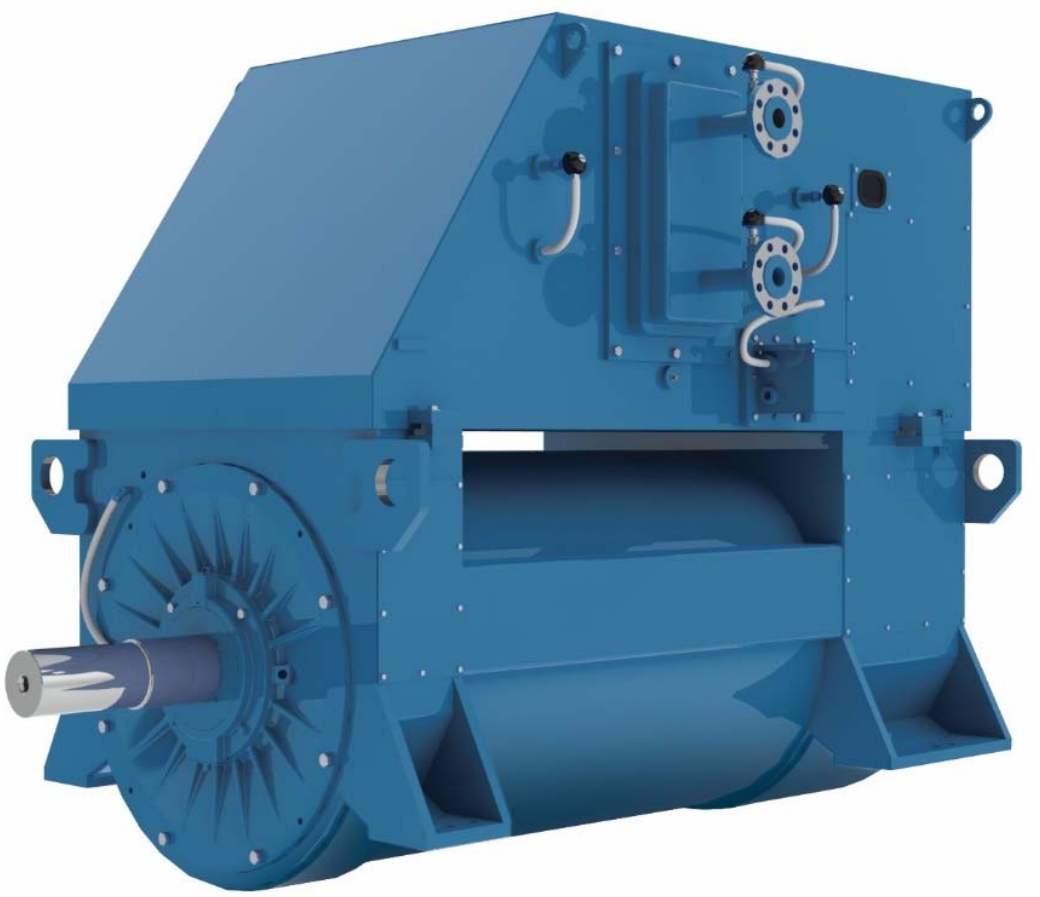
Driving efficiency and sustainability

# Synchronous Alternators

## AN10 line - Horizontal
## Naval application

### Installation, Operation and Maintenance Manual



# Installation, Operation and Maintenance Manual

## Models: AN10

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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.

**WEG EQUIPAMENTOS ELÉTRICOS S.A.**

# INDEX

# 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 firefighting 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: – 15ºC to + 45ºC;
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 cannot 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

#### 3.2.3.6.1 Grease-lubricated rolling bearing

- The rolling bearings are lubricated at the factory for the motor tests.

**ATTENTION**

In order to keep the bearings in good condition during the storage period, **the shaft locking device must be removed every two months, and the motor rotor must be rotated at least 10 complete turns at 30 rpm** to circulate the grease and preserve the internal parts of the bearings.

- Before putting the motor into operation, the rolling bearings must be lubricated;
- If the motor remains stored for a period exceeding two years, the rolling bearings must be disassembled, washed, inspected and relubricated.

#### 3.2.3.6.2 Oil-lubricated rolling bearing

- Depending on the motor mounting position and on the lubrication type, the motor can be transported with or without oil in the bearings;
- The motor storage must be done in its original operating position and with oil in the bearings, when specified;
- The oil level must be respected, remaining in the middle of the sight glass.

**ATTENTION**

In order to keep the bearings in good condition during the storage period, **the shaft-locking device must be removed every two months, and the motor rotor must be rotated at least 10 complete turns at 30 rpm** to circulate the oil and preserve the internal parts of the bearings.

- Before putting the motor into operation, the rolling bearings must be relubricated.
- If the motor remains stored for a period exceeding 2 years, the rolling bearings must be disassembled, washed, inspected and relubricated.

#### 3.2.3.6.3 Sleeve bearing

Depending on the machine mounting position and the lubrication type, the machine can be transported with or without oil in the bearings.
The machine storage must be done in its original operating position and with oil in the bearings, when so specified.
The oil level must be respected, remaining in the middle of the sight glass.
In order to keep the bearings in good conditions during the storage period, the following preservation procedures must be performed:

- Close all the threaded holes with plugs;
- Check if all the flanges (e.g., oil inlet and outlet) are closed. If not, they must be closed with blind covers;
- The oil level must be respected, remaining in the middle of the oil sight glass;
- Every two months the shaft locking device should be removed the shaft, add between 100 and 200ml of lubricating oil through the sight glass at the top of the bearing and rotate the shaft which can be done manually with the help of a lever, two or three complete turns are sufficient.

**NOTES**

For bearings that have a high-pressure oil injection system (jacking), this system must be activated before rotating the machine rotor.
For bearings without an internal oil reservoir (dry sump) and for thrust and counter-bearings, the oil circulation system must be activated to turn the machine shaft.
The shaft rotation must always be done in the machine rotation direction.

After six months of storage, the following procedure must be used for protecting both the bearing internally and the contact surfaces against corrosion:

- Close all the threaded holes with plugs;
- Seal the gaps between the shaft and the bearing seal on the shaft by applying water-proof adhesive tape;
- Check if all the flanges (e.g., oil inlet and outlet) are closed. If not, they must be closed with blind covers;
- Remove the upper sight glass from the bearing and apply the corrosion inhibitor spray (TECTYL 511 or equivalent) inside the bearing;
- Close the bearing with the upper sight glass.

**NOTES**

If the bearing has no upper sight glass, the top cover of the bearing must be disassembled to apply the corrosion inhibitor spray.

Each six months of storage, repeat the procedure described above.
If the storage period exceeds two years, the bearing oil must be replaced.

### 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 damped 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

**ATTENTION**

Before operating the alternator, the insulation resistance must be measured according to the item “Insulation resistance” of this manual.

