use a ventilation system that is single ended, resulting in an increase in air temperature as it passes through the coils and exits. Depending on operating hours of the generator and the air inlet temperature, the cooling effect can be compromised.

Where generators are running continuously, on a lower power factor, or in a hot environment the expected operating temperatures can be exceeded.

Higher operating temperature accelerates degradation of insulation properties leading to machine damaging stresses and high partial discharge in the stator slots.

BRUSH DAX generators larger than 60MVA have air compartments that are split to provide contra flow air across the core and coils to ensure balanced temperatures along the length of the stator.

In machines up to 250MVA, BRUSH closely mould and consolidate the copper and insulation into a rigid and dense structure which has excellent heat transfer properties.

BRUSH uses water coolant directly through the coils on larger capacity generators – 350MVA upwards. Where there is an internal water coolant passage, hydrogen can also be used in the pressure casing.

BRUSH have the capabilities to replace the majority of generators from all manufactures and different sizes, this includes small multipole generators all the way up to large 1000MW generators.





WHY A BRUSH REPLACEMENT?

BRUSH can offer an alternative to endless repairs with a customized solution for your replacement generator.

BRUSH has vast experience in supplying generators for all types, ratings and configurations of turbine. BRUSH ensure each generator is perfectly matched to suit the turbine and any specific requirements customers may have.

- Single or double ended drive
- Brushless or static excitation
- Air cooled, hydrogen cooled or combined cooled
- Indoor & outdoor application
- Modern excitation controller systems to match generators
- Custom fabricated line & neutral cubicles when needed
- Improved efficiency
- Improved acoustics (dBA)
- Cost competitiveness
- Modular constructions
- Option of filter, closed air or closed water cooled
- Power outputs from 10MVA – 1111MVA
- BRUSH will take the lead on site and provide a complete replacement service
- BRUSH provide a full turnkey solution.





BENEFITS OF NEW MACHINE VS. REPAIR

- New BRUSH generators are plant tested, installed and commissioned with a full report and quality records
- New BRUSH generators come with a full machine warranty
- Modern excitation system that can connect to plant monitoring systems/DCS
- Stator slot couplers for on-site PD monitoring
- Current parts & service support available
- BRUSH is one of the few independent manufacturers who custom engineer
- Modular construction giving a fine balance between flexibility and standardisation of components for fast economic construction
- Fully developed system readily adapted to any turbine design
- More efficient operation and lifecycle costs.

BRUSH GENERATORS HAVE BEEN SUPPLIED FOR THE FOLLOWING TURBINE MANUFACTURERS/PACKAGERS

ALLEN POWER	GENERAL ELECTRIC LM 2500+	ROLLS ROYCE OLYMPUS
ALSTOM TYPE 11w	GENERAL ELECTRIC LM 5000	ROLLS ROYCE RB211
DRESSER RAND	GENERAL ELECTRIC LM 6000	ROLLS ROYCE SPEY
EKOL SPOL	GENERAL ELECTRIC LMS 100	ROLLS ROYCE TRENT
ELLIOT COMPANY	HITACHI H25	SHIN NIPPON MACHINERY CO
FINCANTIERI	HYUNDAI THM1304D	SIEMENS
FRANCO TOSI	KAWASAKI L20A	SIEMENS GT35
GENERAL ELECTRIC FRAME 3	MAN TURBO	SIEMENS SGT-500
GENERAL ELECTRIC FRAME 5	mitsubishi MF111	SIEMENS WESTINGHOUSE W251
GENERAL ELECTRIC FRAME 6	MITSUBISHI SB60	SIEMENS WESTINGHOUSE W501
GENERAL ELECTRIC FRAME 7	MITSUBISHI HEAVY INDUSTRIES	SIEMENS WESTINGHOUSE W701
GENERAL ELECTRIC FRAME 9	ORMAT	SKODA POWER
GENERAL ELECTRIC GE10	PETER BROTHERHOOD	SOLAR MARS
GENERAL ELECTRIC LM 1600	PRATT & WHITNEY FT4	SOLAR TITAN
GENERAL ELECTRIC LM 2000	PRATT & WHITNEY FT8	TOSHIBA
GENERAL ELECTRIC LM 2500	ROLLS ROYCE AVON	TURBOMACH



CASE STUDY: 2 POLE GENERATOR, USA

Quixx Corporation and Borger Energy Associates were experiencing continual problems with their W501 gas turbine power generating equipment at their Blackhawk Power Station in Borger, Texas, USA, and decided to replace the generator under a planned outage. BRUSH offered a solution that would fit within the existing power package envelope and committed to a timescale of 30 days to deliver, install and commission the new generator.

