

STAMFORD[®]

**Installation, Service and
Maintenance Manual
For
STAMFORD P0 / P1 Generators**



Original Instructions

SAFETY PRECAUTIONS

First Steps to Safe Operation

Read this manual, obey all Warnings and Cautions, and become familiar with the product.

Warnings & Notices used in this manual

The various warnings are out lined below and appear in the text in this format. Warnings and Cautions appear at the appropriate position in the, to which they refer.

Warning! Information that draws attention to the risk of injury or death.

Caution! Information that draws attention to the risk of damage to the product, process or surroundings.

Note. Used to convey, or draw attention to, additional information or explanations.

Notes appear after the text to which they refer.

Skill requirements of personnel

Service and maintenance procedures should only be carried out by experienced and qualified engineers, who are familiar with the procedures and the equipment. Before any intrusive procedures are carried out, ensure that the engine is inhibited and the generator is electrically isolated.

Electrical Equipment

All electrical equipment can be dangerous if not operated correctly. Always service and maintain the generator in accordance with this manual. Always use genuine 'STAMFORD' replacement parts.

Warning: Electrical shock can cause injury or death. Ensure that all personnel operating, servicing, maintaining or working near this equipment are fully aware of the emergency procedures in case of accidents.

Before removing the protective covers to carry out service maintenance or repair, ensure that the engine is inhibited and the generator is electrically isolated. The AVR access covers are designed to be removed while the generator is on load.

Lifting

Lift the generator using the points provided with the aid of a spreader and chains. The angle on the chains must be vertical during the lift. Do not lift single bearing generators without the, transit bar, securely fitted. When removing the transit bar just prior to offering the generator up to the engine, be aware that the rotor is not securely held in the generator. Keep the generator in the horizontal plane to when the transit bar is not fitted. If large terminal boxes are fitted extensions to the lifting points may be necessary.

Warning! The lifting points provided are designed for lifting the generator only. Do not lift the Generating Set by the generator's lifting points.

Note: Due to our policy of continuous improvement, details in this manual which were correct at time of going to print and may now be due for amendment. Information included must therefore not be regarded as binding.

Foreword

The Manual

Before operating, the generating set read this manual and all additional documentation supplied with it. Great care has been taken with the design of this product to ensure that it is safe to operate. Misuse and the failure to follow the safety precautions contained in the manual are potential causes of accidents.

Read the manual and make sure that all personnel who work on the equipment have access to the manual. The manual should be considered as part of the product and should remain with the product. Make sure that the manual is available to all users throughout the life of the product.

Scope

This manual contains guidance and instructions for the Installation, Servicing and Maintenance of the generator.

It is not possible, within the scope of the manual, to teach the basic electrical and mechanical skills required to safely carry out the procedures enclosed. The manual is written for skilled electrical and mechanical technicians and engineers, who have prior knowledge and experience of generating equipment of this type.

We offer a range of training courses that cover all aspects of STAMFORD generators.

Generator Designation

P	I	1	4	4	E	1	(example)
P	-	Generator type					
I	-	Applications, I = Industrial, M = Marine.					
1	-	Frame size, 0 or 1					
4	-	AS480 AVR					
4	-	Number of poles, 2 or 4					
E	-	Core Size					
1	-	Number of bearings, 1 or 2					

Excitation Boost System (EBS) – is optional

The Product

The product is an AVR controlled, self excited synchronous 'ac generator'. Designed for incorporation into a generating-set. (A generating-set is defined as 'machinery' in European directives).

Serial Number Location

Each generator has a unique serial number stamped into the upper section of the drive end of the frame.

The serial number is also shown on the nameplate.

Two other labels are located inside the terminal box, one on the sheet metal work and the other on the main frame of the generator. Neither of these two labels is considered to be permanently fixed.

Rating Plate

The generator has been supplied with a self-adhesive rating plate label to enable fitting after final assembly and painting. Stick the plate on the side of the barrel (either side, we suggest the opposite side to the output cables). The surface in the area where a label is to be stuck must be clean, dry and any paint finish must be cured before attempting to attach label. Recommended method for attaching label is peel and fold back sufficient of the backing paper to expose some 20 mm of label adhesive along the edge which is to be located against the sheet metal protrusions. Once this first section of label has been carefully located and stuck into position progressively peel off the backing paper and smooth down with a clean cloth. The adhesive will achieve a permanent bond in 24 hours.

A factory fitted metal nameplate is available for some applications.

Caution! Do not exceed the parameters as marked on the rating plate.

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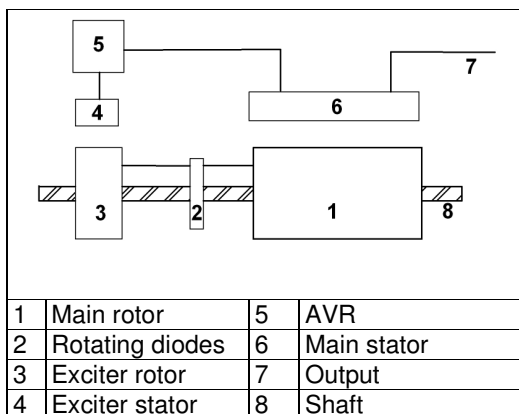
INTRODUCTION

General Description

The P0&P1 generators are brushless with rotating field, available up to 660V/50Hz (1500 rpm, 4 pole and 3000 rpm, 2 pole) or 60Hz (1800 rpm, 4 pole and 3600 rpm, 2 pole), and built to meet B.S. 5000 Part 3 and other international standards.

The P0 & P1 are self-excited generators with excitation power derived from the main output windings, using the AS480.

Self-Excited AVR Controlled Generators

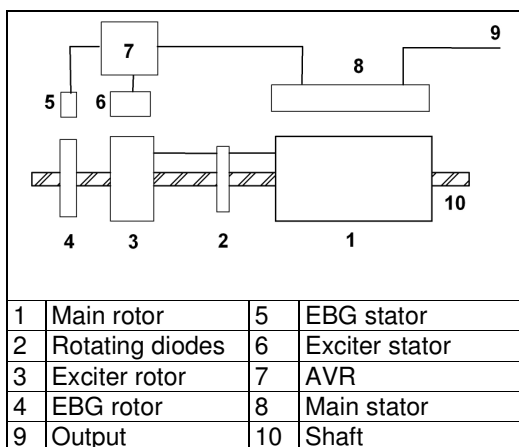


Main Stator Powered AVR

The main stator provides power for excitation of the exciter field via the SX480 AVR which is the controlling device governing the level of excitation provided to the exciter field. The AVR responds to a voltage-sensing signal derived from the main stator winding. By controlling the low power of the exciter field, control of the high power requirement of the main field is achieved through the rectified output of the exciter armature. The AVR senses average voltage on two phases ensuring close regulation. In addition it detects engine speed and provides voltage fall off with speed, below a pre-selected speed (Hz) setting, preventing over-excitation at low engine speeds and softening the effect of load switching

to relieve the burden on the engine. The detailed function of the AVR circuits and their adjustment are covered in the load testing section.

Separately Excited AVR Controlled Generators



Optional Excitation Boost System(EBS)

The EBS is a single, self-contained unit, attached to the non-drive end of the generator.

The EBS unit consists of the Excitation Boost Controller (EBC) and an Excitation Boost Generator (EBG). Under fault conditions, or when the generator is subjected to a large impact load such as a motor starting, the generator voltage will drop. The EBC senses the drop in voltage and engages the output power of the EBG. This additional power feeds the generator's excitation system, supporting the load until breaker discrimination can remove the fault or enable the generator to pick up a motor and drive the voltage recovery.

For Parallel operation

The AS480 AVR also incorporates circuits which, when used in conjunction with accessories, can provide for parallel operation with the addition of a CT, 'Voltage droop' control.

Function and Adjustment of the Fitted Accessories.


Inside the generator terminal box are covered in the accessories section of this book. Separate instructions are provided with other accessories available for control panel mounting.

Standards.

STAMFORD ac generators meet the relevant parts of national and international standards pertaining to generators. The generator must be operated within the limits laid down in the relevant standards and within the parameters on the generator rating plate.

Marine generators meet the requirements of all the major marine classification societies.

European Directives.

EC Declaration of Conformity		Cummins Generator Technologies
This synchronous a.c. generator is designed for incorporation into an electricity generating set and fulfils all the relevant provisions of the following EC Directive(s) when installed in accordance with the installation instructions contained in the product documentation:		
2006/95/EC	Low Voltage Directive	
2004/108/EC	The EMC directive	
2006/42/EC	The Machinery Directive	
and that the standards and/or technical specifications referenced below have been applied:		
EN 61000-6-1:2007	Electromagnetic compatibility (EMC). Generic standards - Part 6-1: Immunity for residential, commercial and light-industrial environments	
EN 61000-6-2:2005	Electromagnetic compatibility (EMC). Generic standards - Part 6-2: Immunity for industrial environments	
EN 61000-6-4:2007	Electromagnetic compatibility (EMC). Generic standards - Part 6-4: Emission standard for industrial environments	
EN ISO 12100-1:2003	Safety of machinery - Basic concepts, general principles for design - Part 1: Basic terminology, methodology	
EN ISO 12100-1:2003	Safety of machinery - Basic concepts, general principles for design - Part 2: Technical principles	
EN ISO 14121-1:2007	Safety of machinery - Risk assessment - Part 1: Principles	
EN 60034-1:2004	Rotating electrical machines - Part 1: Rating and performance	
BS ISO 8528-3:2005	Reciprocating internal combustion engine driven alternating current generating sets - Part 3: Alternating current generators for generating sets	
BS 5000-3:2006	Rotating electrical machines of particular types or for particular applications - Part 3: Generators to be driven by reciprocating internal combustion engines - Requirements for resistance to vibration	
The manufacturer's authorised representative in the Community and person empowered to draw up this declaration and to compile the relevant technical documentation, on behalf of the manufacturer is Mr Jeffrey Matthews - Director Engineering, Cummins Generator Technologies, Barnack Road, Stamford, Lincolnshire, PE9 2NB, England.		
Signed:		Date: 21 st December 2009
Description		Serial Number
Registered in England under Registration No. 441273. Cummins Generator Technologies Ltd. Registered Office: Barnack Road, Stamford, Lincolnshire PE9 2NB, England.		

Each generator is supplied with an 'EC Declaration of Conformity' in accordance with the relevant EU directives designed for incorporation into an electricity generating set and is CE marked.

Our authorized representative in the Community is
Mr Jeffrey Matthews, Director, Engineering,
Cummins Generator Technologies Ltd.

All STAMFORD generators meet the following Standards and Directives:

Directives:

2004/108/EC EMC Directive

2006/95/EC Low Volts Directive

2006/42/EC Machinery Directive

Standards:

EN 61000-6-1

EN 61000-6-2

EN 61000-6-4

EN ISO 12100-1

EN ISO 12100-1

EN ISO 14121-1

EN 60034-1

BS ISO 8528-3

BS5000-3

Note: Once the generator is built into a generating set, it is the responsibility of the generating set manufacture to ensure that the generating set complies with the relevant EC Directives.