### 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 |
| **Sleeve Bearings** | | | | | | |
| Rotate the shaft | | X | | | | |
| Apply corrosion inhibitor spray | | | X | | | |
| Clean the bearings | | | | | X | |
| Change the oil | | | | | | If the storage period exceeds 2 years. |

## 3.3 HANDLING

**Proper handling**

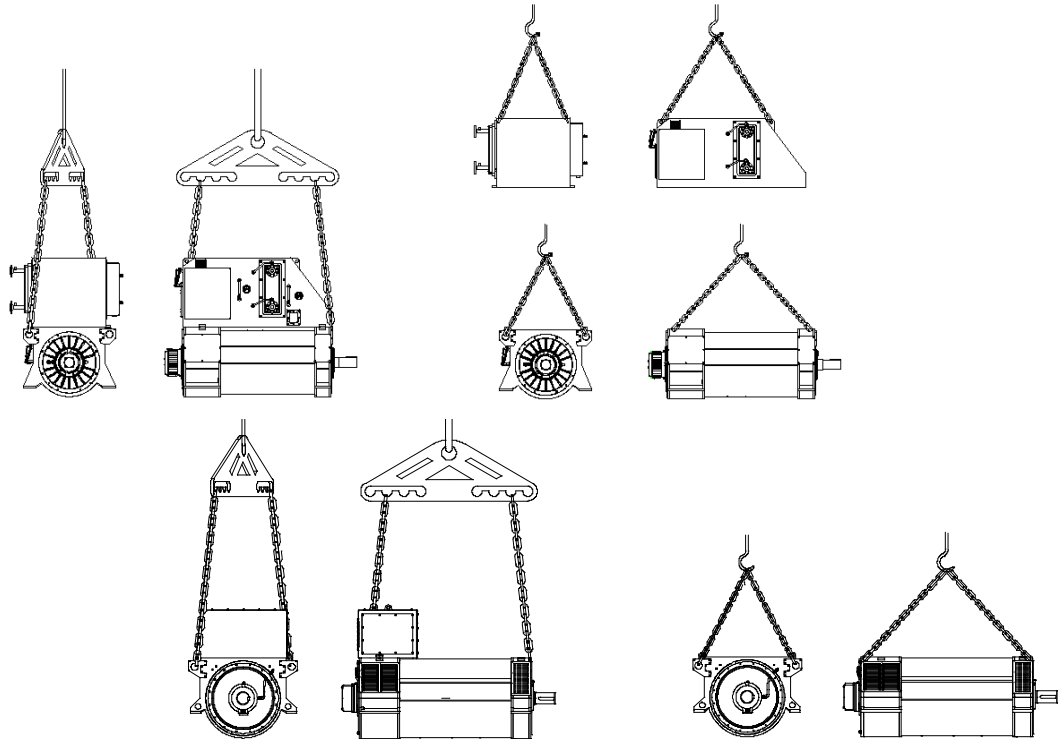


*Figure 3.1: Proper handling*

**Improper handling**

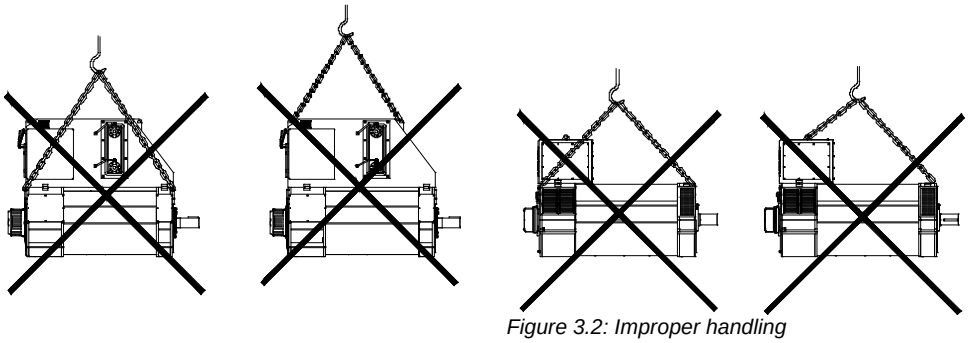


*Figure 3.2: Improper handling*

- 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 SHAFT LOCK

The alternator leaves the factory with a lock on the shaft to prevent damages to the bearings during transportation. This lock must be removed prior to alternator installation.

**ATTENTION**

The shaft-locking device must be installed whenever the alternator is removed from its base (uncoupled) in order to prevent damages to the bearings during transportation.
The shaft end is protected at the factory with a temporary protective agent (rust inhibitor). During the alternator installation, it is necessary to remove this product from the grounding brush (if any) contact track on the shaft.

## 4.3 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.

## 4.4 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.

## 4.5 COOLING

**Open alternators**

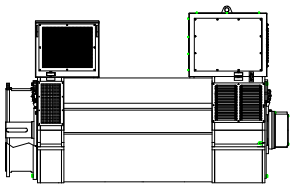


*Figure 4.1: IC01 Cooling*

Open alternators are cooled by the internal fan.

**Closed alternators**

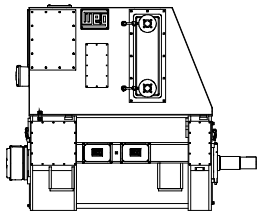


*Figure 4.2: IC81W Cooling*

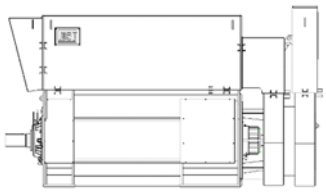


*Figure 4.3: IC611 Cooling*

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.

### 4.5.1 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 4.5.1.
Add additives to the cooling water in proper quantities for protection against corrosion and seaweed growth. The type and number 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 ºC, 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.

### 4.5.2 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.

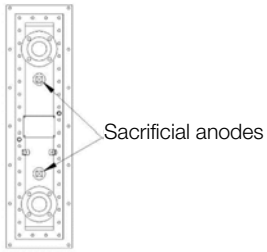



*Figure 4.4: Heat exchanger with sacrificial anodes*

**NOTE**

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

### 4.5.3 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.

### 4.5.4 Protective devices

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

### 4.5.5 Cleaning the air/air heat exchanger

Some fouling of the cooling surface and the pipe wall may occur. This fouling reduces the cooling capacity. The heat exchanger
should therefore be cleaned at regular intervals, to be determined from case to case, depending on the cooling air properties. During the initial period of operation, the heat exchanger should be inspected frequently. Clean the heat exchanger with compressed air or clean it with a suitable brush. Do not use a steel brush on aluminum tubes, as this may damage the tubes; a soft brass round wire brush can be used.

## 4.6 INSULATION RESISTANCE

### 4.6.1 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.

### 4.6.2 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.

### 4.6.3 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:

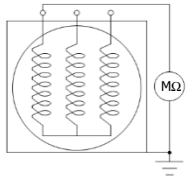



*Figure 4.5: Measurement on the three phases*

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.

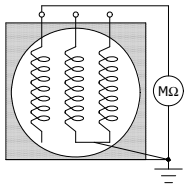



*Figure 4.6: Measurement in separate phases*

### 4.6.4 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 |

### 4.6.5 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.

### 4.6.6 Conversion of the measured values

The insulation resistance measured on the windings shall be converted to 40 ° C using the correction factor provided in Figure 4.7 (IEEE43 standard) and applying the following formula:

$$R_C = Kt \,.\, Rt$$

Where:
R40 = referred insulation resistance at 40 ° C
Kt = Insulation resistance correction factor as a function of temperature, as shown in Figure 4.7,
Rt = measured insulation resistance.

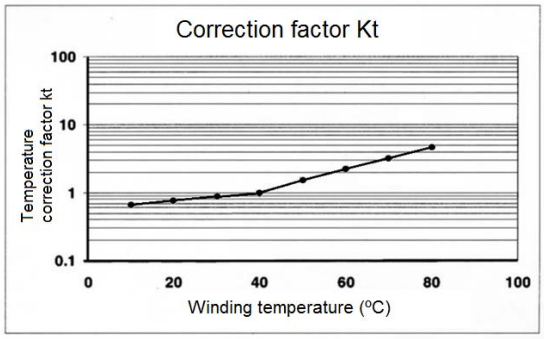



*Figure 4.7: Insulation resistance correction factor due to temperature*

The values used to generate the curve of Figure 4.7 are shown in Table 3.1.

*Table 4.3: Correction factors (Kt) due to temperature*

| t (ºC) | Correction factor kt |
|---|---|
| 10 | 0,7 |
| 20 | 0,8 |
| 30 | 0,9 |
| 40 | 1,0 |
| 50 | 1,5 |
| 60 | 2,3 |
| 70 | 3,3 |
| 80 | 4,6 |

### 4.6.7 Polarization Index (P.I.)

The polarization index is defined by the ratio between the insulation resistance measured in 10 minutes and the insulation resistance measured in 1 minute. This measurement procedure is always carried out at relatively constant temperatures.
The polarization index allows the assessment of the motor insulation conditions.

