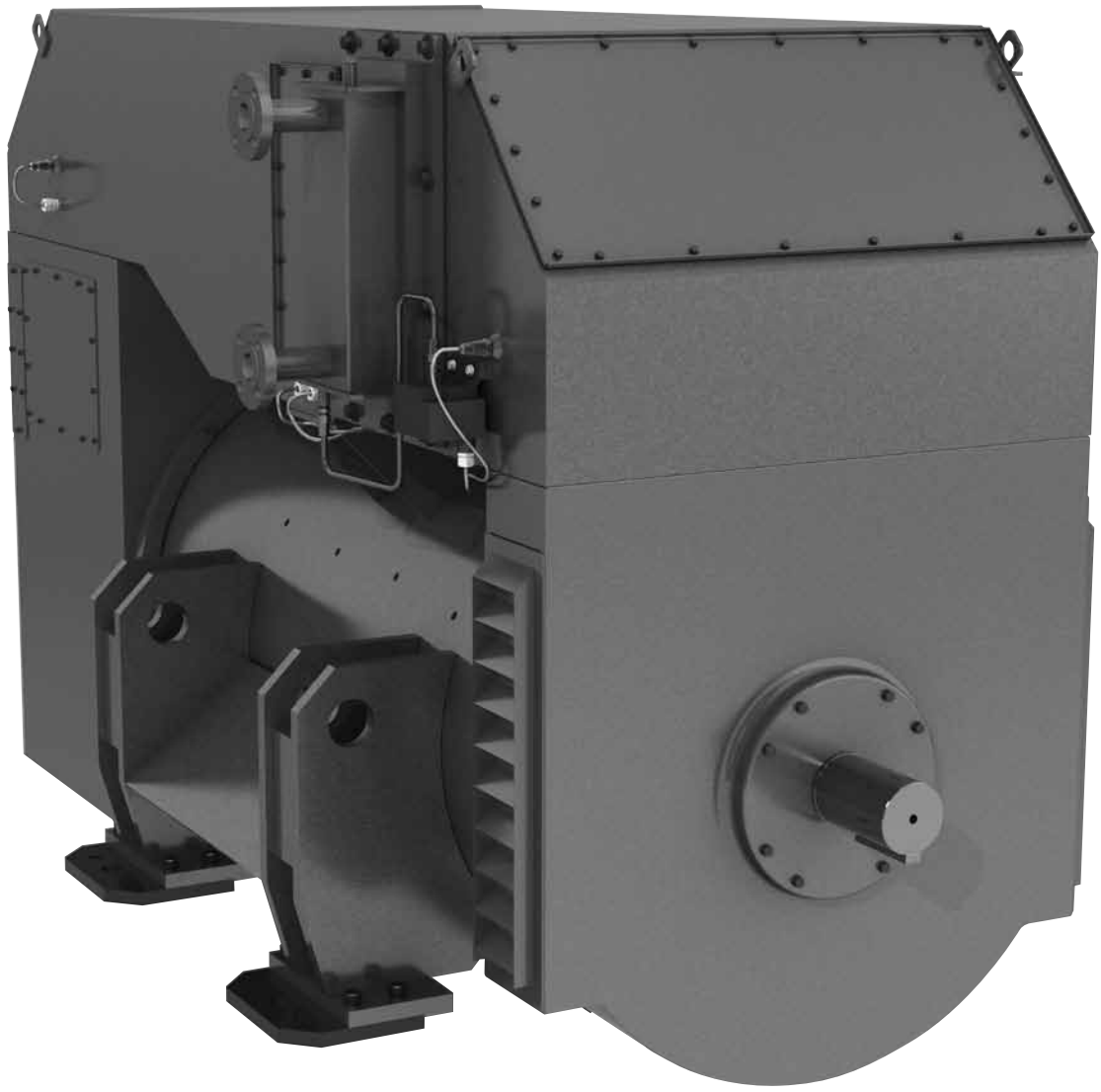
MARINER
DEP/SS

Marine Power Generation for the 21st Century

Installation,
Operation, and
Maintenance Manual



marathon®

Read and Save These Instructions

Safety Instructions

⚠ **This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.**

⚠WARNING **Warning indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.**

⚠CAUTION **Caution indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.**

NOTICE **Notice indicates a situation not related to personal injury which, if not avoided, may result in generator or equipment damage.**

⚠ **Before installing, using, or servicing this product, carefully read and fully understand the instructions including all warnings, cautions, and safety notice statements. To reduce risk of personal injury, death and/or property damage, follow all instructions for proper generator installation, operation and maintenance.**

Although you should read and follow these instructions, they are not intended as a complete listing of all details for installation, operation, and maintenance. If you have any questions concerning any of the procedures, or if you have a safety concern not covered by the instructions, STOP, and contact the generator manufacturer.

Table of Contents

WARNING ELECTRICAL HAZARD

Failure to connect the generator in accordance with the manufacturer's documentation may result in serious personal injury, death, and/or property damage.

WARNING ELECTRICAL SHOCK HAZARD

Failure to follow these instructions may result in serious personal injury, death, and/or property damage.

- Installation and repair of electrical generators and their accessories should be attempted by qualified personnel only. Electrical connections shall be made by a qualified electrician in accordance with all local, national, international and/or other applicable codes, rules or regulations and sound practices.
- Do not touch electrically live parts. Disconnect, lockout and tag prime mover and input power supplies before installing or servicing generator (includes accessory devices). Use a voltmeter to verify that power is off before contacting conductors.
- Do not open terminal box or touch unprotected terminals while the generator shaft is rotating. Shaft rotation produces voltage in generators even when no excitation is applied. Residual voltage is present at the generator leads and regulator connections even when the regulator fuse is removed.
- Ground (earth) generators in accordance with local, national, international and/or other applicable codes, rules or regulations.

WARNING MAGNETIC FIELD HAZARD

Permanent magnet generator (PMG) rotors, when removed from the stator, expose surrounding personnel and equipment to powerful magnetic fields which may cause serious health hazards to persons with pacemakers, hearing aids, or other implanted electronic medical devices and may impact other electronic devices such as mobile phones, credit cards, etc.

WARNING EXPLOSION HAZARD

Beware of arcing when connecting test leads. Arcing could spark an explosion if exposed to battery gases, fuel vapors or other hazardous atmospheres. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

WARNING ROTATING PARTS HAZARD

Keep extremities, hair, jewelry and clothing away from moving parts. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

WARNING FALLING OBJECTS HAZARD

Use proper lifting equipment and personal protective equipment when moving generator or heavy parts of generator. Failure to follow these instructions could result in serious personal injury, death and/or property damage

WARNING OVERSPEED HAZARD

Do not exceed the rated speed of the generator. Excessive centrifugal forces could damage the rotating fields and cause parts to be expelled at a high rate of speed. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

WARNING CENTRIFUGAL FORCE HAZARD

Replace any rotor components which have been damaged prior to running the generator. Rotating parts are subject to high centrifugal forces during operation of the generator. Damaged or compromised condition of the rotor components may cause mechanical failure, resulting in missile hazards. Ejected parts may injure personnel or cause further damage within the generator, leading to possible electrical hazards. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

WARNING DO NOT DISASSEMBLE

Only qualified personnel who know local, national, international and/or other applicable codes, rules or regulations and sound practices should install or repair electric generators and their accessories. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

WARNING HAZARDOUS LOCATIONS

Consult the local authority having jurisdiction concerning the installation and suitability of generators for use in Hazardous Locations. The local authority having jurisdiction must make the final determination of what type of generator is required. Failure to follow these instructions may result in serious personal injury, death, and/or property damage.

General Information

2

Mechanical Design

General
All single and two bearing units are manufactured with cast iron end brackets and adapters and fabricated steel frames. Flexible drive discs and SAE adapters are machined to SAE standards. Standard units are fully guarded and include an IP23 drip shield.

TEWAC
An IP54 TEWAC is available on two bearing units and features a double tube cooler suitable for fresh water of up to 38 °C. The TEWAC is equipped with a leak detector and two 100 ohm platinum RTD's to measure the temperature of the cooling air. The generator with TEWAC includes removable cover plates over the vent and exhaust openings to allow temporary power generation upon loss of cooling water at a reduced rating based on ambient temperature. **(Figure 2-1)**

Conduit Box
The large, front end-mounted conduit box is constructed of formed sheet steel, which will allow the addition of top-mounted control packages. Refer to Marathon Electric for top mounted controls of more than 240 lbs. The conduit box cover properly directs outside ventilating air through the generator, in IP23 enclosure.

Bearings
Prelubricated, regreasable, shielded ball bearings are used on Mariner DEP/SS generators. The bearings are mounted in a bolt-in bearing well, which allows changing of the bearings without the need of an open flame. Grease fittings are located on the outside of the conduit box for convenience. **(Figure 2-2)**

Mariner DEP/SS Uni-Rotor Construction
Laminations are 4-pole, one piece laminations which are shrunk fit and keyed to the shaft. No dovetails, cross bolts or other pole to shaft connecting devices are used. An amortisseur winding is standard. The cast unidirectional aluminum alloy ventilating fan provides even air distribution to maximize cooling and generator efficiency. **(Figure 2-3)**

Adapters and Drive Discs
All single bearing units are available with several adapter and drive disc arrangements. These can be shipped to order or can be changed in the field with standard shop tools. When changing flexible drive discs, spacers are used between the discs and the cast iron hub to maintain SAE standard dimensions.

All two bearing units include a keyed shaft extension.

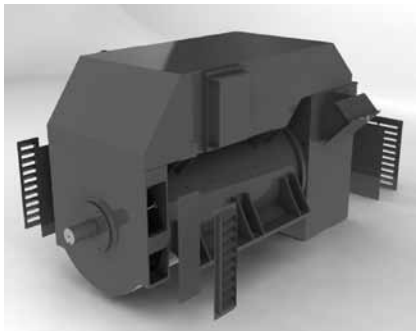


Figure 2-1

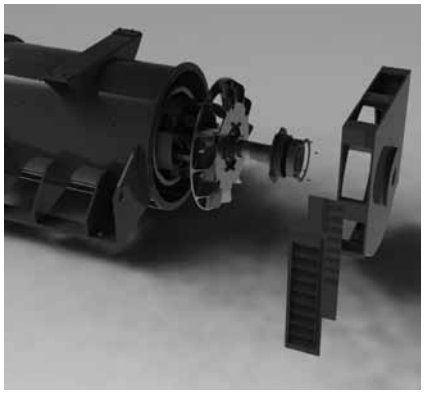


Figure 2-2

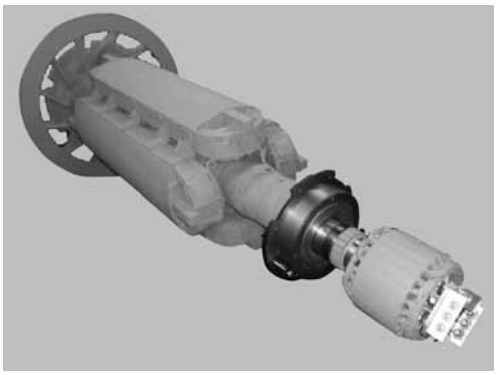


Figure 2-3

Electrical Design

General

All Mariner DEP/SS generators are specifically designed for DEP propulsion systems having 100% nonlinear loads. The standard main windings feature fully taped, form wound coils and hardened steel surge rings to withstand the forces of the IGBT or SCR propulsion systems. (Figure 2-3) The phase sequence is ABC when rotated counterclockwise when viewing from the exciter end.

Temperature Rise

All ratings and frame sizes are based on NEMA and CSA Class F and Class H temperature rises on both the rotor and stator windings.

Power Factor

All standard generators are designed for operation at rated kVA at 0.8 lagging power factor but can be operated at rated kVA over the 0.8 to 1.0 power factor range.

Premium Insulation System

Mariner DEP/SS generators are built with Class H, non-hygroscopic, insulation materials. The main and exciter armature and field windings have epoxy vacuum pressure impregnated (VPI) insulation. The rotor is wet wound with thermosetting epoxy applied between each layer. A final coat of green epoxy paint is applied to all windings for moisture and abrasion resistance. (Figure 2-4)

Heavy Duty Exciter

A toroidally wrapped exciter with VPI epoxy insulation is provided for maximum protection in SCR applications and the harsh marine environment. (Figure 2-5)

Mariner DEP/SS Voltage Regulator

The standard voltage regulator is a fully encapsulated, static type with a solid state build up circuit. Standard features include 3 phase RMS sensing, paralleling, adjustable underfrequency protection, and overexcitation protection. Refer to the regulator manual for more information. (Figure 2-6)

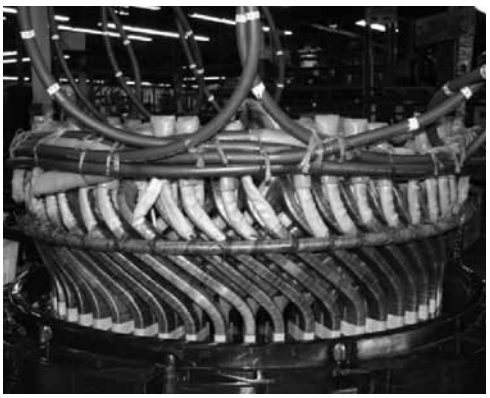


Figure 2-4

Figure 2-5

Figure 2-6

Installation

3

⚠ Read and fully understand the instructions and all warnings, cautions, & safety notice statements before attempting to install, operate or service this product.

⚠ Refer to Section 1 for important safety information.

⚠WARNING ELECTRICAL HAZARD

Failure to connect the generator in accordance with the manufacturer's documentation may result in serious personal injury, death, and/or property damage.

⚠WARNING ELECTRICAL SHOCK HAZARD

Failure to follow these instructions may result in serious personal injury, death, and/or property damage.

⚠WARNING ROTATING PARTS HAZARD

Keep extremities, hair, jewelry and clothing away from moving parts. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

⚠WARNING HAZARDOUS LOCATIONS

Consult the local authority having jurisdiction concerning the installation and suitability of generators for use in Hazardous Locations. The local authority having jurisdiction must make the final determination of what type of generator is required. Failure to follow these instructions may result in serious personal injury, death, and/or property damage.

Receiving Your Mariner DEP/SS Generator

Upon receipt of the generator, it is recommended that it be carefully examined for possible damage incurred in shipment. The generator was given to the freight company in good condition, and they are responsible for the product from our dock to yours. Any damage should be noted on the freight bill before accepting the shipment. Claims for damage must be promptly filed with the freight company.

Unpacking and Handling

⚠WARNING FALLING OBJECTS HAZARD

Failure to follow these instructions may result in serious personal injury, death, and/or property damage.

⚠ Read all instruction cards carefully prior to lifting or moving the generator.

⚠ Use proper lifting equipment and personal protective equipment when moving or lifting generator or heavy components.

⚠ Lift generator only by the lift eyes welded to the frame of the generator.

⚠ TEWAC units include small lift eyes on the TEWAC enclosure which are only intended to lift the TEWAC enclosure, not the generator.

NOTICE TEWAC equipped generators require a 4-point lifting harness which will connect at the lift eyes in the foot gussets of the generator. Use an I-beam or H-beam spreader with four equal length chains to prevent damage to the TEWAC enclosure.

Storage

In the event that the generator is not to be installed on the prime mover immediately, it is recommended that it be stored in a clean, dry area which is not subject to rapid changes in temperature and humidity. See Section 11 for more information.

Preparation for Use

Although the generator is carefully inspected and tested in operation before it leaves the factory, it is recommended that the unit be thoroughly inspected. The insulation on the wire should be inspected and all bolts should be checked for tightness.

Remove all shipping tapes, bags, blocks, and skids which are used to prevent vibration and rotor movement during shipment. Dry, low-pressure compressed air of approximately 30 psi (206 KPa) can be used to blow out the interior of the generator. In the case of two bearing machines, it is possible to turn the rotor by hand to make sure that it rotates smoothly without binding.

If the machine has been in storage for a year or longer, it is recommended that it be lubricated according to the lubrication instructions and chart found in Section 5. If the machine has been exposed to damp, humid conditions, the insulation resistance should be checked. Refer to Section 8.

WARNING **CENTRIFUGAL FORCE HAZARD**
Failure to follow these instructions may result in serious personal injury, death, and/or property damage.

- ⚠ Do not apply force to generator fan for lifting or rotating the rotor. Rotating parts are subject to high centrifugal forces during operation of the generator.
- ⚠ Ejected parts may injure personnel or cause further damage within the generator, leading to possible electrical hazards.
- ⚠ If the fan is damaged during installation, replace it prior to running the generator.

NOTICE **Do not force alignment of the units. Gently shift the generator side to side and up or down as necessary.**

NOTICE **Grade 8 Capscrews and heavy series lockwashers or grade 8 placebolts and hardened washers are recommended to mount the drive discs to the flywheel.**

Generator Mounting – Single Bearing

Single bearing generators are provided with an SAE flywheel adapter and flexible drive discs. Very close tolerances are maintained in the manufacture of the generator so that the alignment procedure is extremely simple. A coupling hub of nodular iron is shrunk onto the shaft and special steel drive discs are bolted to the hub. Holes are provided in the periphery of the coupling disc which correspond to tapped holes in the flywheel. The outside diameter of the discs fits in a rabbet in the flywheel so that concentricity is assured in all cases.

1. Attach a suitable hoist and lifting harness (see Unpacking and Handling, Section 3, first page).

2. Remove the drip cover, screen assembly and shipping braces from the adapter and flex discs. (Figure 3-1)

3. Insert two guide pins in the fly wheel and two in the flywheel housing.

4. Adjust the generator position until the drive discs are piloted into the flywheel.

5. Remove the guidepins.

6. Secure the discs to the flywheel and torque to specification. Refer to section 12.

7. Position generator so that SAE adapter mates with the flywheel housing.

8. Insert four capscrews in the bottom four positions of SAE adapter and flywheel housing. Tighten until snug.

9. Use a feeler gauge (.0015 - .002 inch) between the top of the SAE adapter and flywheel housing (Figure 3-2)

10. Raise the generator or lower the prime mover until the feeler gauge is snug.

11. Insert shims to maintain alignment.

12. Insert remaining bolts between SAE adapter and flywheel housing and torque to specification. Refer to section 12.

13. Install the mounting bolts which secure the generator feet to the base.

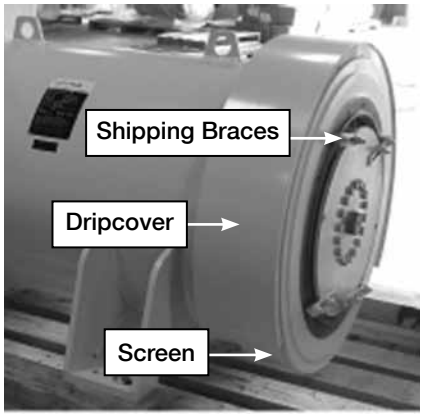


Figure 3-1

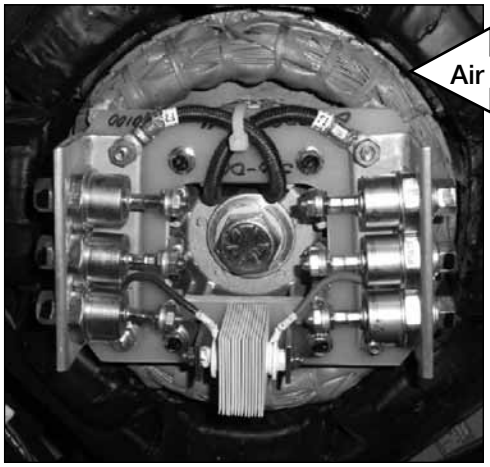


Figure 3-2

Generator Mounting – Two Bearing

NOTICE **Aligning the two machines as accurately as possible will reduce the vibration, increase bearing life, and insure minimum coupling wear. It may be necessary to shim the generator feet for proper support and alignment. Consult the coupling manufacturer's instructions for alignment specifications and procedures.**

Two bearing generators are provided with a shaft extension and keyway. For direct-coupled units, the assembler furnishes a flexible coupling which is installed between the driver and the generator shaft.

1. Attach a suitable hoist and lifting harness (see Unpacking and Handling, Section 3, first page).

2. Adjust the generator position until the shaft aligns with the coupling manufacturer's recommendations.

3. Install coupling in accordance with coupling manufacturer's recommendations.

4. Use a feeler gauge (.0015 - .002 inch) between the top of the SAE adapter and flywheel housing (Figure 3-2)

5. Raise the generator or lower the prime mover until the feeler gauge is snug.

6. Insert shims to maintain alignment.

7. Install the mounting bolts which secure the generator feet to the base.

Environmental Considerations

Dirt, moisture, heat and vibration are enemies of electrical equipment. In moist or humid areas, such as in the tropics and marine service, additional protection is recommended. Excessive exposure to the elements will shorten the life of the generator. The ambient temperature should not exceed the value shown on the generator nameplate. The Mariner DEP/SS generator is built in an IP23 guarded enclosure, or with an IP54 TEWAC cooler, for below deck use. The standard windings are humidity and moisture resistant with VPI insulation and space heaters are provided to increase generator life significantly. In an extremely dirty, dusty or corrosive environment a TEWAC IP54 cooler is recommended as a means of providing filtered cooling to the generator. Refer to your Marathon Electric Generator representative for more information.

Electrical Connections

WARNING ELECTRICAL HAZARD

Failure to connect the generator in accordance with the manufacturer's documentation may result in serious personal injury, death, and/or property damage.

WARNING ELECTRICAL SHOCK HAZARD

Failure to follow these instructions may result in serious personal injury, death, and/or property damage.

