



GE Energy Connections
Power Conversion



GE's Power Conversion business:
Having the right partner is as vital
as having the right technology.

Rotating Machines Manufacturing Capabilities, UK

Center of Excellence for Generators

www.gepowerconversion.com

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GEA32458 GEPC Rotating Machines Rugby, UK - Capability Brochure

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MANUFACTURER OF ELECTRICAL EQUIPMENT & ROTATING MACHINES SINCE 1902

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About GE Power Conversion

GE's Power Conversion business applies the science and systems of power conversion to help drive the electric transformation of the world's energy infrastructure. Designing and delivering advanced motor, generator, drive and control technologies that evolve today's industrial processes for a cleaner, more productive future, it serves specialized sectors such as energy, marine, industry and all related services.

Rotating Machines, UK

100+ years experience

CENTER OF EXCELLENCE

GE Power Conversion's Rotating Machines business in UK has more than 100 years experience in the design, manufacture and test of large rotating electrical machines. GE's Rotating Machines Rugby facility has the capability to manufacture induction and synchronous machines, the Rugby facility is GE's Center of Excellence for generator design and manufacturing.

As a Center of Excellence, we offer an extensive product range of medium & high voltage generators from 2 - 75 MVA. To be driven by gas or steam turbines and, diesel engines including excitation control, suitable for many applications including, Marine, Offshore and Onshore Oil & Gas, Naval, Industrial, Renewable Energy and Power Generation.

All generators delivered from Rotating Machines Rugby are designed and tested in accordance with the relevant IEC, NEMA, IEEE, and ANSI codes.

Designs can be customized to match specific customer specifications.

Machines are designed to operate within the temperature rises specified in the applicable code and to withstand all normal operating conditions, including suddenly applied loads, switching surges and short circuits external to the generator.

Our generators can be designed to meet the requirements of the major marine certifying authorities including DNV, ABS, BV, Lloyds, RMRS, etc.



Rotating Machines Rugby

A Pedigree in Innovation

1900's



1902 - The Rugby Mill Road factory British Thomson Houston (BTH) opens and commences manufacture of motors and generators.

The 1st machine designed in Rugby was a vertical 700kW single-phase turbo-alternator running at 1500rpm.

1910's



1914 - At the beginning of World War I BTH expands its product range into naval electrical equipment and supplies the Royal Navy with lighting, radio and signalling gear.

The company's experience of manufacturing filament lamps enables it to commence manufacture of valves for radio equipment.

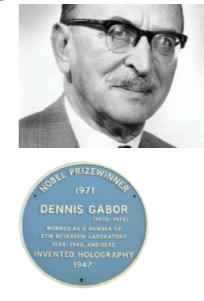
1930's



1937 - Frank Whittle's power jet company builds the world's first prototype jet engine at the BTH works in Rugby.

During World War II, manufacturing in Rugby diverts to support the war effort producing radio valves, transmitters and receivers, aircraft electronics and electric torpedoes.

1940's



1947 - Dennis Gabor a young Hungarian refugee, employed at BTH in Rugby since the 1930's, conducted basic experiments in holography - at that time called 'wave front reconstruction'.

In 1971, Gabor was awarded the Nobel Prize in Physics for his invention and development of the holographic method.

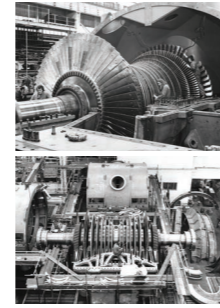
1998 - GEC Alstom and Cegelec projects are re-united as Alstom under French ownership.



Further investment at the Rugby facility sees the opening of a new £3million test facility in 1999.

1990's

1986 - GEC in Rugby separates into GEC Alstom and Cegelec Projects.



The 2 main propulsion motors for Cunard's cruise liner, Queen Elizabeth II are manufactured at the Rugby facility.

1980's

1967 - AEI is acquired by the General Electric Company (GEC).