**DANGER**

In order to avoid accidents, the winding must be grounded immediately after measuring the insulation resistance.

### 4.6.8 Recommended Minimum Values

According to IEEE-43 Standard, the recommended minimum values for winding insulation resistance (R.I.) and Polarization Index (I.P.) are shown in Table 4.4:

*Table 4.4: Minimum R.I. e I.P values*

| Winding Voltage | Minimum R.I. (converted to 40ºC) | Minimum I.P. |
|---|---|---|
| Up to 1000 V | 5 MΩ | Not applicable |
| Greater than 1000 V | 100 MΩ | 2 |

## 4.7 PROTECTIONS

### 4.7.1 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.

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

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.

#### 4.7.1.1 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 4.5 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 4.5: 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.

#### 4.7.1.2 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.

#### 4.7.1.3 Alarm and shutdown temperatures

The alarm and motor switch-off temperatures must be set as low as possible. These temperatures can be determined from factory tests or from the motor's operating temperature. The alarm temperature can be set 10ºC above the machine's operating temperature at full load, always considering the highest ambient temperature in the location.

**ATTENTION**

The alarm and shutdown values can be set according to experience but must not exceed the maximum values indicated in the motor connection diagram.

**ATTENTION**

The motor protection devices are listed in the WEG drawing - connection diagram.
Failure to use these devices is the user's full responsibility and, in case of damage to the motor, will result in loss of warranty.

#### 4.7.1.4 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 this equipment:
- 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.

### 4.7.2 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.

### 4.7.3 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.

### 4.7.4 Protections on the voltage regulator

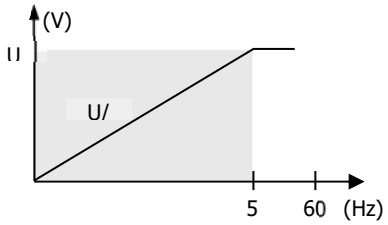
#### 4.7.4.1 Protection against underfrequency

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 overcurrent of the alternator.

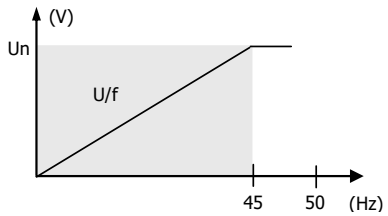
**NOTE**

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

**Application 60HZ**




**Application 50HZ**



## 4.8 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.

## 4.9 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.

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**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.

## 4.10 ELECTRICAL ASPECTS

### 4.10.1 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.

#### 4.10.1.1 Main connection

The main cable connections must be done observing the tightening torque according to Table 4.6 for fixing the cables.

*Table 4.6: 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.

#### 4.10.1.2 Grounding

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

#### 4.10.1.3 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.

#### 4.10.1.4 Terminal identification

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

#### 4.10.1.5 Electrical connection of the voltage regulator

- In order to correctly perform 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.

### 4.10.2 Accessories

#### 4.10.2.1 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.

#### 4.10.2.2 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.

#### 4.10.2.3 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.

## 4.11 MECHANICAL ASPECTS

### 4.11.1 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.
- The customer is responsible for the design and construction of the foundation. It shall be sufficiently rigid to withstand circuit forces. To avoid resonance vibrations the foundation shall be designed so that the natural frequency (reed frequency) of foundation together with machine is not within +/- 20% of running speed frequency. The customer is also responsible for lateral and torsional critical speed analysis of the complete installation.

### 4.11.2 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.

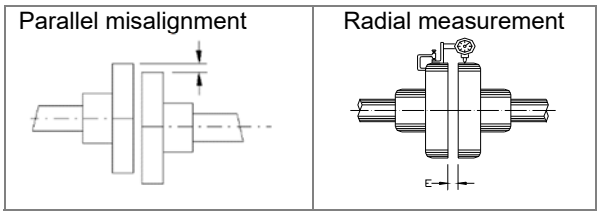



*Figure 4.8: Parallel alignment*

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 90º, 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 0º, half the difference of the dial gauge measurement in points 0º 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.

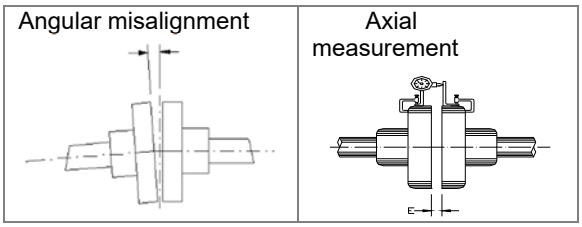



*Figure 4.9: Angular alignment*

Figure 4.9 shows the angular misalignment and the practical way of measuring it
The measurement is made in four points at 90º, 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 0º, half the difference of the dial gauge measurement in points 0º and 180º 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.

## 4.12 COUPLINGS

Only proper couplings, which convey only torque without generating transversal forces, must be used.
For both flexible and rigid couplings, the shaft centers of the coupled machines must be in a single line.
Flexible couplings mitigate the effects of residual misalignments and prevent transmission of vibration between the coupled machines, which does not occur when rigid couplings are used.
The coupling must be mounted or removed with the aid of proper devices and never by means of rudimentary tools, such as hammers, sledgehammers, etc.
Follow the manufacturer's instructions when mounting or removing couplings or other drive elements and cover them with a touch guard. For trial run in uncoupled state, lock or remove the shaft end key.
Avoid excessive radial and axial bearing loads (note manufacture's documentation). The balance of the machine is indicated as H= half and F= full key. In half key cases coupling must be half key balanced without a key. In case of protruding, visible part of the shaft end key, establish mechanical balance.

**ATTENTION**

Dowel pins, nuts, washers and leveling shims may be supplied with the motor, when requested in the purchase order.

**NOTES**

The user is responsible for the motor installation (unless otherwise specified by commercial agreement).
WEG is not liable for damages to the motor, associated equipment and installation occurred because of:

- Transmission of excessive vibration;
- Poor installations;
- Faulty alignment;
- Improper storage conditions;
- Noncompliance with the instructions before start-up;
- Incorrect electrical connections.

### 4.12.1 Direct 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.

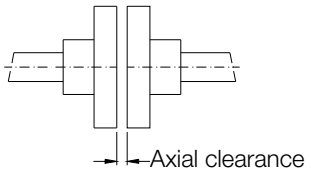



*Figure 4.10: Axial clearance*

**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, 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 system start, as well as the first hours of operation, must be monitored carefully.
**Before putting the motor into operation, verify:**

- If the high-pressure oil injection system (if any) is ON;
- If the external lubrication system (if any) is ON;
- If the used lubricant complies with the specifications;
- The lubricant characteristics;
- The oil level (oil-lubricated bearings);
- If the bearing alarm and trip temperatures are set;
- During the first start, it is important to pay attention to unusual vibrations or noises;
- If the bearing is not working silently and smoothly, the motor must be shut down immediately;
- In case of overheating, the motor must be shut down immediately for the inspection of bearings and temperature sensors, and the correction of possible causes;
- The motor must operate for several hours until bearing temperatures stabilize within the specified limits;
- After the bearing temperatures stabilize, check if there are no leaks through the plugs, gaskets or shaft end.

#### 5.2.2.1 High-pressure oil injection system

In bearings which have the option for shaft lifting when starting or stopping by means of oil pressure, the activation of this system is done by means of an external oil pump, and the following procedure must be observed:

**ATTENTION**

The high-pressure oil injection system must be switched on before putting the motor into operation and during the shutdown procedure, as informed in the motor technical documentation.

### 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

Any evidence of increase in the unbalance or vibration of the motor must be investigated immediately.

**ATTENTION**

After torquing or disassembling any machine screw, it is necessary to apply Loctite.