Applications the Generator is designed for.

STAMFORD ac generators are supplied on the basis that:

They are used for power generation or related functions.

They are to be applied in one of the following environments:

Portable (open construction – temporary site supply)

Portable (enclosed – temporary site supply)

Containerised (temporary or permanent site supply)

Ship – borne, below decks (marine auxiliary power)

Commercial vehicle (road transport / refrigeration etc.)

Road transport (auxiliary power)

Industrial vehicle (earthmoving, cranes etc.)

Fixed installation (Industrial – factory / process plant)

Fixed installation (residential, commercial and light industrial – home / office / health.)

Energy management (combined heat & power and/or peak lopping.)

Alternative energy schemes.

The standard generators are designed to meet the 'industrial' emissions and immunity standards. Where the generator is required to meet the residential, commercial and light industrial emissions and immunity standards reference must be made to document reference N4/X/011. This publication outlines the additional equipment that may be required.

The installation 'earth/ground' arrangements require the connection of the generator frame to the site protective earth conductor using a minimum lead length.

Maintenance and servicing with unauthorised parts, not of STAMFORD brand, will invalidate us from any liability for EMC compliance.

Installation, maintenance and servicing are carried out by adequately trained personnel fully aware of the requirements of the relevant EC directives.

Unsuitable Applications

Synchronous generators require a constant speed for power generation. Applications where the generator is not run at a constant speed are not suitable for the standard generator. Such applications may be possible within certain parameters. Contact the factory for advice, there is every possibility that we can provide you with a satisfactory technical solution to meet your requirement.

Additional information for EMC compliance

Standard generators are designed to meet the 'industrial' emissions and immunity standards. Where the generator is required to meet the residential, commercial and light industrial emissions and immunity standards, reference must be made to document reference N4/X/011. This publication outlines the additional equipment that may be required.



Application of the Generator

Environmental Protection

STAMFORD generators are protected to IP23. IP23 is not adequate protection for use outdoors without additional measures.

Ambient Temperature	<40°C
Humidity	<60%
Altitude	<1000m

This table represents the normal operating conditions that the generator is designed for. Operation outside of these parameters is possible after due consideration and will be reflected on the generator nameplate. If the operating environment for the generator

has changed after purchase, the rating of the generator needs to be revised, refer to the factory for details.

Air Flow

The airflow requirements for the generator can be found in the Data section at the back of this manual. Ensure that the air inlets and outlets are not obstructed when the generator is running.

Airborne Contaminates

Contaminates such as salt, oil, exhaust fumes, chemicals, dust, sand, etc., will reduce the effectiveness of the insulation and lead to premature failure of the windings. Consider using air filters or an enclosure with greater protection to protect the generator.

Air Filters

Air filters are available on request. Filters present a restriction to the airflow so the rating of the generator must be reduced by 5%. If the filters are supplied, factory fitted, the rating on the nameplate will include the reduced rating. The filters can be up-fitted after delivery in which case the customer must apply the power reduction.

Air filters remove airborne particulates above 3 microns. The frequency of changing and cleaning the filters depend on the site conditions. We recommend that the filters are monitored frequently until a suitable cycle of change is established.

Air filters do not remove water. Additional protection must be employed to prevent the filters from getting wet. If the filters are allowed to get wet the airflow will be restricted and the generator will overheat. This will reduce the life expectancy of the insulation leading to premature failure of the generator.

High Humidity environments

The humidity of the air will allow condensation to form on the windings if the temperature of the windings falls below the dew point. The dew point is a relationship between the ambient temperature and humidity. In areas of high humidity additional protection may be required even if the generator is fitted inside an enclosure.

Anti-condensation heaters

Anti-condensation heaters are designed to raise the temperature of the windings above the temperature of the surrounding material so that the condensation will not form on the windings.

We recommend that anti-condensation heaters are fitted to all generators that are left switched off for any period of time. The best practice is to wire the heaters such that the heaters come on when the generator is switched off. This is particularly important in applications where high humidity is a significant problem.

Always check the condition of the generators windings before switching the generator on. If moisture is observed carry out one or more of the drying-out methods outlined in the Service section of this manual.

Enclosures

An enclosure should be employed to protect the generator from adverse environmental conditions.

If the generator is to be fitted inside an enclosure, ensure that there is adequate airflow to support both the engine and the generator. Ensure that the generator air supply is clean (free from moisture and contaminants) and at or below the ambient temperature stated on the rating plate.

The P0 and the P1 generators have round end brackets that will create an air flow pattern that is different to previous generators of this size. The air flow should be modelled to identify and prevent hot air from recirculating within the enclosure.

Vibration

STAMFORD generators are designed to withstand the vibration levels encountered on generating sets built to meet the requirements of ISO 8528-9 and BS 5000-3. (Where ISO 8528 is taken to be broad band measurements and BS5000 refers to the predominant frequency of any vibrations on the generating set).

Definition of BS5000 – 3

Generators shall be capable of continuously withstanding linear vibration levels with amplitudes of 0.25mm between 5Hz and 8Hz and velocities of 9.0mm/s rms between 8 Hz and 200 Hz, when measured at any point directly on the carcass or mainframe of the machine. These limits refer only to the predominant frequency of vibration of any complex waveform.

Definition of ISO 8528 - 9

ISO 8528-9 refers to a broad band of frequencies; the broad band is taken to be between 2 Hertz and 300 Hertz. The table below is an example from ISO 8528 - 9 (value 1). This simplified table lists the vibration limits by kVA and speed for acceptable genset operation.

Vibration Levels As Measured On The Generator				
Engine Speed Min ⁻¹	Set Output Kva	Vibration Displacement (S rms)	Vibration Velocity (V rms)	Vibration Acceleration (a rms)
> 1300 (rpm) <2000	<50 kVA	0.64 mm	40 mm/sec	25 m/sec
The 'Broad band' is taken as 2 Hz - 300 Hz				

Caution: Exceeding either of the above specifications will have a detrimental effect on the life of the bearings and other components. This will invalidate the generator warranty.

Vibration Monitoring

We recommend that the set builder checks the vibration levels using vibration analysing equipment. Ensure that the vibration levels of the generating set are within the levels stated in BS 5000-3 and ISO 8528-9. If the vibration levels are not within tolerance the genset builder should investigate the root cause of the vibrations and eliminate them. The 'best practice' is for the genset builder to take initial readings as a base line and the user to periodically monitor the genset and bearings to detect any deteriorating trend. It will then be possible to plan ahead for bearing changes and eliminate vibration problems before excessive damage to the generating set occurs.

Vibration checks should be made every 3 months.

Excessive Vibration levels

If the vibration levels of the generating set are not within the parameters quoted above:

Consult the genset builder; the genset builder should address the genset design to reduce the vibration levels as much as possible.

Discuss, with us, the impact of not meeting the above levels on both bearing and generator life expectancy.

When requested, or it is deemed necessary, we will work with the genset builder in an attempt to find a satisfactory solution.

Bearings

This product is fitted with sealed for life fitted within machined housings, in the end brackets. All of the bearings have pressed steel cages and have type C3 fit. The grease used is a high specification synthetic compound that must not be mixed with grease with a different specification.

Factors that effect bearing life:

The life of a bearing in service is subject to the working conditions and the environment:

High levels of vibration from the engine or misalignment of the set will stress the bearing and reduce its service life. If the vibration limits set out in BS 5000-3 and ISO 8528-9 are exceeded bearing life will be reduced.

Long stationary periods in an environment where the generator is subject to vibration can cause false brinnelling.

Long stationary periods in an environment where the rotor is stationary will leave flats on the balls and grooves on the races, leading to premature failure when run. Very humid atmospheric or wet conditions can emulsify the grease causing corrosion and deterioration of the grease, leading to premature failure of the bearings.

Health Monitoring of the Bearings

We recommend that the user check the bearing condition, using monitoring equipment, to determine the state of the bearings. The 'best practice' is to take initial readings as a base line and periodically monitor the bearings to detect a deteriorating trend. It will then be possible to plan a bearing change at an appropriate generating set or engine service interval.

Bearing 'Service Life' Expectancy

Bearing manufacturers recognise that the "service life" of their bearings is dependent upon many factors that are not in their control; they cannot therefore quote a "service life".

Although "service life" cannot be guaranteed, it can be maximised by attention to the generating set design. An understanding of the generating set's application will also help the user to maximise the service life expectancy of the bearings. Particular attention should be paid to the alignment, reduction of vibration levels, environmental protection, maintenance and monitoring procedures.

We do not quote life expectancy figures for bearings, but suggests practicable replacement intervals based on the L10 life of the bearing, the type of grease and the recommendations of the bearing and grease manufacturers.

For general-purpose applications: providing the advice above is considered, the correct maintenance is carried out, vibration levels do not exceed the levels stated in ISO 8528-9 and BS5000-3, and the ambient temperature does not exceed 50 °C. Plan to replace bearings within 30,000 hours of operation.

It is important to note that bearings in service, under good operating conditions, can continue to run beyond the recommended replacement period. It should also be remembered that the risk of bearing failure increases with time.

If in doubt about any aspect of the 'bearing life' on STAMFORD generators, contact your nearest supplier of STAMFORD generators or contact the Stamford factory direct.

Installation into the Generating Set

The generator is supplied as a component part for installation into a 'generating set'.

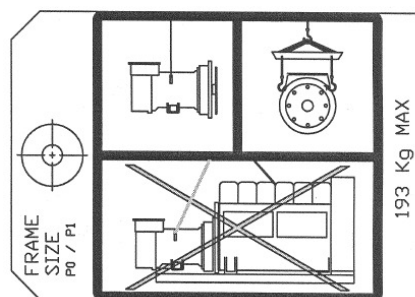
Delivery

Upon receipt of the generator, check the generator for damage that may have occurred during transport. Also check that the rating-plate details are correct and as ordered for the application.

Handling the generator

When lifting the generator always use a spreader bar as shown. Ensure that the lifting chains are vertical to the lifting position on the generator at all times.

When generators are fitted with an optional large box, bolt on extensions to the lifting lugs are required to extend the lifting position clear of the terminal box. When fitted these extensions form an integral part of the terminal box support. Do not remove them.



Warning: The generator lifting points are designed to lift the generator only. Do not lift the complete generating set by the generator lifting lugs.

Single bearing generators have a transit bar fitted at the drive end. This bar holds the rotor in position during transit. The transit bar should be left in position until it is necessary to remove it to allow the generator to be coupled to the engine.

Warning! If the generator is moved without the transit bar be aware that the rotor could fall out of the frame. When moving the generator always keep it in the horizontal plane, this will reduce the risk of the rotor falling out.

Storage

If the generator is not to be used immediately, it must be stored in a clean, dry, vibration free environment. If anti-condensation heaters are fitted, switch them on. If heaters are not fitted use other means to ensure that condensation cannot form on the windings. Spin the shaft by hand every month to prevent flat spots in the bearings and to free up the grease.

