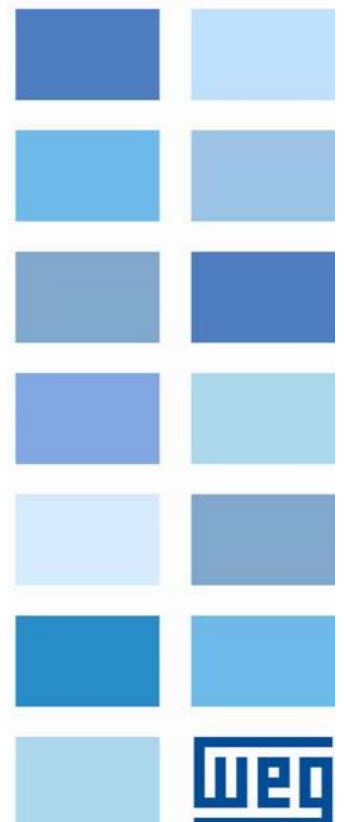
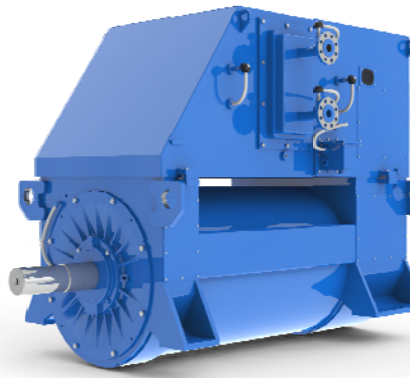
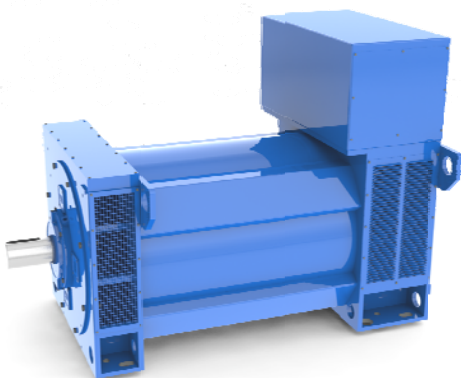


Synchronous Alternators

AN10 line - Horizontal

Naval application

Installation, Operation and Maintenance Manual





Installation, Operation and Maintenance Manual

Document number: 12471188

Models: AN10

Language: English

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May 2014

Dear Customer,

Thank you for purchasing the WEG alternator. It is a product developed with quality and efficiency levels that ensure optimal performance.

Electricity plays a role of major importance for the comfort and well-being of humanity. Since the alternator is responsible for generating this energy, it must be identified and treated as a machine whose characteristics require certain care, including storage, installation, operation and maintenance. All efforts were made to ensure the information contained herein is accurate regarding the configurations and use of the alternator.

Thus, we recommend reading this manual carefully before installing, operating and servicing the alternator in order to ensure a safe and continuous operation of the alternator and guarantee the personnel's and installations' safety. If you need any further information, please, contact WEG. Keep this manual always near the alternator, so it can be referred to whenever necessary.



ATTENTION

1. It is imperative to follow the procedures contained in this manual for the warranty to be valid;
2. The procedures for installation, operation and maintenance of the alternator must be carried out by qualified people.



NOTE

1. Reproduction of the information contained in this manual, in whole or in part, is permitted provided that the source is mentioned;
2. If this manual is lost, a copy in electronic format may be obtained at www.weg.net or you may request WEG a printed copy.

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1 INTRODUCTION

This manual is intended to provide the necessary information on **synchronous alternators AN10** for naval applications. Alternators with special features can be supplied with specific documents (drawings, wiring diagrams, characteristic curves, etc.). These documents must be carefully studied together with this manual before installing, operating or servicing the alternator.

Contact WEG if it is necessary further explanations. All procedures and standards contained in this manual must be observed in order to ensure the correct operation of the alternator and the safety of the professionals involved in its operation. Observing these procedures is also important so as to ensure the warranty of the alternator. Thus, we recommend reading this manual thoroughly before installing and operating the alternator. If applicable further information if necessary, contact WEG.



ATTENTION

In case of replacement of the components mentioned in this manual, the manufacturing date must be checked against the manual review date.

1.1 SAFETY WARNINGS IN THE MANUAL

In this manual are used the following safety warnings:



DANGER

Failure to observe the procedures recommended in this warning may result in substantial property damage, serious injury or death.



ATTENTION

Failure to observe the procedures recommended in this warning may result in property damage.



NOTE

The text with this warning is intended to provide important information for the correct understanding and proper operation of the product.

1.2 TERMINOLOGY

AN10 50 D M K M 2 A V

ALTERNATOR LINE

G – Synchronous machine for generator set

IEC FRAME

45 – Frame 450

50 – Frame 500 ...

OUTPUT RANGE

A – 1100 up to 1250 kVA

B – 1251 up to 1500 kVA

C – 1501 up to 1900 kVA

D – 1901 up to 2250 kVA

E – 2251 up to 2500 kVA

F – 2501 up to 2750 kVA

G – 2751 up to 3000 kVA

X - Outra

VOLTAGE

B – 690 V

M – 4160 V

S – Other

MOUNTING AND SHAFT END HEIGHT

S – IM1001 – height according to IEC standard

K – IM1101 – height 297

M – IM1101 – height 350

X – IM1101 – Other

EXCITATION TYPE

N – Without PMG

M – With single phase PMG

T – With three phase PMG

COOLING and DEGREE OF PROTECTION

1 – IC01 – IP23

2 – IC81W – IP55

3 – IC01 – IP44

4 – IC81W – IP44

9 - Other

NAVAL CERTIFICATION

A – ABS

D – DNV

L – LLOYD'S

B – Bureau Veritas

G – GL

X – Other

WEG DESIGNATION

N, V


2 GENERAL INSTRUCTIONS

Professionals who work with electrical installations, either in their assembly, operation or maintenance, must be continuously updated and informed about safety rules and recommendations concerning the service and are advised to observe them strictly. Before beginning any job, the person in charge must make sure that all the safety measures were properly taken and warn the operators of the dangers inherent to the task performed. Alternators of this kind, if improperly used or poorly serviced, or when service by unqualified people, may cause serious personal injury and/or material damage. Therefore, it is recommended that these services be always performed by qualified people.

2.1 QUALIFIED PEOPLE

The term qualified person means those who, due to their training, experience, education level, knowledge of applicable standards, specifications, safety standards, accident prevention and knowledge of the operating conditions, have been authorized by the people in charge to execute all necessary services, and who are able to recognize and avoid any possible danger. Those qualified people must also know first aid procedures and be able to provide that if necessary. It is assumed that the entire commissioning, maintenance and repair work is made by qualified people only.

2.2 SAFETY INSTRUCTIONS



DANGER

During operation, this equipment has energized or rotating parts exposed, which may present high voltage or high temperatures. Thus, the operation with terminal boxes open, unprotected couplings, or incorrect operation, disregarding the operating standards, may cause serious injury and property damage.

Those responsible for the safety in the installation must ensure that:

- Only qualified people install and operate the equipment;
- Those people have this manual at hand and other documents supplied with the alternator, as well as perform the work strictly observing the service instructions, relevant standards and specific documentation of the products;

Failure to comply with installation and safety standards may void the product warranty.

Equipment for fire fighting and first aid signs must be provided at the workplace in clearly visible and easily accessible places.

Also, observe:

- All technical data regarding applications permitted (operating conditions, connections and installation environment) contained in the catalog, order documentation, operating instructions, manuals and other documents;
- The determinations and conditions specific to the installation site;
- The use of tools and equipment suitable for handling and transport;
- That the protective devices of the individual components be removed shortly before installation.

The individual parts must be stored in an environment free of vibrations, preventing falls and ensuring that they are protected against aggressive agents and/or do not endanger the safety of people.

2.3 STANDARDS

Alternators are specified, designed, manufactured and tested according to the following standards:

Table 2.1: Applicable Standards


	IEC	NBR	ISO
Specification	60034-1	5117	
Dimensions	60072	5432	
Tests	60034-4	5052	
Degree of protection	60034-5	9884	
Cooling	60034-6	5110	
Mounting	60034-7	5031	
Noise	60034-14	5117	8528

2.4 ENVIRONMENT

The ambient operating conditions for which the alternators were designed are as follows:

1. Ambient temperature: – 15°C to + 45°C;
2. Altitude (m.a.s.l.): up to 1000 m;
3. Environments according to the degree of protection of the alternator.

Special environment conditions are described on the nameplate and specific data sheet of the alternator.



ATTENTION

In order to use water-cooled alternators at temperatures below 0 °C, antifreeze additives must be used in the water.

2.4.1 Aggressive and/or sea environments

Aggressive environments comprise sea environment or with salinity and/or high humidity, suspended materials that can be abrasive, naval applications and environments with high ambient temperature variation. The synchronous alternators for naval applications are subject to harsh environments and are provided with additional protection against corrosion and poor insulation, ensuring, upon request, the guarantee of product performance.

2.5 OPERATING CONDITIONS

For the warranty of the product to be valid, the alternator must operate according to the rated data, follow applicable standards and codes and the information contained herein.


3 RECEIVING, STORAGE AND HANDLING

3.1 RECEIVING

All alternators are tested and are supplied in proper operating condition. The machined surfaces are protected against corrosion. The package must be inspected immediately upon receipt so as to check whether it suffered any damage during transport.



ATTENTION
Any damage must be photographed, documented and reported immediately to the carrier, the insurer and WEG. Failure to observe this procedure will void the warranty.




ATTENTION
Parts supplied in additional packs must be checked upon receipt.

- When lifting the package, observe the proper lifting points, the weight stated in the documentation and / or on the nameplate, as well as the capacity and operation of the lifting devices;
- Alternators packed in wooden crates must always be raised by their own eyebolts or by a proper forklift, but never by the wood;
- The package can never be overturned. Place it on the ground carefully (without impacts) to avoid damage to the bearings;
- Do not remove the grease protections against corrosion from the shaft end, coupling discs and flange, or the plugs closing the holes of the terminal box;
- These protections must remain in place until the moment of the final assembly. After unpacking, you must perform a complete visual inspection on the alternator;
- The shaft locking system must be removed just before the installation and stored in a safe place to be used in a future transportation of the alternator.

3.2 STORAGE

Any damage to the paint or protection against rust of the machined parts must be corrected.



ATTENTION
During storage, the space heaters (if applicable) must remain connected to prevent water condensation inside the alternator.

3.2.1 Storage in sheltered environment

If the alternator is not installed immediately upon receipt, it must remain in the package and stored in a place protected from moisture, steam, rapid temperature changes, rodents, insects and other agents that may damage the machine.