## 6.5 BEARING MAINTENANCE

Temperature control of the bearings is also part of the routine maintenance of alternators. The temperature can be controlled permanently with thermometers, placed outside the bearing, or by the thermoresistors installed. The alarm and shutdown temperatures for the bearings can be set to 110ºC and 120ºC, respectively.

### 6.5.1 Grease-lubricated rolling bearings

**NOTE**

The rolling bearing data, amount and type of grease, and lubrication intervals are informed on a bearing nameplate affixed to the motor.
**The bearings shall be relubricated annually or according to the lubrication interval stated on the bearings nameplate, whichever occurs first.**

- The informed lubrication intervals, consider a 70 °C working temperature of the rolling bearing;
- Based on the operating temperature ranges listed in Table 6.1, apply the following correction factors for the rolling bearing lubrication intervals:

*Table 6.1: Reduction factor for lubrication intervals*

| Bearing operating temperature | Reduction factor |
|---|---|
| Below 60 ºC | 1.59 |
| Between 70 and 80 ºC | 0.63 |
| Between 80 and 90 ºC | 0.40 |
| Between 90 and 100 ºC | 0.25 |
| Between 100 and 110 ºC | 0.16 |

#### 6.5.1.1 Instructions for lubrication

The lubrication system was designed in such a way that during the lubrication of the rolling bearings, all the old grease is removed from the rolling bearing races and expelled through a drain which enables the exit of the grease but prevents the ingress of dust or other harmful contaminants. This drain also prevents damage to the rolling bearings by excessive lubrication. It is recommended to make the lubrication with the motor in operation in order to ensure the renewal of the grease in the rolling bearing housing.
If that is not possible due to the presence of rotating parts near the grease nipple (pulleys, etc.) which may put the operator at risk, follow the procedures below:

- With the motor stopped, inject approximately half of the total intended amount of grease and operate the motor for approximately one minute at full speed;
- Stop the motor and inject the rest of the grease.

**ATTENTION**

The injection of all the grease with the motor stopped may lead to the penetration of part of the lubricant into the motor through the internal seal of the rolling bearing cap. It is important to clean the grease nipples prior to lubrication in order to prevent foreign materials from being dragged into the rolling bearing. For lubrication, use only manual grease gun.

### 6.5.1.2 Procedures for rolling bearing relubrication

1. Remove the drain plug;
2. Clean with a cotton cloth around the hole of the grease nipple;
3. With the rotor operating, inject the grease with a manual grease gun until grease starts coming out from the drain or until the proper amount of grease, informed in Table 6.3, has been injected.
4. keep the motor running long enough so that the grease excess passes through the drain;
5. Inspect the bearing temperature to make sure there was no significant change;
6. Put the drain plug back in place.

### 6.5.1.3 Rolling bearing relubrication with drawer device for grease removal

In order to relubricate the bearings, the old grease is removed by means of the device with a drawer installed on each bearing. **Lubrication procedure:**

1. Before starting the lubrication of the bearing, clean the grease nipple with a cotton cloth;
2. Remove the rod with drawer to remove the old grease, clean the drawer and put it back in place;
3. With the motor running, inject the amount of grease specified on the rolling bearing nameplate by means of a manual grease gun;
4. The excess of grease comes out through the bearing lower drain and is deposited in the drawer;
5. Leave the motor running long enough for the grease excess to drain;
6. Remove the excess of grease, by pulling the drawer rod and cleaning the drawer. This procedure must be repeated as many times as necessary until the drawer no longer retains grease;
7. Inspect the bearing temperature to ensure that there was no significant change.

### 6.5.1.4 Type and amount of grease

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

**ATTENTION**

WEG does not recommend the use of greases different from the motor original grease.

It is important to perform a correct lubrication, i.e., to apply the correct grease and in the proper quantity, because either poor or excessive lubrication will damage the rolling bearings.
Excessive amount of grease cause temperature increase, due to the great resistance it offers to the movement of the bearing rotating parts. Consequently, due to the heating, the grease can completely lose its lubricating characteristics.

### 6.5.1.5 Alternative greases

If it is not possible to use the original grease, the alternative greases listed in Table 6.2 can be used, under the following conditions:

1. The motor speed must not exceed the limit speed of the grease, according to the type of rolling bearing, as informed in Table 6.3;
2. The lubrication interval must be corrected by multiplying the interval informed on the bearing nameplate by the multiplication factor informed in Table 6.2;
3. Use the correct procedure to change the grease, according to section 6.5.1.6 of this manual.

*Table 6.2: Options and characteristics of the alternative greases for regular applications*

| Manufacturer | Grease | Constant operating temperature (°C) | Multiplication factor |
|---|---|---|---|
| Exxon Mobil | **UNIREX N3** (Lithium Complex Soap) | (-30 to +150) | 0.90 |
| Shell | **GADUS S2 V100 3** (Lithium Soap) | (-30 to +130) | 0.85 |
| Petrobras | **LUBRAX INDUSTRIAL GMA-2** (Lithium Soap) | (0 to +130) | 0.85 |
| Shell | **GADUS S3 T100 2** (Diurea Soap) | (-20 to +150) | 0.94 |
| SKF | **LGHP 2** (Polyurea Soap) | (-40 to +150) | 0.94 |

Table 6.3 shows the most common rolling bearings used in vertical motors, the quantity of grease and the speed limit for using alternative greases.

*Table 6.3: Alternative greases applications*

| Bearing | Grease quantity (g) | Limit speed of the grease [rpm] Vertical motors | | | | |
|---|---|---|---|---|---|---|
| | | GADUS S3 T100 2 | LGHP 2 | Unirex N3 | GADUS S2 V100 3 | Lubrax Industrial GMA-2 |
| 6215 | 15 | 3600 | 3600 | 3600 | 3000 | 3000 |
| 6217 | 20 | 1800 | 1800 | 1800 | 1800 | 1800 |
| 6220 | 30 | 1800 | 1800 | 1800 | 1800 | 1800 |
| 6222 | 40 | 1800 | 1800 | 1800 | 1800 | 1800 |
| 6224 | 45 | 1800 | 1800 | 1800 | 1800 | 1800 |
| 6228 | 55 | 1800 | 1800 | 1800 | 1800 | 1500 |
| 6232 | 70 | 1800 | 1800 | 1800 | 1500 | 1200 |
| 6236 | 85 | 1800 | 1800 | 1500 | 1500 | 1200 |
| 6240 | 105 | 1800 | 1800 | 1200 | 1200 | 1000 |
| 6048 | 100 | 1500 | 1500 | 1200 | 1200 | 1000 |
| 6052 | 130 | 1500 | 1500 | 1200 | 1000 | 900 |
| 6064 | 290 | 1200 | 1200 | 1000 | 900 | 750 |
| 7216 | 20 | 3600 | 3600 | 3600 | 3000 | 1800 |
| 7218 | 25 | 1800 | 1800 | 1800 | 1800 | 1800 |
| 7222 | 40 | 1800 | 1800 | 1800 | 1800 | 1800 |
| 7224 | 45 | 1800 | 1800 | 1800 | 1800 | 1800 |
| 7228 | 55 | 1800 | 1800 | 1800 | 1800 | 1500 |
| 7322 | 60 | 1800 | 1800 | 1800 | 1800 | 1500 |
| 7324 | 70 | 1800 | 1800 | 1800 | 1800 | 1500 |
| 7326 | 80 | 1800 | 1800 | 1800 | 1500 | 1200 |
| 7328 | 95 | 1800 | 1800 | 1800 | 1500 | 1200 |
| 7330 | 105 | 1800 | 1800 | 1500 | 1500 | 1200 |
| 7332 | 115 | 1800 | 1800 | 1500 | 1200 | 1200 |
| 7332 DT | 230 | 1800 | 1800 | 1500 | 1200 | 1200 |
| 7334 DT | 260 | 1800 | 1800 | 1500 | 1200 | 1000 |
| 7338 DT | 310 | 1500 | 1500 | 1200 | 1200 | 1000 |

### 6.5.1.6 Procedure for changing the grease

In order to replace the **POLYREX EM103** grease by one of the alternative greases, the bearings must be opened to remove the old grease and then filled with the new grease.
If it is not possible to open the bearings, the old grease must be purged by applying new grease until it begins to appear in the exit drawer with the motor running.
In order to replace the **PETAMO GHY 133 N** grease by one of the alternative greases, you must first open the bearings, completely remove the old grease, and then fill it with new grease.