After Storage

After a period of storage, carry out 'pre running checks' to determine the condition of the windings. If the winding are damp or the insulation is low, follow one of the 'drying out procedures', in the Service section of this manual. Replace the bearing after 12 months in storage.

Rotor balancing

Dynamic balancing of the generator rotor assembly has been carried out during manufacture in accordance with BS 6861 Part 1 Grade 2.5 to ensure vibration limits of the generator are in accordance with BS 4999 Part 142.

Generator Vibration, Frequency

The main vibration frequencies produced by the component generator are as follows:

- 4-pole 1500 r.p.m. 25 Hz
- 4-pole 1800 r.p.m. 30 Hz
- 2-pole 3000 r.p.m. 50 Hz
- 2-pole 3600 r.p.m. 60 Hz

However, vibrations induced by the engine are complex and contain frequencies of 1.5, 3, 5 or more times the fundamental frequency of vibration. These induced vibrations can result in generator vibration levels higher than those derived from the generator itself. It is the responsibility of the generating set

designer to ensure that the alignment and stiffness of the bedplate and mountings are such that the vibration limits of BS5000 part 3 and ISO 8528 part 9 are not exceeded.
In standby applications where the running time is limited and reduced life expectancy is accepted, higher levels than specified in BS5000 part 3 can be tolerated, up to a maximum of 18mm/sec.

Side Loads

In the case of belt driven generators, ensure alignment of drive end and driven pulleys to avoid axial load on the bearings. Screw type tensioning devices are recommended to allow accurate adjustment of belt tension whilst maintaining pulley alignment.

Belt and pulley guards are not provided by the company.

Note: **Incorrect belt tensioning will result in excessive bearing wear.**

2/4-Pole	Side Load		Shaft extension mm
	kgf	N	
P0	92	900	82
P1	173	1700	82

Coupling arrangements

Warning! **Do not use the fan to rotate the shaft this is particularly important when the engine and the alternator are connected.**

Single and two bearing arrangements are available both arrangements can be close coupled. Both arrangements also need a firm level foundation.

Two bearing generators require a substantial bedplate with engine/generator mounting pads to ensure a good base for accurate alignment. Close coupling of the engine to the generator can increase the overall rigidity of the set. A flexible coupling, designed to suit the specific engine/generator combination, is recommended to minimise the torsional effects.

Accurate alignment of single bearing generators is essential, vibration can occur due to the flexing of the flanges between the engine and generator. A substantial bedplate with engine/generator mounting pads is required.

For the purposes of establishing set design the bending moment at the engine flywheel housing to generator adaptor interface should not exceed 125ft.lb. (17 kgm).
The maximum bending moment of the engine flange must be checked with the engine manufacturer.

Torsional vibrations occur in all engine-driven shaft systems and may be of a magnitude to cause damage at certain critical speeds. It is therefore necessary to consider the torsional vibration effect on the generator shaft and couplings.

It is the responsibility of the generator set manufacturer to ensure compatibility, and for this purpose drawings showing the shaft dimensions and rotor inertias are available for customers to forward to the engine supplier. In the case of single bearing generators coupling details are included.

Caution! **Torsional incompatibility and/or excessive vibration levels can cause damage or failure of the generator and/or engine components.**

Coupling Two Bearing Generators

Warning! Do not use the fan to rotate the shaft this is particularly important when the engine and the alternator are connected.

A flexible coupling should be fitted and aligned in accordance with the coupling manufacturer's instruction.

If a close coupling adaptor is used the alignment of machined faces must be checked by offering the generator up to the engine. Shim the generator feet if necessary. Ensure adaptor guards are fitted after generator/engine assembly is complete. Open coupled sets require a suitable guard, to be provided by the set builder.

Axial loading of the generator bearings should be avoided. Should it be unavoidable contact the factory for advice.

Warning! Incorrect guarding and/or generator alignment can result in injury and/or equipment damage.

Coupling Single Bearing Generators

Warning! Do not use the fan to rotate the shaft this is particularly important when the engine and the alternator are connected.

Alignment of single bearing generators is critical. If necessary, shim the generator feet to ensure alignment of the machined surfaces.

For transit and storage purposes the generator frame spigot and rotor coupling plates have been coated with a rust preventative. This MUST BE removed before assembly to engine.

A practical method for removal of this coating is to clean the mating surface areas with a de-greasing agent based on a petroleum solvent.

Warning! Care should be taken not to allow any cleaning agent to come into prolonged contact with skin.

4-pole Single Bearing Coupling Alignment

1. On the engine check the distance from the coupling mating face on the flywheel to the flywheel housing mating face. This should be within 0.5mm of nominal dimension. This is necessary to ensure that a thrust is not applied to the ac generator bearing or engine bearing.
2. Check that the bolts securing the flexible plates to the coupling hub are tight and locked into position. torque. (75Nm : 55 lb/ft)
3. Remove air outlet cover from the drive end of the generator to gain access to coupling and adaptor bolts. Check that coupling joint interfaces are clean and lubricant free.
4. Check that coupling discs are concentric with adaptor spigot. This can be adjusted by the use of tapered wooden wedges between the fan and adaptor. Alternatively, the rotor can be suspended by means of a rope sling through the adaptor opening.
5. Consider using alignment studs to ensure that the disc and the flywheel are in alignment.
6. Offer the generator to engine and engage both coupling discs and housing spigots at the same time, pushing generator towards engine until coupling discs are against flywheel face, and the housing spigots are located.

Caution! Do not pull the generator to the engine using bolts through the flexible discs.

7. Fit housing and coupling bolts, taking care to use heavy gauge washers between coupling bolt head and coupling disc. Tighten bolts evenly around assembly sufficiently to ensure correct alignment.
8. Tighten housing bolts.
9. Tighten coupling disc to flywheel bolts. Refer to engine manufacturer's manual for correct tightening torque.
10. Remove rotor aligning aids, the sling, or wooden wedges and replace all covers.

Caution! Incorrect generator alignment can result in damage to the generator.

Warning! Failure to replace protective covers can result in injury.

Earth arrangement

The generator frame should be earth bonded to the generating set bedplate. If anti-vibration mounts are fitted between the generator frame and its bedplate a suitably rated earth conductor (normally one half of the cross sectional area of the main line cables) should bridge across the anti-vibration mounts.

Warning! Refer to local regulations to ensure that the correct earth requirements are incorporated into the installation. Inadequate earth installations put lives at risk.

Paint Finish

Unless previous arrangements have been agreed, the generator will be supplied in a water based primer coat. It is expected that the generating set assembler will want to paint the generating set with a final coat in their company livery. The primer coat will not provide adequate protection for used out-doors.

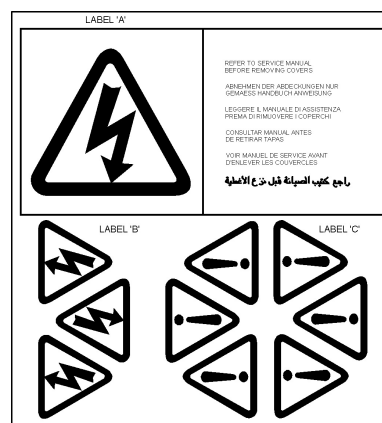
Note The primer coat is not adequate protection for many applications without additional protection.

Warning Labels

Warning labels are affixed to the generator. These must be visible at all times.

As we expect the set builder to paint the generator in his own livery, a second set of labels can be found in a wallet attached to the generator. Use the labels as per the instructions printed on the reverse of the labels.

NOTE: If removed or painted over, it is the genset manufacturer's responsibility to reattach warning symbols onto the generator



Direction of Rotation

The direction of rotation of the generator is designed to be clockwise as viewed from the drive end of the generator. It will run in the reverse direction with some loss of performance. Refer to the factory for guidance.

Phase Rotation

The output from the generator will have a phase sequence of U V W with the generator running clockwise as viewed from the drive end. If the phase rotation of the generator has to be reversed, the customer must rearrange the output cables to a UVW configuration. Ask for a circuit diagram of 'reverse phase connections'.

Voltage and Frequency

Check the generator nameplate to ensure that the generator parameters are as required for the generating-set application.

AVR adjustment

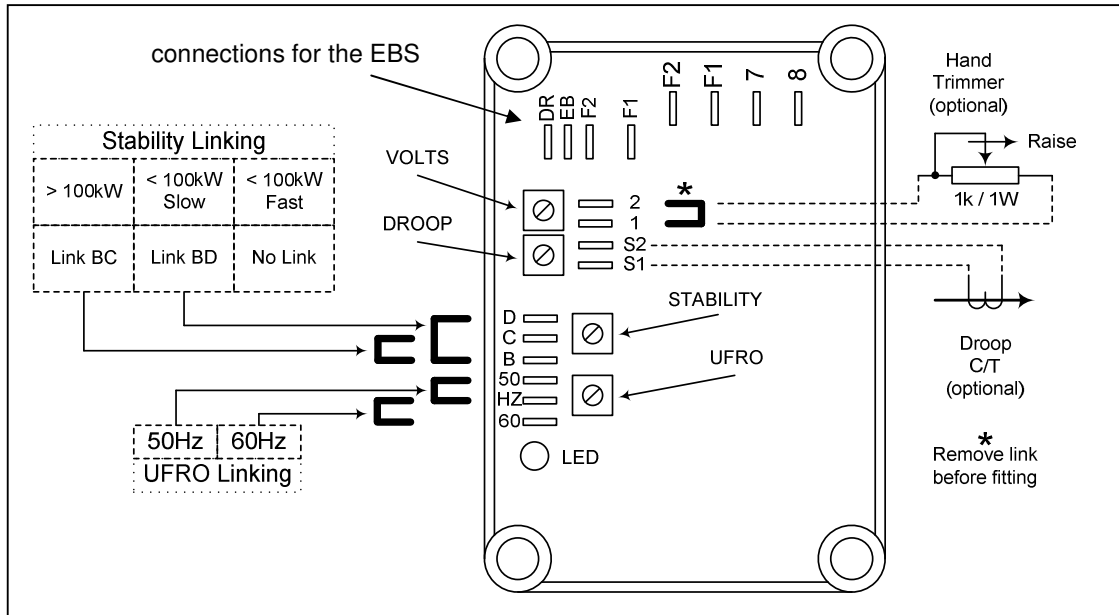
To make AVR selections and adjustments remove the AVR cover. Use the tool provided to make adjustments to the AVR settings. The AVR is factory set and will give satisfactory performance during initial running tests. Subsequent voltage adjustment both on and off load may be required. Guidance can be found in the AVR section.

Automatic Voltage Regulator (AVR)

AS480 AVR

This AVR is specifically designed to fit into and work with the P0 & P1 generator, it is the only AVR that fits into the terminal box and is capable of working with the optional Excitation Boost System (EBS).

The following 'jumper' connections on the AVR should be checked to ensure they are correctly set for the generating set application.