For the bearings not to be damaged, the alternator must be stored in places free from vibration.

3.2.2 Storage in unprotected environment

The alternator should be stored in a dry place, free from floods and vibration.

Repair any damage in the package before storing the alternator, which is needed to ensure proper storage conditions.

Position the alternator on platforms or foundations that ensure protection against soil moisture and prevent it from sinking into the ground. It must be ensured free air circulation underneath the alternator.


The cover or canvas used to protect the alternator against the weather must not be in contact with its surfaces. To ensure the free air circulation between the alternator and such covers, use wooden blocks as spacers.

3.2.3 Extended storage

When the alternator is stored, the empty spaces inside it, in the bearings, in the terminal box and windings are exposed to air humidity, which can condense.

Depending on the type and degree of air pollution, also aggressive substances can penetrate these empty spaces.

As a result, after prolonged storage, the resistance of the winding insulation can fall below the acceptable values. Internal components, such as bearings, may oxidize and the lubrication capacity of the lubricant may be affected. All these influences increase the risk of damage before the operation of the alternator.



ATTENTION
To avoid losing the warranty of the alternator, it must be ensured that all preventive measures described in this manual are observed and recorded.

The instructions outlined below are valid for alternators, which are stored for long periods and/or are out of operation for a period of **two months or more**.

3.2.3.1 Storage location

To ensure the best storage conditions of the alternator for long periods, the location must comply strictly with the criteria described below.

3.2.3.1.1 Storage in sheltered environment

- The environment must be closed and covered;
- The local must be protected against moisture, vapors, aggressive agents, rodents and insects;
- There can't be the presence of corrosive gases such as chlorine, sulfur dioxide or acids;
- The environment must be free of continuous or intermittent vibration;
- The environment must feature ventilation system with air filter;
- Ambient temperature between 5°C and 60°C, seeing that sudden temperature variations must not occur;
- Air relative humidity <50%;
- Feature a dirt and dust prevention system;
- Feature fire detection system;
- It must be provided with electricity to supply the space heaters (if applicable).

If applicable of these requirements is not met in the storage place, WEG suggests that additional protections be incorporated to the package of the alternator during the storage period, as follows:


- Closed wooden box or similar package with electrical wiring that allows the space heaters (if applicable) to be energized;
- If there is a risk of infestation and fungus formation, the package must be protected in the storage place by spraying it or painting it with appropriate chemicals;
- The preparation of the package must be done carefully by a qualified person.

3.2.3.1.2 Unprotected storage environment

It is not recommended to store the alternator in an unprotected place.

If the storage in unprotected environment cannot be avoided, the alternator must be packed in specific package for this condition, as follows:

- For storage in unprotected environment, besides the recommended package for internal storage, the package must be covered with a protection against dust, moisture and other foreign materials, using for this purpose a piece of canvas or sturdy plastic;
- Place the package on platforms or foundations that ensure protection against moisture and prevent it from sinking into the ground;
- Once the alternator is covered, a shelter should be erected to protect it from direct rain, snow or excessive heat from the sun.



ATTENTION

If the alternator is kept in storage for long periods, it is recommended to regularly inspect it as specified in item "**Maintenance Plan during storage**" of this manual.

3.2.3.2 Parts

- If parts are supplied separately (terminal boxes, covers, etc.), these parts must be packed as specified in items 3.2.3.1.1 and 3.2.3.1.2.
- The air relative humidity inside the package must not exceed 50%.
- The bearings must not be subject to shocks, falls or storage with vibration or humidity, which can cause dents on the internal tracks or on the balls, reducing the useful life.

3.2.3.3 Space heaters

The space heaters of the alternator (if applicable) must remain energized during the storage period so as to avoid moisture condensation inside the alternator and thus ensure that the winding insulation resistance remains at acceptable levels.

3.2.3.4 Insulation resistance

During the storage period, the stator, rotor and exciter winding insulation resistance of the alternator must be measured and recorded every three months and prior to the installation of the alternator.

Any drop in the value of the insulation resistance must be investigated.

3.2.3.5 Exposed machined surfaces

All exposed machined surfaces (for example, shaft end, flange, coupling disk) are protected at the factory with a temporary protective agent (rust inhibitor).


This protective coating must be reapplied at least every 6 months or when it is removed and/or damaged.

Recommended Products:

Name: Anticorit BW protective oil, Manufacturer: Fuchs

3.2.3.6 Bearings

The rolling bearings are lubricated at the factory for testing. During the storage period, every two months the locking device must be removed from the shaft and the shaft rotated manually to keep the good conditions of the bearing. After 6 months of storage and before start-up, the rolling bearings must be relubricated. If the alternator is kept in storage for over two years, the rolling bearings must be cleaned, inspected and relubricated so as to ensure their integrity.



ATTENTION

If you cannot turn the shaft of the alternator, as recommended, check the conditions of the rolling bearing before the commissioning of the alternator.

3.2.3.7 Terminal box

When the alternator winding insulation resistance is measured, the main terminal box and the other terminal boxes must be inspected, considering especially the following aspects:

- The inside must be dry, clean and free of dust accumulation;
- The contacts cannot present corrosion;
- The seals must be in proper conditions;
- The cable inputs must be properly sealed according to the machine degree of protection.

If applicable of these items is not correct, the parts must be cleaned or replaced.

3.2.3.8 Inspections and records during storage

Stored alternators must be periodically inspected and inspection records must be filed.

The following points must be inspected:

1. Physical damages;
2. Cleanliness;
3. Signs of water condensation;
4. Conditions of the protective coating of the machined parts;
5. Paint conditions;
6. Signs of aggressive agents;
7. Satisfactory operation of space heaters (if any). It is recommended that a signaling system or alarm be installed in the location in order to detect power interruption in the space heaters;
8. It is recommended to record the ambient temperature and air relative humidity around the machine, winding temperature, insulation resistance and polarization index;
9. The storage location must also be inspected so as to ensure its compliance with the criteria described in the item "**Storage Location**".

3.2.3.9 Preparation for commissioning


3.2.3.9.1 Cleaning

- Generator inner and outer parts must be free of oil, water, dust, and dirt.
- Remove the rust inhibitor from the exposed surfaces with a cloth dampened in a petroleum-based solvent;
- Make sure the bearings and cavities used for lubrication are free of dirt and the cavity plugs are correctly sealed and tightened.

3.2.3.9.2 Bearing lubrication

Use the specified lubricant to lubricate the bearing. The information on bearings and lubricants, as well as the procedure for lubrication, are described in item "**Bearing Maintenance**" of this manual.

3.2.3.9.3 Checking the insulation resistance

	<p>ATTENTION</p> <p>Before operating the alternator, the insulation resistance must be measured according to the item "Insulation resistance" of this manual.</p>
---	---

3.2.3.10 Cooling system

For water-cooled alternators, if they remain out of operation for a long time, it must be ensured the water runs freely in the alternator cooling circuit before starting it again.

3.2.3.10.1 Others

Follow the other procedures described in the item "**Commissioning**" in this manual before performing the start-up of the alternator.

3.2.3.11 Maintenance Plan during storage

During the storage period, the alternator maintenance must be performed and recorded according to the plan described in Table 3.1.

Table 3.1: Storage plan

	Monthly	Every two months	Every six months	Every two years	Before commissioning	NOTE!
Storage location						
Inspect the cleaning conditions		X			X	
Inspect the humidity and temperature conditions		X				
Check signals of aggressive agents		X				
Package						
Inspect physical damage			X			
Inspect relative humidity inside		X				
Change the dehumidifier in the package (if any)			X			Whenever necessary
Space heaters						
Check the operating conditions	X					
Complete alternator						
Perform external cleaning			X		X	
Perform internal cleaning					X	Whenever necessary
Check the paint conditions			X			
Check the oxidation inhibitor on exposed parts			X			Replace the inhibitor, if necessary
Windings						
Measure the insulation resistance		X			X	
Measure polarization index		X			X	
Terminal boxes and ground terminals						
Clean the inside of the terminal boxes				X	X	
Inspect the seals				X	X	
Tighten the terminal connections					X	in accordance with tightening torque informed in this manual
Bearings						
Turn the shaft of the alternator		X				
Relubricate the bearing			X		X	
Disassemble, clean, inspect and relubricate the bearing				X	X	If the storage period is longer than 2 years

3.3 HANDLING

Proper handling

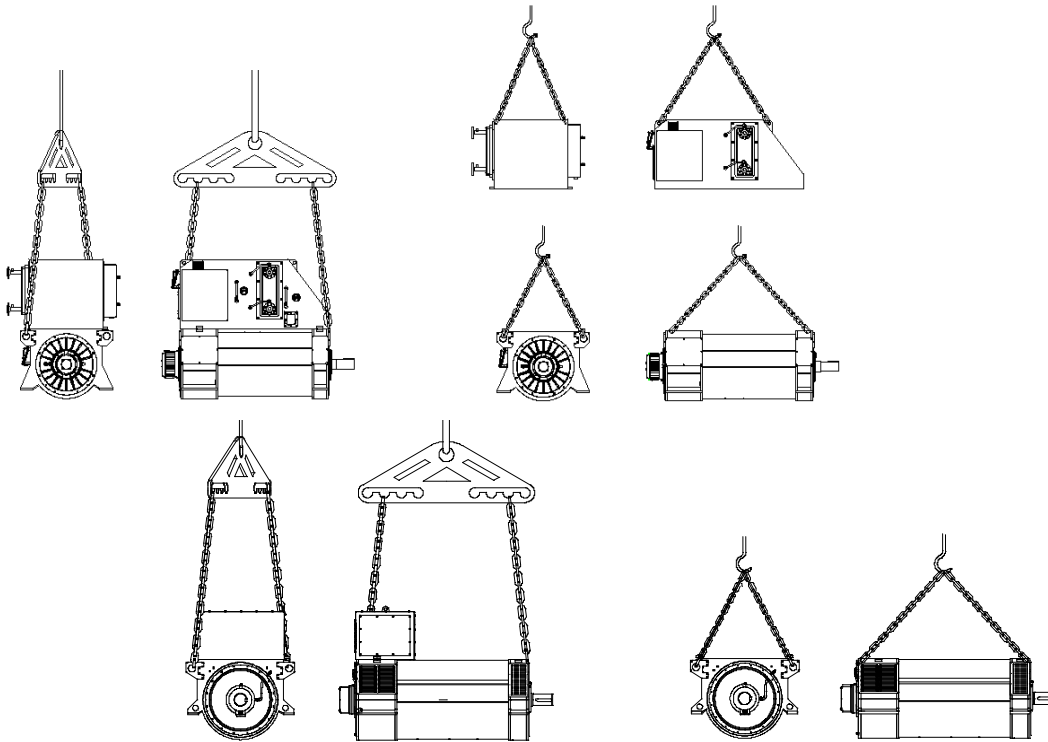


Figure 3.1: Proper handling

Improper handling

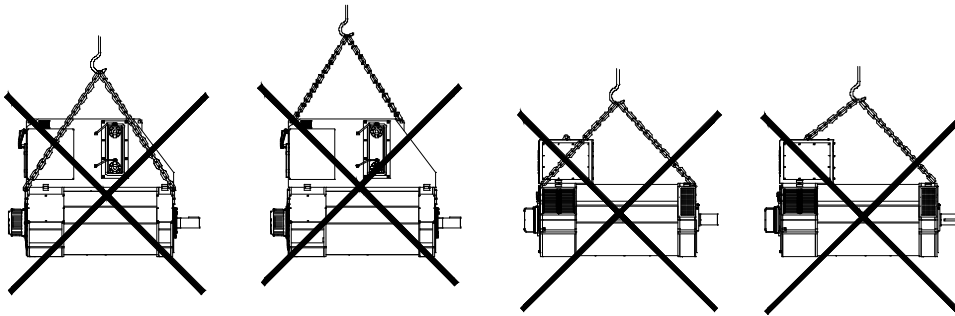


Figure 3.2: Improper handling

- The alternator was designed with eyebolts for lifting. These eyebolts are designed to lift only the alternator; additional loads are not permitted;
- Cables and lifting devices must be appropriate.