**ATTENTION**

When the bearing is opened, inject the new grease through the grease nipple to expel the old grease found in the grease inlet tube, and apply the new grease in the rolling bearing, to the inner and outer bearing caps, filling 3/4 of the empty spaces. In case of double bearings (ball bearing + roller bearing), also fill 3/4 of the empty spaces between the intermediate rings. Never clean the rolling bearing with cotton-based cloths, because they may release some lint, working as solid particles.

**NOTES**

WEG is not liable for the change of grease change or for any damages arising from this change.

### 6.5.1.7 Low temperature greases

*Table 6.4: Grease for application at low temperatures*

| Manufacturer | Grease | Constant operating temperature (°C) | Application |
|---|---|---|---|
| Exxon Mobil | **MOBILITH SHC 100** (Lithium Soap and Synthetic Oil) | (-50 to +150) | Low temperature |

### 6.5.1.8 Grease compatibility

You can say that greases are compatible when the properties of the mixture are within the property ranges of the greases individually. In general, greases with the same type of soap are compatible; however, depending on the proportion of the mixture, there might be incompatibility. Therefore, it is not recommended to mix different types of grease without consulting the grease supplier or WEG. Some thickeners and basic oils cannot be mixed because they do not form a homogeneous mixture. In this case, one cannot rule the possibility of hardening or softening of the grease, or reduction of the dropping point of the resulting mixture.

**ATTENTION**

Greases with different types of bases must never be mixed. For example: Lithium-based greases must never be mixed with sodium or calcium-based greases.

### 6.5.1.9 Disassembly – vertical bearings

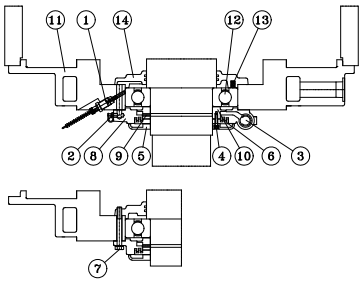



*Figure 6.1: Lower bearing*

***Figure 6.1 legend:***
1. *Temperature sensor*
2. *Grease nipple*
3. *Grease collecting drawer*
4. *Screw*
5. *Protection disc*
6. *Labyrinth taconite seal*
7. *Screw*
8. *Outer bearing cap*
9. *Screw*
10. *Grease flinger*
11. *Lower end shield*
12. *Rolling bearing*
13. *Spring*
14. *Inner bearing cap*

### 6.5.1.10 Before disassembling

- Remove the extension tubes from the grease inlet and outlet;
- Thoroughly clean the external part of the bearing;
- Remove the grounding brush (if any);
- Remove the temperature sensors.

### 6.5.1.11 Lower bearing disassembly

In order to disassemble the bearing, proceed according to the following guidelines:

1. Place the motor in the horizontal position;
2. Remove the screws (4), protection disc (5) and the labyrinth taconite seal (6);
3. Remove the screws (7) from the outer and inner bearing caps (8 and 14);
4. Remove the outer bearing cap (8);
5. Remove the screw (9) that fixes the grease flinger (10);
6. Remove the grease flinger (10);
7. Remove the lower end shield (11);
8. Remove the rolling bearing (12);
9. Remove the inner bearing cap (14), if necessary.

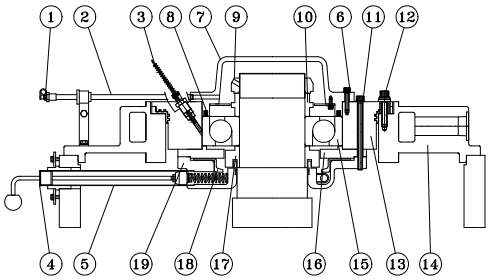



*Figure 6.2: Upper bearing*

***Figure 6.2 legend:***

1. *Grease nipple*
2. *Grease inlet tube*
3. *Temperature sensor*
4. *Grease collecting drawer*
5. *Grease outlet tube*
6. *Screw*
7. *Outer bearing cap*
8. *Spring*
9. *KMT nut*
10. *Spacer ring*
11. *Screw*
12. *Screw*
13. *Bearing hub*
14. *Upper end shield*
15. *Rolling bearing*
16. *Intermediate ring*
17. *Grease flinger*
18. *Guiding ring*
19. *Inner bearing cap*

### 6.5.1.12 Upper bearing disassembly

In order to disassemble the bearing, proceed according to the following guidelines:

1. Support the motor shaft with a hydraulic jack;
2. Remove the screws (6) from the outer bearing cap of the rolling bearing (7);
3. Remove the outer bearing cap (7);
4. Remove the KMT nut (9);
5. Remove the screws (11 and 12) and remove the bearing hub;
6. Remove the upper end shield (14);
7. Move the intermediate ring and the inner bearing cap away from the bearing in order to obtain space to place the device to remove the rolling bearing;
8. Remove the rolling bearing (15);
9. Remove the grease flinger (17), the intermediate ring and the inner bearing cap, if necessary.

**ATTENTION**

- During the bearing disassembly, it is necessary to be careful not to damage the balls, rollers or shaft surface;
- Keep the disassembled parts in a safe and clean place.

### 6.5.1.13 Bearing assembly

- Clean the bearings completely and inspect the disassembled parts and the inside of the bearing caps;
- Make sure the rolling bearing, shaft and bearing cap surfaces are perfectly smooth;
- Fill up to ¾ of the inner and outer bearing cap deposits with the recommended grease (Figure 6.3) and lubricate the rolling bearing with enough grease before assembling it;
- Before assembling the rolling bearing on the shaft, heat it up to a temperature between 50 ºC and 100 ºC;
- For the complete assembly of the bearing, follow the disassembly instructions in the reverse order.
- The efficiency of sealing against taconita will be given by the filling of grease between the protrusions of the labyrinth seal and outer ring (if any)

*Figure 6.3: Outer bearing cap*

## 6.5.2 Oil-lubricated rolling bearing

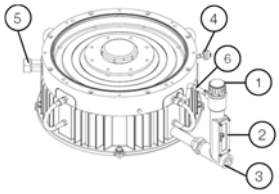



*Figure 6.4: Oil-lubricated rolling bearing*

***Figure 6.4 legend:***

1. *Oil inlet*
2. *Oil sight glass*
3. *Oil outlet*
4. *Temperature sensor*
5. *Cooling water inlet and outlet (optional use)*
6. *Breather hose*

**ATTENTION**

The breather hose (6) must not present any curvature that can accumulate oil inside.

### 6.5.2.1 Lubrication instructions

**Oil drainage:** When it is necessary to change the bearing oil, remove the oil outlet plug (3) and drain the oil completely.

**To fill the bearing with oil:**

- Close the oil outlet with the plug (3);
- Remove the plug from the oil inlet or from the filter (1);
- Fill it with the specified oil up to the level indicated in the oil sight glass.

**NOTES**

1. All threaded holes that are not used must be closed with plugs and no fitting may present leaks;
2. The oil level is reached when the lubricant can be seen approximately in the middle of the sight glass;
3. The use of a larger amount of oil will not damage the bearing; but it can cause leaks through the shaft seals;
4. Never use hydraulic oil or mix it with the bearing lubricant oil.

### 6.5.2.2 Oil type

The type and quantity of **lubricant oil** to be used are specified on the nameplate affixed to the motor.