Control	Function	Direction
VOLTS	Generator output voltage setting	Clockwise raises voltage
STABILITY	Output voltage stability	Clockwise increases stabilisation effect
DROOP	Voltage droop for paralleling	Clockwise increases drooping effect
UFRO	Under-frequency 'Knee' point	Clockwise decreases 'Knee' point

Refer to the Generator Wiring Diagrams for all Connection detail

Main Stator Powered AVR

The main stator provides power for excitation of the exciter field via the SX480 AVR which is the controlling device governing the level of excitation provided to the exciter field. The AVR responds to a voltage-sensing signal derived from the main stator winding. By controlling the low power of the exciter field, control of the high power requirement of the main field is achieved through the rectified output of the exciter armature. The AVR senses average voltage on two phases ensuring close regulation. In addition it detects engine speed and provides voltage fall off with speed, below a pre-selected speed (Hz) setting, preventing over-excitation at low engine speeds and softening the effect of load switching to relieve the burden on the engine. The detailed function of the AVR circuits and their adjustment are covered in the load testing section.

Optional excitation Boost system (EBS)

The EBS is a single, self-contained unit, attached to the non-drive end of the generator. The EBS unit consists of the Excitation Boost Controller (EBC) and an Excitation Boost Generator (EBG). Under fault conditions, or when the generator is subjected to a large impact load such as a motor starting, the generator voltage will drop. The EBC senses the drop in voltage and engages the output power of the EBG. This additional power feeds the generator's excitation system, supporting the load until breaker discrimination can remove the fault or enable the generator to pick up a motor and drive the voltage recovery.

Voltage Adjustment

The generator output voltage is set at the factory but can be altered by adjustment of the VOLTS control on the AVR board or by the external hand trimmer if fitted. Before adjusting the generator output voltage, note the following warnings.

WARNING! Do not increase the voltage above the rated generator voltage shown on the rating plate mounted on the generator case.

WARNING! Do not ground any of the external hand trimmer terminals. Failure to observe this could cause equipment damage.

To adjust the generator output voltage, proceed as follows:

Before running the generator set, turn the [VOLTS] control fully anti-clockwise. Turn the [STABILITY] control to its midway position and the external hand trimmer (if fitted) to its midway position.

1. Connect a suitable voltmeter (0-300Vac) across Line and Neutral of the generator.
2. Start the generator set, on no load at nominal frequency e.g. 50Hz (or 60Hz).
3. If the red Light Emitting Diode (LED) is illuminated, refer to the section on Under-Frequency-Roll-Off adjustment.
4. Carefully turn the [VOLTS] control clockwise until the required voltage is reached.
5. If instability is present at rated voltage, refer to the section on Stability adjustment.
6. Voltage adjustment is now completed.

STABILITY ADJUSTMENT

The AVR includes an optimised stability circuit to provide good steady state and transient performance of the generator. Links are provided to change the response of the stability circuit to suit different frame size generators and applications.

On generators of this size a slow response setting is more appropriate and will prove helpful in reducing lamp flicker.

The correct setting of the Stability adjustment can be found by running the generator at no load and slowly turning the stability control anti-clockwise until the generator voltage starts to become unstable. The optimum position for the control is slightly clockwise from this point (i.e. where the machine volts are stable but close to the unstable region).

UNDER-FREQUENCY-ROLL-OFF ADJUSTMENT: (UFRO)

The AVR incorporates an under-speed protection circuit which produces a volts/Hz characteristic when the generator frequency falls below a preset threshold - known as the "knee" point. The red Light Emitting Diode (LED) gives indication that the UFRO circuit is operating in the low frequency region. The UFRO adjustment is preset and sealed and only requires the selection of 50Hz or 60Hz operation using the jumper link.

Accessories

Droop CT (P1only) RFI suppression, thermistors and anti-condensation heaters are available.

Generator Set Testing

Warning! During testing it may be necessary to remove covers to adjust controls exposing 'live' terminals or components. Only personnel qualified to perform electrical service should carry out testing and/or adjustments.

Test Metering/Cabling

Connect any instrument wiring and cabling required for initial test purposes with permanent or spring-clip type connectors.

Minimum instrumentation for testing should be line - line or line to neutral voltmeter, Hz meter, load current metering and kW meter. If reactive load is used a power factor meter is desirable.

Caution! When fitting power cables for load testing purposes, ensure cable voltage rating is at least equal to the generator rated voltage. The load cable termination should be placed on top of the winding lead termination and clamped with the nut provided.

Check that all wiring terminations for internal or external wiring are secure, and fit all terminal box covers and guards. Failure to secure wiring and/or covers may result in personal injury and/or equipment failure.

INITIAL START-UP**Pre-Running Checks**

Before starting the generating set.

Test the insulation resistance of windings.

Check all connections are in the correct location and tight

Check the generator air path is clear of obstructions

Replace all covers.

Insulation resistance test

1. Disconnect all leads connected to the AVR.
2. Use a 500V Megger or similar instrument.
3. Disconnect any conductor connected between neutral and earth.
4. Megger an output lead terminal U, V or W to earth.

The insulation resistance reading should be in excess of 5 Megohm to earth. Should the insulation resistance be less than 5 Megohm the winding must be dried out. For drying out procedures see the Service section of this Manual.

Caution! The windings have been High Voltage H.V. tested during manufacture and further H.V. testing may degrade the insulation with consequent reduction in operating life. Should it be necessary to demonstrate H.V. testing, for customer acceptance, the tests must be carried out at reduced voltage levels i.e.

Test Voltage= $0.8 (2 \times \text{Rated Voltage} + 1000)$

Warning! During testing it may be necessary to remove covers to adjust controls exposing 'live' terminals or components. Only personnel qualified to perform electrical service should carry out testing and/or adjustments. Refit all access covers after adjustments are completed.

Caution! On completion of generating set assembly and before starting the generating set ensure that all engine manufacturer's pre-running procedures have been completed, and that adjustment of the engine governor is such that the generator will not be subjected to speeds in excess of 125% of the rated speed.

Warning! Over speeding of the generator during initial setting of the speed governor can result in damage to the generator rotating components.

Setting the Voltage

In addition remove the AVR access cover and turn VOLTS control fully anti-clockwise. Start the generating set and run on no-load at nominal frequency. Slowly turn VOLTS control potentiometer clockwise until rated voltage is reached.

Caution! Do not increase the voltage above the rated generator voltage shown on the generator nameplate.

Setting the Stability Control.

The STABILITY control potentiometer should be set to the midway position and with the stability selection correctly set should not normally require adjustment. Should adjustment be required, usually identified by oscillation of the voltmeter, proceed as follows:

Run the generating set on no-load and check that speed is correct and stable.

Turn the STABILITY control potentiometer clockwise, and then turn slowly anti-clockwise until the generator voltage starts to become unstable. The correct setting is slightly clockwise from this position (i.e. where the machine volts are stable but close to the unstable region).

Load Testing

Warning! During testing it may be necessary to remove covers to adjust controls exposing 'live' terminals or components. Only personnel qualified to perform electrical service should carry out testing and/or adjustments. Refit all access covers after adjustments are completed.

AVR Controlled Generators - AVR Adjustment

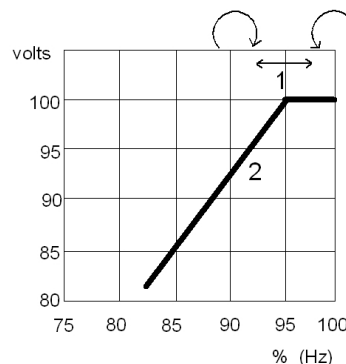
Having adjusted VOLTS and STABILITY during the initial start-up procedure, the AVR control function UFRO should not normally need adjustment.

If however, poor voltage regulation on-load is experienced, refer to the following paragraph to a) check that the symptoms observed do indicate adjustment is necessary, and b) to make the adjustment correctly.

UFRO (Under Frequency Roll Off)

The AVR incorporates an under speed protection circuit, which gives a voltage/speed (Hz) characteristic as shown: The UFRO control potentiometer sets the "knee point".

Symptoms of incorrect setting are a) the light emitting diode (LED) indicator, adjacent to the UFRO Control potentiometer, being permanently lit when the generator is on load, and b) poor voltage regulation on load, i.e. operation on the sloping part of the characteristic.



Clockwise adjustment lowers the frequency (speed) setting of the "knee point" and extinguishes the LED. For Optimum setting the LED should illuminate as the frequency falls just below nominal frequency, i.e. 47Hz on a 50Hz generator or 57Hz on a 60Hz generator.

- 1) Knee point
- 2) Typical slope

Accessories

Generator control accessories may be fitted, as an option, in the generator terminal box. If fitted at the time of supply, the wiring diagram(s) in the back of this book shows the connections. When the options are supplied separately, fitting instructions are provided with the accessory.

Accessories available are droop transformer for parallel operation applicable to P1 generators. and remote voltage adjust (hand trimmer). The latter being available for all AVR types but not fitted on the generator.

Remote Voltage Adjust.

A remote voltage adjust can be fitted to the control panel.

Remove link 1-2 on the AVR and connect adjuster to terminals 1 and 2.

Parallel Operation

Understanding of the following notes on parallel operation is useful before attempting the fitting or setting of the droop kit accessory. When operating in parallel with other generators or the mains, it is essential that the phase sequence of the incoming generator matches that of the busbar and also that all of the following conditions are met before the circuit breaker of the incoming generator is closed on to the busbar (or operational generator)

Frequency must match within close limits.

Voltages must match within close limits.

Phase angle of voltages must match within close limits.

A variety of techniques, varying from simple synchronising lamps to fully automatic synchronisers, can be used to ensure these conditions are met.

Caution! Failure to meet conditions 1, 2, and 3 when closing the circuit breaker, will generate excessive mechanical and electrical stresses, resulting in equipment damage.

Once connected in parallel a minimum instrumentation level per generator of voltmeter, ammeter, watt meter (measuring total power per generator), and frequency meter is required in order to adjust the engine and generator controls to share kW in relation to engine ratings and kVAr in relation to generator ratings.

It is important to recognise that:

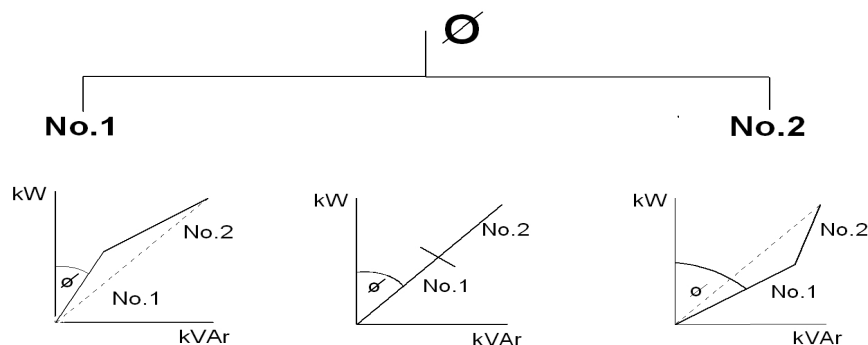
kW derived from the engine, and speed governor characteristics determine the kW sharing between sets.

kVAr derived from the generator, and excitation control characteristics determine the kVAr sharing. Reference should be made to the generating set manufacturer's instructions for setting the governor controls.