NOTES

- Observe the weight informed.
- Do not lift and do not put the alternator on the ground suddenly to avoid damage to the bearings.
- To lift the alternator, use only the existing eyebolts. If you necessary, use a beam to protect parts of the alternator.
- The eyebolts on the covers, bearings, terminal box, etc., are intended to handle these components only.
- Never use the shaft to lift the alternator.
- To move the alternator, the shaft must be locked with the locking device supplied with the alternator.



ATTENTION

Steel cables, clevises and lifting equipment must be appropriate and able to withstand the weight of the alternator so as to avoid accidents, damage to the alternator and injuries.

4 INSTALLATION

4.1 INSTALLATION LOCATION

The alternator must be installed in easily accessible locations, which allow the execution of periodic inspections, local maintenance and, if necessary, the removal of the alternator for external services.

The following environmental features must be provided:

- The alternator must receive fresh and clean air and the location must allow the easy exhaust of the air from the operating environment, preventing air recirculation;
- The alternator must not aspire the exhaust from the diesel engine, because soot is an electric conductor and shortens the life of the insulation, which can cause the burning of the alternator;
- The installation of other equipment or walls must not hinder or obstruct the ventilation of the alternator;
- There must be space enough around and above the alternator for servicing or handling it;
- The environment must comply with the alternator degree of protection.



NOTE

For alternators with single bearing, the shaft locking device (used to protect the rotor/stator against damage during transportation) must only be removed right before coupling it to the driving machine.

4.2 DIRECTION OF ROTATION

Alternators can operate in both directions of rotation.

The phase sequence is set **clockwise rotation** (facing the shaft end of the alternator - drive end).

The alternator terminals are marked in such a way that the sequence of the terminals U, V and W matches the phase sequence R, S and T or L1, L2 and L3, when the rotation is clockwise.

In the case of alternators that need to operate in the **counterclockwise** direction, the phase sequence must be changed (if required). It is recommended to check the direction of rotation and phase sequence required before the start-up of the alternator.



ATTENTION

Wrong phase sequence may cause damage to the equipment supplied by the alternator. In the case of operation in parallel with other alternators and/or network, they must have the same phase sequence.

4.3 DEGREE OF PROTECTION

It is essential to observe the degree of protection of the alternator in relation to the installation environment so as to ensure the proper performance and long life of the equipment.

4.4 COOLING

Open alternators

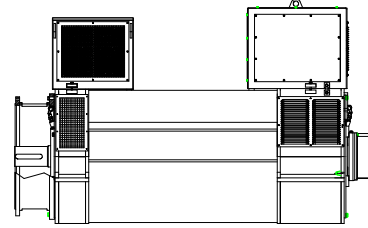


Figure 4.1: IC01 Cooling

Open alternators are cooled by the internal fan.

Closed alternators

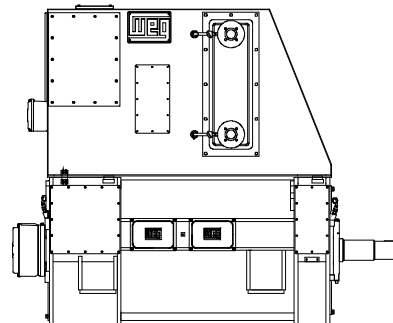


Figure 4.2: IC81W Cooling

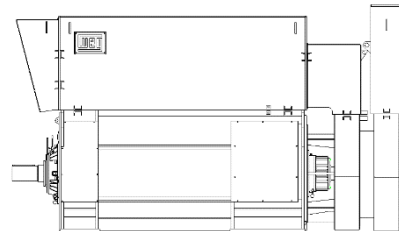


Figure 4.3: IC611 Cooling

Closed alternators are cooled through the air-water heat exchanger (IC81W) or air-air heat exchanger (IC611).

The water supply system for alternators IC81W must be installed by the user, meeting the characteristics of the heat exchanger nameplate.



ATTENTION

- In order to ensure the proper operation and prevent the overheating of the alternator, the data of the cooling system informed on the nameplate must be strictly observed;
- Water or air inputs and outputs must not be blocked in order to prevent overheating and even the burning of the alternator.

4.4.1 Characteristics of the cooling water

Always use treated industrial water with the following characteristics:

- ph: 7.0 to 8;
- Chlorides: < 50 ppm;
- Iron content: < 0.3 ppm
- Hardness: < 150 ppm
- Alkalinity: < 200 ppm
- Conductivity: < 400µS/cm;
- Sulfate: < 50 ppm;
- Nitrate: < 10 ppm;
- Ammonia: < 10 ppm;
- Maximum size of charged particles in the water: ≤ 0.1mm:



ATTENTION

For cooling the alternator, a closed-circuit water system must be used, and the water must meet the characteristics specified in item 4.4.1.

Add additives to the cooling water in proper quantities for protection against corrosion and seaweed growth. The type and amount of additives used must be specified by the manufacturer of these additives and in accordance with the environmental conditions where the alternator is installed.

The additive used should not affect the specific heat of water.

In order to use the alternator in environments with temperatures below 0°C, glycol-based antifreeze additives must be added to the cooling water.



NOTE

On vertical radiators, the water inlet must always be at the bottom and the water outlet at the top of the radiator.

4.4.2 Heat exchangers for applications with sea water



ATTENTION

In the case of heat exchangers for applications with seawater, the materials in contact with water (pipes and mirrors) must be resistant to corrosion.

Furthermore, the heat exchangers may be fitted with sacrificial anodes (for example, zinc or magnesium), as shown in Figure 4.4. In this application, the anodes are corroded during operation, protecting the heads of the exchanger.

In order to maintain the integrity of the heat exchanger heads, these anodes must be replaced periodically according to the corrosion rate appears presented.

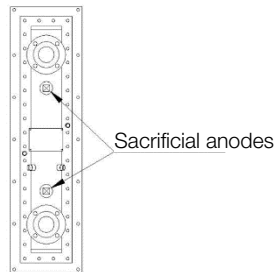


Figure 4.4: Heat exchanger with sacrificial anodes



NOTE

The type, quantity and position of the sacrificial anodes may vary from application to application.

4.4.3 Cooling water temperature


Alternators cooled by air-water heat exchangers are able to operate with a temperature of the cooling water in the input as specified in the project and informed on the heat exchanger nameplate.

4.4.4 Protective devices

The protective devices of the cooling system must be monitored periodically as described in the item **Protections** of this manual.

4.5 INSULATION RESISTANCE

4.5.1 Safety instructions



DANGER

Before measuring the insulation resistance, the alternator must be stopped and disconnected from the charge and the voltage regulator disconnected.

The winding being tested must be connected to the frame and to the ground for a period until removing the residual electrostatic charge.

Failure to observe these procedures may result in personal injury.


4.5.2 General considerations

When the alternator is not immediately put into operation, it must be protected against moisture, high temperature and dirt, thus avoiding damages to the insulation.

The insulation resistance of the windings is measured before commissioning.

If the environment is too humid, it is necessary to check it periodically during storage. It is difficult to determine rules for the real value of the insulation resistance of a machine, since it varies with environmental conditions (temperature, humidity), conditions of machine cleaning (dust, oil, grease, dirt) and quality and conditions the insulating material used.

The assessment of the periodic monitoring records is useful to conclude whether the alternator is able to operate.



NOTE

The insulation resistance must be measured using a **MEGOHMMETER**.

4.5.3 Measuring the stator winding

The test voltage for the stator windings of the alternator must be as per Table 4.1 in accordance with standard IEEE43.

Table 4.1: Voltage for measuring the insulation resistance

Rated voltage of the winding (V)	Insulation resistance test Continuous voltage (V)
< 1000	500
1000 - 2500	500 - 1000
2501 - 5000	1000 - 2500
5001 - 12000	2500 - 5000
> 12000	5000 - 10000

Before making the measurement on the stator winding, check the following:

- If all cables are disconnected from the charge;
- If the voltage regulator is disconnected.
- If the alternator frame and the windings not measured are grounded;
- If the temperature of the winding was measured;
- If all temperature sensors are grounded.

The measurement of the insulation resistance of the stator windings must be done in the main terminal box. The meter (megohmmeter) must be connected between the alternator frame and the winding. The frame must be grounded and the three phases of the stator winding remain connected to the neuter point, as shown below:

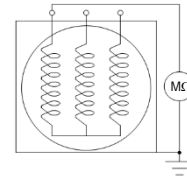


Figure 4.5: Measurement on the three phases

When possible, each phase must be isolated and tested separately. The separate test allows a comparison between the phases. When a phase is tested, the other two phases must be grounded on the same ground of the frame, as shown below.

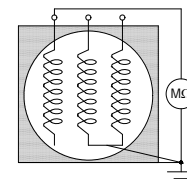


Figure 4.6: Measurement in separate phases

4.5.4 Measurement on the winding of the rotor, exciter and accessories

Measurement on the rotor winding:

- Disconnect the cables of the rotor from the diode cluster;
- Connect the insulation resistance meter (megohmmeter) between the rotor winding and the shaft of the alternator. The measurement current cannot pass through the bearings.

Measurement of the stator winding of the main exciter.