### 6.5.2.3 Oil change

The bearing oil change must be done according to the intervals, which depend on the bearing operating temperature, shown in Table 6.5.

*Table 6.5: Oil change intervals*

| Bearing operating temperature | Bearing oil change intervals |
|---|---|
| Below 75 ºC | 20,000 hours |
| Between 75 and 80 ºC | 16,000 hours |
| Between 80 and 85 ºC | 12,000 hours |
| Between 85 and 90 ºC | 8,000 hours |
| Between 90 and 95 ºC | 6,000 hours |
| Between 95 and 100 ºC | 4,000 hours |

The lifespan of the bearings depends on their operating conditions, on the motor operating conditions and on the maintenance procedures.
Proceed according to the following directions:

- The oil selected for the application must have the proper viscosity for the bearing operating temperature. The type of oil recommended by WEG already considers these criteria;
- Insufficient quantity of oil may damage the bearing;
- The minimum recommended oil level is reached when the lubricant can be seen in the lower part of the oil sight glass with the motor stopped.

**ATTENTION**

The oil level must be inspected daily and must remain in the middle of the oil sight glass.

### 6.5.2.4 Bearing operation

**The system start, as well as the first hours of operation, must be monitored carefully.**
Before starting, check:

- If the used oil complies with the specification on the nameplate;
- The lubricant characteristics;
- The oil level;
- The alarm and trip temperatures set for the bearing.

During the first start, it is necessary to stay alert for unusual vibrations or noises. If the bearing does not operate in a silent and smooth way, the motor must be shut down immediately.
The motor must operate for some hours until the bearing temperatures stabilize. In case of overheating of the bearings, the motor must be shut down for inspection of the bearings and temperature sensors.
Check if there is no oil leak through the plugs, gaskets or shaft end.

### 6.5.2.5 Bearing disassembly

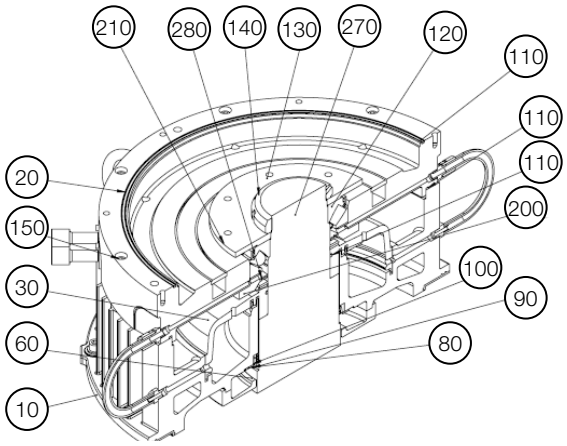



*Figure 6.5: Upper bearing*

***Figure 6.5 legend:***
*10. Oil tank*
*20. Bearing hub*
*30. Oil flinger*
*60. Oil drip pan*
*80. Seal fastening ring*
*90. Socket screw*
*100. Teflon seal*
*110. Gasket*
*120. Rolling bearing*
*130. Upper intermediate ring*
*140. Fastening nut*
*150. Socket screw*
*200. Lower intermediate ring*
*210. Socket screw*
*270. Shaft*
*280. Socket screw*

**Before disassembling the upper bearing:**

- Support the rotor on the shaft end with a hydraulic jack;
- Drain the oil completely from the bearing;
- Clean the external part of the bearing thoroughly;
- Remove the temperature sensors.

**Upper bearing disassembly**
In order to disassemble the bearing, proceed carefully as the following guidelines, keeping all the parts in a safe place.

- Remove the upper bearing cover;
- Remove the KMT nut (140);
- Remove the intermediate ring (130);
- Remove the screws (150) and remove the bearing hub;
- Remove the rolling bearing (120);
- Reinstall the upper intermediate ring (130), fasten it directly to the lower intermediate ring (200) and, using a rolling bearing puller, extract the set formed by the upper ring (130), lower ring (200) and rolling bearing (120).

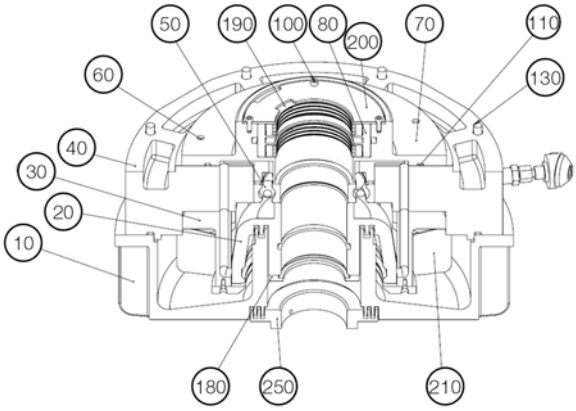



*Figure 6.6: Lower bearing*

***Figure 6.6 legend:***
*10. Oil tank*
*20. Oil flinger*
*30. Oil guide*
*40. Bearing hub*
*50. Rolling bearing*
*60. Socket screw*
*70. Oil injector nozzle*
*80. Seal fastening ring*
*100. Socket screw*
*110. Gasket*
*130. Socket screw*
*180. Segmented ring*
*190. Teflon seal*
*200. Seal fastening ring*
*210. Oil guide*
*250. Labyrinth taconite seal*

**Before disassembling the lower bearing:**
- Drain the oil completely from the bearing;
- Put the motor in the horizontal position;
- Clean the external part of the bearing thoroughly;
- Remove the grounding brush (if any);
- Remove the temperature sensors.

**Lower bearing disassembly**
In order to disassemble the bearing, proceed carefully as the following guidelines, keeping all the parts in a safe place.
- Remove the screws (8) that fasten the labyrinth taconite seal (250);
- Remove the labyrinth taconite seal (250);
- Remove the oil tank (10);
- Remove the segmented ring (180);
- Remove the oil flinger (20);
- Remove the rolling bearing hub (40);
- Remove the rolling bearing (50);

**ATTENTION**
- During the bearing disassembly, it is necessary to be careful not to damage the balls, rollers or shaft surface;
- Keep the disassembled parts in a safe and clean place.

### 6.5.2.6 Bearing assembly

- Clean the rolling bearing and the oil tanks thoroughly and inspect all the parts before the bearing assembly.
- Make sure the rolling bearing contact surfaces are smooth and free of signs of scratches or corrosion;
- Before mounting the rolling bearing on the shaft, heat it up to a temperature between 50 to 100 ºC;
- For the complete assembly of the bearing, follow the disassembly instructions in the reverse order.

**ATTENTION**
During the bearing assembly, apply sealant (e.g., **Curil T**) in order to seal the surfaces of the oil tank.

### 6.5.3 Rolling bearing replacement

The disassembly of rolling bearings must be done with an appropriate tool (rolling bearing puller).
The arms of the puller must be placed on the lateral surface of the bearing inner ring to be disassembled or on an adjacent part.

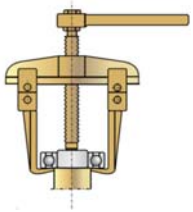


*Figure 6.7: Tool for rolling bearing extraction*

### 6.5.4 Sleeve bearings

#### 6.5.4.1 Bearing data

The characteristic data, such as oil flow, quantity and type, are indicated on the bearing nameplate and must be strictly observed; otherwise, overheating and damages to the bearings may occur.
The hydraulic installation (for bearings with forced lubrication) and the oil supply for the motor bearings are responsibilities of the user.

#### 6.5.4.2 Bearing installation and operation

For information on the bill of materials, assembly and disassembly instructions, and maintenance details, refer to the specific installation and operation manual of the bearings.

#### 6.5.4.3 Cooling by water circulation

The sleeve bearings with cooling by water circulation have a serpentine inside the oil tank through which the water circulates. In order to assure an efficient bearing cooling, the circulating water must have at the bearing inlet a temperature lower or equal to the ambient, so that the cooling takes place. The water pressure must be 0.1 bar and the flow equal to 0.7 l/s. The pH must be neutral.