However, in the interim the existing generator failed severely inhibiting the power station's ability to meet its customer needs in terms of steam, water and electricity. BRUSH responded by working closely with the Quixx and the Blackhawk Power Station management teams, and were able to deliver not just what the customer ordered, but more.

The generator delivery time was shortened and, with a team of mechanical and electrical supervisors from the UK and USA, installation and commissioning was completed in just 28 days but, more importantly, it was right first time.

The power plant was back in service with a new generator within the gas turbine package envelope, synchronized and producing over 100MVA of power - completely operational four months earlier than originally planned.

"Quixx/Borger Energy Associates has been very impressed with the machine construction and comprehensive plant testing, along with the expedited installation, start up and commissioning support services which BRUSH provided.

The generator is crucial in meeting the demands of our contracted customers for electric power and steam. Vital signs of the now running gas turbine generator unit are excellent and we expect many years of durable service supported by your expertise and customer service. Our company would have no hesitation in recommending BRUSH..."

R Ross McCausland of Quixx Corporation.



FRAME	BDAX 8-365 ERH	OUTPUT	42,125KVA
FREQUENCY	60 HZ	LINE VOLTS	13,800 V
SPEED	3600 RPM	SPECIFICATION	IEC
PHASE	3	ROTOR	RADIAL COOLED
POLES	2		



CASE STUDY: 4 POLE GENERATOR, GERMANY

KWG Staßfurt mbH were experiencing continual problems with their 42,125kVA steam turbine generator at their Staßfurt facility in Germany.

The existing 4-pole generator with a cylindrical rotor had been experiencing unexpected outages for some time which was causing significant loss to production.

BRUSH offered a solution that would fit within the existing power package envelope and undertook the project to replace the existing unit with our own design DG215ZL-04 generator. This entailed removal of existing generator, site work preparations and modifications to suit the new generator, design and manufacture of the replacement generator, design and manufacture of the replacement AVR panel and finally the installation and commissioning of replacement generator and auxiliaries.

The outage requirements were very tight but with a team of skilled BRUSH mechanical and electrical engineers and supervisors installation and commissioning was completed in just 28 days.

FRAME	DG215ZL-04	OUTPUT	42,125KVA
FREQUENCY	50 Hz	LINE VOLTS	10,500V
SPEED	1500RPM	SPECIFICATION	IEC
PHASE	3	ROTOR	CACW/TEWAC
POLES	4	ACOUSTICS @ 1M	85 dB(A)



CASE STUDY: HYDROGEN TO AIR COOLED, INDONESIA

PT PJB (PT Power Jawa-Bali) are the principle power producer in Indonesia and operate 6 off power plants with a total capacity of 6,511 MW. During a major power disturbance at Muara Karang PP, serving the capital city of Jakarta, one of the main 143MVA Hydrogen Cooled generators suffered a catastrophic failure. The main objective for PT PJB was to restore the lost capacity in the shortest outage period with a secure and reliable unit to match the undamaged gas turbine.