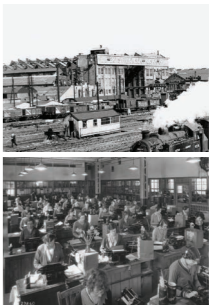
In the 1960's and 1970's there was a big drive to recruit apprentices. GEC's highly regarded apprenticeships were exposed to production of a wide range of industrial products.



1960's

1958 - British Thomson Houston and Metropolitan Vickers merge to become Associated Electrical Industries (AEI).

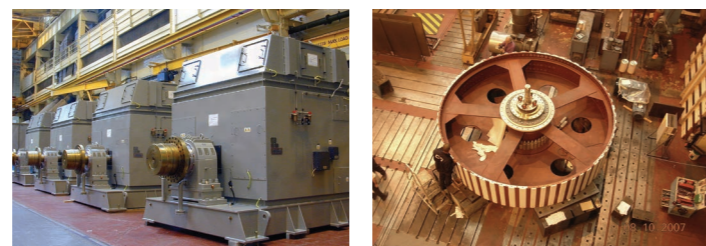
The Rugby facility with 12,000 employees reaches its peak size with the building of a new research laboratory in 1960 on the Rugby, Boughton Road site.



1950's

2006 - Alstom sells its Power Conversion business to private equity firm. Convertteam is formed as a power conversion engineering company.

Permanent Magnet Generators (PMG) are added to the Rugby facility manufacturing line.



2000's

2011 - General Electric acquires Convertteam to become GE's Power Conversion business.

Rugby becomes Centre of Excellence for Generators, supplying customers across the Marine, Naval, Oil & Gas, Metals, Mining and Renewable industries.



2010's

Product Line Manufacturing

Motors & Generators



4 POLE SYNCHRONOUS GENERATORS

For Industrial Applications
5MW to 80MW



MULTI POLE SYNCHRONOUS GENERATORS

For Industrial Applications
5MW to 40MW



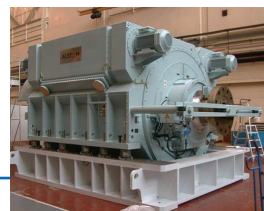
PERMANENT MAGNET GENERATORS (PMG)

For Wind Applications
2.5MW to 8MW



EXCITATION & CONTROL SYSTEMS

High technology digital control



ADVANCED INDUCTION MOTOR

Naval applications
Typical power 20MW



COMPACT INDUCTION MOTOR

Commercial applications
Typical powers 3 to 20MW



VERTICAL INDUCTION MOTOR

Typical powers 4-5MW
600-720RPM



MINE WINDERS

Typical powers 3-5MW
40-60RPM

Processes & Footprint

Unique Manufacturing Capabilities

Machine & Press Shop



Vacuum Pressure Impregnation



Stator & Rotor Build



Assembly, Test & Packaging



Coil Shop & Stator Winding



Footprint: 21,800 m²
Cranage: 200 tonne
Clearance: 21 metres

Machine & Press Shop

The site's heavy materials enter into the facility through the Machine and press shop for initial processing and machining including cold-rolled low-loss silicon steel which is then die cut into laminations.



PRESSES

- 400T & 250 T Presses, Installed 2010
- Semi auto-feed line
- Notching Press, Installed 2010

LATHES

- Shaft Grinding Machine Installed 2009
- Lathe Installed in 2009
- Electrical & Mechanical Run-out Equipment

LAMINATIONS

- Segmented & Ring Laminations
- Pin Vent Laminations

Stator & Rotor Build

STATOR BUILD

Specially designed mandrels are used to build each stator core from our Standard Product Platform (SPP):

- Ring Laminations
- Segmented Laminations

The mandrels guarantee concentricity of the bore and alignment of the coil slots. After the core build process, consolidation pressure of up to 600 tonnes is applied to the core prior to the final welding operation. Adjacent to the mandrels is the pin vent welding facility where a computer controlled machine welds spacing pins to the laminations in a predetermined pattern. Where specified these are added to the core build to provide improved module ventilation.