Droop

The most commonly used method of kVAr sharing is to create a generator voltage characteristic, which falls with decreasing power factor (increasing kVAr). This is achieved with a current transformer (C.T.), which provides a signal dependent on current phase angle (i.e. power factor) to the AVR. The current transformer has a burden resistor on the AVR board, and a percentage of the burden resistor voltage is summed into the AVR circuit. Increasing droop is obtained by turning the DROOP control potentiometer clockwise.

The diagrams below indicate the effect of droop in a simple two-generator system:



Generally 5% droop at full load current zero p.f. is sufficient to ensure kVAr sharing.

If the droop accessory has been supplied with the generator it will have been tested to ensure correct polarity and set to a nominal level of droop. The final level of droop will be set during generating set commissioning.

The following setting procedure will be found to be helpful.

Setting Procedure

Depending upon available load the following settings should be used - all are based on rated current level.

0.8 P.F. LOAD (at full load current) SET DROOP TO 3%

0 P.F. LOAD (at full load current) SET DROOP TO 5%

Setting the droop with low power factor load is the most accurate.

Run each generator as a single unit at rated frequency or rated frequency + 4% depending upon type of governor and nominal voltage. Apply available load to rated current of the generator. Adjust 'DROOP' control potentiometer to give droop in line with above table. Clockwise rotation increases amount of droop.

Refer to AVR section, for potentiometer location. After adjustment check NO LOAD voltage level and adjust if necessary.

Note 1: Reverse polarity of the C.T. will raise the generator voltage with load. The polarities S1-S2 shown on the wiring diagrams are correct for clockwise rotation of the generator looking at the drive end. Reversed rotation requires S1-S2 to be reversed.

Note 2: The most important aspect is to set all generators equal. The precise level of droop is less critical.

Note 3: A generator operated as a single unit with a droop circuit set at rated load 0.8-power factor is unable to maintain the usual level (%) of regulation. A shorting switch can be connected across S1-S2 to restore regulation for single running.

Caution! **LOSS OF FUEL** to an engine can cause its generator to motor with consequent damage to the generator windings. Reverse power relays should be fitted to trip main circuit breaker.

LOSS OF EXCITATION to the generator can result in large current oscillations with consequent damage to generator windings. Excitation loss detection equipment should be fitted to trip main circuit breaker.

Installation on site

General

The extent of site installation will depend upon the generating set build, e.g. if the generator is installed in a canopied set with integral switchboards and circuit breaker, on site installation will be limited to connecting up the site load to the generating set output terminals. In this case reference should be made to the generating set manufacturer's instruction book and any pertinent local regulations.

If the generator has been installed on a set without switchboard or circuit breaker the following points relating to connecting up the generator should be noted.

Glanding

This generator can be fitted with one of several terminal box arrangements. Each box comes in two parts, a four sided body and a lid. The body of the terminal box has knock-out punch holes for customer to fit their gland arrangement. If these are not adequate the box can be removed and additional holes can be punched through.

Incoming cables should be supported from either below or above the box level and at a sufficient distance from the centre line of the generating set so as to avoid a tight radius at the point of entry into the terminal box panel, and allow movement of the generator set on its anti-vibration mountings without excessive stress on the cable.

Before making final connections, test the insulation resistance of the windings. The AVR should be disconnected during this test.

A 500V Megger or similar instrument should be used. Should the insulation resistance be less than 5MW the windings must be dried out as detailed in the Service and Maintenance section of this manual.

When making connections to the terminals the incoming cable termination should be placed on top of the winding lead termination(s) and clamped with the nut provided. eg current carrying component next to current carrying component.

Caution! To avoid the possibility of swarf entering any electrical components in the terminal box, panels must be removed for drilling.

The AVR can be fitted on either side of the NDE bracket in its own compartment. There is sufficient length of wiring to allow the customer to swap sides without rewiring.

Earthing

The neutral of the generator is not bonded to the generator frame as supplied from the factory. An earth terminal is provided inside the terminal box adjacent to the main terminals. Should it be required to operate with the neutral earthed a substantial earth conductor (normally equivalent to one half of the section of the line conductors) must be connected between the neutral and the earth terminal inside the terminal box. A hole is provided on the generator foot, which may be tapped to give an additional earthing point. The feet should be already bonded to the generating set bedplate by the generating set builder, but will normally be required to be connected to the site earth system.

Warning! Reference to local electricity regulations or safety rules should be made to ensure correct earthing procedures have been followed.

Protection

It is the responsibility of the end user and his contractors/subcontractors to ensure that the overall system protection meets the needs of any inspectorate, local electricity authority or safety rules, pertaining to the site location.

To enable the system designer to achieve the necessary protection and/or discrimination, fault current curves are available on request from the factory, together with generator reactance values to enable fault current calculations to be made.

Warning! Incorrect installation and/or protective systems can result in personal injury and/or equipment damage. Installers must be qualified to perform electrical installation work.

Commissioning

Ensure that all external cabling is correct and that all the generating set manufacturer's pre-running checks have been carried out before starting the set. The generator AVR controls will have been adjusted during the generating set manufacturer's tests and should normally not require further adjustment. Should adjustment on site be necessary and for paralleling adjustments see section on Automatic Voltage Regulators.

Should malfunction occur during commissioning refer to Service and Maintenance section 'Fault Finding' procedure.

Service and Maintenance

Service

Warning! Service and fault finding procedures present hazards, which can result in severe personal injury or death. Only personnel qualified to perform electrical and mechanical service should carry out these procedures. Ensure engine-starting circuits are disabled before commencing service or maintenance procedures. Isolate any anti-condensation heater supply.

Winding Condition

Guidance of Typical Insulation Resistance [IR] Values

The following is offered as general information about IR values and is aimed at providing guidance about the typical IR values for generators from new, through to the point of refurbishment.

New Machines

The generator's Insulation Resistance, along with many other critical factors, will have been measured during the generator manufacturing process. The generator will have been transported with an appropriate packaging suitable for the method of delivery to the Generating Set assembler's works. The assembler is expected to store the generator in a suitable location, protected from adverse environmental (and other) conditions.

However, absolute assurance that the generator will arrive at the Genset production line with IR values still at the factory test levels of above 100 Megohm to be guaranteed.

At Generating Set Assembler's Works

The generator should have been transported and stored such that it will be delivered to the assembly area in a clean dry condition. If held in appropriate storage conditions the generator IR value should typically be 25 Megohm

If the unused/new generator's IR values fall below 5 Megohm □ then a drying out procedure should be implemented by one of the processes outlined below, before being despatched to the end customer's site. Some investigation should be undertaken into the storage conditions of the generator while on site.

Generators in Service

It is known that a generator will give reliable service with an IR value of just 1.0 Megohm. For a relatively new generator to be so low it must have been subjected to inappropriate operating or storage conditions. Any temporary reduction in IR values can be restored to expected values by following one of the drying out procedures.

Winding Condition Assessment

Caution! The AVR should be disconnected and the Resistance Temperature Detector (R.T.D.) leads grounded during this test.

Caution! The windings have been H.V. tested during manufacture and further H.V. testing may degrade the insulation with consequent reduction in operating life. Should it be necessary to demonstrate H.V. testing, for customer acceptance, the tests must be carried out at reduced voltage levels i.e.

Test Voltage= 0.8 (2 X Rated Voltage + 1000)

The condition of the windings can be assessed by measurement of insulation resistance [IR] between phase to phase, and phase to earth.

Measurement of winding insulation should be carried out: -

- As part of a periodic maintenance plan.
- After prolonged periods of shutdown.
- When low insulation is suspected, e.g. damp or wet windings.

Care should be taken when dealing with windings that are suspected of being excessively damp or dirty. The initial measurement of the [IR] Insulation Resistance should be established using a low voltage (500V) megger type instrument. If manually powered, the handle should initially be turned slowly so that the full test voltage will not be applied. If low values are suspected or immediately indicated the test should only continue for long enough to very quickly assess the situation.

Full megger tests (or any other form of high voltage test) should not be applied until the windings have been dried out, and if necessary cleaned.

Procedure for Insulation Testing

1. Disconnect all electronic components, AVR, electronic protection equipment etc. Ground the RTD's (Resistance Temperature Detection devices) if fitted.
2. Short out the diodes on the rotating diode assembly. Be aware of all components connected to the system under test that could cause false readings, or be damaged by the test voltage.
3. Carry out the insulation test in accordance with the 'operating instructions' for the test equipment.
4. The measured value of insulation resistance for all windings to earth and phase to phase should be compared with the guidance given above for the various 'life stages' of a generator. The minimum acceptable value is 1.0 Megohm on a 500V megger.

If low winding insulation is confirmed, one or more of the methods, given below, for drying the winding should be carried out.

Methods of Drying Out Generators

Cold Run

In the case of a generator in otherwise good condition that has not been run for some time, and has been standing in damp, humid conditions a simple procedure may suffice. It is possible that simply running the generator set unexcited – AVR terminals “K1” “K2” open circuit - for a period of say 10 minutes will sufficiently dry the surface of the windings and raise the IR to greater than 1.0 Megohm, and so allow the unit to be put into service.

Blown Air Drying

Remove the covers from all apertures to allow the escape of the water-laden air. During drying, air must be able to flow freely through the generator in order to carry off the moisture.

Direct hot air from two electrical fan heaters of around 1 – 3 kW into the generator air inlet apertures. Ensure the heat source is at least 300mm away from the windings to avoid over heating and damage to the insulation.

Apply the heat and plot the insulation value at half hourly intervals. The process is complete when the parameters covered in the section entitled, 'Typical Drying Out Curve', are met.

Remove the heaters, replace all covers and re-commission as appropriate.

If the set is not to be run immediately ensure that the anti-condensation heaters are energised, and retest prior to running.

Short Circuit Method

Warning! This process should only be performed by a competent engineer familiar with safe operating practices within and around generator sets of the type in question. Ensure the generator is safe to work on, initiate all mechanical and electrical safety procedures pertaining to the genset and the site.

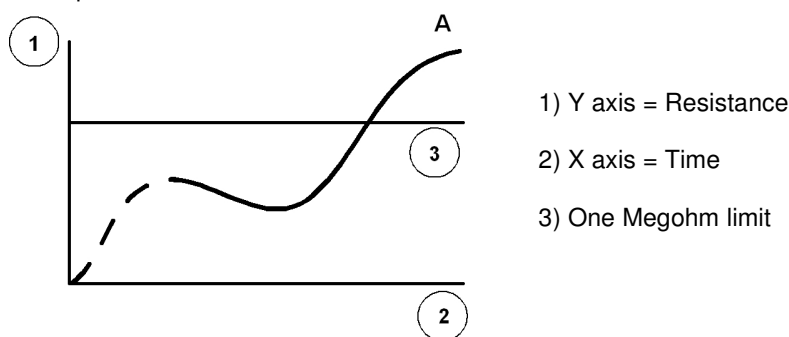
Caution! The short circuit must not be applied with the AVR connected in circuit. Current in excess of the rated generator current will cause damage to the windings.