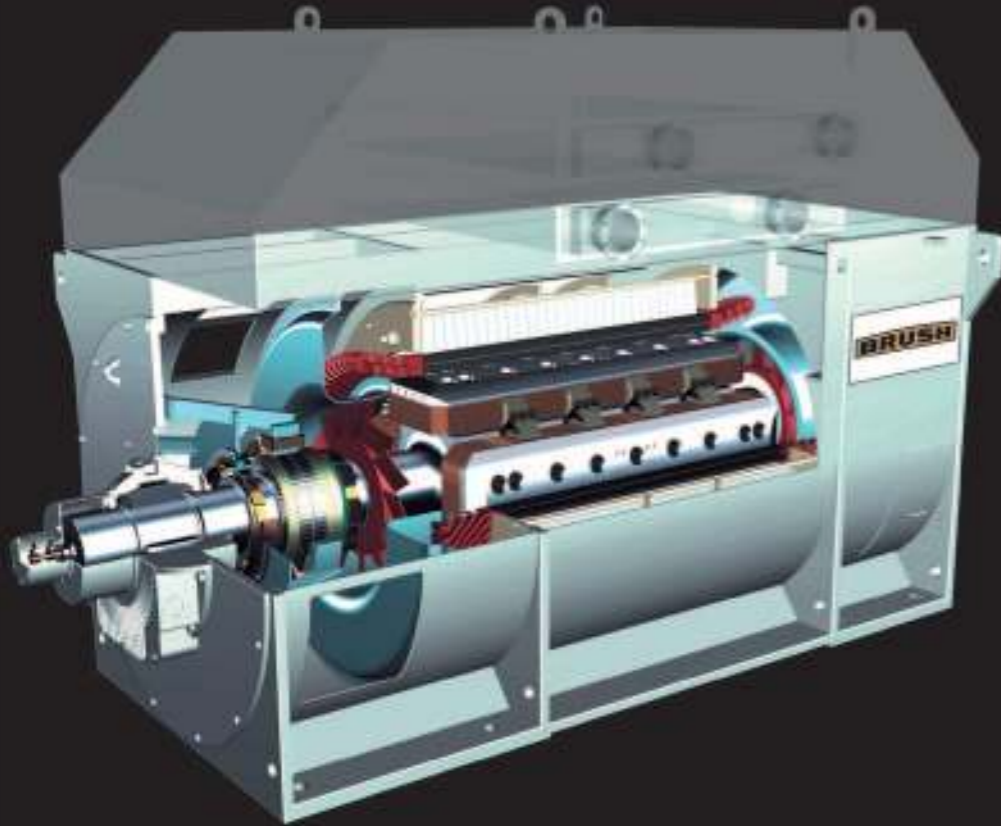
BRUSH provided the complete, comprehensive solution which comprised of a standard range air cooled brushless generator, engineered and manufactured to interface with the existing gas turbine drive train and all associated equipment connections.

The solution included:

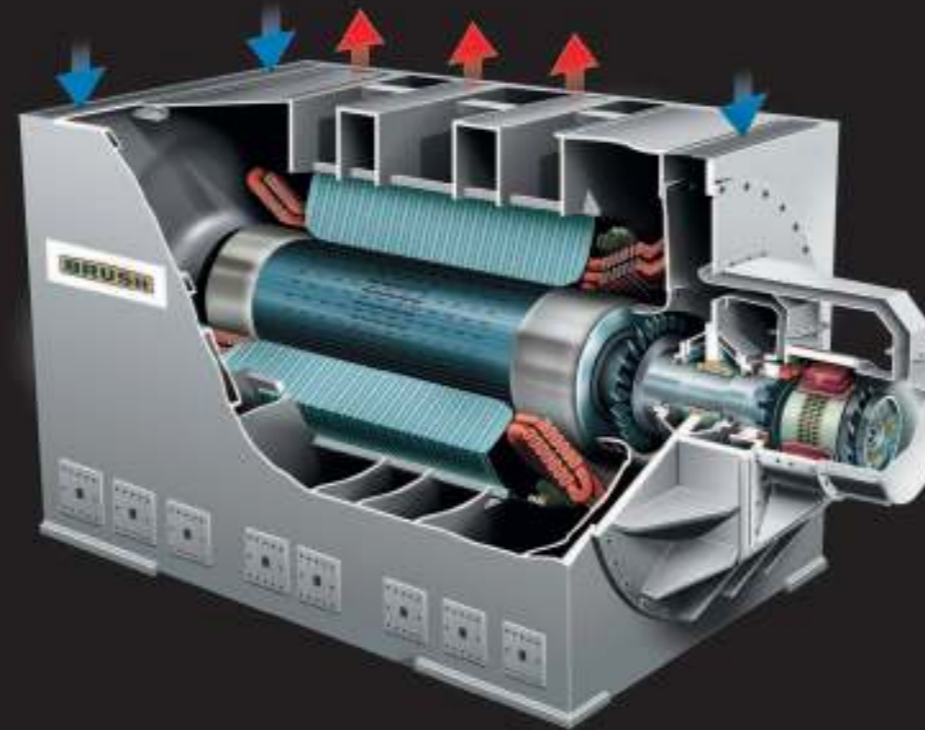
- Air cooled generator BDAX 9-355ERH
- Modern digital excitation and protection system
- New line and neutral cubicles
- New cooler and oil lubrication system
- Bus duct connections
- All transition hardware