- Disconnect the power cables from the exciter;
- Connect the insulation resistance meter (megohmmeter) between the exciter stator winding (terminals F+ and F-) and the alternator frame.

Measurement on the rotor winding of the main exciter.

- Disconnect the cables of the exciter rotor from the diode cluster;
- Connect the insulation resistance meter (megohmmeter) between the rotor winding and the shaft of the alternator. The measurement current cannot pass through the bearings.

Measurement of the stator winding of the auxiliary exciter (PMG)

- Disconnect the cables that connect the auxiliary exciter to the voltage regulator;
- Connect the insulation resistance meter (megohmmeter) between the stator winding of the auxiliary exciter and the alternator frame.



ATTENTION

The test voltage for the rotor, main exciter, auxiliary exciter and space heaters must be 500Vdc and 100Vdc for other accessories. It is not recommended to measure the insulation resistance of thermal protectors.

On machines that are already in operation, higher values of insulation resistance can be measured, compared to the initial values of commissioning. The comparison with values obtained in previous tests on the same machine, in similar load, temperature and humidity conditions is as a better indication of the insulation conditions than the value obtained in a single test, seeing that any sudden reduction is considered suspicious.

Table 4.2: Referential limits of the insulation resistance in electrical machines

Insulation resistance value	Insulation assessment
2MΩ or lower	Dangerous
< 50MΩ	Bad
50...100MΩ	Regular
100...500MΩ	Good
500...1000MΩ	Very Good
> 1000MΩ	Excellent

4.5.5 Minimum insulation resistance

- If the measured insulation resistance is below 100 MΩ at 40 °C, the windings must be carefully inspected and cleaned or, if necessary, dried according to the following procedure before the machine goes into operation:
- Disassemble the alternator by removing the rotor and bearings;
- Place the components that have the winding with low insulation resistance in an industrial oven and heat it up to a temperature of 130°C and keep this temperature for at least 08 hours.
- Check if the insulation resistance achieved is within the acceptable values, in accordance with Table 4.2, otherwise contact WEG.

4.5.6 Polarization index

The polarization index (P.I.) is typically defined by the ratio between the measured insulation resistance in 10 minutes and the insulation resistance measured in 1 minute at relatively constant temperature. By means of the polarization index, the insulation conditions of the alternator can be evaluated according to Table 4.3.

Table 4.3 - Polarization index (ratio between 10 and 1 minute)

Polarization index	Insulation assessment
1 or lower	Dangerous
< 1.5	Bad
1.5 to 2.0	Regular
2.0 to 3.0	Good
3.0 to 4.0	Very Good
> 4.0	Excellent
Minimum polarization index (P.I.) = 2	
According to IEEE13 standard	



DANGER

Immediately after measuring the insulation resistance, ground the winding to avoid accidents.

4.5.7 Conversion of the measured values

If the test is done at a different temperature, it is necessary to correct the reading for 40°C by using a

curve for the variation of the insulation resistance considering the temperature, determined with the machine itself. If this curve is not available, the approximate correction provided by the curve of Figure 4.7 can be used, according to NBR 5383 / IEEE43.

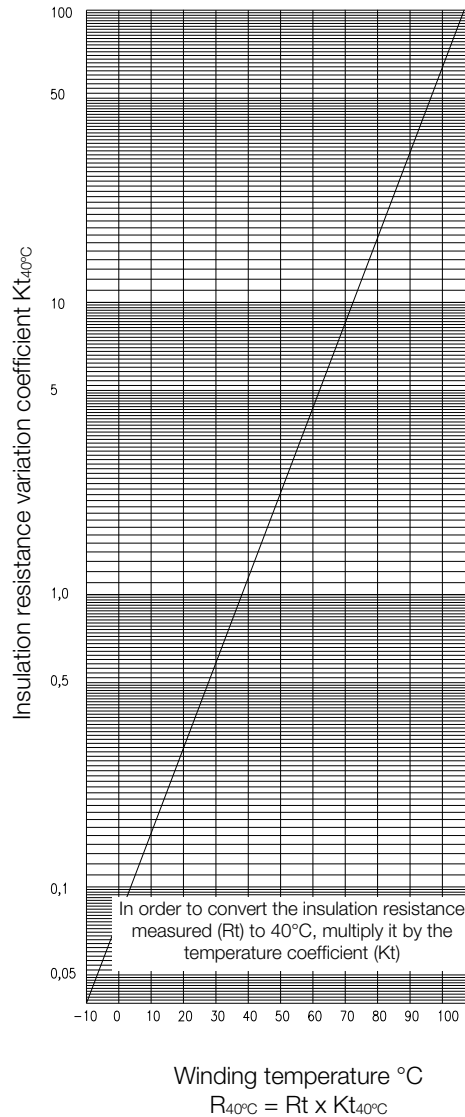


Figure 4.7: Coefficient of insulation resistance variation according to temperature

4.6 PROTECTIONS

4.6.1 Thermal protections

The alternators have protection devices against temperature rise, installed on the main stator coils and bearings, as follows:

Thermoresistance (RTD) - It is a calibrated resistance element. Its operation is based on the principle that the electrical resistance of a metallic conductor varies linearly with temperature. The terminals of the detector must be connected to a control panel which includes a temperature meter.

**NOTE**

The RTD-type thermoresistance allows monitoring the absolute temperature. With this information, the relay can perform the reading of the temperature, as well as the parameterization for alarm and shutdown according to the preset temperatures.

The following formula is used to convert into temperature the value of the ohmic resistance measured by the thermoresistance type Pt 100.

$$\text{Formula: } \frac{\Omega - 100}{0,386} = \text{°C}$$

Where: Ω = ohmic resistance measured on the PT-100

The protective devices, when requested, are listed in the specific wiring diagram of each alternator. Failure in using these devices is the user's sole responsibility, and may result in loss of warranty in case of damage.

4.6.1.1 Temperature limits for the windings

The temperature of the hottest spot of the winding must be kept below the limit of insulation thermal class. The total temperature is composed of the ambient temperature with the temperature rise (T), plus the difference between the average temperature of the winding and the hottest spot of the winding. The ambient temperature is typically at most 40°C. Above this value, the working conditions are considered special. Table 4.4 shows the numerical values and the composition of the acceptable temperature of the hottest spot of the winding for insulation classes F and H.

Table 4.4: Insulation class

Insulation class		F	H
Ambient temperature	°C	40	40
T = temperature rise (resistance method)	°C	105	125
Difference between the hottest spot and the average temperature	°C	10	15
Total: temperature of the hottest point	°C	155	180

**ATTENTION**

If the alternator operates with winding temperatures above the limits of the thermal class, the life of the insulation and hence of the alternator is reduced substantially, or it may even burn.

4.6.1.2 Thermal protections for the bearings

The temperature sensors installed on the bearings are intended to protect them from damage due to operation with over temperature.

4.6.1.3 Alarm and shutdown temperatures

The alarm and shutdown temperatures must be set as low as possible. These temperatures can be determined based on the results of tests or through the alternator operating temperature.

The alarm temperature can be set at 10°C above the alternator operating temperature at full load considering the highest ambient temperature of the local. The temperature values set to shutdown must not exceed the maximum acceptable temperatures as listed in Table 4.5 and Table 4.6.

Table 4.5: Stator maximum temperature

Class of Insulation	STATOR WINDING	
	Maximum temperature settings of protections (°C)	
	Alarm	Shutdown
F	140	155
H	155	180

Table 4.6: Bearing maximum temperature

BEARINGS	
Maximum temperature settings of protections (°C)	
Alarm	Shutdown
110	120

**ATTENTION!**

The temperature values for alarm and shutdown can be set based on experience, but must not exceed the maximum values indicated in Table 4.5 and Table 4.6.

4.6.1.4 Installation of temperature sensors

To avoid noise in the signals of the Pt100 sensors, which can cause errors in temperature readings, the following precautions must be taken when installing these equipments:

- The connecting cables must be shielded and the shield must be grounded;
- The installation of signal cables must be made linearly, avoiding turns on itself and must not be installed close to the power cables.
- The cable connections must be tightened to avoid false contact or that they loosen.

It is recommended that the acquisition of the Pt100 temperature signal be performed by specific instruments for acquiring temperature of electric machines, because these instruments have filters able to eliminate the noise inherent of the application.

4.6.2 Space heater

The space heater used to prevent condensation of water during long periods without operation must be programmed so as to be always energized after the shutdown of the alternator and to be de-energized before the alternator goes into operation.

The dimensional drawing and a specific nameplate on the alternator indicate the supply voltage and the power of the installed space heaters.

**ATTENTION**

If the space heaters remain energized while the machine is in operation, the winding may be damaged.

4.6.3 Diodes protection

The rotating diodes bridge of the main exciter has varistors installed to protect against overvoltage and/or voltage surge.
In case of failure of these components, they must be replaced.

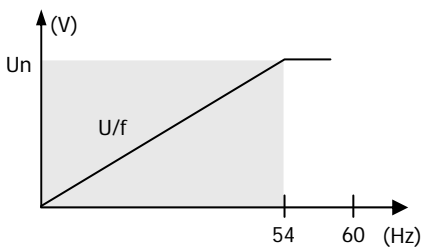
4.6.4 Protections on the voltage regulator

4.6.4.1 Protection against underfrequency

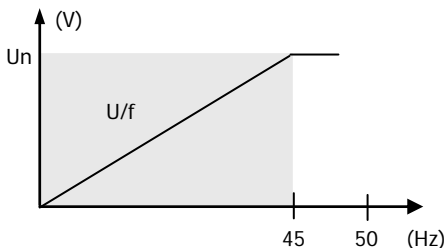
In order to put the alternator into operation, the protection against underfrequency of the voltage regulator must be set at 90% of the rated frequency (it comes set from the factory) or the voltage regulator must remain turned off until the group reaches the rated speed, avoiding excitation overcurrents of the alternator.

NOTE
The other protections of the voltage regulator are described in its specific manual.

Application 60HZ



Application 50HZ



4.7 VOLTAGE REGULATOR

The electronic voltage regulator is designed to keep the voltage of the alternator constant regardless the load. It may be assembled in the terminal box of the alternator or on the control panel.

ATTENTION
Check, in the **Manual of the voltage regulator**, the terminals and wiring diagram and the setting parameters.
A wrong connection may cause the burning of the regulator and/or the alternator windings. Defects caused by this reason are not covered by the warranty.

For further technical details on operation, functions, connections, settings, anomalies, etc., refer to the voltage regulator specific manual.

4.8 AUXILIARY EXCITER

WEG alternators for naval applications are manufactured with the auxiliary exciter (PMG) mounted in its back, which is responsible for feeding the power circuit of the voltage regulator and keeping the power supply of the alternator, even in case of short circuit on bus.