- Bolt a short circuit of adequate current carrying capacity, across the main terminals of the generator. The shorting link should be capable of taking full load current.
- Disconnect the cables from terminals F1 and F2 of the AVR.

- Connect a variable dc supply to the F1 (positive) and F2 (negative) field cables. The dc supply must be able to provide a current up to 2.0 Amp at 0 - 24 Volts.
- Position a suitable ac ammeter to measure the shorting link current.
- Set the dc supply voltage to zero and start the generating set. Slowly increase the dc voltage to pass current through the exciter field winding. As the excitation current increases, so the stator current in the shorting link will increase. This stator output current level must be monitored, and not allowed to exceed 80% of the generator's rated output current.
- After every 30 minutes of this exercise:
Stop the generator and switch off the separate excitation supply, measure and record the stator winding IR values, and plot the results. The resulting graph should be compared with the classic shaped graph. This drying out procedure is complete when the parameters covered in the section entitled 'Typical Drying Out Curve' are met.
- Once the Insulation Resistance is raised to an acceptable level - minimum value 1.0 Megohm the dc supply may be removed and the exciter field leads F1 and F2 re-connected to their terminals on the AVR.
- Rebuild the genset, replace all covers and re-commission as appropriate.
- If the set is not to be run immediately ensure that the anti-condensation heaters are energised, and retest the generator prior to running.

Typical Drying Out Curve

Whichever method is used to dry out the generator the resistance should be measured every half-hour and a curve plotted as shown



The illustration shows a typical curve for a machine that has absorbed a considerable amount of moisture. The curve indicates a temporary increase in resistance, a fall and then a gradual rise to a steady state. Point 'A', the steady state, must be greater than 1.0 Megohm (If the windings are only slightly damp the dotted portion of the curve may not appear).

For general guidance, expect that the typical time to reach point 'A' will be around 3 hours.

Drying should be continued after point "A" has been reached for at least one hour.

It should be noted that as winding temperature increases, values of insulation resistance may significantly reduce. Therefore, the reference values for insulation resistance can only be established with windings at a temperature of approximately 20°C.

If the IR value remains below 1.0 Megohm, even after the above drying methods have been carried out correctly, then a Polarisation Index test [PI] should be carried out.

If the minimum value of 1.0 Megohm for all components cannot be achieved, rewinding or refurbishment of the generator will be necessary.

Caution! The generator must not be put into service until the minimum values are achieved.

After drying out, the insulation resistances should be rechecked to verify the minimum resistances quoted above are achieved. On re-testing it is recommended that the main stator insulation resistance is checked as follows:

Separate the neutral leads

Ground V and W phase and megger U-phase to ground

Ground U and W phase and megger V-phase to ground

Ground U and V phase and megger W-phase to ground

Caution! The generator must not be run if the minimum insulation value of 1.0 Megohm is not obtained.

Air Filters

Air filters for the removal of airborne particulate matter (dust) are offered as an addition to the standard build option. The filter elements do not remove WATER and must not be allowed to get wet.

The frequency of filter maintenance will depend upon the severity of the site conditions. Regular inspection of the elements will be required to establish when cleaning is necessary.

Caution! Do not charge filters with oil.

Warning! Removal of filter elements enables access to LIVE parts. Only remove elements with the generator out of service.

Air Filter Cleaning Procedure

1. Remove the filter elements from the filter frames, taking care not to damage them.
2. Invert the filters dirty side down and agitate to remove particles of dirt.
To remove stubborn particles low-pressure air can be used, in the reverse direction of flow, to force out stubborn particles.
If necessary use a soft brush to gently brush off any remaining dirt particles.
3. Clean the sealing gaskets and surrounding area.
4. Visually check the condition of the filter elements and sealing gaskets, replace as necessary.
5. Ensure that the filter elements are dry before putting them back into service.
6. Carefully replace the filter elements

Maintenance

Fault Finding

Caution! Before commencing any fault finding procedures examine all wiring for broken or loose connections. Three excitation control systems can be fitted to the range of generators covered by this manual, identified by the last digit of the generator frame size designation. Refer to the nameplate and then proceed to the appropriate subsection as indicated below:

AVR - Fault Finding

No voltage build-up when starting set	1. Check speed 2. Check residual voltage. 3. Follow separate excitation test procedure to check generator
Unstable voltage either on no-load or with load	1. Check speed stability. 2. Check stability setting.
High voltage either on no-load or with load	1. Check speed. 2. Check that generator load is not capacitive (leading power factor).
Low voltage no-load	1. Check speed. 2. Check link 1-2 or external hand trimmer leads for continuity.

Low voltage on-load	<ol style="list-style-type: none"> 1. Check speed. 2. Check UFRO setting. 3. Follow separate excitation procedure to check generator and AVR.
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Residual Voltage Check (Field Flashing)

This procedure applies to all generators fitted with AVR control.

With the generator set stationary remove AVR access cover and leads F1 and F2 from the AVR.

Start the set and measure voltage across AVR terminals 7-8. A minimum level of 5 volts is required at these terminals.

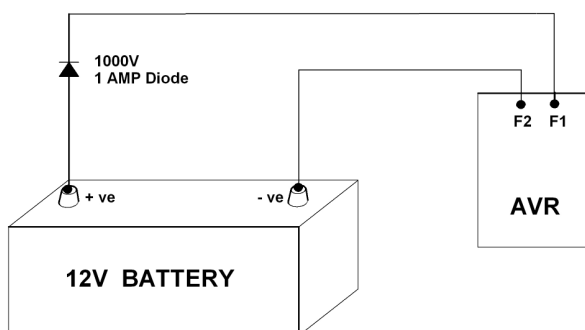
Replace leads F1 and F2 on the AVR terminals.

If the voltage is less than 5 volts stop the set, and carry out field flashing procedure.

Field Flashing procedure.

Using a 12-volt D.C. battery as a supply, clip leads from battery negative to AVR terminal F2, and from battery positive through a diode to AVR terminal F1.

Caution! A diode must be used as shown below to ensure the AVR is not damaged.



Caution! If the generating set battery is used for field flashing, the generator main stator neutral must be disconnected from earth.

Restart the set and note output voltage from the main stator, which should be approximately nominal voltage, or voltage at AVR terminals 7 and 8, which should be between 170 and 250 volts.

Stop the set and unclip battery supply from terminals F1 and F2. Restart the set. The generator should now operate normally. If no voltage build-up is obtained it can be assumed a fault exists in either the generator or the AVR circuits. Follow the SEPARATE EXCITATION PROCEDURE to check generator windings, rotating diodes and AVR.

Separate Excitation Test Procedure

The generator windings, diode assembly and AVR can be checked using this procedure. With the generating set stationary remove AVR access cover and leads F1 and F2 from the AVR. Connect a 60W 240-volt household lamp (or two 120V lamps in series) to AVR terminals F1 and F2. Connect a 0-12 volt, 1.0 Amp supply to leads F1 and F2. The positive of the D.C. supply is connected to the lead marked F1 and the negative to the lead marked F2.

The procedure is simplified by dividing into two sections:

Generator Windings and Rotating Diodes, and Excitation Control Test.

1 Generator Windings and Rotating Diodes

Caution! The resistances quoted apply to a standard winding. For generators having windings or voltages other than those specified refer to factory for details. Ensure all disconnected leads are isolated and free from earth.

This procedure is carried out with leads F1 and F2 disconnected at the AVR and with a 12 volt d.c. supply to leads F1 and F2.

- Start the set and run at rated speed, on no-load.
- Measure the voltages at the main output terminals U, V and W. These should be balanced and within 10% of the generator nominal voltage.

Balanced Main Terminal Voltages

If all voltages are balanced within 1% at the main terminals, it can be assumed that all exciter windings, main windings and main rotating diodes are in good order, and the fault is in the AVR. Refer to AVR section for test procedure.

If voltages are balanced but low, there is a fault in the main excitation windings or rotating diode assembly. Proceed as follows to identify:

Rectifier Diodes

The diodes on the main rectifier assembly can be checked with a multimeter. The flexible leads connected to each diode should be disconnected at the terminal end, and the forward and reverse resistance checked. A healthy diode will indicate a very high resistance (infinity) in the reverse direction, and a low resistance in the forward direction. A faulty diode will give a full deflection reading in both directions with the test meter on the 10,000 ohms scale, or an infinity reading in both directions.

Replacement of Faulty Diodes

The rectifier assembly is split into two plates, the positive and negative, and the main rotor is connected across these plates. Each plate carries 3 diodes, the negative plate carrying negative biased diodes and the positive plate carrying positive biased diodes. Care must be taken to ensure that the correct polarity diodes are fitted to each respective plate. When fitting the diodes to the plates they must be tight enough to ensure a good mechanical and electrical contact, but should not be over tightened. The recommended torque tightening is 4.06 - 4.74Nm (36-42lb in).

Surge Suppressor

The surge suppressor is a metal-oxide varistor connected across the two rectifier plates to prevent high transient reverse voltages in the field winding from damaging the diodes. This device is not polarised and will show a virtually infinite reading in both directions with an ordinary resistance meter. If defective this will be visible by inspection, since it will normally fail to short circuit and show signs of disintegration. Replace if faulty.

2 Excitation Control Test

AVR Function Test

1. Remove exciter field leads F1 & F2 from the AVR terminals F1 & F2.
2. Connect a 60W 240V household lamp to AVR terminals F1 & F2.
3. Set the AVR VOLTS control potentiometer fully clockwise.
4. Connect a 12V, 1.0A DC supply to the exciter field leads F1 & F2 with F1 to the positive.
5. Start the generating set and run at rated speed.
6. Check that the generator output voltage is within +/- 10% of rated voltage.
7. Voltages at AVR terminals 7-8 should be between 170 and 250 volts. If the generator output voltage is correct but the voltage on 7-8 is low, check auxiliary leads and connections to main terminals.
8. The lamp connected across F1 & F2 should glow. Turning the "VOLTS" control potentiometer fully anti-clockwise should turn off the lamp. Failure to turn off indicates faulty protection circuit and the AVR should be replaced.
9. Should the lamp fail to light the AVR is faulty and must be replaced.

Caution! After this test turn the VOLTS control potentiometer fully anti-clockwise.

Main Excitation Windings

If after establishing and correcting any fault on the rectifier assembly the output is still low when separately excited, then the main rotor, exciter stator and exciter rotor winding resistances should be checked (see Resistance Charts), as the fault must be in one of these windings. The exciter stator resistance is measured across leads F1 and F2. The exciter rotor is connected to six studs, which also carry the diode lead terminals. The main rotor winding is connected across the two rectifier plates. The respective leads must be disconnected before taking the readings.