- ⚠ Installation and repair of electrical generators and their accessories should be attempted by qualified personnel only. Electrical connections shall be made by a qualified electrician in accordance with all local, national, international and/or other applicable codes, rules or regulations and sound practices.
- ⚠ Do not touch electrically live parts. Disconnect, lockout and tag prime mover and input power supplies before installing or servicing generator (includes accessory devices). Use a voltmeter to verify that power is off before contacting conductors.
- ⚠ Do not open terminal box or touch unprotected terminals while the generator shaft is rotating. Shaft rotation produces voltage in generators even when no excitation is applied. Residual voltage is present at the generator leads and regulator connections even when the regulator fuse is removed.
- ⚠ Ground (earth) generators in accordance with local, national, international and/or other applicable codes, rules or regulations.

The generator conduit box includes a conduit entry duct *(Figure 3-3)* which may be mounted on either side, for conduit access from above or below. It features a removable, non-metallic gland plate for ease of mounting cable glands.

Refer to the connection diagram supplied with the generator and/or the appropriate diagram shown in this section. Clean all contact surfaces of bus bars and lugs to assure high quality, low resistance connections. Use heavy duty terminal lugs or high quality clamps for making all connections. **Insulate all connections properly in accordance with all local, national, international and/or other applicable codes, rules or regulations and sound practices.**

To minimize the transmission of vibration, it is essential that flexible conduit be used for all electrical entrance to the generator.

Auxiliary Electrical Connections

The generator conduit box includes terminals *(Figure 3-4)* for connection of the voltage regulator circuit and instrumentation to prewired current transformers, RTD's, space heaters, and other accessories.

Install conduit box covers after completing connections.

Cooling Water Connections (TEWAC only)

The heat exchanger may be installed with water connections on either side of the generator. Refer to the heat exchange manual for installation instructions.

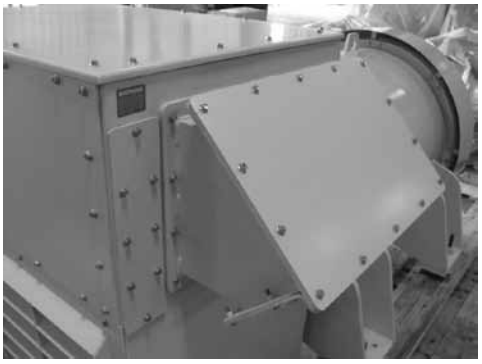


Figure 3-3

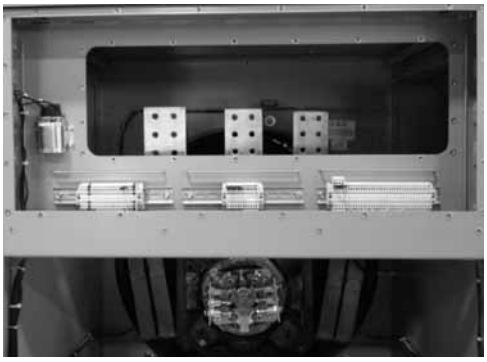
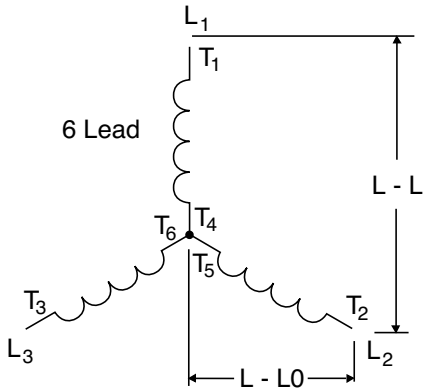


Figure 3-4

6 Lead Wye

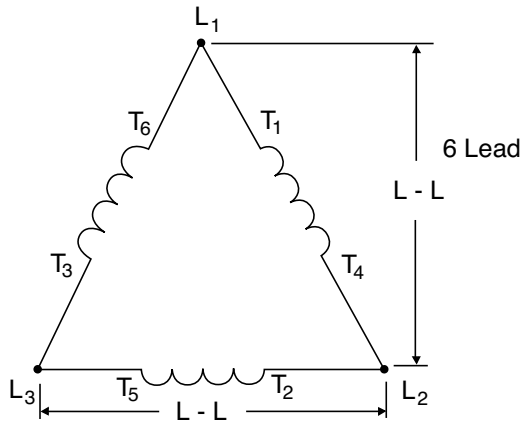


Six lead generators have 3 coil groups with 6 bus bars.

Voltage	
L-L	L-L0
480	277
600	347
690	398
3300	1907
4160	2405

Connect	L_1	L_2	L_3	L-0
T_4 T_5 T_6	T_1	T_2	T_3	T_4 T_5 T_6

6 Lead Delta

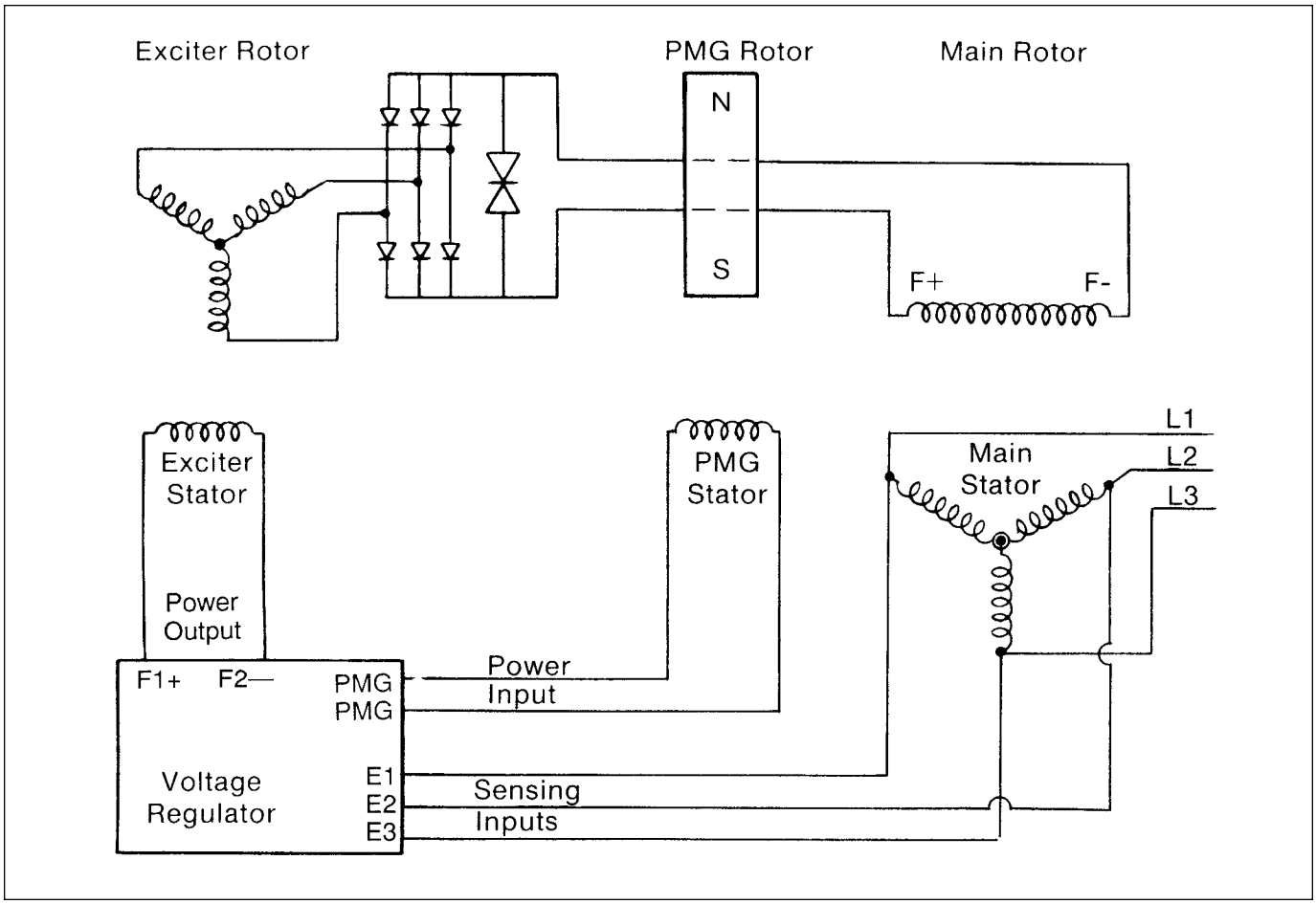


Six lead generators have 3 coil groups with 3 bus bars.

Voltage
L-L
480
600
690
2400

Connect	L_1	L_2	L_3
T_1 T_6	T_1	T_2	T_3
T_2 T_4			
T_3 T_5			

Typical System Diagram



Paralleling Operations

Mariner DEP/SS generators come standard with amortisseur windings die cast as an integral part of the rotor. This exclusive uni-rotor construction makes all Mariner DEP/SS generators suitable for paralleling operations when the proper control equipment is added. Paralleling with other generator sets and/or with the utility power grid offers a number of advantages. Multiple unit installations increase power capacity; they can be added or removed from the line depending on the load requirements; they can be better maintained and repaired (since single source breakdown would mean total loss of power), and they often provide more reliable, efficient, and economical operation.

Successful parallel operation means that the generators deliver power to the external system without delivering power to each other, or accepting power from the load bus or power grid. Additional equipment is necessary to insure safe and successful operation.

Prime Mover

The prime mover provides the speed and torque which will be necessary to keep the machines in synchronized operation. The governor will directly control the watt or kW load and frequency of the unit. The prime mover speed is controlled by a governor. The governor must have special paralleling provisions to permit parallel operation with the other machines.

Voltage Regulator

The voltage regulator controls the generator output voltage and the reactive power supplied by the generator. When two or more AC generators operate in parallel, the voltage regulator must have paralleling provisions (either internally or external to the regulator) to allow the voltage regulator to control the reactive or VAR load while it is in parallel operation. A separate paralleling current transformer is required to sense the reactive current and signal the voltage regulator. This additional paralleling circuitry is absolutely necessary to control the reactive current flowing between the generator sets.

Switchgear

There are additional relays and breaker controls which are necessary to insure safe, trouble free operation of paralleled units. Reverse power relays monitor the direction of power flow to insure that the generator is delivering the power, not accepting it. These power relays control breakers, which are a means of connecting and disconnecting the generator from the load. The total system can include over-voltage, over-current protection, under frequency protection, power factor correction provision and various associated control equipment from manual switchgear to microprocessors. The amount of control gear and level of sophistication will be determined by the needs and requirements of the particular application.

Paralleling Basics

The following points are basic criteria which must be met before two units can be paralleled. THIS IS NOT MEANT TO BE SPECIFIC INSTRUCTIONS FOR PARALLELING OPERATION.

1. Additional paralleling circuitry
   A. Voltage regulator-paralleling provisions
   B. Paralleling current transformer(s)
   C. Paralleling provisions on governor controls
   D. Switchgear
2. The voltage and frequency must be the same for all sets with voltages in phase.
3. The voltage regulation characteristics of the individual generators should be similar.
4. The generators must have the same phase rotation.
5. The driving engines should have the same speed regulation characteristics and the governors should be adjusted to give the same speed regulation.

Before operating generator sets in parallel, each set should be checked by starting, operating, and adjusting the sets as individual units before attempting paralleling.

Reactive Load Control

When two identical generators are operating together in parallel and an unbalance occurs in field excitation, circulating currents begin to flow

between the generators. This current will appear as a lagging power factor or inductive load to the highly excited generator, and as a leading power factor or capacitive load to the generator with the lower field current. This is known as the reactive circulating current, and there are two methods of controlling it in parallel operation:

1. Reactive droop compensation (formerly known as parallel droop compensation) – the bus voltage droops, or decreases, as the reactive lagging power factor load is increased.
2. Reactive differential compensation (formerly known as cross current compensation) – the reactive differential compensation circuit allows parallel generators to share reactive loads with no decrease or droop in generator voltage. The circuit must meet the following criteria:

   A. All paralleling current transformers for all the generators being paralleled must be included in the secondary interconnection loop.

   B. When different size generators are paralleled, all paralleling current transformers must have the same or proportional ratios that give approximately the same secondary current.

   C. Voltage regulator paralleling circuitry must be the same.

   D. Current transformer secondaries and the generator lines must be isolated electrically.

      Because of the preceding criteria, reactive differential compensation cannot be used when paralleling with the utility power grid. There is no limit, however, in the number of generators that can be included in this type of circuit.

   E. It is also desirable to have an auxiliary contact on the main generator breaker to short the parallel CT secondary when that breaker is open (not connected to the load bus).

Paralleling Circuitry

Because of the number of variables involved in paralleling generator sets, every installation will have its own circuitry and methods or procedure of bringing paralleled units on line. There are numerous ways of connecting paralleled units and an almost unlimited variety of applications and associated equipment. When parallel operation is desired, it is important that the control manufacturer, the generator manufacturer, and the systems engineer work together to insure the proper selection of all components. Please refer to Marathon Electric for application assistance.

IBGT or SCR Loading

Mariner DEP/SS generators are specifically designed for IBGT or SCR propulsion systems. Solid state electronic control devices which utilize IBGT or SCR firing circuits (such as variable frequency induction motor controls, precision motor speed controls, no-break powered battery chargers, etc.) can introduce high frequency harmonics which adversely affect or destroy the normal waveform of the generator. This creates additional heat in the generator stator and rotor and can cause overheating. These devices can and do present problems to non-utility power generating equipment or any limited power bus system. The problems which can occur are not limited to the generator itself, but can effect the solid state control device, the equipment it controls, other associated loads, monitoring devices, or a number of combinations over the entire system.

Mariner DEP/SS generators can supply power to IGBT or SCR loads when properly applied. When SCR loads are more than 25% of the total load, select the generator based on the 80°C R/R rating. The standard voltage regulator is PMG powered and senses 3 phase RMS voltages for maximum stability against severely distorted wave forms. SCR type applications such as cranes, shovels, etc., require special consideration of the generator insulation system due to greater dielectric stress and severe environmental conditions. It is important that the control manufacturer, the generator manufacturer, and the systems engineer work together to insure the proper selection of all components. Please refer to Marathon Electric for application assistance.

Operation

⚠ Read and fully understand the instructions and all warnings, cautions, & safety notice statements before attempting to install, operate or service this product.

⚠ Refer to Section 1 for important safety information.

⚠WARNING ELECTRICAL SHOCK HAZARD

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- ⚠ Do not open terminal box or touch unprotected terminals while the generator shaft is rotating. Shaft rotation produces voltage in generators even when no excitation is applied. Residual voltage is present at the generator leads and regulator connections even when the regulator fuse is removed.
- ⚠ Ground (earth) generators in accordance with local, national, international and/or other applicable codes, rules or regulations.

⚠WARNING ROTATING PARTS HAZARD

Keep extremities, hair, jewelry and clothing away from moving parts. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

⚠WARNING CENTRIFUGAL FORCE HAZARD

Failure to follow these instructions could result in serious personal injury, death and/or property damage.

- ⚠ Do not apply force to generator fan for lifting or rotating the rotor. Rotating parts are subject to high centrifugal forces during operation of the generator.
- ⚠ Ejected parts may injure personnel or cause further damage within the generator, leading to possible electrical hazards.
- ⚠ If the fan is damaged during installation, replace it prior to running the generator.

Pre-Start Inspection

Before operating the generator for the first time, the following checks are recommended:

1. A visual inspection should be made to check for any loose parts, connections, or foreign materials. Refer to section 8.
2. Check for clearance in the generator and exciter air gap. Be sure the generator set turns over freely. Bar the generator over by hand at least 2 revolutions to be sure there is no interference.
3. **Check all wiring against the proper connection diagrams and make sure all connections are properly insulated. Support and tie leads to keep them from being damaged by rotating parts or by chafing on sharp corners.**
4. **Be sure the equipment is properly grounded.**
5. Inspect for any remaining packing materials and remove any loose debris, building materials, rags, etc., that could be drawn into the generator.
6. Check fasteners for tightness.
7. Check to be sure no tools or other hardware have been left inside or near the machine.
8. Check resistance of windings to ensure no short circuit exists.
9. Install and check to be sure all covers and guards are in place and secure.
10. If TEWAC unit, verify cooling water is available and flowing through cooler.

WARNING OVERSPEED HAZARD

Do not exceed the rated speed of the generator. Excessive centrifugal forces could damage the rotating fields and cause parts to be expelled at a high rate of speed. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

Starting Up the Generator

The following procedure should be followed for starting up the generator for the first time:

1. The generator output must be disconnected from the load. Be certain that the main circuit breaker is open.
2. Disable the voltage regulator by removing the fuse.
3. Follow the manufacturer's instructions and start the prime mover. Check the speed and adjust the rpm shown on the generator nameplate.
4. Replace the regulator fuse and adjust the voltage to the required value (Figure 4-2). Check all line to line and line to L0 voltages to be sure they are correct and balanced. If the voltages are not correct, shut down immediately and recheck all connections. See section 3.
5. Close the main circuit breaker and apply the load.
6. Monitor the generator output current to verify it is at or below nameplate amps.
7. Adjust engine speed at full load to 1800 rpm for 60 Hz, 1500 rpm for 50 Hz (refer to prime mover/governor instruction manuals).
8. Before stopping the engine, remove the load by tripping the main circuit breaker.

Voltage Adjustments

The generator output voltage is controlled by the voltage regulator. Refer to the voltage regulator operator manual for information.

Other Adjustments

Depending upon application, adjustments to other protective and control gear may be required. Refer to instructions supplied by the generator set manufacturer.

The standard Mariner DEP/SS voltage regulator also has many protective and control circuits built in. Refer to the regulator manual for further details.

Field Flashing

The standard Mariner DEP/SS generator is supplied with a PMG (permanent magnet generator). It will never require field flashing.

In rare cases where a special generator may be furnished without a PMG, refer to the factory for more detailed information. Include the complete generator model and serial number (see page 3).

Maintenance

⚠ Read and fully understand the instructions and all warnings, cautions, & safety notice statements before attempting to install, operate or service this product.

⚠ Refer to Section 1 for important safety information.

⚠WARNING ELECTRICAL SHOCK HAZARD

Failure to follow these instructions may result in serious personal injury, death, and/or property damage.

- ⚠ Installation and repair of electrical generators and their accessories should be attempted by qualified personnel only. Electrical connections shall be made by a qualified electrician in accordance with all local, national, international and/or other applicable codes, rules or regulations and sound practices.
- ⚠ Do not touch electrically live parts. Disconnect, lockout and tag prime mover and input power supplies before installing or servicing generator (includes accessory devices). Use a voltmeter to verify that power is off before contacting conductors.
- ⚠ Do not open terminal box or touch unprotected terminals while the generator shaft is rotating. Shaft rotation produces voltage in generators even when no excitation is applied. Residual voltage is present at the generator leads and regulator connections even when the regulator fuse is removed.
- ⚠ Ground (earth) generators in accordance with local, national, international and/or other applicable codes, rules or regulations.

⚠WARNING CENTRIFUGAL FORCE HAZARD

Failure to follow these instructions could result in serious personal injury, death and/or property damage.

- ⚠ Do not apply force to generator fan for lifting or rotating the rotor. Rotating parts are subject to high centrifugal forces during operation of the generator.
- ⚠ Ejected parts may injure personnel or cause further damage within the generator, leading to possible electrical hazards.
- ⚠ If the fan is damaged during installation, replace it prior to running the generator.

⚠WARNING ROTATING PARTS HAZARD

Keep extremities, hair, jewelry and clothing away from moving parts. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

Maintenance – General Information

Dirt, heat, moisture, and vibration are common enemies of a generator. Keeping the generator clean and dry, maintaining proper alignment of the generator and its prime mover, and preventing overloads will result in efficient operation and long life.

Dirt and dust will conduct electricity between points of different electrical potential. Moisture will aggravate the problem further. Insulation system failure can result if corrective action is not taken. The condition of the insulation system can be tested by measuring insulation resistance (see section 8 - Generator Testing).

Insulation resistance should be checked when putting the generator into service after it has been in storage and any time contamination by moisture and dirt is suspected. Normally, moisture buildup is not a problem when the generator is running since heat produced internally will tend to keep it dry. Moisture can collect in the generator when it is shut down. The problem will be worse in humid environments or in areas where extreme temperature changes cause condensation (dew) to form inside the generator. Space heaters, are provided and should be used to prevent condensation.

Accumulations of dust and dirt not only contribute to insulation breakdown, but they can also increase temperature by restricting ventilation and by blocking the dissipation of heat. The most harmful type of foreign materials include carbon black, metallic dust and chips, and similar substances which not only impede the ventilation, but also form a conductive film over the insulation, increasing the possibility of insulation failure. Machines operating in dirty places should be disassembled and cleaned periodically.

Electrical Connections and Windings

Inspect for loose or contaminated connections. Check wires for cracked or frayed insulation. Tighten connections and replace defective or oil-soaked insulation.

⚠ Read and fully understand the instructions and all safety warning statements before attempting to service this product.

NOTICE Refer to the generator nameplate for proper grease type, interval and amount. Standard Generators are pre-greased with Mobil® Polyrex® EM NGLI 2 grease unless stated otherwise on the generator nameplate. Non-compatible lubricants can break down polyurea thickened grease and cause bearing failure. Compatible greases include, but are not limited to, Chevron® SRI, Shell® Gadus® S5 T100, Rykon® Premium EP NLGI 2, Texaco® Polystar® RB NLGI 2, and Shell® Oil Dolium R. Use only non-contaminated grease and prevent contamination while regreasing. Table 5-3 intervals and amounts are general guidelines.