NOTES
Because the alternator maintains high SCC, an overcurrent relay must be installed to open the main breaker in no more than 20s, under penalty of burning the alternator.

4.9 ELECTRICAL ASPECTS

4.9.1 Electrical connections

The alternator electrical connections are responsibility of the end user and must be carried out by qualified people. The connection diagrams are provided along with the technical documentation of the alternator.

4.9.1.1 Main connection

The main cable connections must be done observing the tightening torque according to Table 4.7 for fixing the cables.

Table 4.7: Tightening torque of the terminal screws for fixing the main cables

Thread Diameter	Tightening torque (Nm)
M5	5-6
M8	20-25
M10	39-49
M12	64-84
M16	165-206


- Make sure the section and insulation of the connecting cables are suitable for the alternator current and voltage;
- Before making the electrical connections between the alternator and the load or power line, it is necessary to check carefully the winding insulation resistance, according to Table 4.2.

4.9.1.2 Grounding

The alternators must always be grounded with a cable of proper section by using the terminal located in one of its feet.

4.9.1.3 Electronic voltage regulator

The electronic voltage regulator must be correctly adjusted before operating the alternator
In order to change the connections or settings, refer to the voltage regulator manual.



ATTENTION

In order to change the set points of the voltage regulator, refer to its manual supplied with the alternator.

4.9.1.4 Terminal identification

The identification of the alternator and accessory terminals is provided in the specific wiring diagram of each alternator.

4.9.1.5 Electrical connection of the voltage regulator

- In order to perform correctly the electrical connections of the alternator to the voltage regulator, refer to the manual of the voltage regulator.
- The model of the used voltage regulator depends on the characteristics of the alternator and the desired application. Therefore, the electrical connections to the alternator and the identification of the terminals may differ from one model to another.

4.9.2 Accessories

4.9.2.1 Excitation and sensing

- The permanent magnet generator (PMG) provides AC voltage to supply the power circuit of the voltage regulator, which is responsible for rectifying and controlling the excitation of the alternator.
- The voltage regulator responds to the voltage signal of the sensing transformer, connected to the stator terminals of the alternator by controlling the excitation voltage and keeping constant the alternator voltage.

4.9.2.2 Parallel operation

- For two or more alternators operate in parallel, the voltage regulator should be able to control or allow the reactive control (VAR) during operation.
- Is necessary a current transformer (paralleling CT) for the voltage regulator control the reactive power. This paralleling circuit is necessary to control the reactive power flow between the generators connected in parallel.

4.9.2.3 Differential protection

- Current transformers (CTs) for differential protection (when supplied) are installed in the neutral of the alternator. The signal from the secondary of these transformers must feeding the differential protection relay, comparing with the CTs installed on phases of the alternator or on the control panel and protection of the generation system.
The secondary of these CTs must have the same characteristics



ATTENTION

Should ensure that all CTs are correctly connected to the system or with the secondary short-circuited when the alternator go into operation.

4.10 MECHANICAL ASPECTS

4.10.1 Bases and foundations

- The dimensioning of the bases must be performed so as to confer rigidity to the structure, avoiding amplification of the vibration levels of the set. The base must have a flat surface against the feet of the alternator in order to prevent deformations on the frame.
- The base must always be leveled in relation to the ground (floor). The leveling is obtained by placing shims between the base and the floor.
- The shims for leveling must cover at least 80% of the surface area of contact with the feet.
- The material of the leveling shims must provide the same rigidity of the basis.

4.10.2 Alignment and leveling

The alternator must be perfectly aligned with the driving machine, especially in cases of direct coupling



ATTENTION

An incorrect alignment may damage the bearings, cause vibration and break the shaft.

The alternator must be correctly aligned with the driving, especially in cases of direct coupling.
The alignment must be done according to the recommendations of the coupling manufacturer.
It is necessary to make the parallel and angular alignment of the alternator, as shown in Figure 4.8 and Figure 4.9.

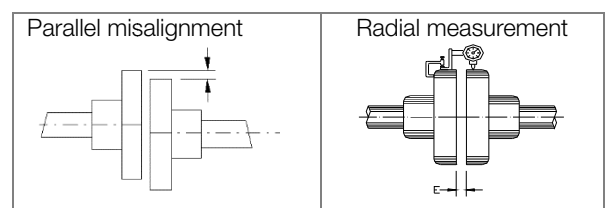


Figure 4.8: Parallel alignment

Figure 4.8 shows the parallel misalignment of the two shaft ends and the practical way to measure it by using suitable dial gauges.

The measurement is made in four points at 90°, with the two half-couplings rotating together so as to eliminate the effects of surface irregularities on the dial gauge contact surface. Choosing the upper vertical point 0°, half the difference of the dial gauge measurement in points 0° and 180° represents the vertical coaxial error. This must be properly corrected by adding or removing shims. Half the difference of the dial gauge measurement in points 90° and 270° represents the horizontal coaxial error.

Thus we get an indication of how much it is necessary to raise or lower the alternator or move it to the right or left on the drive end in order to eliminate the coaxial error. Half the difference of the dial gauge measurement in a full revolution represents the maximum eccentricity.

The maximum acceptable eccentricity for rigid or semi-flexible coupling is 0.03 mm.

Where flexible couplings are used, higher values than those aforementioned are acceptable, but they must not exceed the value given by the coupling manufacturer. It is recommended to keep a safety margin in these values.

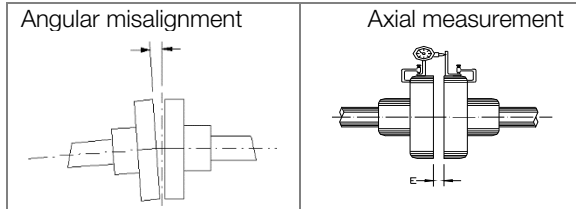


Figure 4.9: Angular alignment

Figure 4.9 shows the angular misalignment and the practical way of measuring it. The measurement is made in four points at 90°, with the two half-couplings rotating together so as to eliminate the effects of surface irregularities on the dial gauge contact surface. Choosing the upper vertical point 0°, half the difference of the dial gauge measurement in points 0° and 180° represents the vertical misalignment. This must be properly corrected by adding or removing shims. Half the difference of the dial gauge measurement in points 90° and 270° represents the horizontal misalignment. This must be properly corrected with the lateral/angular movements of the alternator. Half the maximum difference of the dial gauge measurement in a full revolution represents the maximum angular misalignment.

The maximum acceptable misalignment for rigid or semi-flexible coupling is 0.03 mm

Where flexible couplings are used, higher values than those aforementioned are acceptable, but they must not exceed the value given by the coupling manufacturer. It is recommended to keep a safety margin for these values.

In alignment/leveling, it is important to consider the effect of temperature of the alternator and of the driving machine. Different levels of expansion of the coupled machines can change the alignment/leveling during the operation.

4.10.3 Coupling

It must be used coupling that optimize the vibration level of the set.



ATTENTION

Carefully align the shaft ends, using a flexible coupling whenever possible, leaving a minimum clearance of 3 mm between the couplings.

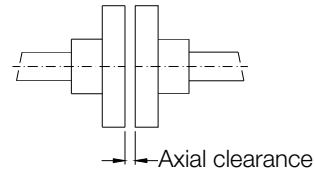


Figure 4.10: Axial clearance



NOTE

The user is responsible for the installation of the alternator. WEG is not responsible for damages to the alternator, associated equipment and installation which occurred due to:

- Excessive transmitted vibrations;
- Poor installations;
- Alignment failures;
- Improper storage conditions;
- Noncompliance with the instructions before start-up;
- Incorrect electrical connections.

5 START-UP

5.1 PRELIMINARY INSPECTION

Before the first start-up or after a long time out of operation, check:

1. If the alternator is clean and if the packaging materials and protective elements were removed;
2. If the connection parts of the coupling are in perfect conditions and well greased and tightened where necessary;
3. If the alternator is aligned;
4. If the bearings are properly lubricated and in working condition;
5. If the cables of the accessories are connected;
6. If the windings insulation resistance has the prescribed value;
7. If all objects, such as tools, measuring instruments and alignment devices, were removed from the alternator operation place;
8. If the alternator is properly fixed;
9. If the electrical connections are in accordance with the wiring diagram of the alternator;
10. If the voltage regulator is properly connected and adjusted according to its installation manual;
11. If the conductors of the line are properly connected to the main terminals so as to prevent a short circuit or disconnection;
12. If the alternator is properly grounded;
13. If the cooling system is working.
14. If the air inputs and outputs are clear;
15. If the water inputs and outputs are clear (alternators with air-water heat exchanger);
16. Manually rotate the assembly in order to ascertain whether there is no interference in the air gap. After the alternator is driven with no load, it must rotate smoothly without strange noises;

5.2 INITIAL OPERATION

In addition to following the safety instructions given in item 2.2 of this manual, in order to perform the first start-up of the alternator, the following procedure must be adopted:

- a) Make sure that the alternator terminals are disconnected from the load by removing the fuses on the panel or placing the circuit breaker in the "off" position;
- b) Turn off the space heaters of the alternator, before starting it;
- c) Disconnect the voltage regulator.



ATTENTION

The PID gains of the voltage regulator shall be correctly adjusted to allow a rapid and appropriate load variation response.

- d) Rotate the assembly and check for strange noises;
- e) Drive the alternator up to the rated speed and verify noises and vibration, and check all protective devices;

After following the procedures described above and solving any problems that may have occurred (see anomalies/solutions), turn off the set.

- f) With the alternator completely stopped, connect the voltage regulator, activate the set and make the necessary adjustments. The manual of the voltage regulator describes the procedures for the available settings (stability, voltage, U/F).

- g) Close the main circuit breaker and apply load and monitor the alternator current, making sure that it is within the specification.
- h) Check the vibration and temperature levels of the set and monitor the measuring instruments (current, voltage and frequency). If there is significant variation in the vibration of the set between the initial condition and after the temperature stabilizes, it is necessary to reassess the alignment/leveling of the set.



ATTENTION

All measuring and control instruments must be under constant observation so that any changes in operation can be detected and remedied.

5.2.1 Temperatures

The temperatures of the bearings, stator winding and cooling water (if applicable) must be monitored while the alternator is operation. These temperatures must stabilize within 4 to 8 hours of operation.

The temperature of the stator winding depends on the load; therefore, the supplied load must also be monitored during the operation of the alternator.

5.2.2 Bearings

The start-up of the system, and the first hours of operation must be continuously monitored.