The stator core assembly consists of insulated laminations of low-loss silicon steel, clamped between compression plates (to reduce eddy current losses). Our generators employ GE's patented Pin Vent technology. In this construction the conventional drawn beams are replaced by circular steel pins. Pin Vent technology maximises heat transfer and efficiency by increasing the number of ducts and hence core surface area.

ROTOR BUILD

Dependent upon the size of the machine, the rotor will be constructed from one of our standard product platforms (SPPs)

- 4 Pole Laminated Rotor
- 4 Pole Solid Pole Rotor
- Multipole Laminated Rotor
- Separate Poles



Coil Shop & Stator Winding

Vacuum Pressure Impregnation (VPI)

COIL SHOP

The coil shop undertakes the winding and insulating of the diamond coils ready for stator winding. This area boasts the site's first automated robot arm, specially designed to apply insulation materials.

The coils are inserted into the stator slots and are firmly held in position with epoxy glass wedges. The end windings are then securely braced before the complete wound stator undergoes a Vacuum Pressure Impregnation (VPI) process, giving a full class F insulation system.

STATOR WINDING

The winding facility is located in a designated clean area. All stators are wound in this environment. The manufacturing processes include operations such as coil insertion, interconnecting, bracing and high-voltage testing.

The stator coils are produced in-house from annealed copper strip insulated with mica. Once loops of the correct number are formed, the coil straight portion is pressed to bond the strand together prior to being pulled to the required shape. The coil is insulated with the appropriate number of layers of mica tape followed with a finishing tape on the end winding portion which provides additional protection.

WINDING & COILS - CAPABILITY

- Stator Windings Copper Ready for "Looping installed 2010
- Specialized Looping Machine installed 2011
- Stator Coil Loops Press Installed 2010
- Stator Winding Diamond Winding Pulling Machine Installed 2010
- Stator Winding Diamond Winding Pulling Machine Installed 2012
- Stator Winding Insulating Machine Installed 2010
- Special Stator Winding Insulating Machine Installed 2011
- Hand-Taping Area
- Stator Winding Quality Checking Gauge
- Rotor & Stator Test Area
- Stator Winding



VACUUM PRESSURE IMPREGNATION (VPI) - CAPABILITY

- 1 tank (5.5 metre diameter)
- 2 x tanks (4.5 metre diameter)
- VPI Oven & Horizontal VPI Tank
- VPI Computer Controls

The Vacuum Pressure Impregnation (VPI) facility or VPI consists of three vessels, one horizontal and two vertical. The larger of the vertical vessels, has a volume of 145,000 litres with a diameter of 5.5 metres and an overall height of 6 metres. It's foundations penetrate the ground by 8 metres.

The complete wound stators are Vacuum Pressure Impregnated with a GE specified resin and rotated whilst they are being cured. This rotate curing process in the GE manufacturing technique ensures uniformity of distribution and retention of resin and consolidation of the insulation and winding.

All stators are impulse and HV tested prior to and after impregnation.



Assembly, Test & Packaging

ASSEMBLY

In the assembly the generators and motors are assembled using flow-line principles and techniques.