Resistance values should be within 10% of the values given in the table below:

4 - Pole	Main Rotor	Exciter stator	Exciter Rotor	EBS
P044D	0.437	17.5	0.211	12.9
P044E	0.415	17.7	0.211	12.9
P044F	0.465	18.5	0.228	12.9
P044G	0.551	18.5	0.228	12.9
P044H	0.545	18.5	0.228	12.9
P144D	0.657	18.5	0.228	12.9
P144E	0.67	19.36	0.215	12.9
P144F	0.708	20.25	0.201	12.9
P144G	0.857	22.25	0.201	12.9
P144H	0.89	22.9	0.21	12.9
P144J	0.983	22.9	0.21	12.9
P144K	0.99	22.9	0.21	12.9

2 - Pole	Main Rotor	Exciter stator	Exciter Rotor	EBS
P042D	0.798	13.5	0.0479	12.9
P042E	0.895	13.5	0.0479	12.9
P042F	0.931	13.5	0.0479	12.9
P042G	0.993	13.5	0.0479	12.9
P142D	1.125	18	0.128	12.9
P142E	1.214	19	0.134	12.9
P142F	1.28	20	0.105	12.9
P142G	1.479	20	0.105	12.9
P142H	1.59	20	0.105	12.9
P142J	1.709	20	0.105	12.9

Incorrect resistances indicate faulty windings and component replacement is necessary.

Main Stator Resistance

If voltages are unbalanced, this indicates a fault on the main stator winding or main cables to the circuit breaker.

NOTE Faults on the stator winding or cables may also cause noticeable load increase on the engine when excitation is applied.

Disconnect the main cables and separate the winding leads U1-U2, U5-U6, V1-V2, V5-V6, W1-W2, W5-W6 to isolate each winding section.

Measure insulation resistance between sections and each section to earth.

Unbalanced or incorrect winding resistances and/or low insulation resistances to earth indicate rewinding of the stator will be necessary.

4 - Pole	Main stator winding resistances
windings	311
P044D	1.908
P044E	1.33
P044F	0.95
P044G	0.625
P044H	0.51
P144D	0.353
P144E	0.3
P144F	0.26
P144G	0.213
P144H	0.171
P144J	0.15
P144K	0.155

2 - Pole	Main stator winding resistances
Windings	311
P042D	1.149
P042E	0.726
P042F	0.640
P042G	0.494
P142D	0.336
P142E	0.283
P142F	0.231
P142G	0.165
P142H	0.144
P142J	0.118

Removal and Replacement of Component Assemblies

Caution!
removed

The following procedures assume that the generator has been from the generating set. On single bearing generators before removal from the engine, position the rotor such that a full pole face is at bottom dead centre. Use engine pulley to turn rotor. Metric threads are used throughout.

Warning!

When lifting single bearing generators, care is needed to ensure the generator frame is kept in the horizontal plane. The rotor is free to move in the frame and can slide out if not correctly lifted. Incorrect lifting can cause serious personal injury.

Removal of EBS unit

This unit is designed to be fitted and removed as a single unit.

1. Remove the AVR cover and disconnect the flag connectors from terminals DR EB F2 F1 on the AVR, ensure the cable is free to move.
2. Remove the terminal box lid and free the cable ties holding the cable in place, ensure the cable is free to move.
3. Remove the cover from the rear of the EBS unit.
4. Look into the unit and identify the bolt holding the rotor to the shaft remove and put aside.
5. Remove four bolts holding the unit in position.

The whole unit together with the connecting cable can be lifted clear as one unit.

Assemble in reverse order, torqued to 10Nm.

Removal of the Rotor (two bearing generator)

1. Remove the EBS unit if fitted.
2. Ensure that a full pole face of the rotor is at the bottom dead centre of the stator.
3. Remove the eight bolts from the DE bracket and use fox wedges to remove the bracket.
4. Remove the outer section of the fan. This is necessary on large cores but good practice on all cores.
5. Disconnect stator leads at the terminal block.
6. Remove the plastic cover from the NDE bracket
7. Access is now available for the removal of the bolts holding the NDE bracket in place.
8. Because of the angle on the rotor caused by the removal of the DE bracket it will help with the removal if the rotor is pulled out by a few cm. Use a rope or web sling to support the rotor when moving it.
9. Lift the NDE bracket clear when free to do so.
10. The rotor is now free at both ends and can be inched out with the careful use of slings.

Note **bearings can now be changed, without moving the rotor.**

Assemble in reverse order, torque to 26Nm

Removal of the Rotor (single bearing generator)

1. Remove the EBS unit if fitted.
2. Ensure that a full pole face of the rotor is at the bottom dead centre of the stator.
3. Remove the coupling disc and the outer section of the fan to prevent damage to them
4. Disconnect stator leads at the terminal block.
5. Remove the plastic cover from the NDE bracket
6. Access is now available for the removal of the bolts holding the NDE bracket in place.
7. Because of the angle on the rotor it will help with the removal of the NDE bracket if the rotor is pulled

out by a few cm. Use a rope or web sling to support the rotor from when moving it.

8. Lift the NDE bracket clear when free to do so.
9. The rotor is now free at both ends and can be inched out with the careful use of slings.

Note **bearings can now be changed, without moving the rotor.**

Assemble in reverse order, torque to 26Nm

Bearing Removal

- Use the appropriate method described above to remove the end bracket(s) or remove the rotor.
- Use three legged bearing pullers to remove the bearings from the shaft.

Fitting new bearings

Only use genuine STAMFORD replacement parts. The bearings are pre-packed with grease and sealed for life.

note **do not reuse the old bearing , 'o' rings or wave washers, always use the new ones supplied with the bearing kit.**

Caution! **set up a clean area around the job to eliminate the possibility of contamination.**

Unpack the bearing and clean off the preservative oil using a lint free cloth.

Heat the bearing to 20°C above ambient (do not exceed 100°C)

fit the 'o' ring in the bearing housing(s) using using (MP14002 – Kluber Altenp Q NB 50) anti-fretting grease. Position the wave washer.

fit the bearing(s) onto the shaft, ensure that it is hard up against the shoulder. Allow to cool.

Refit the NDE bracket; gently tap the bracket onto the bearing using a hide mallet.

Use slings work the rotor back into the frame.

Position and bolt up NDE bracket.

On two bearing generators, align and fit the bracket onto the bearing.

Align the DE bracket, position the bolts and take up the slack.

Tighten and torque from both ends ensuring that the shaft is free to rotate at all times.

Replacing anti-condensation heaters

Warning! **ensure that the power is removed from the heaters.**

Remove the plastic end cover from the non drive end to gain access to the heater.

Identify the heater at the bottom of the NDE bracket. Cut the leads, unbolt the fixin arrangement

Replacing Rectifier diodes and Surge Suppressor

Remove the plastic end cover from the non drive end to gain access.

The rectifier plates are positioned on the NDE of the exciter rotor.

Rotate the rotor until each diode, in turn, is accessible from the bottom quadrant.

Remove and replace each diode and the suppressor in turn.

Smear Midlands Silicons Heat sink compound, type MS2623, on the underside of each diode when assembling the diodes.

Caution **This compound must not be applied to the thread of the diodes.**

Diodes to be tightened to a torque of 2.03-2.37 Nm.

Removing the Terminal box

The terminal box has knockouts for customer cables there should be no need to remove the box.

To remove the box take off the lid and remove 4 bolt securing the box. The box is in two parts the lid and a four sided frame. There are optional, larger boxes for customers that require additional room.

Lifting the generator with a large box

The standard fitted lifting eyes will be obstructed if the large box is fitted. A set of extension pieces can be bolted onto the standard lifting eyes to facilitate the lift.

Spares and After Sales Service

Recommended Spares

Service parts are conveniently packaged for easy identification. Genuine parts may be recognised by the STAMFORD name.

We recommend the following for Service and Maintenance. In critical applications a set of these service spares should be held with the generator. *

AVR	P0 / P1 AVR control	E000-14800*
Bearings	Bearing 6306 C3	051-01058*
	O' Ring	051-21792*
Diodes	Rectifier service kit	RSK-1101*
	Comprises:-	
	Metal Oxide Varistor BC	073-08063
	Diode Stud (fwd)	073-50032
Complete Rectifier Assembly	Diode Stud (rev)	073-50033
	Rectifier assembly	45-0427
	Rectifier assembly BC-fwd	130-1413
EBS	Rectifier assembly BC-rev	130-1414
	EBS	190-EBS0001

When ordering parts the machine serial number or machine identity number and type should be quoted, together with the part description.

Orders and enquiries for parts should be addressed to:

STAMFORD PARTS Dept.
STAMFORD
Lincolnshire
PE9 2NB
UK

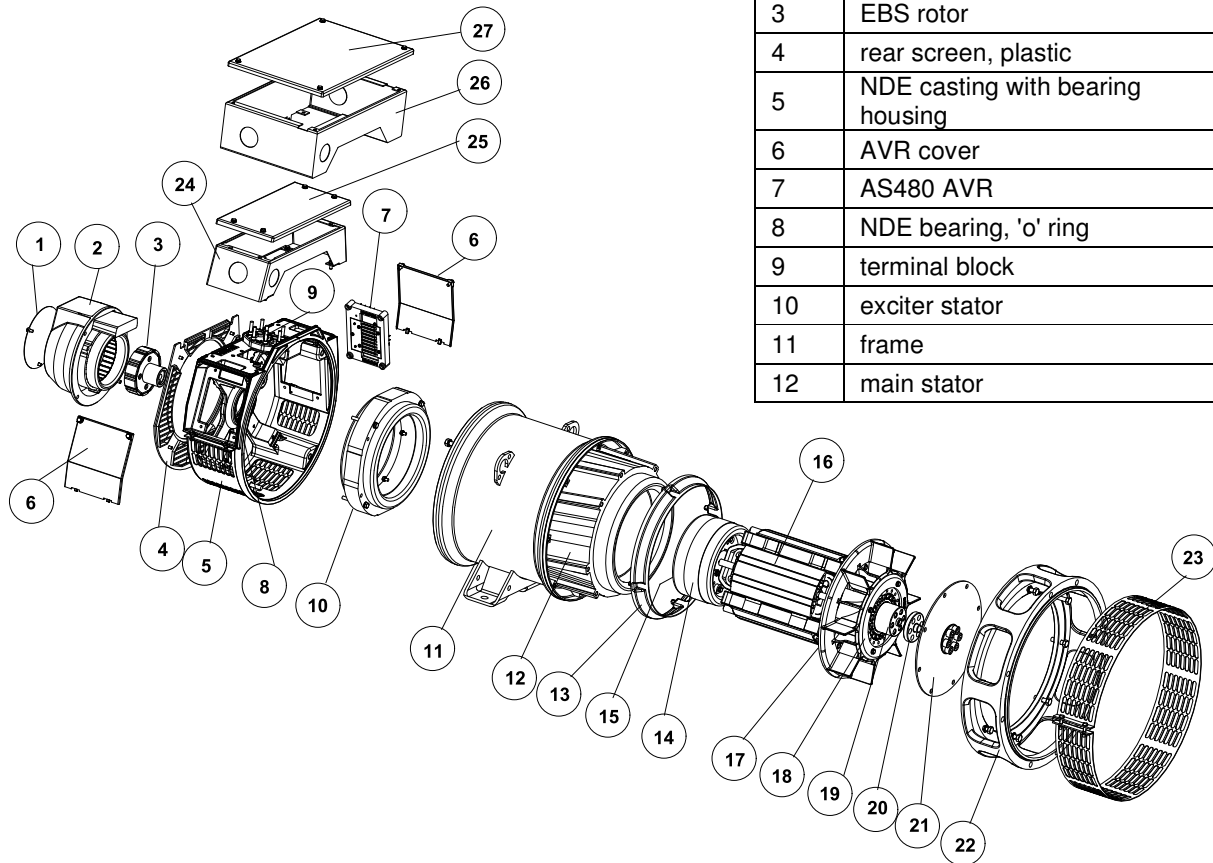
Telephone: 44 (0) 1780 484000
Fax: 44 0)1780766074Stamford

Or any of our subsidiary companies listed on the back cover.