NOTICE Overgreasing bearings can cause premature bearing and/or generator failure. The quantity of grease added must be carefully controlled.

Lubrication

All generators are lubricated before leaving the factory and are ready for operation. As a general rule, bearings should be relubricated annually or at the indicated intervals in table 5-1, whichever occurs first. Unusually severe operating conditions, such as high ambient or dusty environments, require more frequent lubrication (every six months or one-half the table intervals, whichever occurs first).

Use grease that is specified on the generator nameplate and add the amount specified at the interval specified.

During an overhaul, the grease reservoir should be thoroughly cleaned and new grease added. The reservoir should be 1/3 to 1/2 filled with new grease.

Generators are properly lubricated at the time of manufacture. It is not necessary to lubricate at the time of installation unless the generator has been in storage for a period of 12 months or longer.

Table 5-1

Generator		Amount of Grease per Bearing			Interval (Hours) ①	
Frame Size	Bearing Size	Ounces	Cubic Inches	Tea-spoons	1800 RPM (60 Hz)	1500 RPM (50 Hz)
741	322	2.4	4.2	14	3000	4500
742						
743						
744						

① Hours of running time or annually, whichever occurs first.

NOTE: *Mobil and Polyrex are registered trademarks of Exxon Mobil Corporation or one of its subsidiaries.*

Lubrication Procedure

1. Stop generator.
2. Lock-out and tag prime mover.
3. Remove contaminants from fill and drain plugs and surrounding area.
4. Remove fill and drain plugs. (Figure 5-1)
5. Check fill and drain holes for blockage and clean as necessary to allow unobstructed grease flow.
6. Insert 1/8" N.P.T. grease fitting in fill pipe.
7. Add proper type and amount of grease per generator nameplate or refer to Table 5-1
8. Start generator and run for 15 minutes to allow excess grease to drain.
9. Stop generator.
10. Wipe off excess grease.
11. Replace fill and drain plugs. (Figure 5-1)

Generator is ready for operation.

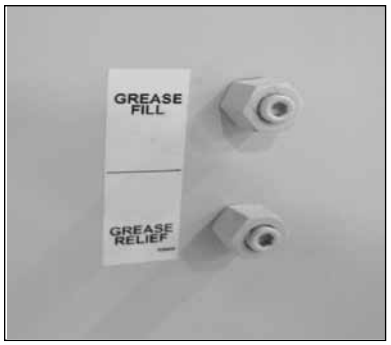


Figure 5-1

Maintenance

⚠ Read and fully understand the instructions and all safety warning statements before attempting to service this product.

⚠WARNING ELECTRICAL SHOCK HAZARD

Failure to follow these instructions may result in serious personal injury, death, and/or property damage.

- **⚠** Installation and repair of electrical generators and their accessories should be attempted by qualified personnel only. Electrical connections shall be made by a qualified electrician in accordance with all local, national, international and/or other applicable codes, rules or regulations and sound practices.
- **⚠** Do not touch electrically live parts. Disconnect, lockout and tag prime mover and input power supplies before installing or servicing generator (includes accessory devices). Use a voltmeter to verify that power is off before contacting conductors.

⚠WARNING EXPLOSION HAZARD

Beware of arcing when connecting exciter leads. Arcing could spark an explosion if exposed to battery gases, fuel vapors or other hazardous atmospheres. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

Drying Electrical Insulation

Electrical components must be dried before placing in operation if tests indicate that the insulation resistance is below a safe value (see section 8 – generator testing for test procedure).

Machines that have been idle for sometime in unheated and damp locations may have absorbed moisture. Sudden changes in temperature can cause condensation or the generator may have become wet by accident. Windings should be dried out thoroughly before being put into service. The following are recommended drying methods.

Space Heaters

Electric space heaters are installed inside of the generator. When energized (from a power source other than the generator), they will heat and dry the inside of the generator. If an alternate source of electricity is not available, enclose the generator with a covering and insert heating units to raise the temperature 15–18°F (8–10°C) above the temperature outside of the enclosure. Leave a hole at the top of the enclosure to permit the escape of moisture.

Oven

Place the machine in an oven and bake it at a temperature not to exceed 194°F (90°C). The voltage regulator and any electronic component accessories must be removed from the generator when using this method.

Forced Air

A portable forced air heater can be used by directing heat into the air intake (conduit box) and running the generator with no load and without excitation (this can be accomplished by removing the regulator fuse). Heat at point of entry should not exceed 150°F (66°C).

"Short Circuit" Method

The generator can be dried out quickly and thoroughly by using this method.

1. Disconnect exciter leads F1 and F2 from the regulator.
2. Connect a battery or other DC power source of approximately 20–35 volts to the exciter leads F1 and F2. An adjustable voltage source is desirable, however a rheostat (rated approximately 2 amps) in series with the DC power source will work.
3. Short circuit the generator output lead wires to each other (L1 to L2 to L3). If using jumpers, be sure they are large enough to carry full load amperage.
4. Start the generator and measure the current through the output leads with a clip-on ammeter.
5. Adjust the voltage source to produce approximately 80% of the rated AC nameplate amps, but in no case exceed nameplate amps. If an adjustable source is not available and current is excessive,

use a lower DC source voltage or a larger resistor in series with the source.

Running time will be determined by the amount of moisture present in the machine. Insulation resistance checks should be taken every one to four hours until a fairly constant value is obtained (see section 8 – Generator Testing for instructions on measuring insulation resistance).

6. After the generator is dry and the insulation resistance is brought up to specifications, remove the short circuit from the line leads, disconnect the DC source, and reconnect the F1 and F2 leads at the regulator. Be sure all connections are tight and correct before attempting to run the generator.

Air Intake and Exhaust (IP23 Only)

Check the area around the air intake and exhaust openings to be sure they are clean and unobstructed. Remove all foreign material and clean all screens *(Figure 5-2)*.

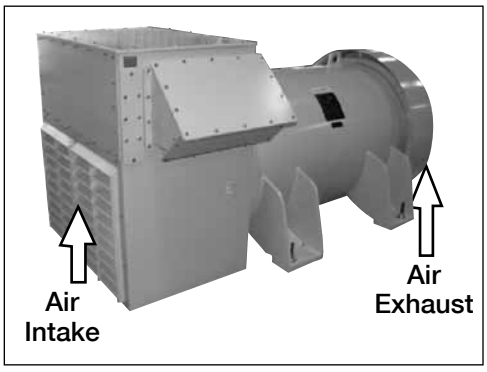


Figure 5-2

⚠ **Read and fully understand the instructions and all safety statements before attempting to clean this product.**

Cleaning Methods

When electrical components get dirty, the insulation must be cleaned. There are a number of acceptable methods for cleaning the generator, each of which will necessitate disassembly of the unit. The method of cleaning will be determined by the kind of dirt and when the unit must be returned to service. Drying after cleaning is necessary.

Whenever the generator is disassembled, the windings should be given a thorough inspection and the insulation cleaned, if necessary. The inspection should include the connection of the windings, insulation, and varnish coverage. Check the winding ties and coil supports. Look for any signs of coil movement or looseness and repair as required.

An electric motor repair shop in your area can normally assist with the proper cleaning of the generator windings. They may also be experienced in special problems (such as seacost, marine, oil rig, mining, etc.) that may be peculiar to a certain area.

⚠CAUTION Read solvent warning label and use as directed. Adequate ventilation and personal protective equipment should be used to avoid inhalation and contact with skin or eyes.

NOTICE Winding varnishes are epoxy or polyester based. Use a solvent that will not damage these materials.

Solvents

A solvent is usually required to remove accumulated soil containing oil or grease. Only petroleum distillates should be used for cleaning electrical components. Petroleum solvents of the safety type with a flash point greater than 100°F (38°C) are recommended.

Apply the solvent with a soft brush or rag. Be careful not to damage the magnet wire or insulation on the windings.

Dry components thoroughly with moisture-free, low pressure compressed air.

Cloth and Compressed Air

Cleaning with a dry cloth may be satisfactory when components are small, the surfaces are accessible, and only dry dirt is removed.

Blowing dirt out with compressed air is usually effective particularly when the dirt has collected in places

which cannot be reached with a cloth. Use clean dry air at 30 psi (206 KPa).

Brushing and Vacuum Cleaning

Dry dust and dirt may be removed by brushing with bristle brushes followed by vacuum cleaning. **Do not use wire brushes.** Vacuum cleaning is an effective and desirable method of removing dry and loose dirt.

Steam Cleaning

If the generator is completely disassembled, including bearings and electronic components, steam cleaning of the major parts and windings is very effective. However, before the generator can be put back into service, the machine must be thoroughly dried in an oven to remove all moisture.

⚠ Read and fully understand the instructions and all warnings, cautions, & safety notice statements before attempting to install, operate or service this product.

⚠ Refer to Section 1 for important safety information.

⚠WARNING ELECTRICAL SHOCK HAZARD

Failure to follow these instructions may result in serious personal injury, death, and/or property damage.

- ⚠ Installation and repair of electrical generators and their accessories should be attempted by qualified personnel only. Electrical connections shall be made by a qualified electrician in accordance with all local, national, international and/or other applicable codes, rules or regulations and sound practices.
- ⚠ Do not touch electrically live parts. Disconnect, lockout and tag prime mover and input power supplies before installing or servicing generator (includes accessory devices). Use a voltmeter to verify that power is off before contacting conductors.
- ⚠ Do not open terminal box or touch unprotected terminals while the generator shaft is rotating. Shaft rotation produces voltage in generators even when no excitation is applied. Residual voltage is present at the generator leads and regulator connections even when the regulator fuse is removed.
- ⚠ Ground (earth) generators in accordance with local, national, international and/or other applicable codes, rules or regulations.

⚠WARNING CENTRIFUGAL FORCE HAZARD

Failure to follow these instructions could result in serious personal injury, death and/or property damage.

- ⚠ Do not apply force to generator fan for lifting or rotating the rotor. Rotating parts are subject to high centrifugal forces during operation of the generator.
- ⚠ Ejected parts may injure personnel or cause further damage within the generator, leading to possible electrical hazards.
- ⚠ If the fan is damaged during installation, replace it prior to running the generator.

⚠WARNING ROTATING PARTS HAZARD

Keep extremities, hair, jewelry and clothing away from moving parts. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

Removal from Prime Mover

⚠ Review safety messages at the beginning of this section and all referenced safety information.

⚠WARNING ELECTRICAL SHOCK HAZARD

Ensure all remote sources of voltage are de-energized prior to disconnecting any electrical connections. Failure to follow these instructions may result in serious personal injury, death, and/or property damage.

Note: Record connections prior to disconnecting to facilitate reconnection later. Add markings if necessary.

1. Stop generator.
2. Lock-out and tag prime mover.
3. Remove conduit box covers. (Figure 6-1)
4. Disconnect all external wiring entering the conduit box at the terminals and bus bars.
5. Remove all conduits from the conduit box. Note: The cable gland plates are removable.

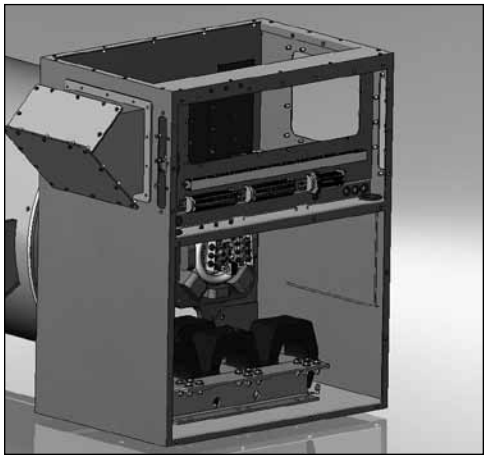


Figure 6-1

WARNING **FALLING OBJECTS HAZARD Failure to follow these instructions may result in serious personal injury, death, and/or property damage.**

- ⚠ Use proper lifting equipment and personal protective equipment when moving or lifting generator or heavy components.
- ⚠ Lift generator only by the lift eyes welded to the frame of the generator.
- ⚠ TEWAC enclosure lift eyes are only intended to lift the TEWAC enclosure, not the generator.

NOTICE **TEWAC equipped generators require a 4-point lifting harness which will connect at the lift eyes in the foot gussets of the generator. To prevent damage to the TEWAC enclosure, spreaders must be used. An I-beam spreader with four equal length chains or an H-style beam type spreader are recommended.**

6. Attach a suitable hoist to the generator lifting lugs.

WARNING **CENTRIFUGAL FORCE HAZARD Failure to follow these instructions may result in serious personal injury, death, and/or property damage.**

- ⚠ Do not apply force to generator fan for lifting or rotating the rotor. Rotating parts are subject to high centrifugal forces during operation of the generator.
- ⚠ Ejected parts may injure personnel or cause further damage within the generator, leading to possible electrical hazards.
- ⚠ If the fan is damaged during installation, replace it prior to running the generator.

7. For single bearing generators:
   a. Remove the bolts mounting the screen assembly to the SAE adapter and remove the screen and dripcover (Figure 6-2). Note: Do not remove the dripcover from the screen.
   b. Remove the capscrews attaching the drive discs to the flywheel.
   c. Remove the capscrews attaching the SAE adapter to the flywheel housing.

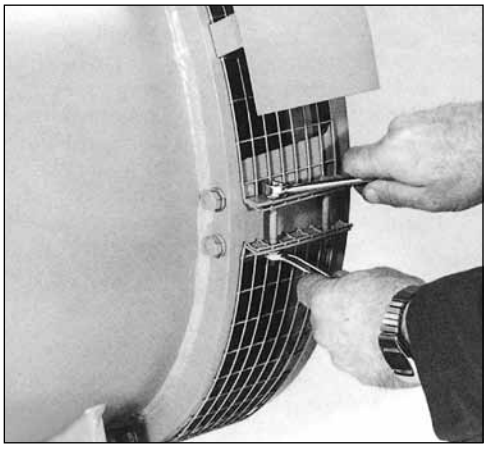


Figure 6-2

8. For two-bearing generators, disconnect the coupling between the generator and prime mover. Note: Refer to coupling instructions provided by others.
9. Remove the mounting bolts which secure the generator feet to the base. To simplify reinstallation later, mark the position of and save any shims that were used under the feet for alignment.
10. On single bearing generators, refer to Shipping Instructions (Section 11) for proper rotor support if planning to transport the generator. (Figure 6-3)
11. On TEWAC generators, refer to additional removal instructions which follow.

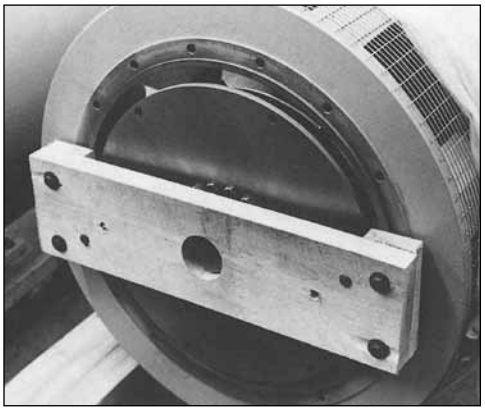


Figure 6-3

TEWAC Removal Instructions

Note: The TEWAC unit is supported at three points. For removal from the prime mover, the TEWAC may remain mounted at the drive end and center supports.

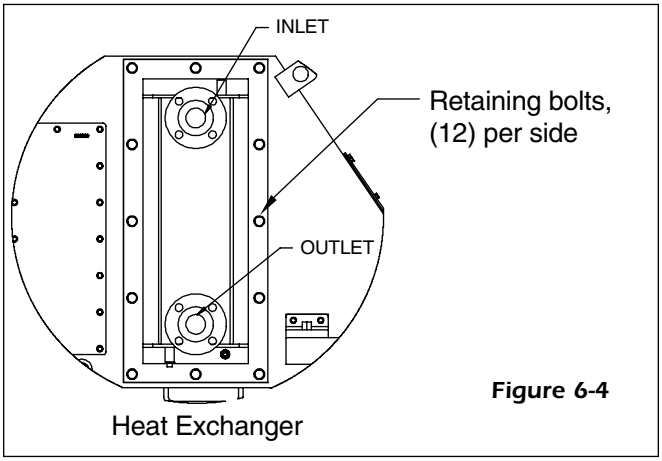


Figure 6-4

1. Shut-down, lock out and tag out the coolant supply and return lines.
2. Drain coolant from the heat exchanger.
3. Remove the coolant supply and return fittings from the heat exchanger flanges. (Figure 6-4)

   Refer to the heat exchanger manual for details.
4. Disconnect Air Flow RTD wires from terminals AF1 and AF2 and Leak Detector Form-C contact wires from terminals LD. (Figure 6-9)
5. Remove the angled cover on the opposite drive end for access to the conduit box bolts.

   (Figure 6-5)
6. Remove the bolts which secure the TEWAC enclosure to the conduit box from above.

Figure 6-5

WARNING FALLING OBJECTS HAZARD Failure to follow these instructions may result in serious personal injury, death, and/or property damage.

- ⚠ Use proper lifting equipment and personal protective equipment when moving or lifting heat exchanger.
- ⚠ Heat exchanger dry weight is 550 lbs (250 kg)

7. If replacing the heat exchanger:
   a. Remove bolts securing heat exchanger to the TEWAC enclosure. (Figure 6-4)
   b. Slide heat exchanger out from flanged end.
8. If completely removing the TEWAC:
   a. Remove the angled cover from the drive end (Figure 6-6)
   b. Remove the bolts which secure the TEWAC enclosure to the drive end bracket from above, inside TEWAC.
   c. Remove the bolts in the center mounted bracket. (Figure 6-7)

WARNING FALLING OBJECTS HAZARD Failure to follow these instructions may result in serious personal injury, death, and/or property damage.

- ⚠ TEWAC enclosure lift eyes are only intended to lift the TEWAC enclosure, not the generator.

   d. Lift the TEWAC off the generator using the lifting lugs at the four corners of the top of the TEWAC enclosure with an appropriate harness.

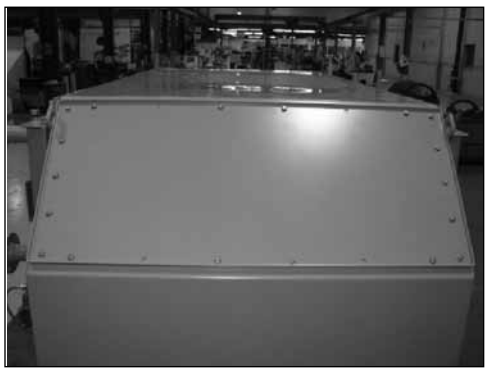


Figure 6-6

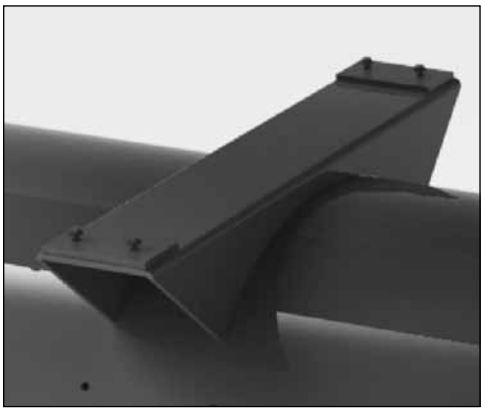


Figure 6-7

Conduit Box Removal

⚠ **Review safety messages at the beginning of this section and all referenced safety information.**

WARNING ELECTRICAL SHOCK HAZARD

Ensure all remote sources of voltage are de-energized prior to disconnecting any electrical connections. Failure to follow these instructions may result in serious personal injury, death, and/or property damage.

NOTICE Record connections prior to disconnecting to facilitate reconnection later. Add markings if necessary.