TEST

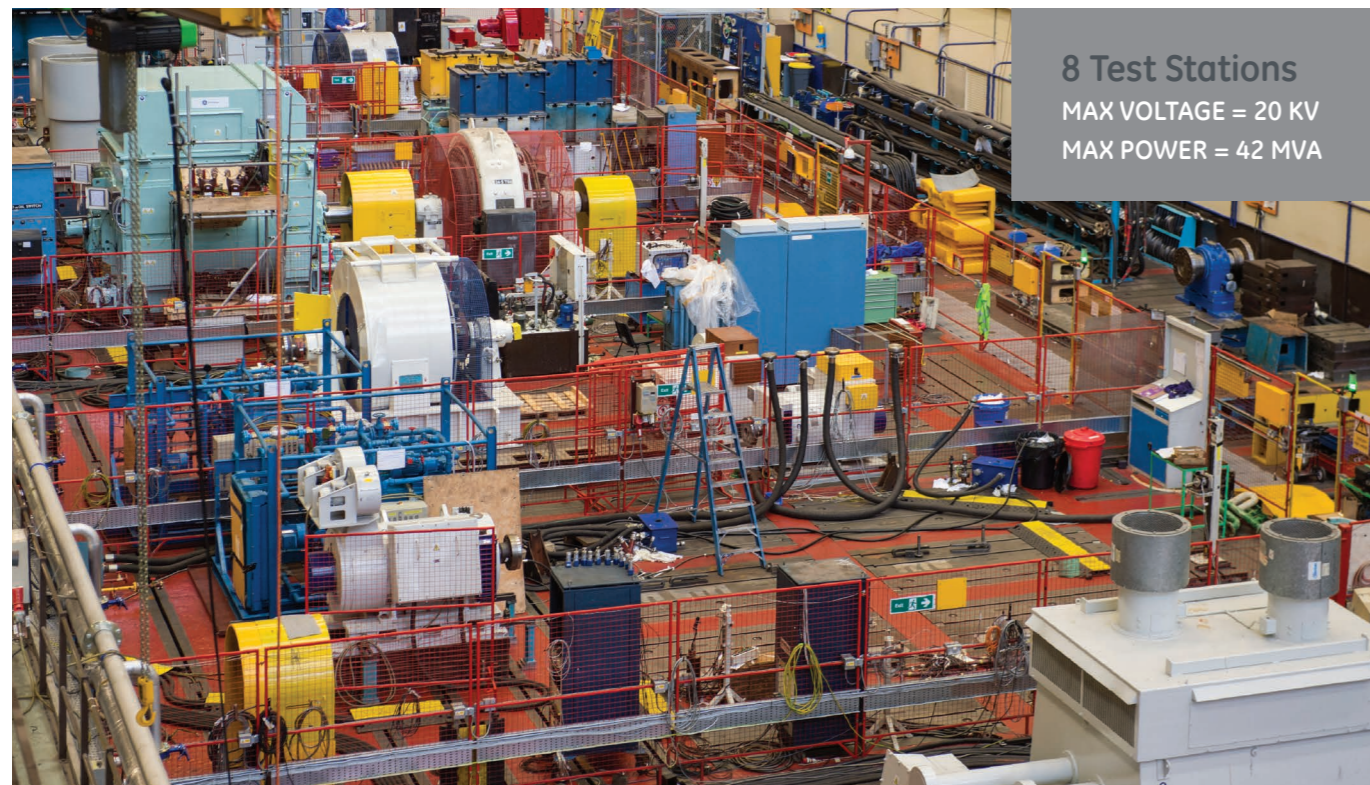
Comprehensive and modern test facilities, offer tests for individual machines; packaging equipment with gear boxes; and for combined testing with variable speed drives and driven machinery. Eight integrated test stations provide extensive flexibility for testing both horizontal and vertical machines. The test stations are backed by automated control and online measuring.

IEC 60034 Testing

- Static:** Resistances, HV Test...
- Mechanical Running:** Vibration, Bearing Run, Rotor over speed.
- Electrical Running:** OC/SC Characteristics and losses, Zero pf simulated load testing...

PACKAGING

The packaging facility customises electrical machines to meet our customers' specifications. Activities include air-gap setting, gear box line-out, instrumentation wiring and assembly of the bearing housing. The packaging facility has the capability to assemble and move a complete machine weighing up to 200 tonnes.



References

The experience list below highlights a selection of installed base which has been provided out of the Rotating Machines Rugby facility. Further references can be provided on request; please note that project/customer name cannot be disclosed for confidentiality reasons.