- Watch for vibration or abnormal noise. If the bearing does not work in a silent and smooth way, the alternator must be stopped immediately, the cause found and corrected.
- The alternator must operate for several hours until the bearing temperature stabilizes within the limits mentioned in this manual.
- If the bearing temperature rises, the alternator must be stopped in order to check the bearings and temperature sensors.
- After reaching the bearing working temperature, check for leaks through the plugs, gaskets or shaft end.

5.2.3 Radiator

In alternators with air-water heat exchanger, the following procedures must be followed during the first start-up:

- Control the temperature in the input and output of the radiator and, if necessary, correct the water flow;
- Adjust the water pressure to just overcome the resistance in the pipes and radiator;
- To control the operation of the alternator, it is recommended to record the air and water temperatures in the input and output of the radiator at certain intervals;
- Recording or signaling (buzzer, light bulbs) instruments can be installed in certain places.


Verification of the radiator performance

- In order to control the operation, it is recommended that the water and air temperature in the input and output of the radiator be measured and recorded periodically.
- The performance of the radiator is expressed by the difference in temperatures between cold water and cold air during normal operation. This difference must be checked periodically. If it is observed an increase in this difference after a long period of normal operation, it may be a sign that the radiator must be cleaned.
- A reduction in the performance or damage to the radiator can also occur due to accumulation of air inside it. In this case, bleeding the air from the radiator and water pipes can correct the problem.
- The pressure difference on the water side can be considered an indicator of the need for cleaning the radiator.

It is also recommended to measure and record the values of the water pressure difference before and after the radiator. Periodically, the new values must be compared to the original value, and an increase in the pressure difference indicates the need for cleaning the radiator.

5.3 SHUTDOWN

- a) Before stopping the alternator, open the main circuit breaker to disconnect the load;
- b) Turn off the voltage regulator (if possible);
- c) Reduce the speed of the alternator until it comes to a full stop;
- d) In alternators with air-water heat exchanger, after the alternator stops completely, close the valve of the cooling water.
- e) Turn on the space heaters if the alternator remains stopped for a long period.



DANGER

Even after de-excitation, there is still voltage at the terminals of the machine. Therefore, only after the full stop of the equipment, it is allowed to perform any work.

The noncompliance with the procedure above implies risk of death.

5.4 PARALLEL ALTERNATORS

5.4.1 Parallel to Each Other and/or to the Line

Minimum requirements for operation of the alternators in parallel, not including the driving machine control:

1. The alternator must have the same operating voltage of the alternator or another network;
2. The voltage regulator must permit the operation of the alternator in parallel;
3. Add a parallel CT to one of the phases of the alternator and make the electrical connection according to the manual of the voltage regulator.
4. Have a panel suitable for protection and operation of the alternator in parallel.
5. The synchronization and setting of the real power must be imposed by the speed control of the primary machine.

6 MAINTENANCE

Maintenance procedures must be performed so as to ensure the proper performance of the equipment. The frequency of the inspections will largely depend on the application local conditions and operating conditions.

Failure to comply with one of the items listed below may lead to the reduction of the alternator life, unnecessary stops and/or damage to the facilities.

6.1 EMERGENCY GENERATOR GROUPS

To ensure reliability and maintenance of the insulation level, alternators used in emergency generators must be placed in operation and, if possible, receive load 2 to 3 hours each month.

6.2 CLEANING

The frame, multi-leaf dampers, grids and fan covers must be kept clean, without accumulation of oil or dust on the outside to facilitate the heat exchange with the environment.

Also, the inside of the alternators must be kept clean and free of dust, debris and oil. In order to clean them, brushes or clean cotton rags must be used. If the dust is not abrasive, an air gun must be used to blow the dirt off from the fan cover and eliminate all the accumulation of dust contained on the fan blades and frame.

The debris impregnated with oil or humidity can be cleaned with cloth moistened in a suitable solvent.

The terminals in the terminal box must be clean, free of rust, in perfect mechanical condition and without deposits of grease or verdigris.

6.3 NOISE

The noise must be observed daily. In case of anomalies, the alternator must be stopped and the causes must be investigated and corrected.

6.4 VIBRATION

Maximum vibration level for the alternator under load: **20mm/s** (RMS).

Confirm standard ISO-8528

6.5 BEARINGS

The temperature control on the bearings is also part of routine maintenance of the alternators.

The temperature can be controlled permanently with thermometers placed outside the bearing, or through the thermoresistances.

The alarm and shutdown temperatures for the bearings can be adjusted respectively for 110°C and 120°C.

6.5.1 Lubrication

The bearings must be relubricated **annually** or according to the lubrication intervals reported on the nameplate of the bearings fixed on the alternator and to the technical documentation, prevailing whichever occurs first.

6.5.1.1 Type and amount of grease

The relubrication of the bearings must always be made with the **original grease**, specified on the bearing nameplate and the documentation of the alternator.



ATTENTION

1. When the bearing is opened, inject the new grease through the grease nipple to expel the old grease found in the grease input tube and insert the new grease in the bearing, in the inner ring and outer ring, filling $\frac{3}{4}$ of the empty spaces.
2. Never clean the roller with cotton-based cloths, because they leave some lint as solid particles.
3. It is important to perform a proper lubrication, that is, to apply the grease correctly and in a suitable quantity, because both poor lubrication and excessive lubrication adversely affect the bearing.



NOTE

WEG is not responsible for the change of grease or for any damages arising from the exchange.

6.5.1.2 Instructions for lubrication



NOTE

The data of the rolling bearings, quantity and type of grease and lubrication intervals are informed in a nameplate fixed on the alternator. Check this information before performing the lubrication.

The lubrication system is designed in such a way that during the relubrication of the bearings, all the old grease is removed from the rolling bearings tracks and expelled through a drain that enables the exit, but prevents the entering of dust or other harmful contaminants. This drain also prevents damage to the bearings by the well-known problem of excessive lubrication. It is advisable to perform the lubrication with the alternator in operation, so as to ensure the renewal of grease in the bearing housing.

If this is not possible due to the presence of rotating parts near the nipple (pulleys, etc.), which can put the operator in danger, proceed as follows:

- With the alternator stopped, inject approximately half the total amount of grease recommended and operate the alternator for approximately 1 minute at full speed;

- Stop the alternator and inject the remaining grease. The injection of all grease with the alternator stopped may cause penetration of the lubricant into the alternator.



ATTENTION

It is important to clean the grease nipples prior to lubrication so as to prevent foreign materials from being dragged into the bearing.

- The lubrication intervals informed on the plate consider a working temperature of the bearing of 70°C.
- Based on the operating temperature ranges listed below, apply the following correction factors for the lubrication of bearings:
 - Operating temperature below 60°C: 1.59.
 - Operating temperature 70°C to 80°C: 0.63.
 - Operating temperature 80°C to 90°C: 0.40.
 - Operating temperature 90°C to 100°C: 0.25
 - Operating temperature 100°C to 110°C: 0.16.

6.5.1.3 Relubrication of bearings with the alternator operating

Bearing with grease outlet by runoff drain

1. Remove the cover of the drain;
2. Clean with a cotton cloth around the hole of the grease nipple;
3. With the alternator running, inject grease until new grease begins to flow from the drain or until the amount of grease informed on the bearing nameplate have been injected;
4. Run the alternator for time enough to eliminate the excess of grease through the drain;
5. Inspect the bearing temperature to make sure that there was no significant change;
6. Put the cover of the drain back in place.

Bearings with grease outlet by a drawer and rod

1. Before starting the lubrication of the bearing, clean the grease nipple with a cotton cloth;
2. Remove the drawer and rod to remove the old grease, clean the drawer and put it back;
3. With the alternator running, inject the amount of grease specified on the nameplate of the bearings using a manual grease gun;
4. The excess of grease comes out through the bearing lower drain and is deposited in the drawer;
5. Maintain the alternator running long enough for the grease excess to drain;
6. This grease must be removed by pulling the rod and cleaning the drawer. This procedure must be repeated as many times as necessary until the drawer no longer retains grease;

Inspect the bearing temperature to ensure that there was no significant change.

6.5.2 Bearing



ATTENTION

For safety reasons, the change of bearings must be done with the alternator disconnected from the driving machine.

To change the bearings on the alternator, it is necessary to disassemble the alternator completely.

6.5.2.1 Bearing replacement

The disassembly of the bearings must always be done with the use of appropriate tools (bearing puller).



Figure 6.1: Bearing extractor



ATTENTION

A bearing must only be removed from the shaft when absolutely necessary.

Instructions:

1. The puller jaws must be placed on the side surface of the bearing internal ring or on an adjacent part.
2. Before the installation of the new bearings, the shaft seats must be cleaned and slightly lubricated.
3. The bearings must be heated up to a temperature between 50°C and 100°C to facilitate the assembly.

6.6 MAINTENANCE OF THE EXCITER


6.6.1 Exciter

For the proper performance of its components, the alternator exciter must be kept clean. Check the insulation resistance of the windings of the main exciter and auxiliary exciter periodically so as to determine the insulation conditions, following the procedures described herein.

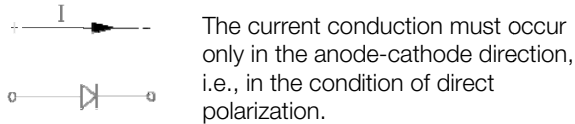
6.6.2 Diode test

Diodes are components that last for a long time and do not require frequent tests. If the alternator presents a defect, which indicates a diode fault or an increase in the field current for the same load condition, then the diodes must be tested in accordance with the following procedure:

1. Disconnect all the diodes from the exciter rotor winding;
2. With an ohmmeter, measure the resistance of each diode in both directions.

 **NOTA**

When testing the diodes, observe the polarity of the test terminals in relation to the diode polarity.
The polarity of the diode is indicated by an arrow on its housing.




The diode is considered good when you have low ohmic resistance (up to approximately 100Ω) in its direct polarization and high resistance (approx. $1M\Omega$) in the opposite direction. Defective diodes have ohmic resistance of 0Ω or greater than $1M\Omega$ in both directions. In most cases, the test method which uses an ohmmeter to the diodes is enough to identify faults in the diodes. However, in some extreme cases it may be necessary to apply the rated blocking voltage and/or current circulation in order to detect a fault in the diodes. Due to all the work required to perform these tests, if you are not sure of the conditions of the diodes, it is recommended replace them.

6.6.3 Diode Replacement

In order to replace the diodes, proceed as follows:

- Disconnect the six diodes from the exciter rotor winding;
- Install three new diodes of the same polarity (AND or CTD) in one of connecting bridges;
- Install, on the other connecting bridge, three new diodes with polarity opposite to that of the three diodes previously installed;
- Fix all the diodes, tightening them with a torque wrench, observing the torques of Table 6.1;
- Make the connections of the diodes with the exciter rotor winding.