In addition to the supplied equipment BRUSH took on a principle role in engineering and leading the complete site exchange program, involving highly skilled local site contractors to execute a seamless transition from old to new within a predetermined schedule. The prompt completion of the installation and dynamic commissioning by BRUSH Aftermarket engineers ensured that PT PJB could return to full output capacity including the added benefits of an entirely modern brushless system within the shortest period available.

FRAME	BDAX 9-355ERH	OUTPUT	143MVA
FREQUENCY	50 HZ	LINE VOLTS	11,500V
SPEED	3000 RPM	SPECIFICATION	IEC
PHASE	3	ROTOR	CACW/TEWAC
POLES	2		



SELECTING A GENERATOR



BRUSH has a number of different models of generators, all tested and proven in the field and suitable for a variety of installations.

BRUSH provide a mechanical and electrical compliant solution to meet the demands of the specific application. This solution, whilst being delivered in the most cost effective way, will meet the required quality standards including ISO 9001:2008 as well as achieving the specific industry standards and approval bodies such as IEEE, IEC, NEMA, CSA. BRUSH also has the ability to meet the most demanding site environment conditions (e.g. H2S).

The BRUSH range of generators allows you to choose the best fit solution to suit your needs utilising the latest technologies, even if your existing unit is over thirty years old.

LM 6000 GAS TURBINE IN 60HZ APPLICATION

BRUSH recommended solution: BRUSH DAX 2-pole generator operating at 3,600rpm (no gear box required).