Product	Environment	Location	No.of Units	KVA of Each Unit	Power Factor	No.of Poles	Speed RPM	Voltage (V)	Enclosure	Hazardous Area	Type Of Drive	Year Of Order
ALPHA	ONSHORE	Angola	2	52750	0.8	4	1500	11500	CACW	Safe	GT 6B	2015
ALPHA	ONSHORE	Thailand	3	46473	0.8	4	1500	11000	CACW	Safe	ST	2015
ALPHA	ONSHORE	Nigeria	8	44375	0.8	4	1500	11000	CACW	Safe	MS6001	2015
ALPHA	ONSHORE	Ghana	3	34375	0.8	4	1800	13800	CACW	Safe	LM2500+G4	2015
ALPHA	ONSHORE	Indonesia	1	33500	0.8	4	1500	11000	CACW	Safe	MS5001PA	2015
ALPHA	ONSHORE	South Korea	1	28240	0.8	4	1800	11000	CACW	Safe	Steam Turbine	2015
ALPHA	ONSHORE	India	1	27500	0.8	4	1500	11000	CACW	Safe	MS5001PA	2015
ALPHA	ONSHORE	France	1	19000	0.8	4	1500	6000	None	Safe	CX400	2015
ALPHA	ONSHORE	Malaysia	2	15750	0.8	4	1500	11000	CACW	Safe	Expander	2015
ALPHA	ONSHORE	Lebanon	1	14286		4	1500	6300	CACW	Safe		2015
ALPHA	ONSHORE	UK	3	10250	0.8	4	1800	11000	CACA	Safe	SGT300	2015
ALPHA	ONSHORE	Tunisia	2	10000	0.8	4	1500	6600	CACA	Ex n	SGT300	2015
ALPHA	ONSHORE	Tunisia	1	5392	0.8	4	1500	6600	CACA	Safe	SGT100	2015
ALPHA	ONSHORE	Indonesia	1	44706	0.85	4	1500	13800	CACW	Safe	ST	2014
ALPHA	ONSHORE	Thailand	1	43757	0.7	4	1500	11000	CACW	Safe	ST	2014
ALPHA	ONSHORE	Singapore	2	37500	0.8	4	1800	11000	CACW	Safe	ST	2014
ALPHA	ONSHORE	Malaysia	4	36400	0.8	4	1500	13800	CACW	Ex p	PGT25+G4	2014
ALPHA	ONSHORE	Ghana	3	34375	0.8	4	1800	13800	CACW	Safe	LM2500 + G4	2014
ALPHA	ONSHORE	Brazil	3	34375	0.8	4	1800	11000	CACW	Ex n	LM2500 + G4	2014
ALPHA	ONSHORE	Egypt	1	32000	0.85	4	1500	6000	CACW	Safe	ST	2014
ALPHA	ONSHORE	USA	1	31250	0.8	4	1800	13800	CACA	Safe	ST	2014
ALPHA	ONSHORE	U.A.E	3	30000	0.8	4	1500	11000	CACA	Ex n	PGT25+G4	2014
ALPHA	ONSHORE	Italy	1	22000	0.8	4	1500/1800	10500/13800	CACW	Safe	LT1600	2014
ALPHA	ONSHORE	Italy	1	19000	0.8	4	1500	6000	CACW	Safe	ST	2014
ALPHA	ONSHORE	Ghana	2	18300	0.8	4	1500	11000	CACA	Safe	14.4MW SGT400	2014
ALPHA	ONSHORE	Thailand	1	16000	0.8	4	1500	11000	CACW	Safe	ST	2014
ALPHA	ONSHORE	Algeria	3	14375	0.8	4	1500	11000	CACA	Ex n	SGT400	2014
DELTA		USA	8	14215	0.8	14	514	6600	CACW	Safe	Diesel Engine	2014
ALPHA	ONSHORE	Iraq	3	10800	0.8	4	1500	11000	CACA	Safe	SGT-400	2014
ALPHA	ONSHORE	Ghana	1	10250	0.8	4	1500	11000	CACA	Safe	SGT300	2014
ALPHA	ONSHORE	Sweden	1	9928	0.85	4	1800	6600	CACA	Ex n	SGT 300	2014
BETA	OFFSHORE	France	4	9333	0.9	14	514	6600	CACW	Safe	Diesel Engine	2014
ALPHA	ONSHORE	Pakistan	3	9110	0.8	4	1500	6600	CACA	Safe	SGT-300	2014
BETA	OFFSHORE	France	1	8366	0.9	14	514	6600	CACW	Safe	Diesel Engine	2014
BETA	OFFSHORE	France	1	8366	0.9	14	514	6600	CACW	Safe	Diesel Engine	2014
BETA	OFFSHORE	France	4	8333	0.9	14	514	6600	CACW	Safe	Diesel Engine	2014
ALPHA	ONSHORE	Iraq	3	7800	0.8	4	1500	11000	CACA	Safe	SGT-300	2014
DELTA		USA	4	7650	0.8	14	514	6600	CACW	Safe	Diesel Engine	2014
BETA	OFFSHORE	China	6	6111	0.9	10	900	11000	CACW	Safe	Diesel Engine	2014
ALPHA	ONSHORE	India	1	4500	0.8	4	1500	6600	CACW	Ex p	Turbo Expander	2014