 **ATTENTION**

It is vital that the tightening torques indicated be observed so that the diodes will not be damaged in the assembly.

Table 6.1: Tightening torque of the diodes

Thread of the diode base (mm)	Torque wrench number (mm)	Tightening torque (mm)
M6	11	2
M8	17	4
M12	24	10
M16	32	30

6.6.4 Varistor test

The varistor is the device installed between the two diode connecting bridges and is intended to protect the diodes against overvoltage.

To test the operating conditions of the varistor, an ohmmeter can be used. The resistance of a varistor must be very high ($\pm 20,000$ ohms).

In case of damages to the varistor or if the resistance is very low, it must be replaced.

6.6.5 Varistor replacement

In order to replace the varistor, WEG recommends that you observe the following recommendations:


1. Replace the damaged varistor by a new varistor identical to the original one;
2. In order to replace the varistor, loosen the screws that fasten it to the diode connecting bridges ;
3. When removing the varistor, observe carefully how the components were assembled so that the new varistor will be installed the same way;
4. Before mounting the new varistor, make sure that all the contact surfaces of the components are clean, leveled and smooth so as to ensure a perfect contact between them;
5. Fix the new varistor by tightening the screws that fasten it to the connecting bridges just enough to make a good electrical connection.

6.7 AIR FLOW

The air inlet and outlet of the alternator must be kept clear, so that the heat exchange is efficient. If the heat exchange is hindered, the alternator will overheat and the winding may get damaged (burning of the alternator).

6.8 MAINTENANCE OF THE COOLING SYSTEM

- The tubes of the air-air heat exchanger (if applicable) must be kept clean and clear to ensure a perfect heat exchange. In order to remove the dirt accumulated in the tubes, a rod with a round brush on the tip may be used.
- In case of air-water heat exchangers, periodic cleaning in the radiator pipes is necessary in order to remove any fouling.

 **NOTE**

If the alternator is equipped with filters in the air input and/or output, they must be cleaned with compressed air.
If the dust is difficult to remove, wash the filter with cold water and mild detergent and then dry it in the horizontal position.

6.8.1 Maintenance of the radiators

If clean water is used, the radiator can remain in operation for several years without the need for cleaning. With dirty water, you need to clean it every **12 months**.

The level of dirt in the radiator can be detected by the increase in the air temperature in the output. When the temperature of the cold air, under the same operating conditions, exceeds the specified value, it can be assumed that the pipes are dirty.

If corrosion is found, it is necessary to provide adequate protection (i.e., zinc anodes, plastic cover with plastic, epoxy or other similar protecting products) in order to prevent greater damages to the parts already affected. The external surface of all radiator parts must be always kept in good condition.

Instructions for removing and servicing the radiator

The removal of the heat exchanger for maintenance must follow the following steps:

1. Close all the water input and output valves after the ventilation is stopped;
2. Drain the water through the radiator drain plugs;
3. Remove the heads, keeping the screws, nuts and washers and seals (gaskets) in a safe place;
4. Brush the tubes inside carefully with nylon brushes for removing residues. If during the cleaning damages to the radiator tubes are found, they can be repaired;
5. Reassemble the heads, replacing the gaskets, if necessary.

6.9 ALTERNATOR OUT OF OPERATION

The following special care must be taken if the alternator will remain for a long period out of operation:

- Connect the space heaters for the temperature inside the alternator to be kept slightly above the ambient temperature, thereby preventing condensation and consequent decrease in the winding insulation resistance and oxidation of metal parts.
- All the radiators and water pipes (if applicable) must be drained to reduce corrosion and deposit of materials suspended in the cooling water.

Follow the remaining procedures described in item **“Extended storage”** of this manual.

Storage of the radiator after operation

When the radiator remains out of operation for a long period, it must be drained and dried. Drying can be done with preheated compressed air. During the winter, if there is danger of freezing, the radiator must be drained, even when it is out of operation for a short period, in order to prevent deformation or damage.



NOTE

During short stops, it is preferable to maintain the water flow at low speeds instead of stopping its circulation, thus ensuring that harmful compounds such as ammonia and hydrogen sulfide are taken out of the heat exchanger and do not settle inside.

6.10 SHAFT GROUNDING DEVICE

A brush for ground the shaft is a device use to prevent the flow of electrical current through the bearings. The brush is placed in contact with the shaft and connected to the alternator frame, which must be grounded.

The types of shaft grounding used on alternators of the AN10 line are:

6.10.1 Grounding with internal brush

The shaft grounding is made with internal brush, according to Figure 6.2

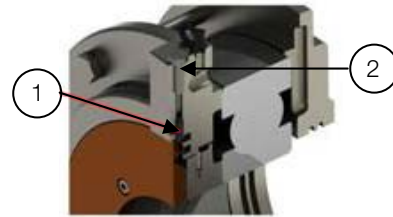


Figure 6.2: Internal brush for shaft grounding

Legend of Figure 6.2

1. Grounding brush
2. Brush fixing screw

Procedure to replace the brush

- Remove the screw (2)
- Remove the wear brush (1)
- Install a new brush and the fixing screw.

6.10.2 Grounding with external brush

The shaft grounding is made with internal brush, according to Figure 6.3

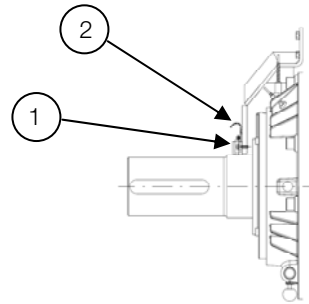


Figure 6.3: External brush for shaft grounding

Legend of Figure 6.3

1. Grounding brush
2. Pressure spring of brush-holder

Procedure to replace the brush

- Remove the pressure spring (2)
- Remove the wear brush (1)
- Install a new brush and the pressure spring.



ATTENTION

The brush must be monitored constantly during operation, and at the end of its useful life, it must be replaced by another of the same quality (grain). In order to ensure a perfect contact of the grounding brush shaft, this oil, and any residue between the shaft and the brush, must be removed before placing the alternator start-up.

6.11 COMPLETE CHECKUP

The frequency of checkups must be defined according to the environment where the alternator is installed. The more aggressive the environment (dirt, oil, sea breeze, dust, etc.), the shorter the checkup interval, as follows:

- Clean the dirty windings with a brush;
- Use a cloth moistened in a suitable solvent to remove grease, oil and other impurities from the winding;
- Dry with dry air;
- Blow compressed air through the ventilation channels on the lamination core of the stator, rotor and on the bearings.



NOTE

The compressed air must always be blown after the cleaning, never before.

- Drain the condensed water;
- Clean the inner part of the terminal box;
- Measure the insulation resistance.



ATTENTION

If complete checkups are not performed, dirt will build up inside the alternators. The operation under these conditions may reduce the life of the machine and cause unwanted downtime and additional costs to restore the equipment.

7 DISASSEMBLY AND ASSEMBLY OF THE ALTERNATOR

All the repair, disassembly and assembly services must be performed by properly qualified and trained professionals only. The sequence for the disassembly and assembly depends on the model of the alternator.

7.1 DISASSEMBLY

Below are some recommendations that must be observed when disassembling an alternator:

1. Always use proper tools and devices to disassemble the alternator;
2. Before disassembling the alternator, disconnect the water cooling and lubrication tubing (if applicable);
3. Disconnect the electric connections and accessories;
4. Remove the heat exchanger and noise suppressor (if applicable);
5. Remove the bearing temperature sensors and grounding brush;
6. In order to prevent damages to the rotor, provide a support for supporting the shaft in the drive and non-drive ends;
7. For disassembling the bearings, follow the procedures described in this manual;
8. The removal of the rotor from inside the alternator must be done with a suitable device and with extreme care so that the rotor does not drag on the stator lamination core or coil heads, preventing damages.

7.2 ASSEMBLY

Below are some cautions that must be taken when assembling an electric alternator:

1. Always use proper tools and devices for assembling the alternator;
2. For assembling the alternator, follow the disassembly procedures in the reverse order;

It is recommended that any damaged part (cracks, dents on the machined parts, damaged threads) be replaced, avoiding repairing the parts.

7.3 SPARE PARTS

WEG recommends keeping in stock the following spare parts:

- DE bearing;
- NDE bearing;
- Temperature sensor for DE bearing;
- Temperature sensor for NDE bearing;
- Space heater;
- Felt for filter (if applicable);
- Diode set
- Varistor set
- Voltage regulator

The spare parts must be stored in a clean, dry and well ventilated environment, if possible, at constant temperature.

7.4 TIGHTENING TORQUES

Table 7.1 shows the tightening torques of the screws recommended for assembling the alternator or its parts:

Table 7.1: Tightening torques of the screws

Material / Resistance class		Carbon steel / 8.8 or above		Stainless steel / A2 – 70 or above	
Type of fastening		Metal / Metal	Metal / Insulation	Metal / Metal	Metal / Insulation
% Yield strength		60%	33%	70%	33%
Diam.	Pitch (mm)	Tightening torque of the screws (Nm)			
M3	0.5	0.9	0.5	0.75	0.4
M4	0.7	2.1	1	1.8	1
M5	0.8	4.2	2	3.6	1.7
M6	1	8	4.4	6.2	3.4
M8	1.25	19.5	10.7	15	8.3
M10	1.5	40	21	30	16.5
M12	1.75	68	37	52	28
M14	2	108	60	84	46
M16	2	168	92	130	72
M18	2.5	240	132	180	100
M20	2.5	340	187	255	140
M22	2.5	470	260	350	190
M24	3	590	330	440	240
M27	3	940	510	700	390
M30	3.5	1170	640	880	480
M33	3.5	1730	950	1300	710
M36	4	2060	1130	1540	840
M42	4.5	3300	1800	2470	1360
M48	5	5400	2970	4050	2230

NOTE
 The resistance class is usually indicated on the head of the hex screws.

7.5 GENERAL RECOMMENDATIONS

ATTENTION
 All the services described herein must be carried out by qualified and experienced persons; otherwise, damages to property or personal injuries may occur.

 If any further explanations are necessary, contact WEG.

7.6 MAINTENANCE PLAN

The maintenance plan detailed in Table 7.2 is only referential, considering that the intervals between each maintenance intervention may vary according to the motor location and operation conditions. For associated equipment, such as the voltage regulator and control panel, the specific manuals must also be consulted.