**NOTE**
Under no circumstances can water leak into the oil tank because this will contaminate the lubricant.

#### 6.5.4.4 Oil change

**Self-lubricated bearings**
The bearing oil change must be done according to the intervals, which depend on the bearing operating temperatures, shown in Table 6.6:

*Table 6.6: Oil change intervals*

| Bearing operating temperature | Bearing oil change intervals |
|---|---|
| Below 75 ºC | 20,000 hours |
| Between 75 and 80 ºC | 16,000 hours |
| Between 80 and 85 ºC | 12,000 hours |
| Between 85 and 90 ºC | 8,000 hours |
| Between 90 and 95 ºC | 6,000 hours |
| Between 95 and 100 ºC | 4,000 hours |

**Bearings with external oil circulation**
The oil of the bearings must be changed every 20,000 hours of operation or whenever the lubricant presents modifications in its characteristics. The oil viscosity and pH must be checked periodically.

**NOTE**

The oil level must be inspected daily, and it must remain in the middle of the oil sight glass.

The bearings must be lubricated with the specified oil, respecting the flow rate informed on their nameplate. All threaded holes that are not used must be closed with plugs and no fitting may present leaks. The oil level is reached when the lubricant can be seen approximately in the middle of the sight glass. The use of a larger amount of oil will not damage the bearing, but it can cause leaks through the shaft seals.

**ATTENTION**

The care with the lubrication will determine the useful life of the bearings and the safety in the motor operation. Therefore, the following recommendations must be observed:

- The selected lubricant oil must be the one with proper viscosity for the operating temperature of the bearings; That must be observed at every oil change or during periodical maintenances;
- Never use or mix hydraulic oil with the lubricant oil of the bearings;
- Lack of lubricant, due to incomplete filling or non-monitoring of the level, can damage the bearing shells;
- The minimum oil level is reached when the lubricant can be seen in the lower part of the sight glass with the motor stopped.

### 6.5.4.5 Sealing

Make visual inspections of the sealing, making sure that the dragging marks of the seal on the shaft do not compromise its integrity, checking for cracks and broken parts. Cracked or broken parts must be replaced.
In case of bearing maintenance, in order to assemble the seal, it is necessary to carefully clean the seal contact surfaces and its enclosure and cover the sealing with a non-hardening component (i.e., **Curil T**). The two halves of the labyrinth taconite seal must be joined by a garter spring. The drain holes located in the lower half of the seal must be cleaned and unobstructed. Improper installation can damage the sealing and cause oil leakage.

**ATTENTION**

For further information about the dismounting and mounting of sleeve bearing seals, refer to the specific manual of this equipment.

### 6.5.4.6 Sleeve bearing operation

**The system start, as well as the first hours of operation, must be monitored carefully.**
Before starting, check:

- If the oil inlet and outlet tubes (if any) are, clean. Clean the tubes by pickling, if necessary;
- If the used oil complies with the specification on the nameplate;
- The lubricant characteristics;
- The oil level;
- The alarm and trip temperatures set for the bearing.

During the first start, it is necessary to stay alert for unusual vibrations or noises. If the bearing does not operate in a silent and smooth way, the motor must be shut down immediately.
The motor must operate for several hours until the bearing temperatures stabilize. In case of overheating of the bearings, the motor must be shut down for inspection of the bearings and temperature sensors.
Check if there is no oil leak through the plugs, gaskets or shaft end.

### 6.5.4.7 Sleeve bearing maintenance

The sleeve bearing maintenance includes:

- Periodic checking of the oil level and its lubricating conditions;
- Checking the bearing noise and vibration levels;
- Monitoring of the operating temperatures and retightening of the fastening and mounting screws;
- In order to facilitate the heat exchange with the environment, the frame must be kept clean, without external dust or oil accumulation;
- The NDE bearing is electrically insulated. The spherical seat surfaces of the bearing shell on the frame are covered with insulating material. Never remove this cover;
- The anti-rotation pin is also insulated, and the seals are made of non-conducting material;
- Temperature control devices that are in contact with the bearing shell must also be properly insulated.

### 6.5.4.8 Bearing disassembly and assembly

**NOTE**

If the supplied bearings are manufactured by WEG, refer to the specific bearing manual supplied with the motor, containing the assembly, disassembly and maintenance information.

### 6.5.4.9 Thrust bearing (upper)

The upper thrust bearing function is to withstand the weight of the motor and the axial thrust for which it was designed. Its main elements are the stationary axial pads and the rotating pivots (see Figure 6.8).
The pivots receive the load through the thrust pads.

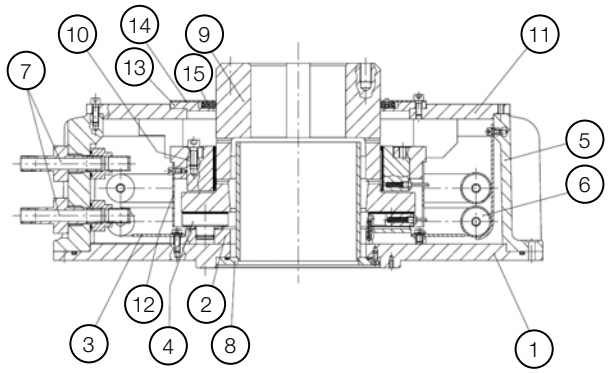



*Figure 6.8: Upper thrust bearing*

***Figure 6.8 legend:***
1. *Lower flange*
2. *Base ring of the pads*
3. *Axial segment*
4. *Axial pad*
5. *Bearing housing*
6. *Serpentine (optional)*
7. *Fittings for cooling water*
8. *Standpipe*
9. *Runner*
10. *Bearing shell*
11. *Bearing cover*
12. *Vertical guide plate*
13. *Seal box*
14. *Seal fastening ring*
15. *Floating seal*

**Before disassembling:**
- Support the rotor at the shaft end with a hydraulic jack;
- Drain the oil thoroughly from the bearing;
- Clean the external part of the bearing thoroughly;
- Remove the temperature sensors.

**Disassembly**
- Support the rotor at the shaft end with a hydraulic jack;
- Remove the screws that fix the bearing upper cover and remove it;
- Disassemble the bearing following the manufacturer manual instruction.

**Assembly**
Follow the disassembly instructions in reverse order.

### 6.5.4.10 Guide bearing (lower)

The lower guide bearing function is to provide the radial location of the motor shaft without load or axial displacement limitation.

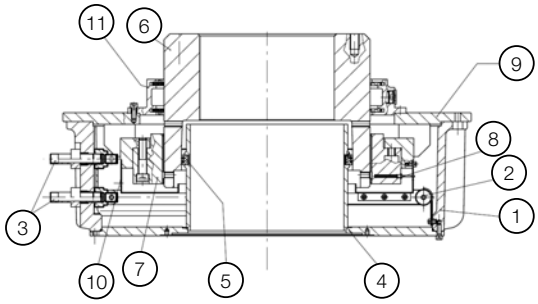



*Figure 6.9: Lower guide bearing*

***Figure 6.9 legend:***
1. *Bearing housing*
2. *Serpentine*
3. *Fittings for cooling water*
4. *Standpipe*
5. *Standpipe seal*
6. *Runner*
7. *Bearing shell*
8. *Thermoresistance (optional)*
9. *Cover*
10. *Radial segment*
11. *Double seal*

**Before disassembling:**
- Drain the oil thoroughly from the bearing;
- Thoroughly clean the external part of the bearing;
- Remove the temperature sensors;
- Remove the grounding brush (if any);
- Uncouple the motor and place it in the horizontal position.

**Disassembly**
- Remove the screws that fix the bearing lower cover and remove it;
- Disassemble the bearing following the manufacturer manual instruction.