Rotating Machines Services...

...Across the product life cycle

CARING FOR YOUR NEEDS

At GE, we understand that the goals of your organization are demanding, and evolving. To help you meet these goals here at GE Power Conversion we provide a service that goes beyond just waiting for your call.

We offer a range of aftermarket services including replacement units, field services, spares, in-shop repairs, service agreements, unit upgrades and technical support. Our mission is to satisfy our customer needs in the aftermarket of power generation.

INSTALLATION & COMMISSIONING

Installing with confidence. Our team of field service engineers are on hand to ensure that your assets go into active service functioning efficiently.

TRAINING PROGRAMS

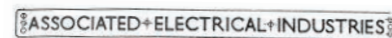
Through our in-depth training modules we provide our customers with the knowledge and skills to operate and maintain equipment in the field.

INSPECTION & REPAIR

We offer a broad array of motor, generator, excitation and protection relaying inspection and repairs services, supported through our international network of GE specialists and service shops.

Our team of project management experts are available to support schedule your overhaul requirements, working with you to ensure you are provided regular project updates and work is completed to your satisfaction on time.

OEM SERVICES FOR ALL HISTORICAL RUGBY INSTALLED BASE



SERVICE CONTACT CENTERS

Our global service call center is available 24 hours a day, 7 days a week. Supporting our customers to register and assign your enquiry to the appropriate expert team within the GE Power Conversion technical network for assistance.

Contact our global service call centre* by telephone or email: escg.geem@ge.com.

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*Note that you may be charged different rates when calling from a mobile. Toll free numbers are toll free only in certain countries. Please check with your local provider.

ENHANCED TECHNICAL SUPPORT

We offer enhanced technical support to customers with service agreements. Our enhanced technical support agreements are designed to suit your specific needs including the availability of 24/7 on-call technical assistance, remote support and immediate mobilization to emergencies.

SPARES AND CONSUMABLES

The GE Parts team is available to advise the appropriate spares and consumable parts for you to hold in stock. For those emergencies the team will support provide the parts you need on time and at the quality you expect.

DIAGNOSTICS AND SPECIALIZED

Delivering high technology and diagnostic services our specialist field engineers will apply our in-house analysis tools to analyse the asset's performance. Working with you to resolve issues on installations in the field efficiently and reliably.

UNIT UPGRADES

To extend the life of your asset, our engineering design team will provide you with suitable upgrade options aligned to meet your technical specification and requirements to improve efficiency, production and to reduce emissions.

SERVICE FOR A LIFETIME

Our goal is to provide you with a complete product life-cycle solution, to minimize risk and help you get the most out of your asset.

We're at work with you

Wherever you are across the globe... We're adding people, parts and perspective to your everyday operations. Helping to keep your operations running smoothly... for the long term

HAVING THE RIGHT
PARTNER IS AS VITAL
AS HAVING THE RIGHT
TECHNOLOGY

GE as a Partner

Contact us

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We **innovate** to provide the **most advanced technologies** to deliver clear **competitive advantages** to our customers' processes. Return on Investment, Reliability, Safety, Efficiency, Compact-Light Weight, High Torque Density, Low Noise and Vibration Signature

Today and into Future Generations.