Table 7.2: Maintenance plan

DAILY	
▪ Whole alternator	▪ Inspect noise, vibration, bearing and winding temperature
MONTHLY	
▪ Whole alternator	▪ Measure noise, vibration, bearing and winding temperature ▪ Inspect cooling system – air and water flow
▪ Bearings	▪ Inspect the bearings visually ▪ Inspect and, if necessary, relubricate the bearings
▪ Protection and control equipments	▪ Verify the operation ▪ Record the measurement values ▪ Monitor the excitation current, making sure that is according to the value informed in the alternator data sheet.
▪ Air-water heat exchanger	▪ Inspect the sacrificial anodes (when use sea water)
▪ Air filter (if any)	▪ Inspect and, if necessary, clean or change it
EACH 6 MONTH	
▪ Whole alternator	▪ Verify and retighten the alternator fixation screws ▪ Inspect and, if necessary, clean the alternator internally and externally ▪ Alternator whole inspection ▪ Verify parts and components
▪ Rotor, stator and exciter	▪ Visual inspection, cleaning, verify terminals, measure insulation resistance
▪ Exciter	▪ Inspect and, if necessary, clean the exciter compartment ▪ Inspect diodes and varistors ▪ Verify winding insulation resistance
▪ Air-water heat exchanger	▪ Inspect the coolers, ▪ Inspect the sacrificial anodes (if any) ▪ Inspect and, if necessary, change the gaskets of the heat exchanger heads
▪ Connection boxes and grounding	▪ Inspect and clean the inner of the connection boxes ▪ Retighten the screws and grounding connections
▪ Coupling	▪ Inspect the alignment and retighten the coupling screws
▪ Bearings ¹	▪ Inspect the lubricant quality and relubricate when necessary
▪ Electrical connections	▪ Retighten the electrical connection terminals ▪ Inspect the electrical connections of the voltage regulator ▪ Inspect the accessories electrical connections
▪ Grounding	▪ Inspect and retighten the grounding connections ▪ Inspect the shaft grounding brush and replace it, if necessary
EVERY 3 YEARS (TOTAL REVISION)	
▪ Rotor, stator and exciter windings	▪ Clean the windings ▪ Inspect windings and check the fastening of the wedges on slots ▪ Inspect the winding electrical connections
▪ Rotor	▪ Inspect the shaft (wear, fouling)
▪ Bearings ^{1,2}	▪ Replace the bearings ▪ Inspect shaft seat and, if necessary, restore
▪ Protection, monitoring and control equipments	▪ Test the operation
▪ Air-water heat exchanger	▪ Clean the coolers

1. Check the lubrication intervals and amount of grease in the bearing nameplate and technical documentation.

2. The bearing replace must be carried out according to the lifetime reported in the alternator technical documentation.



NOTE

The checks and tasks described in the table above must be performed according to item 6 of this manual.

8 ANOMALIES

Below are listed some anomalies that may occur on the alternator in operation, as well as the correct procedure for verification and correction.

8.1 ELECTRICAL ANOMALIES

THE ALTERNATOR WILL NOT EXCITE	
CAUSE	CORRECTIVE PROCEDURE
Power supply of voltage regulator with faulty	<ul style="list-style-type: none"> Verify the power supply of the voltage regulator
Field signal inverted	<ul style="list-style-type: none"> Verify the field signal (F+ e F-)
Driving speed is not correct	<ul style="list-style-type: none"> Measure the speed and regulate it
Interruption in the main excitation circuit	<ul style="list-style-type: none"> Check the continuity of exciter connection cables Perform measurements on all the diodes and replace defective diodes.
Voltage regulator defective	<ul style="list-style-type: none"> Replace the voltage regulator.
Varistor defective	<ul style="list-style-type: none"> If defective, the varistor must be replaced, or, if there are no spare parts, remove it temporarily..

ALTERNATOR WILL NOT EXCITE UP TO THE RATED VOLTAGE	
CAUSE	CORRECTIVE PROCEDURE
Rotating diodes defective	<ul style="list-style-type: none"> Replace the diodes.
Incorrect speed	<ul style="list-style-type: none"> Measure the speed of the primary machine and adjust it.
Supply of the voltage regulator is not within the voltage range determined by the manufacturer.	<ul style="list-style-type: none"> Check the power supply of the voltage regulator.

VOLTAGE BELOW RATED WITH NO LOAD	
CAUSE	CORRECTIVE PROCEDURE
Speed below rated	<ul style="list-style-type: none"> Measure the drive machine speed and adjust
Voltage regulator no adjusted	<ul style="list-style-type: none"> Check the voltage reading of the voltage regulator software with the alternator phases voltage Check the PT sensing voltage to the alternator Adjust the PT ratio Adjust the sensing voltage of the voltage regulator
Rotating diodes defective	<ul style="list-style-type: none"> Replace the diodes

OVERVOLTAGE WITH NO LOAD	
CAUSE	CORRECTIVE PROCEDURE
Power thyristor of the regulator defective.	<ul style="list-style-type: none"> Replace the regulator.
Sensing transformer of the regulator defective	<ul style="list-style-type: none"> Measure the sensing voltage at the voltage regulator terminals
Voltage regulator no adjusted	<ul style="list-style-type: none"> Check the PT ratio Check the voltage reading of the voltage regulator software with the alternator voltage Adjust the PT ratio Adjust the sensing voltage of the voltage regulator
Incompatible voltage regulator software	<ul style="list-style-type: none"> If replacing the voltage regulator, make sure that the software versions are compatible or choose to manually parameterization

OSCILLATION IN THE ALTERNATOR VOLTAGE	
CAUSE	CORRECTIVE PROCEDURE
PID gain of the voltage regulator is no adjusted	<ul style="list-style-type: none"> Check signal stability for the field generated by the voltage regulator and adjust PID gains
Oscillations in the speed of the drive machine	<ul style="list-style-type: none"> Check and eliminate speed oscillations

SHARP VOLTAGE DROP WITH LATER RECOVERY: (BLINKS)	
CAUSE	CORRECTIVE PROCEDURE
Incorrect setting of the stability	<ul style="list-style-type: none"> Adjust the instability correctly in the voltage regulator
Alternator operating in single mode with the parallelism system activated.	<ul style="list-style-type: none"> Shut down the parallelism system
Momentary overload	<ul style="list-style-type: none"> Check the load and adjust the rated data of the alternator

VOLTAGE DISCHARGE WHEN ENTERING THE LOAD	
CAUSE	CORRECTIVE PROCEDURE
Connection of the signal CT inverted on voltage regulator	<ul style="list-style-type: none"> ▪ Invert the CT connection

LARGE VOLTAGE DROP WHEN SUBJECT TO LOAD	
CAUSE	CORRECTIVE PROCEDURE
Speed droop of the drive machine	<ul style="list-style-type: none"> ▪ Observe the speed comportment of the diesel engine
Voltage regulator no adjusted	<ul style="list-style-type: none"> ▪ Check the PID gain adjust of the voltage regulator ▪ Check the actuation of the voltage regulator limiters
Diodes defectives	<ul style="list-style-type: none"> ▪ Check the diodes and replace them, if necessary
Field winding defective	<ul style="list-style-type: none"> ▪ Check the field winding

8.2 MECHANICAL ANOMALIES

OVERHEATING OF THE BEARING	
CAUSE	CORRECTIVE PROCEDURE
Bearing defective	<ul style="list-style-type: none"> ▪ Replace the bearing
Excess or lack of lubrication in the bearing	<ul style="list-style-type: none"> ▪ Check the lubrication of the bearing
Incorrect lubricant	<ul style="list-style-type: none"> ▪ Use the lubricant according to bearing nameplate
Excessive axial clearance	<ul style="list-style-type: none"> ▪ Correct the axial clearance

OVERHEATING ON ALTERNATOR WINDINGS	
CAUSE	CORRECTIVE PROCEDURE
Air input or output partially blocked	<ul style="list-style-type: none"> ▪ Clear the air passages
Hot air is returning to the alternator	<ul style="list-style-type: none"> ▪ Direct the hot air out of the alternator installation environment
Overload on the alternator	<ul style="list-style-type: none"> ▪ Check the load and adjust the rated data of the alternator
Over excitation.	<ul style="list-style-type: none"> ▪ Check the alternator excitation current and compare with the rated data. Correct it (if necessary).
Radiator with incorrect temperature, flow or pressure	<ul style="list-style-type: none"> ▪ Check and adjust the water characteristics of the radiator

EXCESSIVE VIBRATION	
CAUSE	CORRECTIVE PROCEDURE
Misalignment	<ul style="list-style-type: none"> ▪ Adjust the alignment of the alternator with the driving machine
Assembly defect	<ul style="list-style-type: none"> ▪ Check for assembly problems of the alternator and correct them (feet fixation, coupling, flange, etc.)
Excessive clearance in the coupling	<ul style="list-style-type: none"> ▪ Correct the clearance in the coupling



ATTENTION

The machines included in this manual are in continuous improvement, so the information in this manual is subject to change without previous notice.



9 WARRANTY

These products, when operated under the conditions stipulated by WEG in the operating manual for such product, are warranted against defects in workmanship and materials for twelve (12) months from start-up date or eighteen (18) months from manufacturer shipment date, whichever occurs first.

However, this warranty does not apply to any product which has been subject to misuse, misapplication, neglect (including without limitation, inadequate maintenance, accident, improper installation, modification, adjustment, repair or any other cases originated from inadequate applications).

The company will neither be responsible for any expenses incurred in installation, removal from service, consequential expenses such as financial losses nor transportation costs as well as tickets and accommodation expenses of a technician when this is requested by the customer.

The repair and/or replacement of parts or components, when effected by WEG within the Warranty period do not give Warranty extension, unless otherwise expressed in writing by WEG.

This constitutes WEG's only warranty in connection with this sale and is in lieu of all other warranties, expressed or implied, written or oral.

There are no implied warranties of merchantability or fitness for a particular purpose that apply to this sale.

No employee, agent, dealer, repair shop or other person is authorized to give any warranties on behalf of WEG nor to assume for WEG any other liability in connection with any of its products.

In case this happens without WEG's authorization, Warranty is automatically cancelled.

LIABILITY

Except as specified in the foregoing paragraph entitled "Warranty Terms for Engineering Products", the company shall have no obligation or liability whatsoever to the purchaser, including, without limitation, any claims for consequential damages or labor costs, by reason of any breach of the express warranty described therein.

The purchaser further hereby agrees to indemnify and hold the company harmless from any causes of action (other than cost of replacing or repairing the defective product as specified in the foregoing paragraph entitled "Warranty Terms for Engineering Products"), arising directly or indirectly from the acts, omissions or negligence of the purchaser in connection with or arising out of the testing, use, operation, replacement or repair of any product described in this quotation and sold or furnished by the company to the purchaser.



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