1. DO NOT DISCONNECT the internal wiring for the Voltage inputs (E1, E2, E3), current transformers, space heaters or opposite drive end (ODE) bearing RTD.
2. Disconnect exciter leads F1 and F2 from terminals F+ and F-. *(Figure 6-8)*
3. Disconnect PMG leads at capacitor. *(Figure 6-8)*

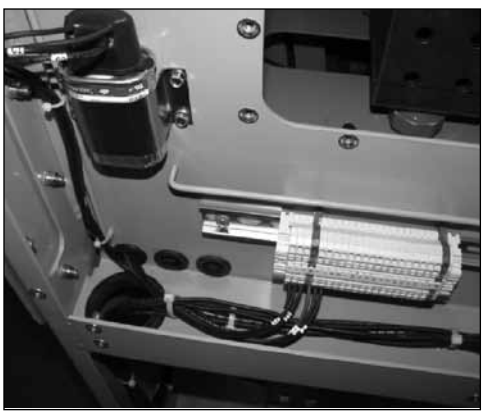


Figure 6-8

4. Disconnect RTD wires from terminals R1 - R6, and DE. (Figure 6-9)

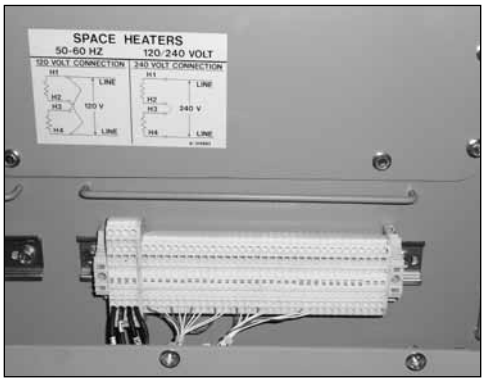


Figure 6-9

5. Bundle RTD wires carefully and push them up into the area above the 'T' leads.
6. Remove ODE bearing RTD by twisting the bayonet connector counterclockwise at the front bracket where it protrudes through a short nipple. Pull the RTD out of the bracket and retain it within the conduit box. Protect the RTD and wiring from damage while continuing. (Figure 6-10 and 6-11)
7. Remove two screws from each of the four space heaters to release them from the front bracket. (Figure 6-11)
8. Record the main stator power lead wire numbers at each bus bar (line and neutral) and disconnect the leads from the bus bars.
9. Remove the bolts which hold the conduit box to the generator body (Figure 6-11 and Figure 6-12).
10. Remove conduit box. (Figure 6-14)

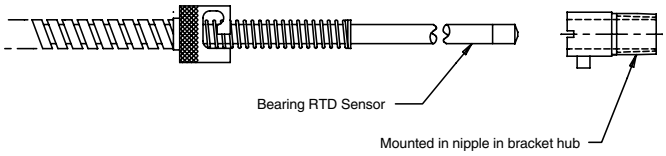


Figure 6-10

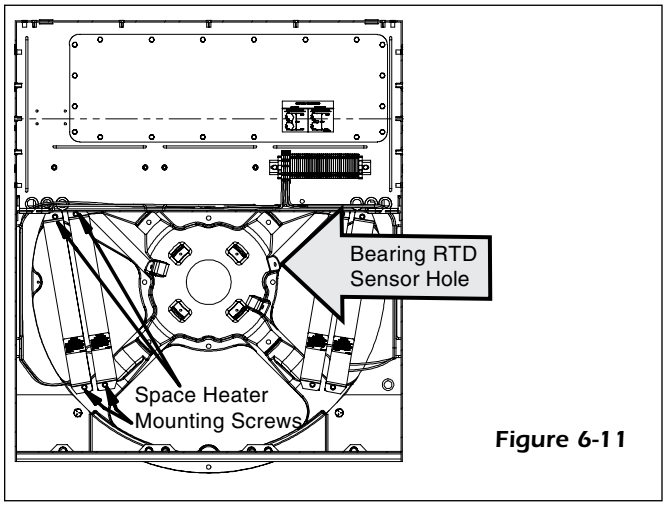


Figure 6-11

Figure 6-12

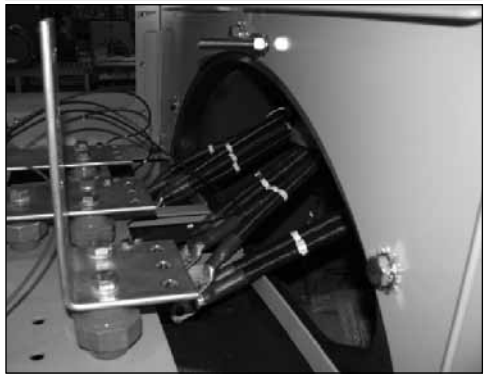


Figure 6-13

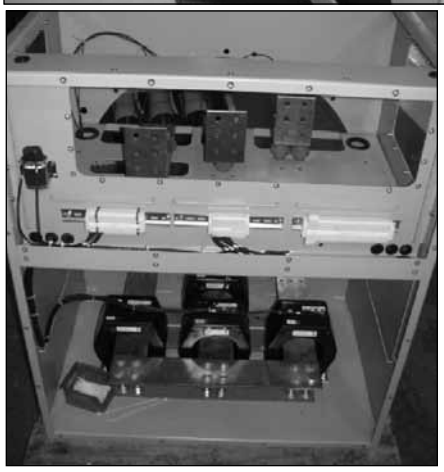


Figure 6-14

6

Exciter Stator (Field) Removal

1. Disconnect F1 and F2 leads from the corresponding F+ and F- terminals in the left group on the panel above *(Figure 6-15)*.
2. Remove all cable ties so the F1 and F2 leads can be removed with the exciter stator. Remove the four capscrews and belleville washers holding the exciter stator in place *(Figure 6-16)*. Remove the exciter stator using a lifting strap or fixture.

Exciter Armature (Rotor) Removal

1. Note markings and disconnect the main rotor leads coming out of the aluminum standoff plate lead hole from the rectifier aluminum angle *(Figure 6-17)*.
2. Remove the capscrew and belleville washer which holds the exciter (rotor) armature to the generator shaft *(Figure 6-18)*.
3. Use a six inch, 7/8-14NF capscrew for a puller. The hole that the mounting bolt goes through is threaded. Screw the puller bolt into the hole and it will push against the end of the shaft *(Figure 6-19)*. Carefully feed the main rotor leads through the hole as the exciter armature is removed *(Figure 6-20)*.

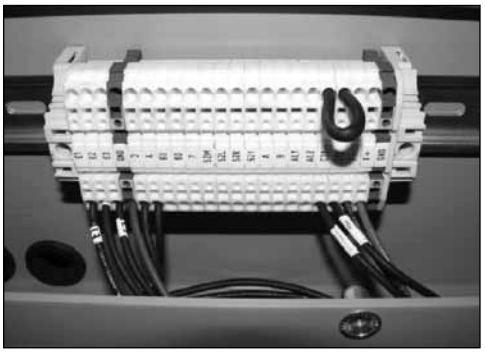


Figure 6-15

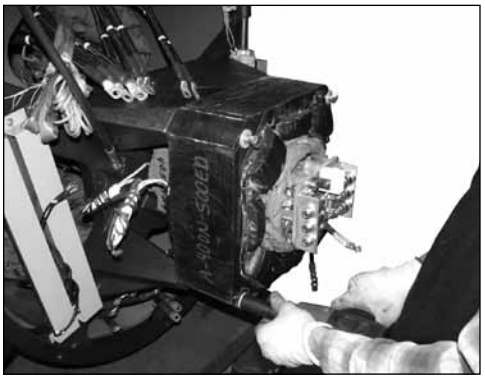


Figure 6-16

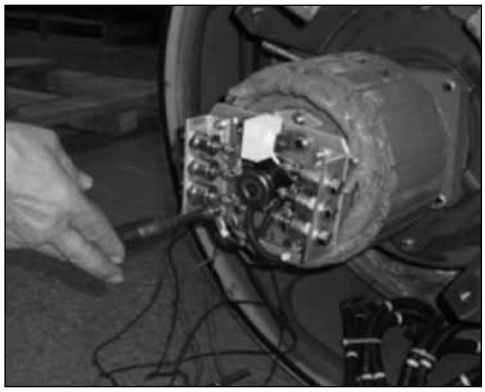


Figure 6-17

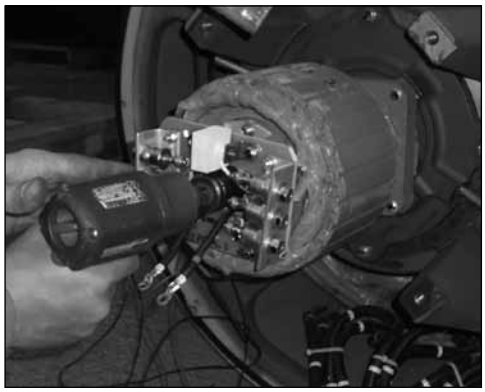


Figure 6-18

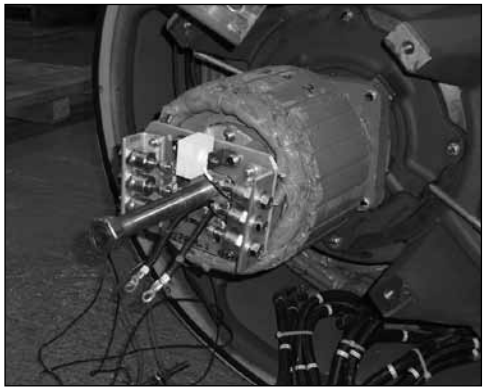


Figure 6-19

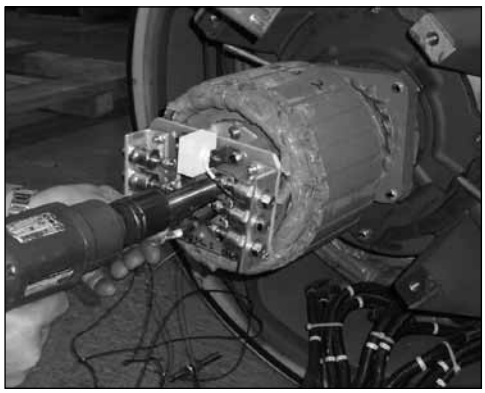


Figure 6-20

NOTICE **Do not tighten the puller bolt beyond the end of the threads. If a bolt with sufficient thread length cannot be found, use a piece of threaded rod with a nut welded on the end.**

WARNING **MAGNETIC FIELD HAZARD**
Permanent magnet generator (PMG) rotors, when removed from the stator, expose surrounding personnel and equipment to powerful magnetic fields which may cause serious health hazards to persons with pacemakers, hearing aids, or other implanted electronic medical devices and may impact other electronic devices such as mobile phones, credit cards, etc.

PMG Stator Removal

1. Remove exciter armature (follow instructions found earlier in this section).
2. Remove the PMG output leads from the capacitor (Figure 6-21) and loosen all cable ties so the leads can be removed with the PMG stator.
3. Note the position of the PMG stator leads which exit at the left inboard side or mark the stator so it can be reinstalled in the same position.
4. Remove the four mounting capscrews (see Figure 6-22).
5. Carefully remove the PMG stator from its mounting pads and slide over the PMG rotor. The magnets used in the PMG are very strong. They will resist removal of the PMG stator (Figure 6-23).

PMG Rotor Removal

1. Remove the exciter armature and PMG stator (follow instructions found earlier in this section).
2. Remove the snap ring which holds the PMG rotor in place on the shaft (Figure 6-24 and 6-25).
3. Slide the PMG rotor off of the shaft (Figure 6-26).

Figure 6-21

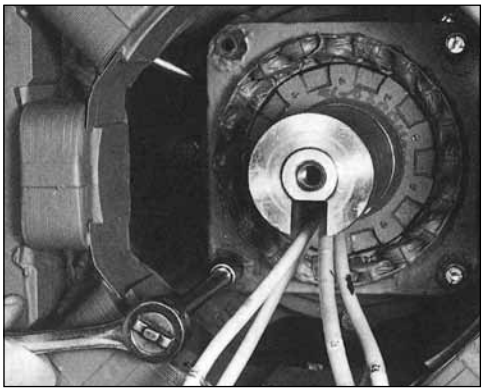


Figure 6-22

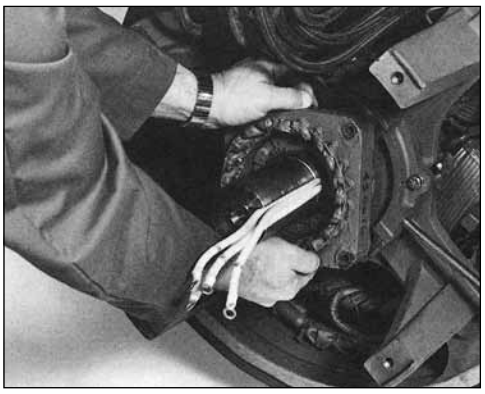


Figure 6-23

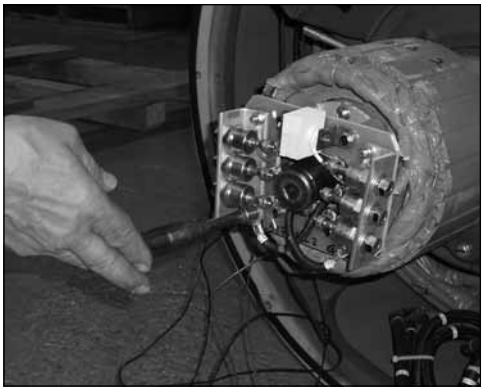


Figure 6-24

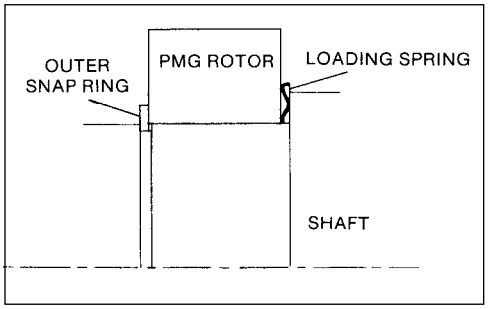


Figure 6-25

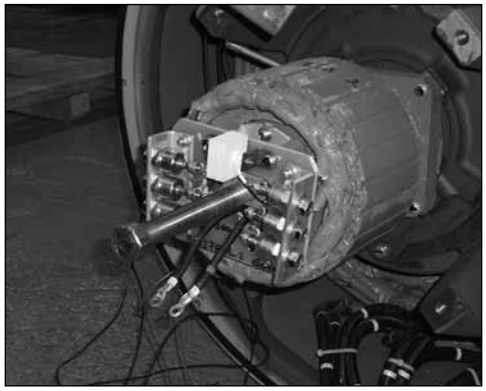


Figure 6-26

WARNING FALLING OBJECTS HAZARD

Use proper lifting equipment and personal protective equipment when moving generator or heavy parts of generator. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

Main Rotor Removal

1. Remove the exciter armature and PMG (follow instructions found earlier in this section).
2. For two-bearing generators, remove the drive coupling or sheave and key from the shaft extension. Remove the eight capscrews holding the bearing lock to the drive end bracket (Figure 6-27).
3. If the screen assembly is still mounted, remove the bolts securing the screen assembly to the drive end bracket or the SAE adapter and remove the screen assembly (Figure 6-28). (Note: Do not remove the drip cover from the screen assembly if so equipped).
4. For single bearing generators, remove the capscrews and hardened washers holding the drive discs to the drive hub (Figure 6-29). Remove all drive discs (and spacers, if any).

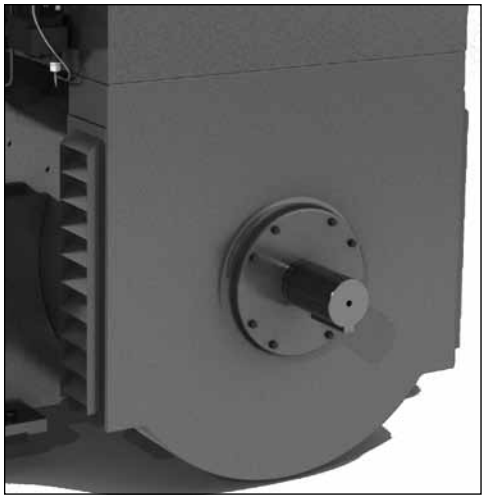


Figure 6-27

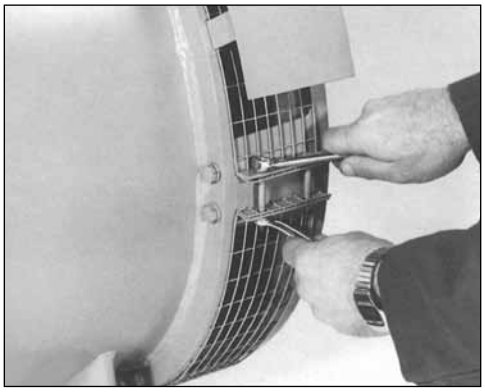


Figure 6-28

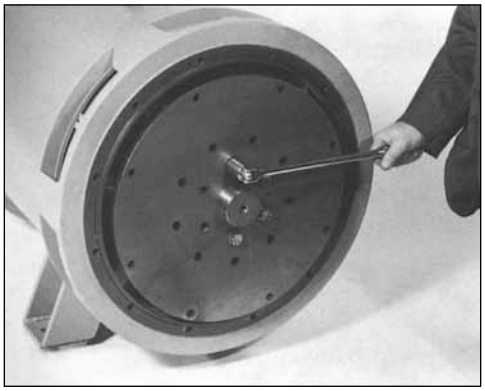


Figure 6-29

WARNING **FALLING OBJECTS HAZARD**

Use proper lifting equipment and personal protective equipment when moving generator or heavy parts of generator. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

WARNING **CENTRIFUGAL FORCE HAZARD**

Failure to follow these instructions could result in serious personal injury, death and/or property damage.

- ⚠ Do not apply force to generator fan for lifting or rotating the rotor. Rotating parts are subject to high centrifugal forces during operation of the generator.
- ⚠ Ejected parts may injure personnel or cause further damage within the generator, leading to possible electrical hazards.
- ⚠ If the fan is damaged during installation, replace it prior to running the generator.

NOTICE **A hoist and lifting strap should be used to assist in drive end bracket or SAE adaptor removal.**

5. a. For single bearing generators, remove the capscrews holding the SAE adapter to the generator and remove the adapter (Figure 6-30 and 6-31).
   b. For two-bearing generators, remove the capscrews holding the drive end bracket to the generator and remove the bracket (Figure 6-30 and 6-32).

NOTICE **Special care should be taken when removing the main rotor, winding damage could result if the rotor is allowed to hit the main stator.**

6. Using a rotor lifting fixture and a suitable hoist, carefully remove the rotor assembly from the main stator and frame assembly through the drive end (Figure 6-33).

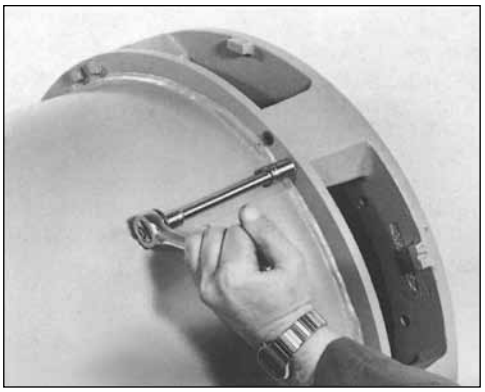


Figure 6-30

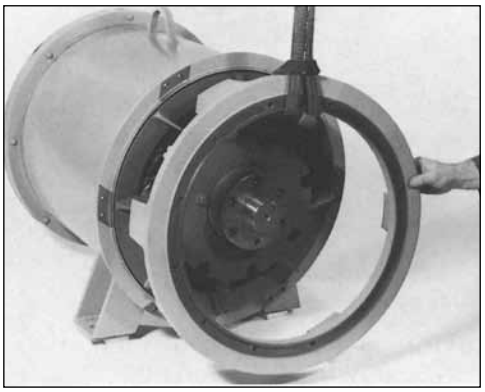


Figure 6-31

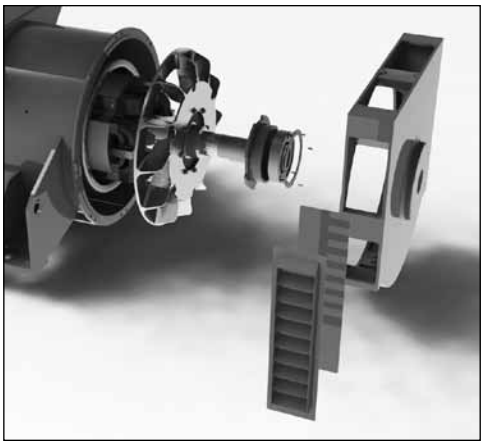


Figure 6-32

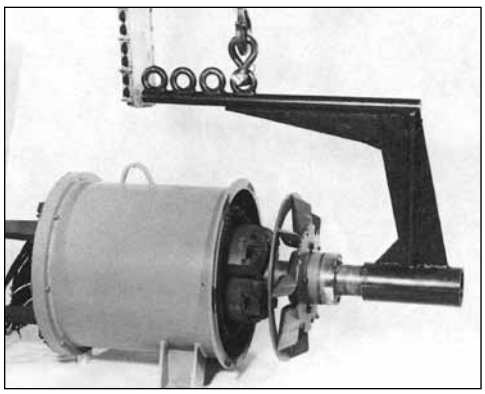


Figure 6-33

WARNING FALLING OBJECTS HAZARD
Use proper lifting equipment and personal protective equipment when moving generator or heavy parts of generator. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

NOTICE A hoist and lifting strap should be used to assist in the front end bracket removal.

Front End Bracket Removal

1. Remove front bracket mounting screws (Figure 6-34).
2. Remove the front end bracket from the main stator assembly (Figure 6-35).

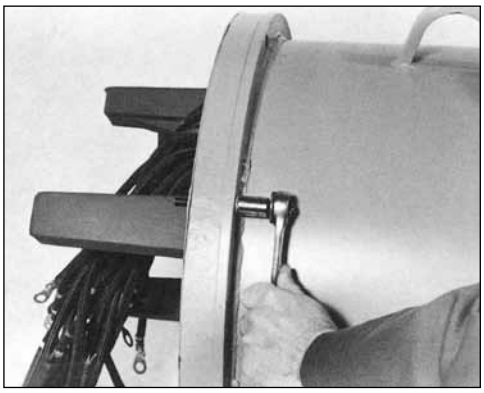


Figure 6-34

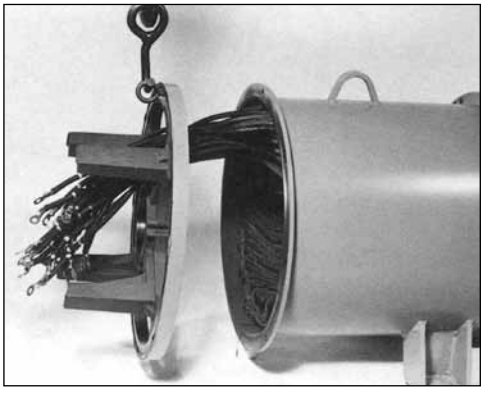


Figure 6-35

Exciter Inspection

A. Exciter Stator

1. Clean dust and dirt from the stator winding (see Figure 6-36 and section 5).
2. Check the exciter stator for a loose, frayed, or burnt winding. Measure winding resistance and insulation resistance (see section 8). Repair or replace as necessary. If field repair of the winding is necessary, contact Marathon Electric for special winding procedures and materials.
3. Look for score marks in the bore of the exciter core caused by rubbing (this could indicate bearing or assembly problems and should be investigated).