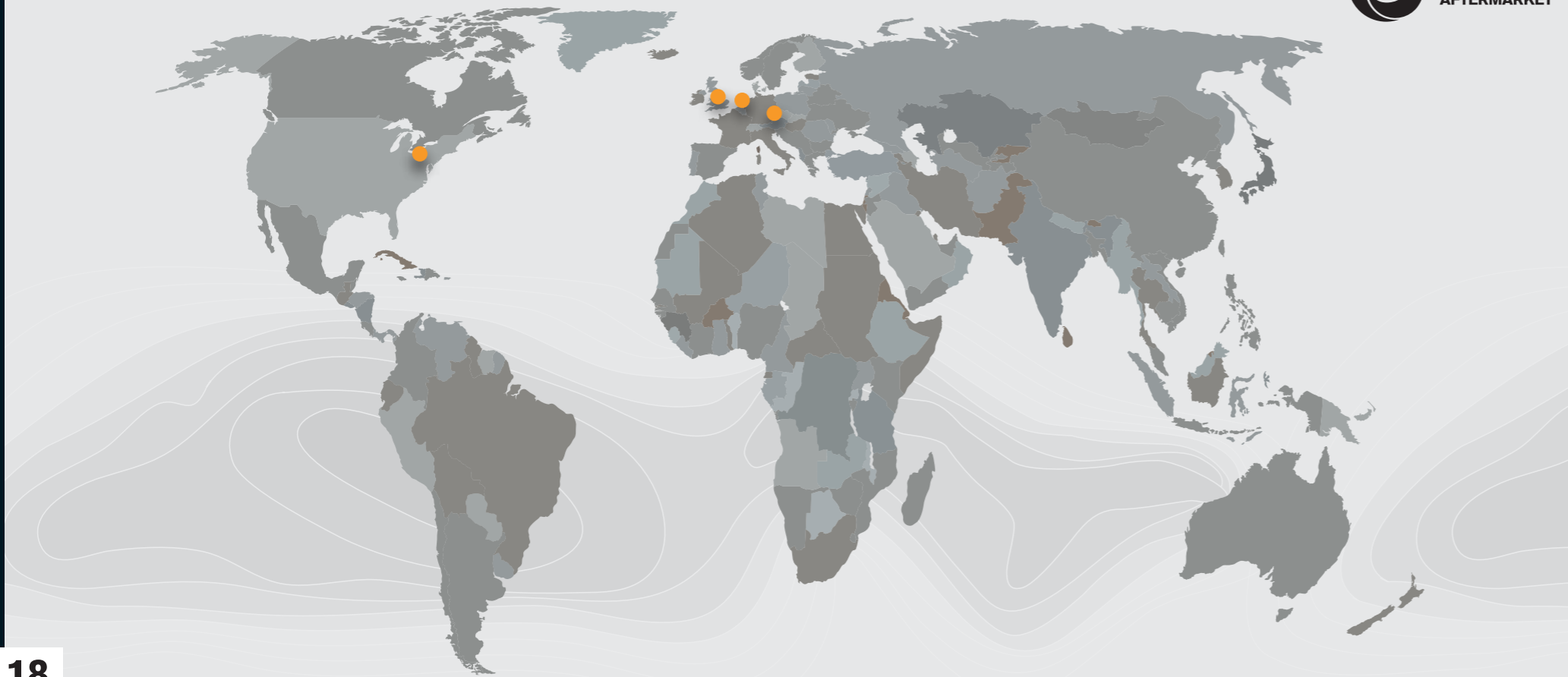
FRAME 5 GAS TURBINE IN 50HZ APPLICATION

BRUSH recommended solution: BRUSH DG 4-pole generator operating at 1,500rpm (with gear box).

GENERATOR TYPE	DIRECT COUPLED TO TURBINE	COUPLED THROUGH A GEAR BOX
BRUSH 4-POLE AIR COOLED	-	YES
Recommended for non-synchronous speed turbine applications from 10MVA through to 64MVA		
BRUSH 2-POLE AIR COOLED	YES	-
Recommended for synchronous speed turbine applications from 10MVA through to 250MVA		
BRUSH 2-POLE AIR COOLED	-	YES
Recommended for non-synchronous speed turbine applications from 64MVA through to 250MVA		
BRUSH 2-POLE HYDROGEN COOLED	YES	-
Recommended for steam turbine applications from 140MVA to 200MVA		
BRUSH 2-POLE COMBINED COOLED	YES	-
Recommended for steam turbine applications from 300MVA to 1111MVA		



GLOBAL CAPABILITIES



BRUSH has provided engineering driven solutions for generation equipment in electric utility and industrial plants for over 130 years. With a full range of inspection, testing, repair and patented retrofits, BRUSH ensures customers receive an unrivalled service incorporating custom engineering for life extension and maintenance of a wide range of generators and excitation systems.

BRUSH is dedicated to upholding high standards of excellence and offer value solutions for all third party generators, providing technical solutions in line with the OEM, using BRUSH's OEM expertise and support network for generators and control systems.

Highly skilled and uniquely qualified service engineers are dedicated to providing timely service to meet both scheduled and emergency outage needs. Support teams can answer any queries you may have about quotations and technical advice.

ROTOR SERVICING

BRUSH offer complete rotor servicing including: inspection, testing, rewind, machining, life extension and engineering. BRUSH has experience rewinding the fields of all the major OEMs. BRUSH has capability in its 50,000 sq ft manufacturing plant to handle rotors up to 100 tons. With two heavy duty lathes and a complete compliment of milling machines, BRUSH can perform any necessary machine operation.

STATOR SERVICING

BRUSH can offer complete stator services from a visual inspection and testing by experienced personnel to a complete rewind. BRUSH provides all the standard electrical and mechanical testing and inspections plus EL-CID, loop test and end winding stiffness ("Bump") testing and analysis.

BRUSH has four centres of excellence spanning the globe, each offering unique facilities that contribute in making the company the largest independent manufacturer of turbogenerators in the world.

LOUGHBOROUGH, UK	SPECIALIZING IN 2 POLE GENERATORS AND PRISMIC BRUSHLESS EXCITATION SYSTEMS
RIDDERKERK, NL	SPECIALIZING IN 4 POLE GENERATORS
PLZEN, CZ	SPECIALIZING IN HYDROGEN COOLED, COMBINED COOLED AND PRISMIC STATIC EXCITATION SYSTEMS
PITTSBURGH, USA	SPECIALIZING IN BRUSHLESS EXCITERS

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