After Sales Service

A full technical advice and on-site service facility is available from our Service Department at Stamford or through our Subsidiary Companies. A repair facility is also available at our Stamford Works.

Parts Identification Single Bearing

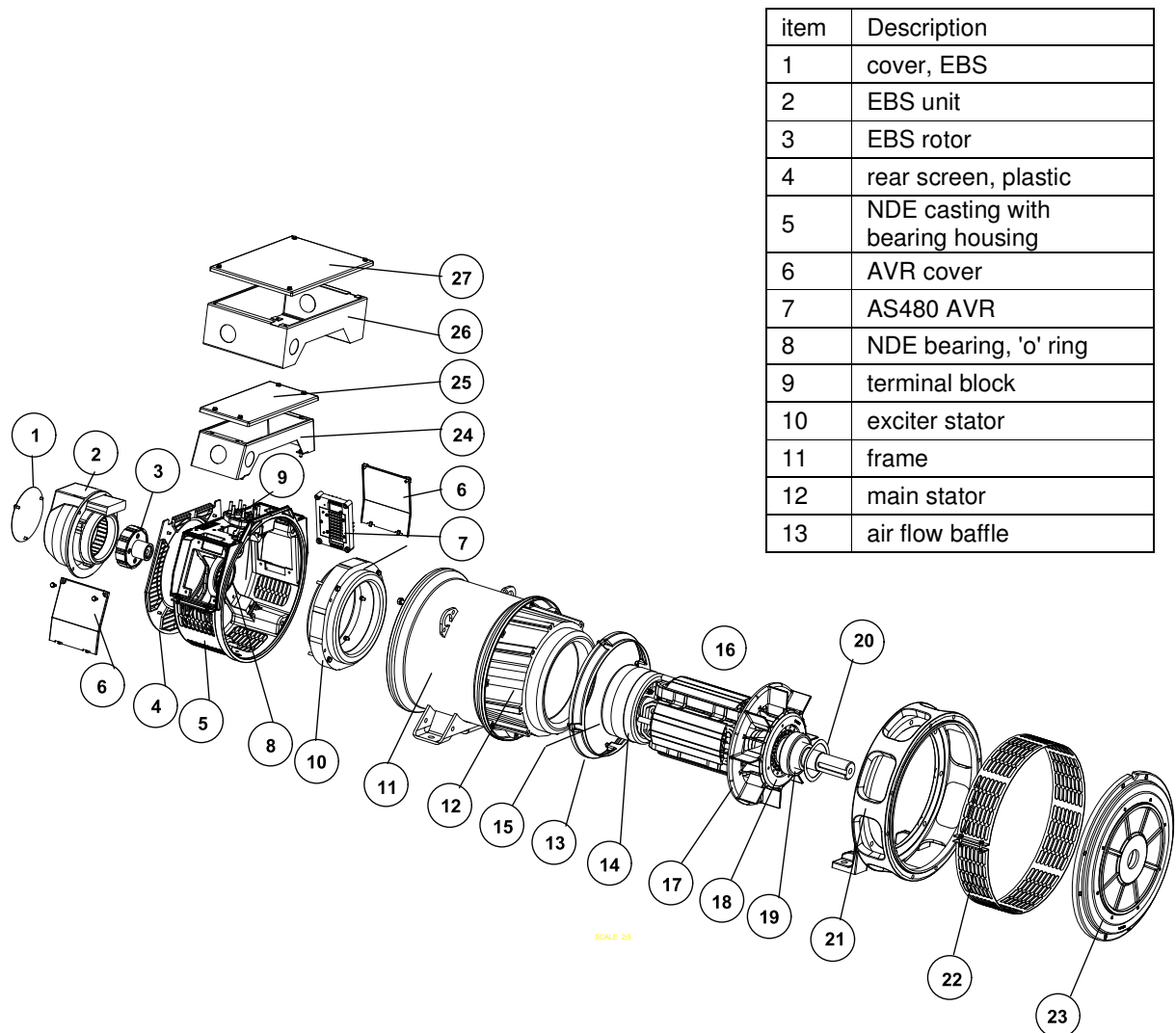


item	Description
1	cover, EBS
2	EBS unit
3	EBS rotor
4	rear screen, plastic
5	NDE casting with bearing housing
6	AVR cover
7	AS480 AVR
8	NDE bearing, 'o' ring
9	terminal block
10	exciter stator
11	frame
12	main stator

13	air flow baffle
14	exciter rotor
15	rotating rectifier assembly
16	main rotor assembly
17	fan, removable
18	fan hub, fixed
19	shaft
20	shaft spacer
21	coupling disc
22	DE adapter
23	DE screen
24	standard terminal box
25	standard terminal box lid
26	large terminal box
27	large terminal box lid

N.D.E. Non Driven End
 D.E. Driven End
 A.V.R. Automatic Voltage Regulator

Parts Identification Two Bearing

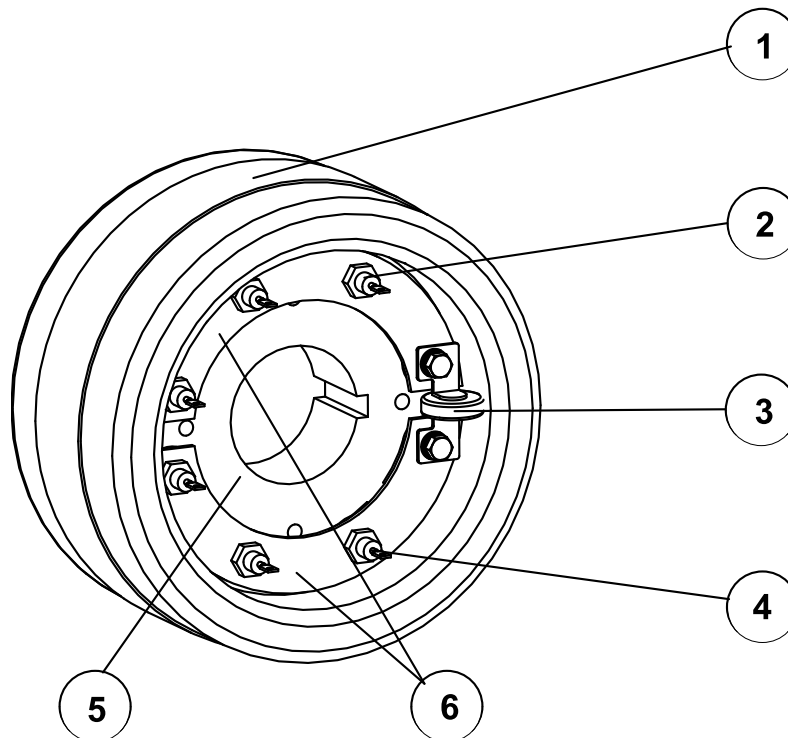


item	Description
1	cover, EBS
2	EBS unit
3	EBS rotor
4	rear screen, plastic
5	NDE casting with bearing housing
6	AVR cover
7	AS480 AVR
8	NDE bearing, 'o' ring
9	terminal block
10	exciter stator
11	frame
12	main stator
13	air flow baffle

14	exciter rotor
15	rotating rectifier assembly
16	main rotor
17	fan, removable
18	fan hub, fixed
19	bearing,
20	wave washer
21	DE adapter
22	DE screen
23	DE adapter with bearing housing
24	standard terminal box
25	standard terminal box lid
26	large terminal box
27	large terminal box lid

N.D.E. Non Driven End
D.E. Driven End
A.V.R. Automatic Voltage Regulator

Parts Identification Rectifier Assembly



	Description	Quantity
1	exciter field	1
2	forward diodes	3
3	varistor	1
4	reverse diodes	3
5	exciter hub	1

The rectifier assembly is on the NDE of the exciter rotor.

NOTE Coat the underside of diodes with Midlands Silicons Heat sink compound type MS2623, Code 030-02318. This compound must not be applied to diode thread.

Diodes to be tightened to a torque of 2.03-2.37 Nm.

A.C. GENERATOR WARRANTY**WARRANTY PERIOD****A.C. Generators**

In respect of A.C. generators the Warranty Period is eighteen months from the date when the goods have been notified as ready for despatch or twelve months from the date of first commissioning (whichever is the shorter period).

DEFECTS AFTER DELIVERY

We will make good by repair or, at our option, by the supply of a replacement, any fault which under proper use appears in the goods within the period specified on Clause 12, and is found on examination by us to be solely due to defective material and workmanship; provided that the defective part is promptly returned, carriage paid, with all identification numbers and marks intact, or our works or, if appropriate to the Dealer who supplied the goods.

Any part repaired or replaced, under warranty, will be returned free of charge (via sea freight if outside the UK).

We shall not be liable for any expenses, which may be incurred in removing or replacing any part sent to us for inspection or in fitting any replacement supplied by us. We shall be under no liability for defects in any goods which have not been properly installed in accordance with recommended installation practices as detailed in the publication 'Installation, Service and Maintenance Manual', or which have been improperly stored or which have been repaired, adjusted or altered by any person except ourselves or our authorised agents, or in any second-hand goods, proprietary articles or goods not of our own manufacture although supplied by us, such articles and goods being covered by the warranty (if any) given by the separate manufacturers.

Any claim under this clause must contain fully particulars of the alleged defect, the description of the goods, the date of purchase, and the name and address of the Vendor, the Serial Number (as shown on the manufacturers identification plate) or for Spares the order reference under which the goods were supplied.

Our judgement in all cases of claims shall be final and conclusive and the claimant shall accept our decision on all questions as to defects and the exchange of a part or parts.

Our liability shall be fully discharged by either repair or replacement as above, and in any event shall not exceed the current list price of the defective goods.

Our liability under this clause shall be in lieu of any warranty or condition implied by law as to the quality or fitness for any particular purpose of the goods, and save as expressly provided in this clause we shall not be under any liability, whether in contract, tort or otherwise, in respect of defects in goods delivered or for any injury, damages or loss resulting from such defects or from any work undone in connection therewith.



Head Office Address:
Barnack Road
Stamford
Lincolnshire, PE9 2NB
United Kingdom
Tel: +44 (0) 1780 484000
Fax: +44 (0) 1780 484100

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