B. Exciter (Rotor) Armature

1. Clean dust and dirt from the exciter armature and rectifier assembly (see Figure 6-37 and section 5).
2. Check the exciter armature for burrs on the mating surfaces.
3. Check the rectifiers and surge protector for proper operation (see section 8). Replace defective parts.

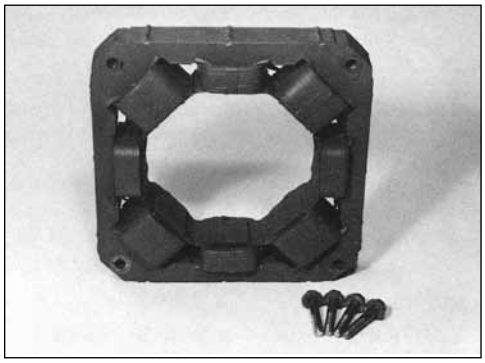


Figure 6-36

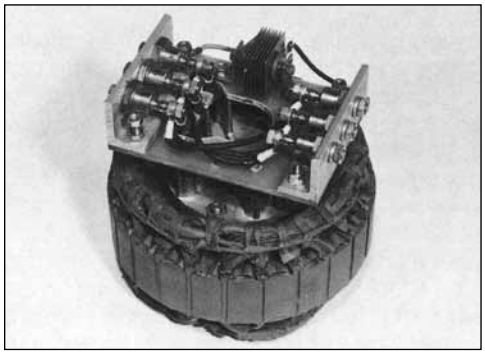


Figure 6-37

NOTICE **Three forward polarity and three reverse polarity diodes are used. Be sure you have the correct part installed in the correct location. The surge suppressor is polarized. Observe polarity markings when changing the surge suppressor (Figure 6-38).**

Torque mounting nuts to 80 in-lb.
Torque lead terminal nuts to 25 in-lb.
Never torque against the diode terminal – use a 7/16 inch wrench to support the terminal (Figure 6-39).

4. Check the exciter armature and rectifier assembly for a loose, frayed, or burnt winding or loose connections. Measure winding resistance and insulation resistance (see section 8). DO NOT megger diodes or surge suppressor. Repair or replace as necessary. If field repair of the winding is necessary, contact Marathon Electric for special winding procedures and materials.
5. Look for score marks on the outside diameter of the armature core caused by rubbing (this could indicate bearing or assembly problems and should be investigated).

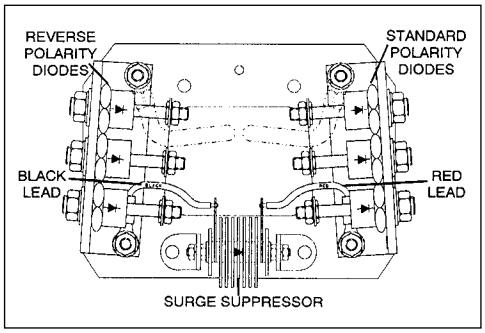


Figure 6-38

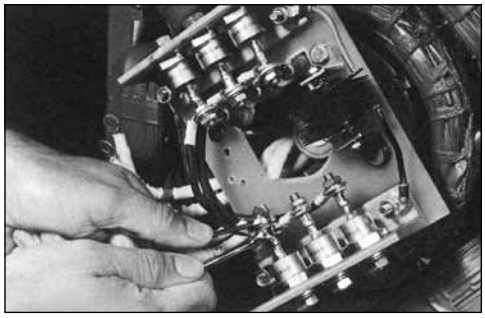


Figure 6-39

6

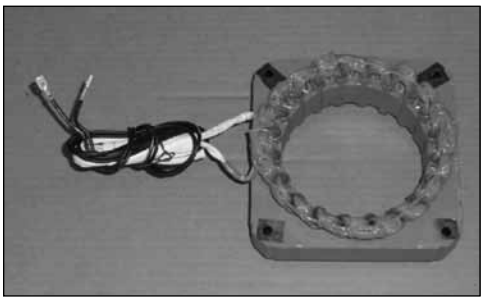


Figure 6-40

PMG Inspection

A. PMG Stator (Figure 6-40)

1. Clean dust and dirt from the PMG stator winding (see section 5).
2. Check PMG stator for a loose, frayed, or burnt winding. Measure winding resistance and insulation resistance (see section 8). Repair or replace as necessary. Contact Marathon Electric for special winding procedures and materials.
3. Look for score marks in the bore caused by rubbing (this could indicate bearing or assembly problems and should be investigated).

B. PMG Rotor (Figure 6-41)

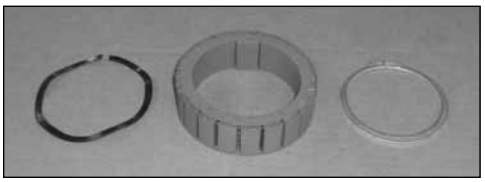


Figure 6-41

WARNING The PMG rotor uses very strong magnets. Keep away from iron and steel parts that could be drawn to the magnets. Keep away from other components that can be damaged by strong magnetic fields.

1. Clean dust and dirt from the PMG rotor (see section 5).
2. Check to be sure all magnets are tightly bonded to the PMG rotor.
3. Check for burrs or corrosion in the bore and keyway where the rotor mounts to the shaft.
4. Look for score marks on the outside diameter caused by rubbing (this could indicate bearing or assembly problems and should be investigated).
5. Inspect snap ring and loading spring; replace as required.

Main Rotor Inspection

A. Bearings

1. Check the bearing for damage or wear. Clean the old grease from the bearing cap, and fill the bearing cap grease cavity 1/3 to 1/2 full of new grease. Refer to page 17.

NOTICE If the bearing needs to be removed for any reason, always install a new bearing.

2. Bearing Replacement

a. If the bearing is to be replaced, remove bearing cartridge with a suitable puller (Figure 6-42).

b. Be sure the inner bearing cap is on the shaft before installing the new bearing.

c. Heat the new bearing and cartridge in an oven to a maximum temperature of 212°F (100°C). Apply a thin coat of clean lubricating oil to the press-fit area of the rotor shaft. Using suitable heat resistant gloves, install the bearing over the end of the shaft until it seats against the shaft shoulder (Figure 6-43). The bearing should slide on the shaft and be seated without excessive force. If the bearing binds on the shaft before being fully seated, a piece of tubing, slightly larger than the press-fit area, can be used to drive the bearing into place. Using light taps with a soft mallet, apply pressure to the inner race only.

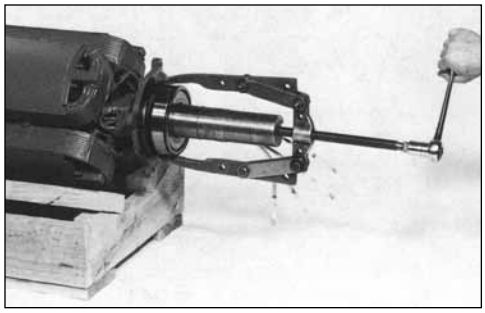


Figure 6-42

NOTICE **Under no circumstances should pressure be applied to the outer race of the new bearing, as permanent bearing damage could result.**

d. Allow the bearing to cool for one hour before attempting to assemble the generator.

B. Fan

1. Check the fan for cracks or broken blades. Replace the fan if defective.
2. Mark the hub and fan for alignment. This is necessary to be sure the balance weights will be in the same position when the fan is reinstalled.
3. a. For single bearing generators, remove the fan mounting capscrews (Figure 6-44) and slide the fan off the shaft (Figure 6-45).

   b. For two-bearing generators, remove the drive end bearing and bearing cap (see bearing removal instructions). Remove the fan mounting capscrews and slide fan off the shaft (*Figures 6-44 and 45*).
4. To install, slide the fan on the shaft making sure the fan mounting surface is toward the drive hub. Align reference marks (this is important for assembly balance) and mount the fan to the drive hub with the capscrews and belleville washers (*Figure 6-46*). Torque the capscrews to 60 ft-lb (81 N-m).
5. **Note:** Balance weights on the fan are for balance of the complete rotor assembly. The rotor assembly should be rebalanced if a new fan has been installed.
6. On two-bearing generators, install bearing cap and new bearing according to the bearing assembly instructions (Item A).

C. Drive Hub (Single Bearing Generators Only)

1. Check the drive hub for cracks or stripped drive disc mounting holes. Replace the hub if

Figure 6-43

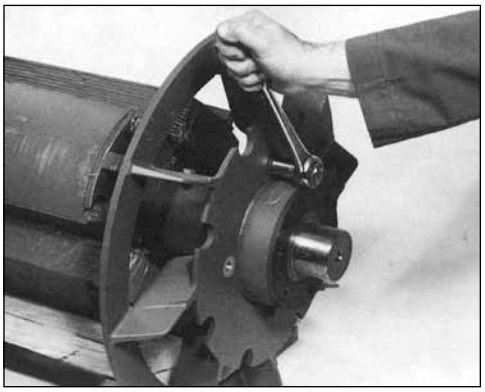


Figure 6-44

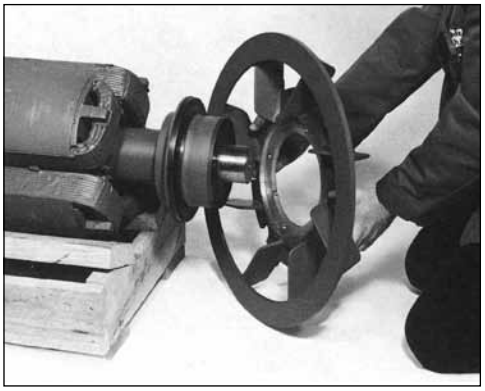


Figure 6-45

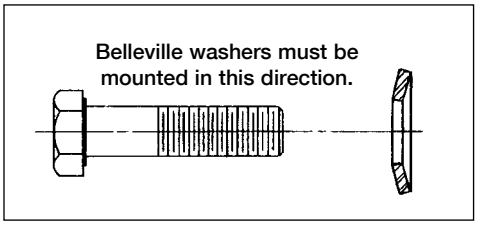


Figure 6-46

2. If the hub is to be replaced, remove the fan (see Item B) and install a suitable puller to the hub. Remove the two setscrews in the hub over the key. Using a torch, rapidly heat the hub at the outer diameter while tightening the puller (this must be done rapidly before the heat can expand the shaft). Remove the hub (Figure 6-47).

3. To insure proper fan location, mark the new hub in the same place as the old hub relative to the keyway. Install key in shaft. Heat the new hub in an oven to 500-600°F (260-316°C). Using suitable heat resistant gloves, slide the hub over the key in the shaft until it seats against the shaft shoulder (Figure 6-48).

4. Allow the hub to cool for one hour. After the hub has cooled, tighten the setscrews in the hub to 50 ft-lb (68 N-m) torque. Match the alignment marks on the fan and hub and mount the fan (see Item B).

5. Rebalancing the rotor assembly is not necessary if only the hub is replaced and the fan is mounted in the same location relative to the hub and shaft.

D. Main Rotor Core and Windings

1. Clean all parts. Remove dust and dirt from the rotor windings (see section 5).

   Remove any accumulated dust or dirt in the winding air passages with a piece of wire or with low-pressure, moisture-free air (Figure 6-49).

NOTICE **If a piece of wire is used for cleaning the air passages, care must be taken not to scratch the winding as this could cause an insulation failure.**

2. Check the rotor for loose, frayed, or burnt windings. Measure winding resistance and insulation resistance (see section 8). Test for shorted turns using an AC impedance test (see section 8). A defective rotor winding must be rewound by a Marathon Electric recommended service location. The rotor assembly must be rebalanced after any rework or repair has been completed.

E. Drive Discs (Single Bearing Generators Only)

1. Inspect the drive discs for distorted or bent edges (Figure 6-50). Inspect for worn mounting holes. Replace all defective discs as necessary.

2. Inspect the drive disc mounting capscrews for damaged threads. Replace capscrews if damaged.

Figure 6-47

Figure 6-48

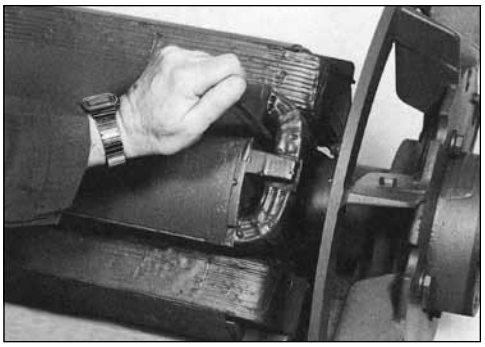


Figure 6-49

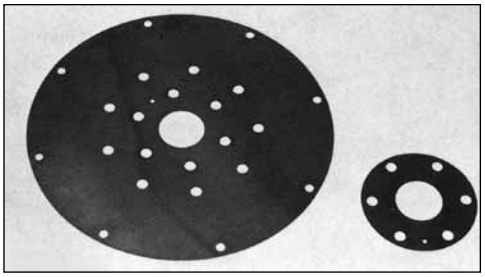


Figure 6-50

Front (Exciter) End Bracket Inspection

1. Remove the filler and drain grease hoses and the grease plugs from end bracket (Figure 6-51).
2. Clean the end bracket, grease pipes, and capscrews to remove all dust, dirt, and grease.
3. Inspect the end bracket for stripped threads, cracks, and burred or rough mating surfaces. Inspect the bearing bore for burrs or wear. If the bracket shows excessive bearing bore wear, it should be repaired or replaced (Figure 6-52).
4. Inspect the mounting pads for the PMG stator and exciter stator. Be sure they are smooth, clean, and free of any burrs or rust that could interfere with proper alignment (Figure 6-51 and 6-52).
5. Reassemble the grease pipes and fittings to the bracket.

Drive End Bracket or SAE Adapter Inspection

1. For two-bearing generators, remove the grease plugs from the bracket.
2. Clean the bracket or adapter, capscrews, and screen assembly to remove all dust, dirt, and grease.
3. Inspect the capscrews for stripped threads and replace if defective.
4. Inspect the bracket or adapter for stripped threads, cracks, and burred or rough mating surfaces (Figure 6-53 and 6-54).
5. For two-bearing generators, inspect the bearing bore for burrs or wear. If the drive end bracket shows excessive bearing bore wear, it should be repaired or replaced.

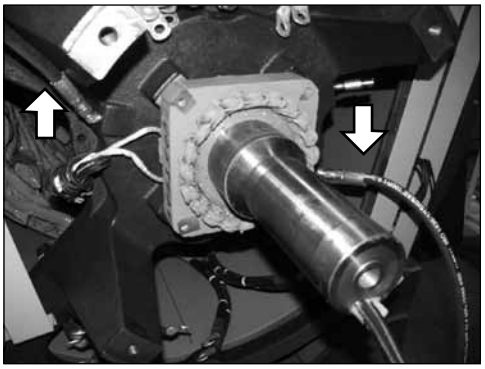


Figure 6-51

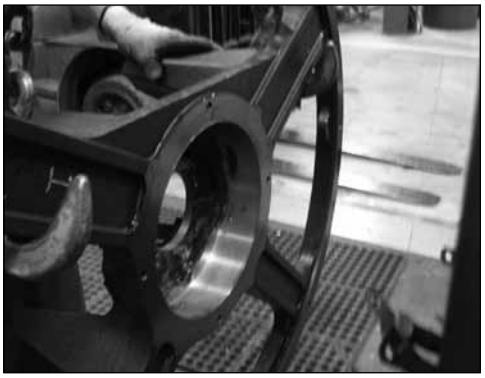


Figure 6-52

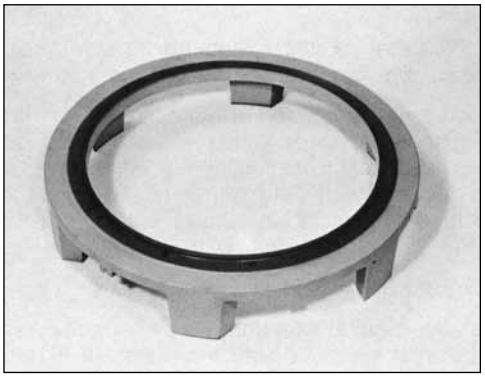


Figure 6-53

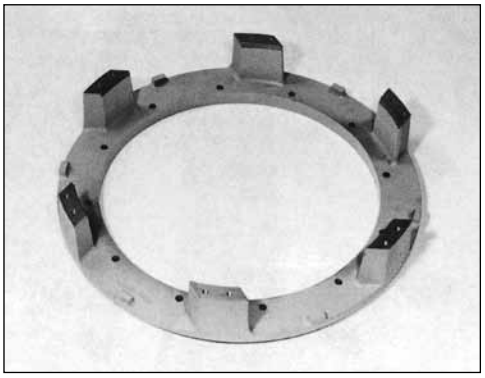


Figure 6-54

Main Stator Inspection

1. Clean dust and dirt from the stator frame and winding (see Figure 6-55 and section 5).
2. Inspect the frame for stripped threads, cracks, burred mating surfaces, or other damage.
3. Inspect the stator for a loose, frayed, or burnt winding. Measure winding resistance and insulation resistance (see section 8). Repair or replace as necessary. If field repair of the winding is necessary, contact Marathon Electric for winding data.

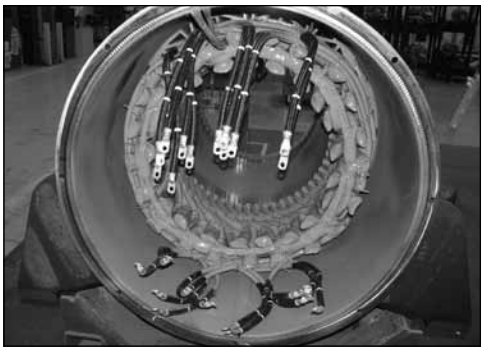


Figure 6-55

WARNING FALLING OBJECTS HAZARD

Use proper lifting equipment and personal protective equipment when moving generator or heavy parts of generator. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

NOTICE A hoist and lifting strap should be used to assist in the front end bracket installation.

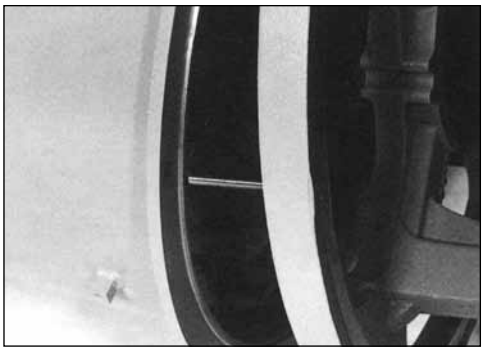


Figure 6-56

Front End Bracket Installation

1. Install two guide pins (threaded rod can be used) into the generator side of the end bracket mounting holes. Align the guide pins with the holes in the generator frame and slide the bracket onto the frame (Figure 6-56). Install bracket mounting capscrews (Figure 6-57).
2. Remove the two guide pins and insert the remaining capscrews and torque to specifications given in section 12.

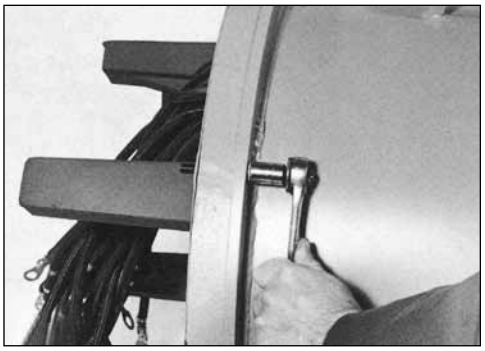


Figure 6-57

WARNING FALLING OBJECTS HAZARD

Use proper lifting equipment and personal protective equipment when moving generator or heavy parts of generator. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

WARNING CENTRIFUGAL FORCE HAZARD

Failure to follow these instructions could result in serious personal injury, death and/or property damage.

- ⚠ Do not apply force to generator fan for lifting or rotating the rotor. Rotating parts are subject to high centrifugal forces during operation of the generator.
- ⚠ Ejected parts may injure personnel or cause further damage within the generator, leading to possible electrical hazards.
- ⚠ If the fan is damaged during installation, replace it prior to running the generator.

NOTICE Special care should be taken when installing the rotor assembly. Winding damage could result if the rotor is allowed to hit the main stator.

Main Rotor Installation

1. Grease bearing cavity and bearing with new grease. Refer to page 12.
2. Using a rotor lifting fixture and a suitable hoist, carefully install the rotor assembly into the main stator assembly through the drive end (**Figure 6-58**). Carefully feed the rotor leads through the front end bracket shaft hole as the rotor is installed.
3. a. For single bearing generators, slide the SAE adapter over the fan and secure to the main stator and frame assembly with capscrews torqued per section 12 (**Figure 6-59** and **6-60**). It may be necessary to raise the rotor assembly slightly to allow the mounting of the SAE adapter.

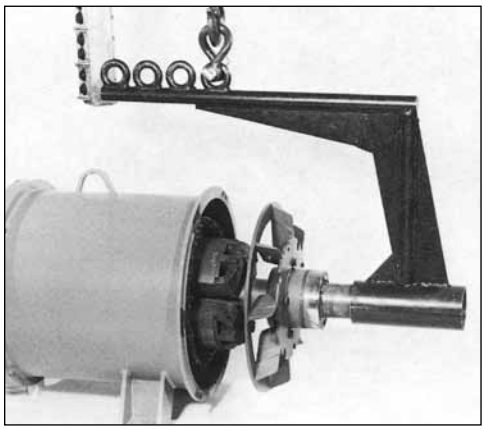


Figure 6-58

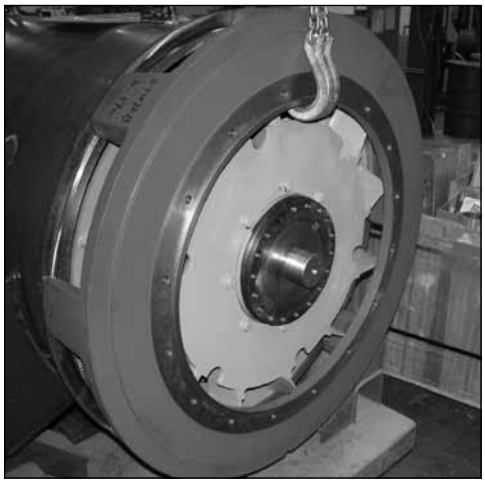


Figure 6-59

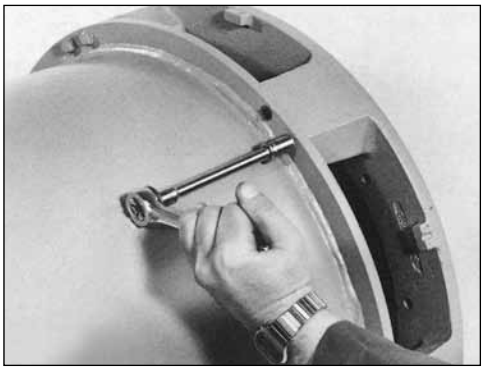


Figure 6-60

6

3. b. For two-bearing generators, insert two guide pins in the rear bearing lock holes (Figure 6-61). Fill the grease cavity of the drive end bracket 1/3 to 1/2 full of new grease. Refer to page 12. Assemble all grease plugs in the bracket. Mount the bracket on the bearing and guide the bearing lock pins through the bracket holes (Figure 6-62). Align the drive end bracket and mount with the capscrews (Figure 6-63). Insert two capscrews with lockwashers into the bearing lock and tighten. Remove the guide pins and replace with the remaining two capscrews with lock washers. Torque bearing capscrews to 25 ft-lb (34 N-m). Torque bracket mounting capscrews per specifications given in section 12.

WARNING FALLING OBJECTS HAZARD

Use proper lifting equipment and personal protective equipment when moving generator or heavy parts of generator. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

NOTICE A hoist and lifting strap should be used to assist in the drive end bracket or the SAE adapter assembly.

4. For single bearing generators, insert a guide stud into the drive hub. Position all spacers (if any), then all drive discs, one at a time until all discs are installed (Figure 6-64). Make sure that all disc mounting holes at the inner and outer-diameter are properly aligned. Secure the discs with the grade 8 5/8-18 capscrews and hardened washers. Torque to 192 ft-lb (260 N-m) (see Figure 6-65 for torquing sequence).

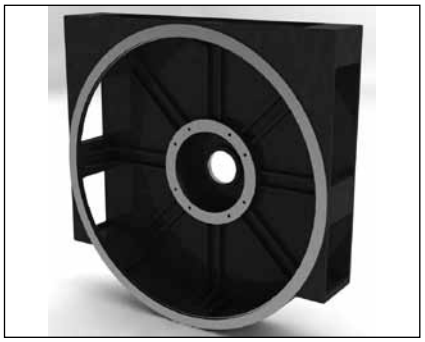


Figure 6-61

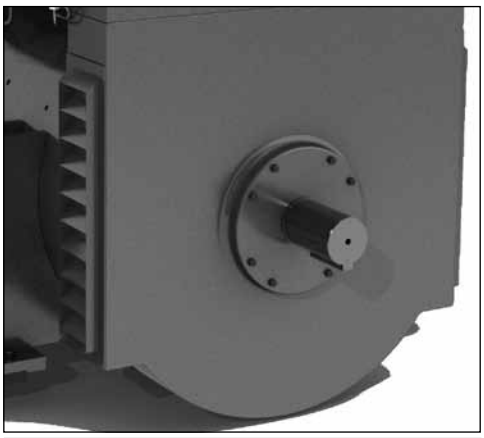


Figure 6-62

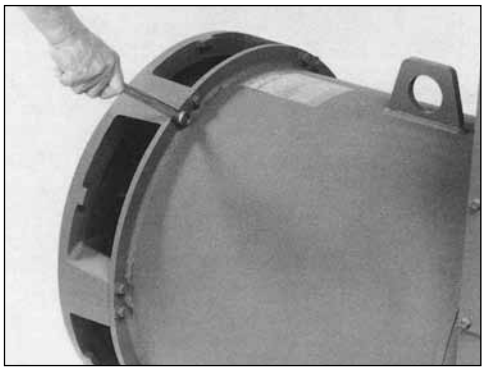


Figure 6-63

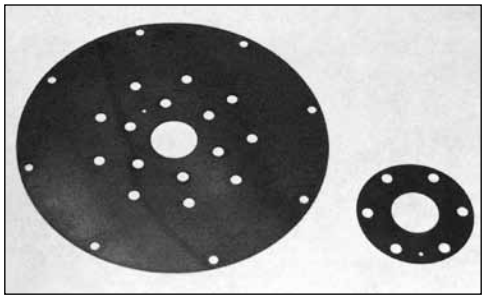
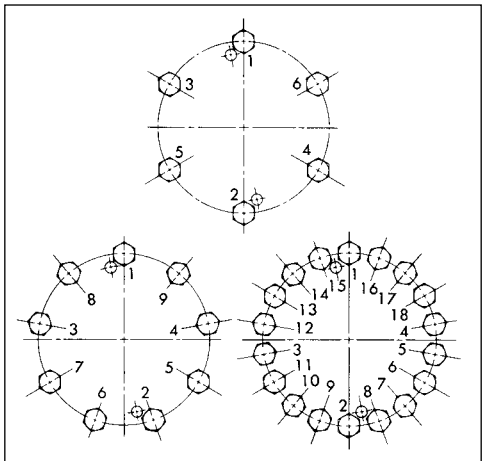


Figure 6-64



Torque the bolts in the above sequence according to the correct bolt pattern.

Then check the torque in each bolt in a clockwise direction around the bolt circle to insure that all the bolts are properly torqued.

Figure 6-65

WARNING MAGNETIC FIELD HAZARD

Permanent magnet generator (PMG) rotors, when removed from the stator, expose surrounding personnel and equipment to powerful magnetic fields which may cause serious health hazards to persons with pacemakers, hearing aids, or other implanted electronic medical devices and may impact other electronic devices such as mobile phones, credit cards, etc.

PMG Installation

1. Install loading spring on shaft (Figure 6-66).
2. Slide PMG rotor onto shaft (Figure 6-66).
3. Install snap ring (Figure 6-67). Use a piece of pipe slightly larger than the shaft (2-3/4 inches) to push the rotor back against the loading spring until the snap ring seats in the slot (Figure 6-68).
4. Install the PMG stator on it's mounting pads, with the leads in the left (9 o'clock) inboard position, and secure with the four mounting capscrews and belleville washers (Figure 6-69 and 6-70). Torque to 4 ft-lb (5 N-m).
5. Route and secure PMG stator leads away from moving parts.

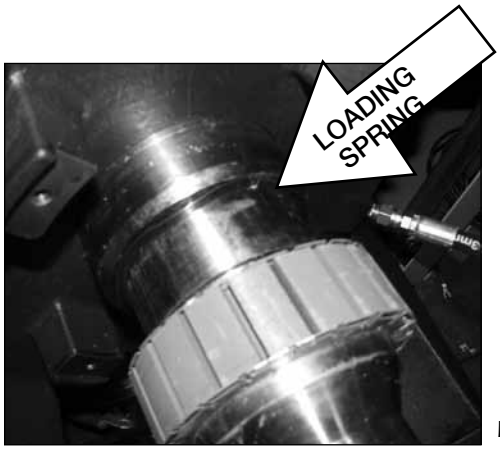


Figure 6-66

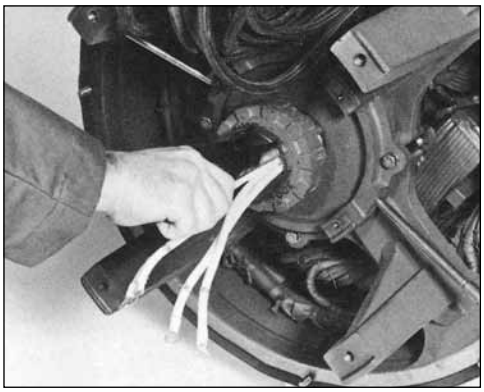


Figure 6-67

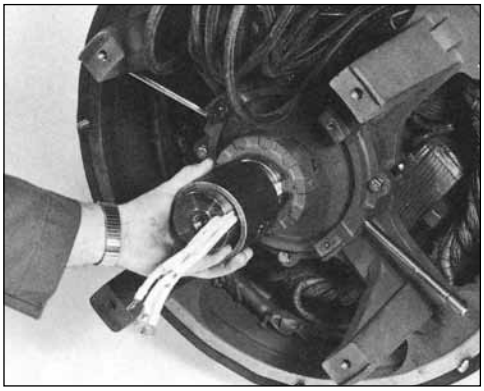


Figure 6-68

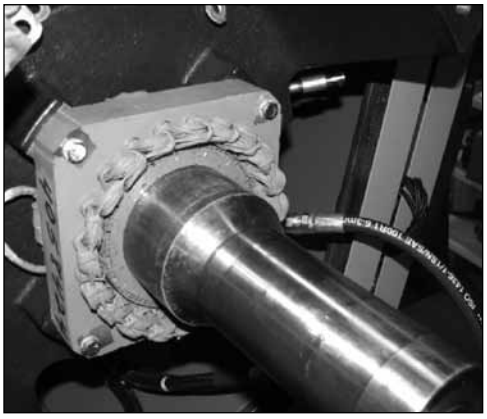


Figure 6-69

Figure 6-70

Exciter Installation

1. Attach a wire to the main rotor leads and feed the wire through the armature bore and out the lead hole in the aluminum standoff plate. On larger exciters, it will be helpful to install a guide pin in the end of the shaft to support the armature while fishing the rotor leads through. Align the key in the armature bore to the keyway in the shaft. Slide the armature on the shaft while feeding the main rotor leads through the lead hole in the aluminum standoff plate (**Figure 6-71**).
2. Insert the capscrew and belleville washer (**Figure 6-72**) through the mounting hole in the aluminum standoff plate and secure to the shaft (**Figure 6-73**). Tighten the capscrew until the armature seats on the shaft Torque to 84 ft-lb (114 N-m) for 1/2" bolt or 300 ft-lb (407 N-m) for 3/4" bolt.
3. Observe the polarity markings and connect the main rotor leads to the rectifier assembly (**Figure 6-74**). Torque the nuts to 4 ft-lb (5.4 N-m).
4. Position the exciter field leads at the left (9 o'clock) inboard position. Using a suitable lifting device, mount the exciter stator on the front end bracket mounting pads and align the mounting holes (**Figure 6-75**). Mount with the capscrews and belleville washers (**Figure 6-72**). Torque the capscrews to 60 ft-lb (81 N-m). Route and secure the exciter stator leads away from any moving parts.

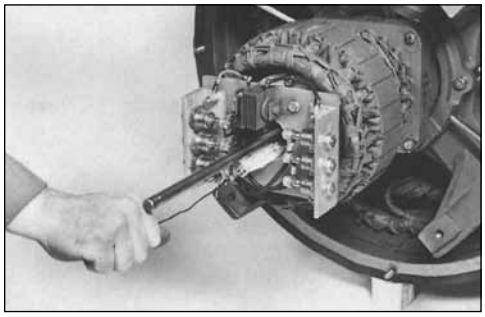


Figure 6-71

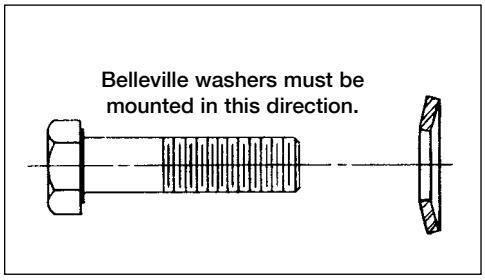


Figure 6-72

Figure 6-73

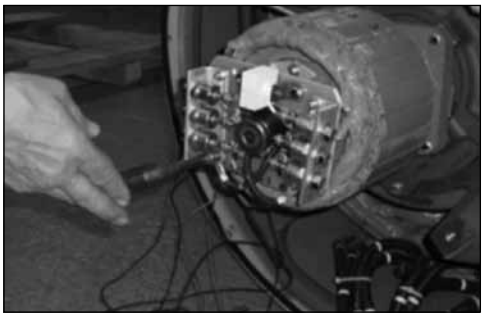


Figure 6-74

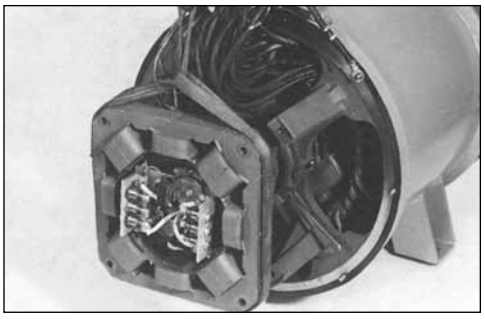


Figure 6-75

Conduit Box Installation

1. Prepare main stator leads for installation of the conduit box. (Figure 6-76)

2. Bundle RTD wires amongst the T leads to protect them from damage while positioning the conduit box. (Figure 6-76)

3. Using a suitable lifting device, carefully position the conduit box against the front bracket, aligning the bolt holes. (Figure 6-77)

4. Install bolts and lock washers through conduit box, into front bracket. (Figure 6-78)

5. Mount the (4) space heaters with (2) screws each to the bracket. (Figure 6-79)

6. Install bearing RTD sensor into bracket bayonet connector and secure the bayonet lock by twisting clockwise. (Figure 6-79 and 80)

Figure 6-77

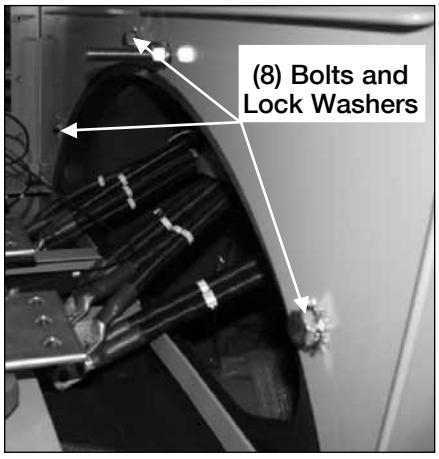


Figure 6-78

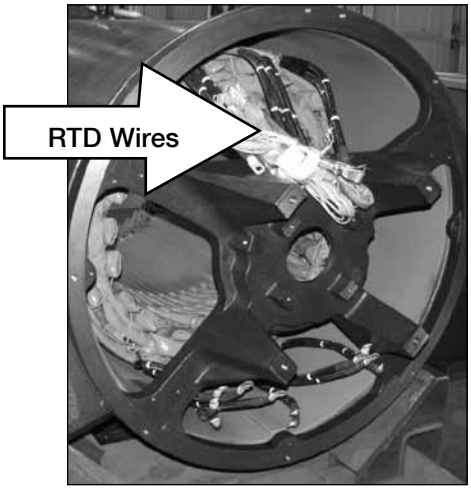


Figure 6-76

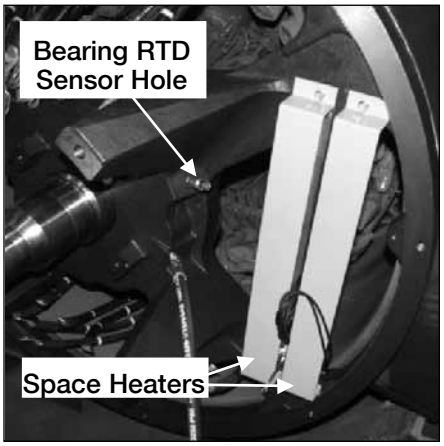


Figure 6-79

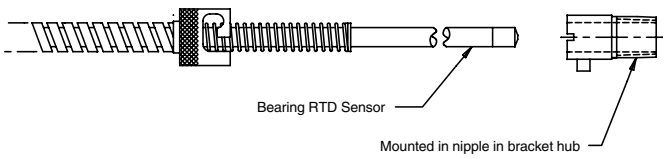


Figure 6-80

7. Connect the main stator power lead wires to the corresponding bus bars. (Figure 6-81)

8. Connect the RTD wires to terminals R1 - R6 and DE. (Figure 6-82)

9. Lift the boot to reveal the capacitor terminals and connect PMG leads 3 & 4. (Figure 6-83)

10. Connect exciter leads F1 and F2 to terminals F+ and F-. (Figure 6-84)

11. Connect grease hoses to grease fittings in side of conduit box. (Figure 6-85)

12. If TEWAC unit, bolt TEWAC enclosure to top frame of conduit box.

13. When ready to install covers, install new gaskets.

Figure 6-81

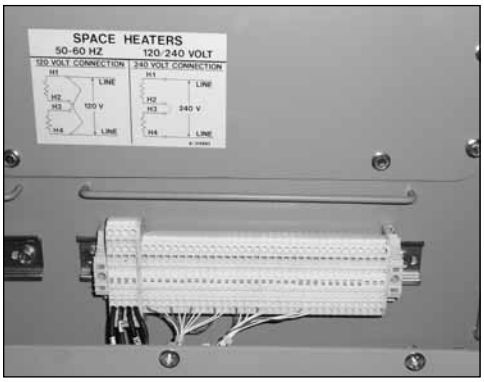


Figure 6-82

Figure 6-83

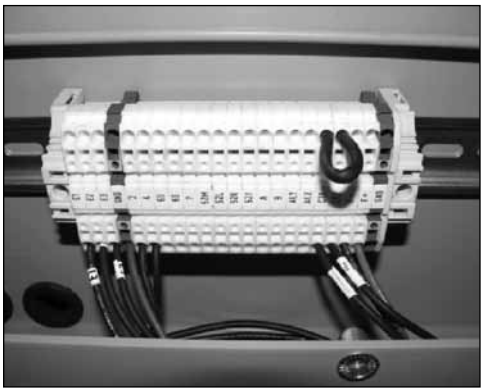


Figure 6-84

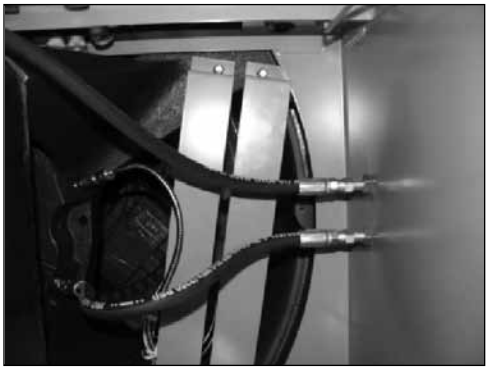


Figure 6-85

WARNING FALLING OBJECTS HAZARD

Failure to follow these instructions may result in serious personal injury, death, and/or property damage.

- ⚠ Use proper lifting equipment and personal protective equipment when moving or lifting generator or heavy components.
- ⚠ Lift generator only by the lift eyes welded to the frame of the generator.
- ⚠ TEWAC enclosure lift eyes are only intended to lift the TEWAC enclosure, not the generator.

Heat Exchanger Installation

If replacing the heat exchanger:

1. Slide heat exchanger into the TEWAC enclosure, non-flanged end first.

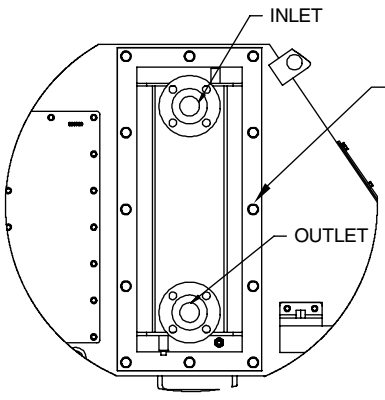
2. Clean all surfaces which will be sealed with gaskets thoroughly.

3. Position new gaskets and outer end plates.

4. Install the bolts securing the heat exchanger to the TEWAC enclosure on both sides. (**Figure 6-86**)

5. Connect supply and return lines to the inlet (top) and outlet (bottom) flanges, respectively.

6. Refer to the heat exchanger manual for additional details.



Heat Exchanger **Figure 6-86**

TEWAC Installation

1. Clean all surfaces which will be sealed with gaskets thoroughly.

2. Position new gaskets on the top of the conduit box frame and drive end bracket mating surfaces.

3. Using a hoist with an appropriate harness, set the TEWAC on the generator using the lifting lugs at the four corners of the TEWAC enclosure, carefully align all mounting holes prior to tightening any bolts. (**Figure 6-87**)

4. Loosely install the bolts in the center mounted bracket. (**Figure 6-88**)

Figure 6-87

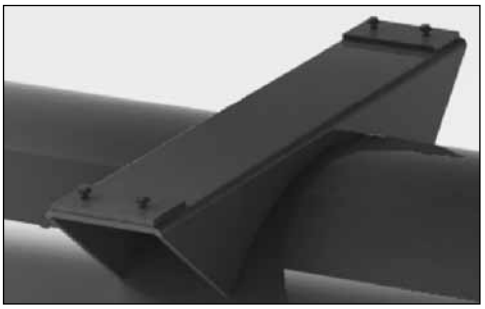


Figure 6-88

5. Loosely install the bolts which secure the TEWAC enclosure to the drive end bracket.

6. Loosely install the bolts which secure the TEWAC enclosure to the conduit box.

7. Check fit of gaskets at all points.

8. Tighten bolts evenly to prevent distortion of enclosure or gaskets.

9. Connect Air Flow RTD wires to terminals AF1 and AF2 and Leak Detector Form-C contact wires to terminals LD. (*Figure 6-89*)

10. Install the coolant supply and return fittings to the heat exchanger flanges. Refer to the heat exchanger manual for details.

11. Replace the angled covers and gaskets on top of the TEWAC enclosure. (*Figure 6-90*)

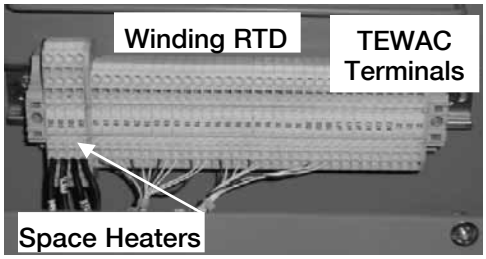


Figure 6-89

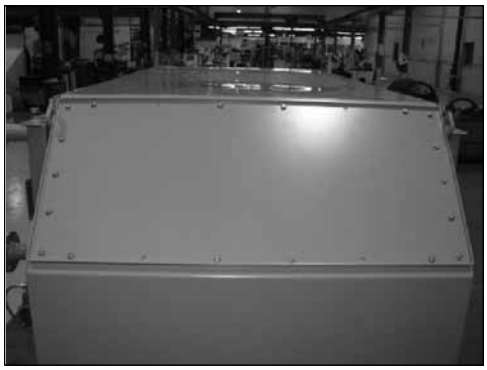


Figure 6-90

Assembly to Prime Mover

Refer to Section 3, Installation

⚠ Read and fully understand the instructions and all warnings, cautions, & safety notice statements before attempting to install, operate or service this product.

⚠ Refer to Section 1 for important safety information.

⚠WARNING ELECTRICAL SHOCK HAZARD

Failure to follow these instructions may result in serious personal injury, death, and/or property damage.

- ⚠ Installation and repair of electrical generators and their accessories should be attempted by qualified personnel only. Electrical connections shall be made by a qualified electrician in accordance with all local, national, international and/or other applicable codes, rules or regulations and sound practices.
- ⚠ Do not touch electrically live parts. Disconnect, lockout and tag prime mover and input power supplies before installing or servicing generator (includes accessory devices). Use a voltmeter to verify that power is off before contacting conductors.
- ⚠ Do not open terminal box or touch unprotected terminals while the generator shaft is rotating. Shaft rotation produces voltage in generators even when no excitation is applied. Residual voltage is present at the generator leads and regulator connections even when the regulator fuse is removed.

⚠WARNING ROTATING PARTS HAZARD

Keep extremities, hair, jewelry and clothing away from moving parts. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

⚠WARNING EXPLOSION HAZARD

Beware of arcing when connecting test leads. Arcing could spark an explosion if exposed to battery gases, fuel vapors or other hazardous atmospheres. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

Introduction

This section is intended to suggest a systematic approach to locating and correcting generator or regulator malfunctions. The sections are arranged according to the symptoms of the problem. The steps in each section have been arranged in an attempt to:

1) Do the easy checks first.
2) Prevent further damage when troubleshooting a disabled machine.

The first and perhaps most important step of troubleshooting should be to gather as much information as possible from personnel who may have been present during the failure. Information on how long the generator had been running, what loads were on the line, weather conditions, what protective equipment operated, etc., can help isolate the problem.

Always make a thorough visual inspection to check for any obvious problems before attempting to run the generator.

Troubleshooting

Symptom: Generator Produces No Voltage or Residual Voltage

Regulator Fuse Blown	Check fuse with an ohmmeter. Replace bad fuse; refer to regulator manual.
Voltmeter Off	Check to be sure meter phase selector switch is not in the *off* position.
Incorrect Connections	Verify generator connections (refer to drawings supplied with generator set and section 3).
Defective Connections/Wiring	Inspect all wiring for grounds, open circuits, and short circuits (refer to section 8).
Defective Voltmeter	Verify proper operation of panel meter with another meter that is known to be accurate (refer to section 8).
No Regulator Input	Measure voltage at regulator input (PMG output). Refer to section 8.
Defective Diodes, Surge Suppressor, or Generator Windings	Test generator with constant excitation (12 volt battery test). Refer to sections 8 and 12.
Voltage Regulator Protective Shutdown Circuits are Operating	Correct problem and adjust regulator. Refer to regulator manual.
Voltage Regulator Inoperative	Adjust or replace regulator. Refer to regulator manual.

Symptom: Generator Produces Low Voltage – No Load

Underspeed Operation	Check speed using tachometers and/or frequency meters.
Defective Voltmeter	Verify operation of panel meter with another meter that is known to be accurate (refer to section 8).
Residual Voltage	Disconnect F1 and F2 leads at the voltage regulator. If voltage goes down, continue onto next step. If voltage does not change, refer to troubleshooting for symptoms of “No Voltage – Residual Voltage”.
Incorrect Generator Connections	Verify generator connections (refer to drawings supplied with generator set and section 3).
Defective Connections/Wiring	Inspect all wiring for grounds, open circuits, short circuits, loose connections, and dirty connections.
Regulator Adjustments	Adjust regulator (refer to regulator manual). Check exciter field volts (refer to sections 8 and 12).

Symptom: Generator Produces Low Voltage – No Load (continued)

Defective Diodes, Surge Suppressor, or Generator Windings	Test generator with constant excitation (12 volt battery test). Refer to sections 8 and 12.
Voltage Regulator Not Operating Properly	Adjust or replace regulator (refer to regulator manual).

Symptom: Generator Produces Low Voltage When Load Is Applied

Overload	Measure amps and verify that the load does not exceed the nameplate rating of the generator (refer to section 8).
Overload – Defective Ammeter	Verify operation of ammeter by using a separate meter that is known to be accurate.
Droop Circuit	If the generator set is equipped for paralleling, some voltage droop is normal as load increases (refer to the regulator instruction manual).

Continue troubleshooting for symptoms “Generator Produces Low Voltage – No Load”.

Symptom: Generator Produces High Voltage

Defective Voltmeter	Verify operation of panel meter with another meter that is known to be accurate (refer to section 8).
Incorrect Operating Speed	Verify speed with tachometer or frequency meter.
Incorrect Connections	Verify generator connections (refer to drawings supplied with generator set and section 3).
Defective Connections/Wiring	Inspect all wiring for grounds, open circuits, and short circuits.
Regulator Adjustments	Adjust regulator (refer to regulator manual).
Diode Polarity Incorrect	Check diodes: verify proper diodes are installed and polarity is correct (refer to section 6).
Voltage Regulator Not Operating Properly	Adjust or replace regulator (refer to regulator instruction manual).

Troubleshooting

Symptom: Generator Voltage Is Fluctuating

Incorrect Speed	Verify speed with tachometer or frequency meter.
Unstable Speed	Verify governor stability.
Voltage Regulator Stability	Adjust regulator stability (refer to regulator manual).
Defective/Loose Connections	Inspect all wiring for loose or dirty connections.
Defective Diodes, Surge Suppressor, or Generator Windings	Test generator with constant excitation (12 volt battery test). Refer to sections 8 and 12.
Remote Voltage Adjust (if used)	Check operation (refer to regulator manual).
Defective Regulator	Replace regulator (refer to regulator manual).

Symptom: Generator Operates Satisfactorily When Cold, but Shuts Down When Warm

Regulator Shutdown On Over Temperature	Correct cooling problems (refer to regulator manual).

Symptom: Generator Builds Voltage From Start-Up, Then Goes to Low (Residual) Voltage

Regulator Protective Circuit Is Operating	Check indicators on regulator. Correct problems and adjust regulator as required (refer to regulator manual).

Symptom: Equipment Runs Normally on Utility Power, but Will Not Run on Generator Set

Voltage Waveform Is Distorted	Analyze load. Excessive SCR (Thyristor) loading will cause distortion. Some equipment may be sensitive to distorted waveforms (refer to Marathon Electric).

⚠ **Read and fully understand the instructions and all warnings, cautions, & safety notice statements before attempting to install, operate or service this product.**

⚠ **Refer to Section 1 for important safety information.**

⚠WARNING **ELECTRICAL SHOCK HAZARD**

Failure to follow these instructions may result in serious personal injury, death, and/or property damage.

- ⚠ Installation and repair of electrical generators and their accessories should be attempted by qualified personnel only. Electrical connections shall be made by a qualified electrician in accordance with all local, national, international and/or other applicable codes, rules or regulations and sound practices.
- ⚠ Do not touch electrically live parts. Disconnect, lockout and tag prime mover and input power supplies before installing or servicing generator (includes accessory devices). Use a voltmeter to verify that power is off before contacting conductors.
- ⚠ Do not open terminal box or touch unprotected terminals while the generator shaft is rotating. Shaft rotation produces voltage in generators even when no excitation is applied. Residual voltage is present at the generator leads and regulator connections even when the regulator fuse is removed.

⚠WARNING **ROTATING PARTS HAZARD**

Keep extremities, hair, jewelry and clothing away from moving parts. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

⚠WARNING **EXPLOSION HAZARD**

Beware of arcing when connecting test leads. Arcing could spark an explosion if exposed to battery gases, fuel vapors or other hazardous atmospheres. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

Visual Inspection

Whenever testing and troubleshooting a generator set, it is always a good practice to make a thorough visual inspection. Remove covers and look for any obvious problems. Burnt windings, broken connectors, leads, mounting brackets, etc., can usually be identified. Look for any loose or frayed insulation, loose or dirty connections, and broken wires. Be sure all wiring is clear of rotating parts.

Verify that the generator is connected for the voltage required. This is especially important on new installations.

Check for any foreign objects, loose nuts, bolts, and electrical connectors. Clear paper, leaves, building materials, etc., that could be sucked into the generator. (Generator is air cooled; air enters the lower portion of the conduit box.) Check the air gap for clearance or obstructions (main generator and exciter).

If possible, rotate the generator rotor by hand to be sure it turns freely.

If serious problems can be identified before attempting to operate the machine, additional damage can be avoided.

Constant Excitation (12V Battery) Test

Theory: The generator output voltage is dependent on generator speed, generator design, load, and exciter input current. If the generator speed and exciter input are known, the output voltage at no load can be measured and compared to the design value. Problems can be isolated to either the generator or regulator system by using this test.

Test Procedure:

1. Shut the generator set down.
2. Connect a voltmeter to the generator output.
3. Disconnect the F1 and F2 leads at the regulator.
4. Connect a 12 volt battery capable of supplying 1 amp to the F1 and F2 leads. F1 is positive (+), F2 is negative (–).

5. With no load applied to on the generator (main breakers open), run generator at rated speed (1800 rpm – 60 Hz or 1500 rpm – 50 Hz).
6. Measure the generator output voltage.
7. Shut generator down.
8. Disconnect battery (see preceding ⚠WARNING statement).
9. Compare voltage reading with value shown in section 12.

Conclusion: If voltage readings are normal, the main generator and exciter are operating properly. Troubleshooting should continue with the regulator. If readings are not normal, the problem is in the generator. Continue testing diodes, surge suppressor, and windings.

Measuring Voltages

When testing the generator and regulator, the most frequent (and usually easiest) measurement will be a voltage. The generator will need to be running at rated speed and may have some of the protective guards and covers removed. **Be Careful.** Keep yourself and your test leads out of the way. When using alligator clips or push-on terminals, be sure the leads are supported so vibration does not shake them loose when running the generator set.

See (*Figure 8-1*) for measurement points and expected meter range settings. When in doubt, start with a higher range and work down.

Consult meter instruction manual to verify its operation and limitations.

Current (Amp) Measurements

Current measurements (AC) can be easily taken with a clamp-on type meter.

Note: Most clamp-on ammeters will not measure DC.

When measuring generator output current, be sure the clamp is around all cables **for each phase.** If the physical size of the conductors or the capacity of the meters will not permit all cables to be measured at once, each one can be measured individually. Add the individual readings together to get the total. Compare readings to the generator nameplate (nameplate ratings are always given per phase).

Amperage should never exceed the nameplate rating when running the intended load (amperage may go above nameplate momentarily when starting large motors).

When measuring exciter field amps (F1 and F2 leads), a DC meter is required. The maximum field current under full regulator forcing is 6.5 amps DC. Normal full load reading is approximately 3 amps DC.

Figure 8-1: Typical Voltage Measurements

Voltage Measurement	Test Point	Meter/Range Selection Requirement	
Generator Output Voltage	Output "T" leads or bus bars, also main circuit breaker "line" side.	System voltage – volts AC (see generator nameplate and connection diagram).	
Regulator Output (Excitor Stator Input)	F1 and F2 terminals at the regulator.	200 volts DC range. F1 is plus (+) and F2 is minus (–).	
Regulator Sensing Voltage	E1, E2, and E3 terminals at the regulator.	Usually the same as the system voltage (generator output volts); however, in some cases, sensing is taken from winding center taps or instrument potential transformers. Maximum 600 volts AC. **Example:** Center tap of 480 volt system would give 240 volts at E1, E2, or E3. **Example:** A 4160 volt system must use a transformer to step voltage down below 600 volts. See the connection diagram supplied with generator set.	
Regulator Input Volts (PMG Output Volts)	"PMG" leads at the regulator or capacitor.	200-240 VAC 180-220 VAC	300 Hz @ 1800 rpm 250 Hz @ 1500 rpm

Measuring Resistance

The generator windings can be measured and compared to the values shown in the service specification section 12.

Main Stator

The main stator winding resistance is very low. A meter capable of readings in the milliohm range would be required; however, a standard VOM (volt ohm meter) can be used to check for continuity, shorts, or grounds.

Example: With leads disconnected, a measurement from T1 to T4 should be very low (continuity on most VOMs). Measured from T1 or T4 to any other lead should be infinite. Measure from the "T" lead to the generator frame to check for grounds (reading should be infinite).

Exciter Stator

The exciter stator resistance is measured by disconnecting the F1 and F2 leads at the regulator. Measure the resistance between the leads (this value is 22–24 ohms on standard generators). Measure from the leads to the frame to check for grounds.

Main Rotor

Note markings and disconnect the main rotor leads (F1 leads and F2 leads) from the rectifier assembly. Measure the resistance of the main rotor winding. Compare reading to value shown in service specification, section 12. Measure from the leads to the exciter mounting bolt to check for grounds.

Exciter Rotor

Disconnect the exciter rotor leads at the diodes (leave leads disconnected if proceeding to check diodes). Measure resistance between phases. Compare value to service specifications, section 12. Measure from the leads to the exciter mounting bolt to check for grounds.

Testing Diodes (Rectifiers)

Diodes perform the function of an "electrical check valve." They conduct in one direction only and are used to "rectify" AC current into DC current. To test, measure the resistance first in one direction and then reverse the leads and test in the other direction. The reading should be high in the reverse direction and low in the forward direction. A shorted diode will read low in both directions. An open diode will read high in both directions.

Notes:

1. Two different polarities of diodes are used. The only difference is in the way the device is mechanically placed in the case. When changing diodes, be sure the correct polarity is used (refer to section 6, Figure 6-38).
2. Some meters do not have enough voltage output from their internal batteries to turn the diode on (about 0.6 volts is required), and the voltage can change with different range settings. Consult the instruction manual for your meter.
3. Polarities supplied by the meter's internal battery may or may not correspond to the (+) (–) markings on the meter.

Insulation Resistance – General

Insulation resistance is a measurement of the integrity of the insulating materials that separate the electrical windings from the generator's steel core. This resistance can degrade over time or due to contaminants (dust, dirt, oil, grease, and especially moisture). Most winding failures are due to a breakdown in the insulation system. In many cases, low insulation resistance is caused by moisture collected when the generator is shut down. The problem can be corrected simply by drying out the windings (see section 5).

Normally the resistance of the insulation system is on the order of millions of ohms. It is measured with a device called a "megger" which is a megaohm meter (meg is for million) and a power supply. The power supply voltage varies, but the most common is 500 Vdc. A megger voltage over 500 is not recommended, except for measuring medium voltage (2400/4160) stators only.

Generator Testing

NOTICE **First disconnect any electronic components. Regulators, diodes, surge protectors, protective relays, etc., will be destroyed if subjected to the high megger voltages.**

To measure insulation resistance, connect the red or positive megger lead to the leads for the winding to be tested, connect the back or negative megger lead to the generator frame. Be sure the leads of the part being tested are not touching any metal parts of the generator (if the neutral is grounded, it must be disconnected). Take megger reading (refer to the manual for the megger).

Insulation Resistance – Main Stator

NOTICE **Be sure the regulator, and any other electric components, metering, protective relays, etc., are disconnected before meggering. High megger voltages will destroy these parts.**

All stator leads must be isolated from ground and connected together (on most systems with grounded neutrals, the neutral can be isolated from ground and used as a test point). Connect the positive megger lead to the main stator leads. Connect the negative megger lead to the generator grounding stud. Take the megohm reading (refer to instructions for the megger).The minimum acceptable value for random wound coils is 5 megohms. For form wound coils, the value is 100 megohms.

If the reading is below the recommended value, the winding must be dried out or repaired.

Insulation Resistance – Main Rotor

Disconnect the main rotor leads from the diode bridge on the exciter rotor. Connect the leads together with the positive megger lead. Connect the negative megger lead to a good ground on the rotor assembly such as the exciter mounting bolt. Take the megohm reading (refer to instructions for the megger).

The minimum value is 5 megohms.

If the reading is low, the winding must be dried out or repaired.

Insulation Resistance – Exciter Stator

Disconnect the exciter leads F1 and F2 from the regulator. Never subject the regulator to a megger. Connect F1 and F2 together with the positive megger lead. Connect the negative megger lead to the ground stud. Take the megohm reading (refer to instructions for the megger).

The minimum value is 5 megohms.

If the reading is low, the winding must be dried out or repaired.

Insulation Resistance – Exciter Rotor

Disconnect the exciter rotor windings (6 leads from the diodes). Connect all leads together with the positive megger lead. Connect the negative megger lead to a good ground on the rotor assembly such as the mounting bolt. Take the megohm reading (refer to the instructions for the megger).

The minimum value is 5 megohms.

If the reading is low, the winding must be dried out or repaired.

Main Rotor Field AC Impedance Test

Theory: The main rotor resistance can be measured with a very accurate meter that is able to measure low (1 ohm) resistance, but it is difficult to determine if there are turn-to-turn shorts in the field pole windings. One shorted turn would only change a resistance reading on the order of one half of one percent.

The AC impedance test measures the impedance (inductance and resistance) of the field pole coils. Shorted turns in the field pole windings change the coil inductance to a much greater degree than the resistance.

Procedure:

Step 1: The rotor must be supported on a non-magnetic surface such as a wooden skid. Do not use a steel table that would create a magnetic "short circuit" between the poles.

Step 2: Apply 120 volts AC to disconnected main rotor leads F1 and F2.

Step 3: Measure and record voltages across each pole. Between points"A" and "B", "B" and "C", "C" and "D", and "D" and "E" (Figure 8-2).

Step 4: The voltage readings should balance within one volt.

Results: If the AC voltages are not balanced (30V ± 1V AC with 120V AC input) across each pole, the winding has shorted turns and should be rewound.

Refer to Marathon Electric for further information.

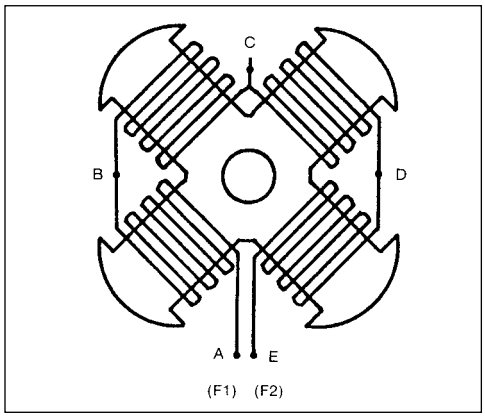
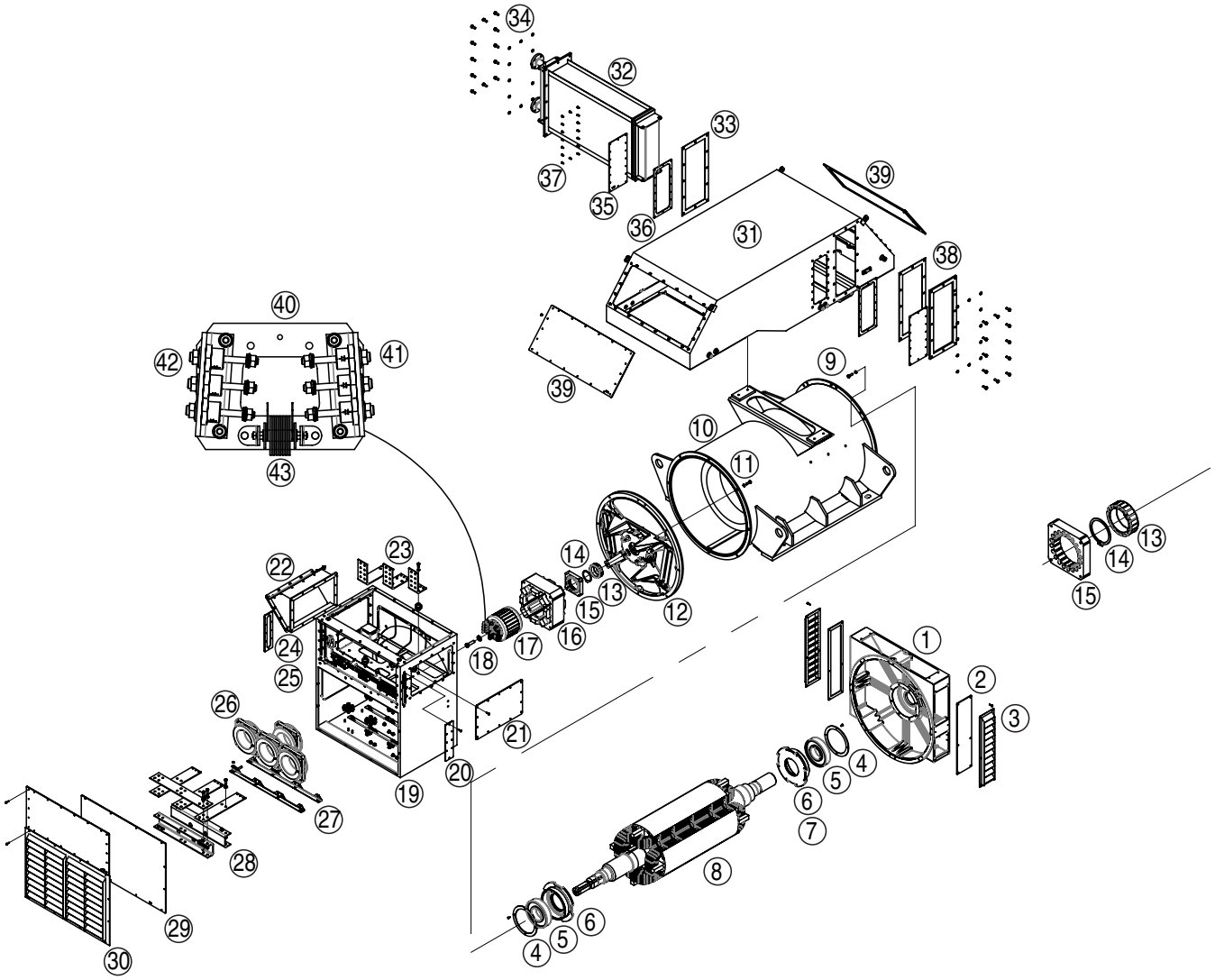


Figure 8-2

Mariner DEP/SS Parts
Two Bearing with TEWAC
Figure 9-1



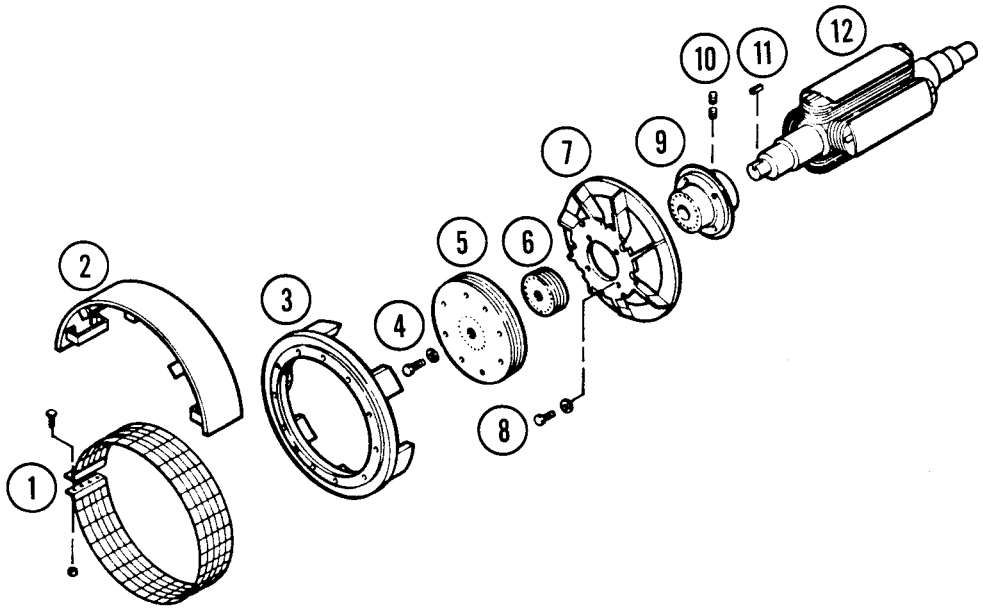
Parts List - Two Bearing with TEWAC
Table 9-1:

Item	Part Description
1	Drive End Bracket and Bearing Well
2	Solid cover (2) (Remove for emergency operation upon loss of coolant)
3	Louvered cover (2)
4	Bearing Cap
5	Bearing
6	Bearing Cartridge
7	Fan (Not Shown)
8	Main Rotor
9	Bracket Mounting Hardware
10	TEWAC Support Bracket
11	Main Body Assembly
12	Front Bracket
13	PMG Rotor
14	Snap Ring
15	PMG Stator
16	Exciter Stator
17	Exciter Rotor (Includes #40, Rectifier Assembly)
18	Exciter Rotor Retaining Screw & Washer
19	Symmetrical Conduit Box
20	Control Wire / Terminal Access Cover (2)
21	Conduit Box Side Cover
22	Conduit Entry Duct and Gland Plate (Port or Starboard mounting)
23	Line Bus Bars
24	Capacitor
25	Control Wire / Terminal Compartment
26	Current Transformers
27	Current Transformer Mounting Brackets
28	Neutral Bus Bars
29	Solid cover (Remove for emergency operation upon loss of coolant)
30	Louvered cover
31	TEWAC Enclosure
32	Heat Exchanger
33	Heat Exchanger Bracket
34	Heat Exchanger Mounting Hardware
35	TEWAC Access Cover (2)
36	TEWAC Access Cover Gasket (2)
37	TEWAC Access Cover Mounting Hardware
38	TEWAC Side Cover & Mounting Hardware
39	TEWAC Drive End Cover (2)
40	Rotating Rectifier Assembly
41	Diode Standard Polarity (3)
42	Diode Reverse Polarity (3)
43	Surge Suppressor

Note: This parts list is for reference only. Always give complete generator model and serial numbers when ordering parts.

Single Bearing Drive End Detail

Figure 9-2



Parts List - One Bearing wiht Adaption

Table 9-2:

Item	Part Description
1	Screen Assembly & Mounting Hardware
2	Drip Cover Assembly & Mounting Hardware
3	SAE Adapter
4	Drive Disc Mounting Hardware
5	Drive Discs
6	Disc Spacers
7	Fan
8	Fan Mounting Hardware
9	Drive Hub
10	Drive Hub Set Screws
11	Drive Hub Key
12	Main Rotor Assembly

Standard Tools

The Mariner DEP/SS generator is assembled with American standard SAE hardware. Wrench sizes from 5/16 inch to 7/8 inch are used. A socket head set screw is used in the drive hub. A 1/4 inch allen type wrench is required to remove it.

All fasteners should be properly torqued (see section 12). Torque wrenches ranging from 25 in-lb through 200 ft-lb should be available.

Electrical test equipment should include a voltmeter or multimeter (VOM), clamp on ammeter, accurate frequency meter or tachometer and a megohmmeter. (See section 8 – Generator Testing for more information.)

Special Tools

In addition to the standard tools mentioned above, the following special tools will facilitate removal and installation of large and/or special parts. These tools can be obtained from the Marathon Electric parts department.

Exciter Stator Lifting Fixture (Figure 10-1) – In cases where the exciter stator is to be serviced without removing the generator conduit box, this fixture can be used with overhead rigging to remove and reinstall the exciter stator.

Exciter Rotor Puller Bolt (Figure 10-2) – The exciter rotor has a built-in pulling system. With the use of this bolt, the rotor can be easily removed from the shaft without damage to the winding.

Snap Ring Pliers (Figure 10-3) – The PMG rotor is installed to the generator shaft with a snap ring. The nominal shaft diameter is 2-3/4 inches and the ring must be spread approximately 3/4 inches for removal. To install the snap ring, use a piece of pipe with a 2-3/4 inch ID (Figure 10-4). Push the PMG rotor and snap ring onto the shaft until the ring snaps into the groove.

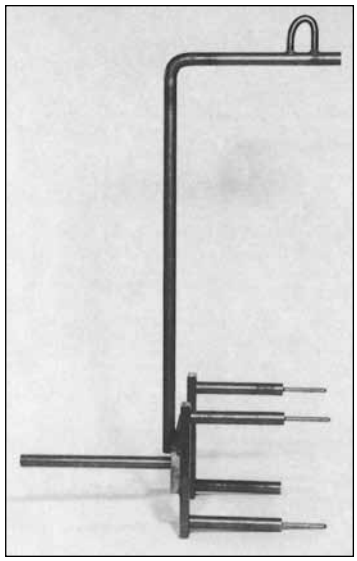


Figure 10-1

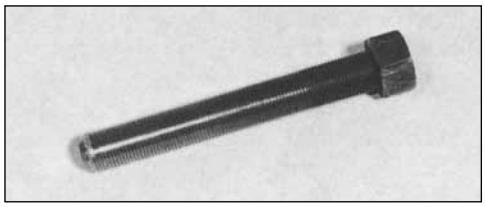


Figure 10-2

Figure 10-3

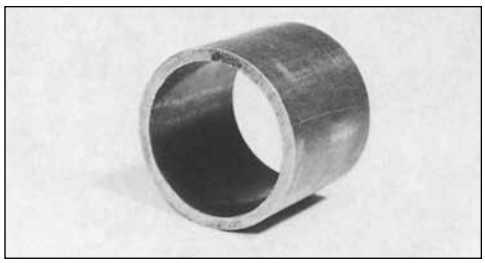


Figure 10-4

Rotor Lifting Fixture (Figure 10-5) – The main generator rotor is heavy (approx. 1/2 the weight of the generator) and difficult to handle. The proper fixture should be used whenever removing or installing the main rotor into the main stator. Without proper care and equipment, the windings can be easily damaged.

Miscellaneous

A selection of wiring devices such as electric connectors, tape, cable ties, crimping and stripping tools, etc., should also be a part of the generator service tool kit. The standard regulator uses flat 1/4 inch female insulated terminals for AWG #14 wire.

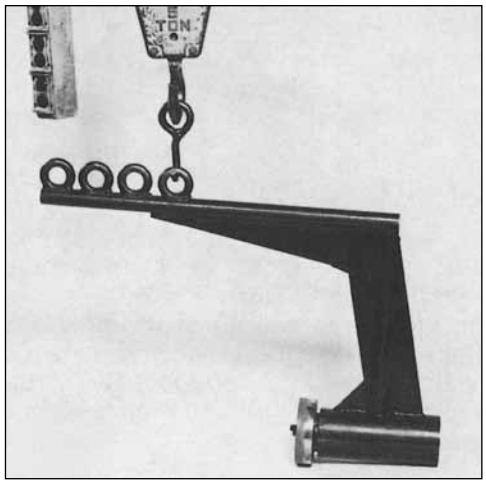


Figure 10-5

Preparation For Shipment Or Extended Storage

Shipping Instructions

Shipping and handling will be much easier if the generator is fastened to a suitable shipping skid that will allow handling by a forklift. The skid should extend beyond the generator in all directions. If the original skid is available, it should be used. Marathon Electric will supply shipping skid drawings upon request.

Overseas shipping may require special export crating. Check with your freight carrier.

When installed, single bearing generator rotors are supported on the drive end by the drive discs bolted to the engine flywheel. When the engine is removed, the rotor must be supported by an appropriate fixture to prevent main rotor, main stator, or exciter damage (Figure 11-1). Before shipping any single bearing generator, the main rotor must be supported by the adapter using an appropriate fixture.

NOTICE **Do not attempt to transport any generator without proper rotor support. Extensive equipment damage can occur.**

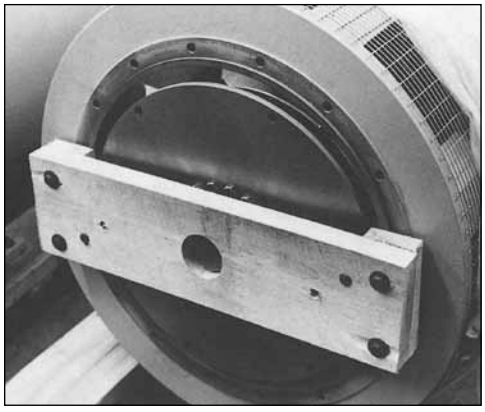


Figure 11-1

Storage Instructions

If the generator or gen-set is placed into storage, the following precautions should be taken to protect it:

A. Equipment must be kept clean.
   1. Store indoors.
   2. Keep covered to eliminate airborne dust and dirt.
   3. Cover openings for ventilation, conduit connections, etc., to prevent entry of rodents, snakes, birds, insects, etc.

B. Equipment must be kept dry.
   1. Store in a dry area indoors.
   2. Temperature swings should be minimal to prevent condensation.
   3. If stored in an unheated or damp building, space heaters will be required to prevent internal condensation.
   4. Treat unpainted flanges, shafts, drive discs, and fittings with a rust inhibitor.
   5. Check insulation resistance of all windings **before** starting the generator. If readings are low, the windings must be dried (see section

C. Keep bearings lubricated.
   1. Every six months, rotate shaft several turns to distribute grease in bearings.
   2. If unit has been stored more than one year, add grease before start-up.

D. Review and follow instructions in sections 3 and 4 before putting the gen-set into service.

Specifications

12

Table 12-1: Mariner® DEP/SS – **Fastener & Torque Specifications**

Part Description	Fastener Spec. ③	570 Frames Size ① Dia.–Thread	570 Frames Torque ② Ft-Lb	740 Frames Size ① Dia.–Thread	740 Frames Torque ② Ft-Lb
Front Bracket	Grade 5 capscrews with flat and lock washers	3/8-16	25	1/2-13	60
Bearing Caps	Grade 5 capscrews with lock washers	3/8-16	25	3/8-16	25
Drive Disc	Grade 8 capscrews with hardened washers	5/8-18	192	5/8-18	192
Adapter (or Rear Bracket)	Grade 5 capscrews with flat and lock washers	3/8-16	25	1/2-13	60
Conduit Box	Grade 5 capscrew with star type lock washer	3/8-16	25	1/2-13	60
PMG Stator	Grade 5 capscrews with belleville washers	1/4-20	4	1/4-20	4
Exciter Stator	Grade 5 capscrews with belleville washers	1/2-13	60	1/2-13	60
Exciter Armature (Rotor)	Grade 8 capscrew with belleville washer	1/2-13 3/4-10	84 300	1/2-13 3/4-10	84 300
Cooling Fan	Grade 5 capscrews with belleville washers	1/2-13	60	1/2-13	60
Main Rotor Coil Supports ④	Grade 8 capscrews with belleville washers	5/16-18	19	3/8-16	35
Rectifier Assembly Mounting	Grade 5 capscrews	1/4-20	4	1/4-20	4
Drive Hub Set Screw	Socket head set screw – 1/4 in. hex key	1/2-13	50	1/2-13	50

NOTES:

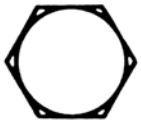
① All fasteners are SAE (American) standard.

② All torque values are for plated hardware which is standard on the Mariner® DEP/SS. If hardware is replaced with non-plated, refer to Table 12-2.

③ Always use quality hardware of the grade specified.

④ 570 and 740 frame only.

Table 12-2: Capscrew Torque Values

Capscrew Dia. and Ultimate Tensile Strength (PSI)	To 1/2 – 69,000 PSI To 3/4 – 64,000 PSI To 1 – 55,000 PSI			To 3/4 – 120,000 PSI To 1 – 115,000 PSI			150,000 PSI		
SAE Grade Number	1 or 2			5			8		
Capscrew Head Markings									
Capscrew Body Size (Inches) – (Thread)	Torque Ft-Lb (N-m)			Torque Ft-Lb (N-m)			Torque Ft-Lb (N-m)		
	Dry	Oiled	Plated	Dry	Oiled	Plated	Dry	Oiled	Plated
1/4 - 20	5 (7)	4.5 (6)	4 (5)	8 (11)	7 (9)	6 (8)	12 (16)	11 (15)	10 (14)
- 28	6 (8)	5.4 (7)	4.8 (6)	10 (14)	9 (12)	8 (11)	14 (19)	13 (18)	11 (15)
5/16 - 18	11 (15)	10 (14)	9 (12)	17 (23)	15 (20)	14 (19)	24 (33)	22 (30)	19 (26)
- 24	13 (18)	12 (16)	10 (14)	19 (26)	17 (23)	15 (20)	27 (37)	24 (33)	22 (30)
3/8 - 16	18 (24)	16 (22)	14 (19)	31 (42)	28 (38)	25 (34)	44 (60)	40 (54)	35 (47)
- 24	20 (27)	18 (24)	16 (22)	35 (47)	32 (43)	28 (38)	49 (66)	44 (60)	39 (53)
7/16 - 14	28 (38)	25 (34)	22 (30)	49 (66)	44 (60)	39 (53)	70 (95)	63 (85)	56 (76)
- 20	30 (41)	27 (37)	24 (33)	55 (75)	50 (68)	44 (60)	78 (106)	70 (95)	62 (84)
1/2 - 13	39 (53)	35 (47)	31 (42)	75 (102)	68 (92)	60 (81)	105 (142)	95 (129)	84 (114)
- 20	41 (56)	37 (50)	33 (45)	85 (115)	77 (104)	68 (92)	120 (163)	108 (146)	96 (130)
9/16 - 12	51 (69)	46 (62)	41 (56)	110 (149)	99 (134)	88 (119)	155 (210)	140 (190)	124 (168)
- 18	55 (75)	50 (68)	44 (60)	120 (163)	108 (146)	96 (130)	170 (230)	153 (207)	136 (184)
5/8 - 11	83 (113)	75 (102)	66 (89)	150 (203)	135 (183)	120 (163)	210 (285)	189 (256)	168 (228)
- 18	95 (129)	86 (117)	76 (103)	170 (230)	153 (207)	136 (184)	240 (325)	216 (293)	192 (260)
3/4 - 10	105 (142)	95 (130)	84 (114)	270 (366)	243 (329)	216 (293)	375 (508)	338 (458)	300 (407)
- 16	115 (156)	104 (141)	92 (125)	295 (400)	266 (361)	236 (320)	420 (569)	378 (513)	336 (456)
7/8 - 9	160 (217)	144 (195)	128 (174)	395 (535)	356 (483)	316 (428)	605 (820)	545 (739)	484 (656)
- 14	175 (237)	158 (214)	140 (190)	435 (590)	392 (531)	348 (472)	675 (915)	608 (824)	540 (732)
1 - 8	235 (319)	212 (287)	188 (255)	590 (800)	531 (720)	472 (640)	910 (1234)	819 (1110)	728 (987)
- 14	250 (339)	225 (305)	200 (271)	660 (895)	594 (805)	528 (716)	990 (1342)	891 (1208)	792(1074)

NOTES:

① Capscrews threaded into aluminum may require reductions in torque of 30% or more.

Generator Formulas

Generator Formulas ①

To Find	Known Values	Three Phase
kWe	Volts, Current, Power Factor	$\frac{E \times 1 \times 1.73 \times PF}{1000} = kVA \times PF$
kVA	Volts, Current	$\frac{E \times 1 \times 1.73}{1000} = \frac{kWe}{PF}$
RkVA	Volts, Current, Power Factor	$\frac{E \times 1 \times 1.73 \times \sqrt{1 - (PF)^2}}{1000}$
HP – Engine Output	Generator kWe Generator Efficiency Radiator Cooling Fan HP Battery Charging Generator HP	$\frac{kWe}{Efficiency \times .746} + \text{Rad. Cooling Fan HP} + \text{Bat. Chg. Gen. HP}$
kWe – Required for Motor	Motor HP, Eff.	$\frac{HP \times .746}{Efficiency}$
kVA – Required for Motor	Motor HP, Eff., Power Factor	$\frac{HP \times .746}{Efficiency \times PF}$
Amps	HP, Volts	$\frac{HP \times .746}{1.73 \times E \times Efficiency \times PF}$
Amps	kWe, Volts, Power Factor	$\frac{kWe \times 1000}{E \times 1.73 \times PF}$
Amps	kVA, Volts	$\frac{kVA \times 1000}{E \times 1.73}$
Frequency (Hz)	rpm, Poles	$\frac{rpm \times Poles}{2 \times 60}$
Poles	Hz, rpm	$\frac{2 \times 60 \times Hz}{rpm}$
rpm	Hz, Poles	$\frac{2 \times 60 \times Hz}{Poles}$

① E = Volts
I = Current (Amps)
PF = Power Factor

Important Information

Resale of Goods

In the event of the resale of any of the goods, in whatever form, Resellers/Buyers will include the following language in a conspicuous place and in a conspicuous manner in a written agreement covering such sale:

The manufacturer makes no warranty or representations, express or implied, by operation of law or otherwise, as to the merchantability or fitness for a particular purpose of the goods sold hereunder. Buyer acknowledges that it alone has determined that the goods purchased hereunder will suitably meet the requirements of their intended use. In no event will the manufacturer be liable for consequential, incidental or other damages. Even if the repair or replacement remedy shall be deemed to have failed of its essential purpose under Section 2-719 of the Uniform Commercial Code, the manufacturer shall have no liability to Buyer for consequential damages.

Resellers/Buyers agree to keep a printed copy of this entire document in a conspicuous place and in a conspicuous manner in writing to instruct users on the safe usage of the product.

This information should be read together with all other printed information supplied by Marathon Electric.

For more information contact: Marathon Electric Generators, RBC Manufacturing Corporation, 100 E. Randolph St., Wausau, WI 54401 Phone: 715-675-3311 or Fax: 715-675-8030.

Notes

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