**Assembly**
In order to assemble the bearing, follow the disassembly procedures in the reverse order.

### 6.5.5 Setting the protections

**ATTENTION**

The following temperatures must be adjusted in the bearing protection system:
ALARM: 110 ºC SHUTDOWN: 120 ºC
The alarm temperature must be adjusted at 10 ºC above the working temperature, not exceeding the limit of 110 ºC

### 6.5.6 Disassembly/assembly of the sleeve bearing temperature sensors

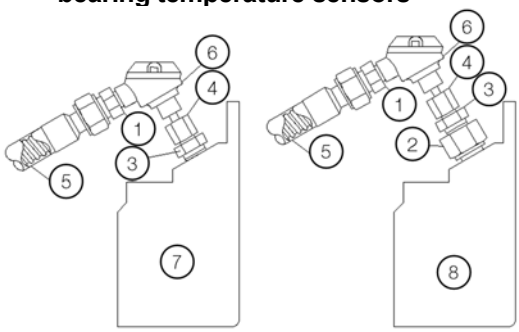



*Figure 6.10: Pt100 on the bearings*

***Figure 6.10 legend:***
*1. Reduction nipple*
*2. Insulating adapter*
*3. Locknut*
*4. Bulb*
*5. Flexible metal tube*
*6. Pt-100 temperature sensor*
*7. Non-insulated bearing*
*8. Insulated bearing*

**Disassembly instructions:**
If it is necessary to remove the Pt100 for bearing maintenance, proceed according to the following instructions:
- Remove the Pt100 carefully, locking the locknut (3), and unscrewing just the Pt100 from the bulb (4);
- Parts (2) and (3) must not be disassembled.

**Assembly instructions:**

**ATTENTION**

Before assembling the Pt100 on the bearing, check if it does not contain marks of knock or any other damage that may compromise its operation.

- Insert the Pt100 into the bearing;
- Restrain the locknut (3) with a wrench;
- Screw it in the bulb (4), adjusting it so that the tip of the Pt100 touches the outer surface of the bearing.

**NOTES**

- The assembly of the Pt100 on non-insulated bearings must be done directly on the bearing, without the insulating adapter (2);
- The tightening torque to assemble the Pt100 and the adapters must not exceed 10Nm.

## 6.6 MAINTENANCE OF THE EXCITER

### 6.6.1 Exciter

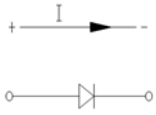
For the proper performance of its components, the alternator exciter must be kept clean.
Check the insulation resistance of the windings of the main exciter and auxiliary exciter periodically so as to determine the insulation conditions, following the procedures described herein.

### 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.

**NOTE**

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 current conduction must occur only in the anode-cathode direction, i.e., in the condition of direct polarization.

The diode is considered good when you have low ohmic resistance (up to approximately 100Ω) in its direct polarization and high resistance (approx. 1MΩ) in the opposite direction. Defective diodes have ohmic resistance of 0Ω or greater than 1MΩ 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 6.7;
- 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 6.7: 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 (± 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, 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 6.11

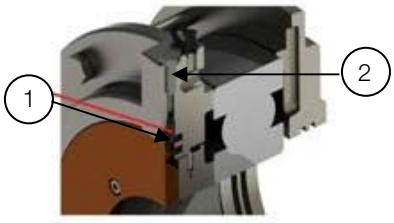



*Figure 6.11: Internal brush for shaft grounding*

***Legend of Figure 6.11***
*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 6.12

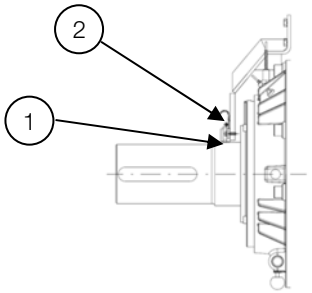



*Figure 6.12: External brush for shaft grounding*

***Legend of Figure 6.12***
*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 AIR-GAP MEASUREMENT

After disassembling and assembling the motor, it is necessary to measure the air gap in order to check the concentricity between rotor and stator. Measure the air gap between the metal support of the shaft seal the motors, measure shaft at four shaft equidistant points (45°, 135°, 225° and 315°). The difference between the air gap measurements at two diametrically opposed points should be less than 10% of the average air gap.

**ATTENTION**

The bearing can only be closed after completion and projected from the air gap

For the single bearing:

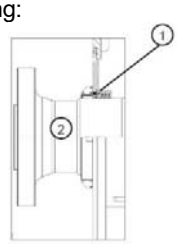



*Figure 7.1: DE shaft seal*

***Figure 7.1 caption:***
*1. DE shaft seal*
*2. Motor shaft*

## 7.4 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.

## 7.5 TIGHTENING TORQUES

The Table 7.1 and Table 7.2 shows the tightening torques of the screws recommended for assembling the motor.

**NOTE**

The resistance class is normally indicated on the head of the hex bolts.

*Table 7.1: Screw tightening torque for metal/metal parts*

| Material / Resistance class | | Carbon Steel / 8.8 or above | | Stainless steel / A2 – 70 or above | |
|---|---|---|---|---|---|
| % Yield Strength | | 70% | | 70% | |
| Lubricant | | Dry | Molycote 1000 | Dry | Molycote 1000 |
| Diam | Pitch (mm) | Screws tightening torque (Nm) | | | |
| M4 | 0,7 | 2,1 | 1,8 | 1,8 | 1,3 |
| M5 | 0,8 | 4,2 | 3,6 | 3,6 | 2,7 |
| M6 | 1 | 8 | 6 | 6,2 | 4,5 |
| M8 | 1,25 | 19,5 | 15 | 15 | 11 |
| M10 | 1,5 | 40 | 29 | 30 | 22 |
| M12 | 1,75 | 68 | 51 | 52 | 38 |
| M14 | 2 | 108 | 81 | 84 | 61 |
| M16 | 2 | 168 | 126 | 130 | 94 |
| M18 | 2,5 | 240 | 174 | 180 | 130 |
| M20 | 2,5 | 340 | 245 | 255 | 184 |
| M22 | 2,5 | 470 | 335 | 350 | 251 |
| M24 | 3 | 590 | 424 | 440 | 318 |
| M27 | 3 | 940 | 621 | 700 | 466 |
| M30 | 3,5 | 1170 | 843 | 880 | 632 |
| M33 | 3,5 | 1730 | 1147 | 1300 | 860 |
| M36 | 4 | 2060 | 1473 | 1540 | 1105 |
| M42 | 4,5 | 3300 | 2359 | 2470 | 1770 |
| M48 | 5 | 5400 | 3543 | 4050 | 2657 |

*Table 7.2: Screw tightening torque for metal/isolated parts*

| Material / Resistance class | | Carbon Steel / 8.8 or above | | Stainless steel / A2 – 70 or above | |
|---|---|---|---|---|---|
| % Yield Strength | | 40% | | 40% | |
| Lubricant | | Dry | Molycote 1000 | Dry | Molycote 1000 |
| Diam | Pitch (mm) | Screws tightening torque (Nm) | | | |
| M4 | 0,7 | 1 | 1 | 1 | 1,3 |
| M5 | 0,8 | 2 | 2 | 1,7 | 2,7 |
| M6 | 1 | 4,4 | 3 | 3,4 | 4,5 |
| M8 | 1,25 | 10,7 | 7,5 | 8,3 | 11 |
| M10 | 1,5 | 21 | 15 | 16,5 | 22 |
| M12 | 1,75 | 37 | 26 | 28 | 38 |
| M14 | 2 | 60 | 42 | 46 | 61 |
| M16 | 2 | 92 | 65 | 72 | 94 |
| M18 | 2,5 | 132 | 90 | 100 | 130 |
| M20 | 2,5 | 187 | 126 | 140 | 184 |
| M22 | 2,5 | 260 | 172 | 190 | 251 |
| M24 | 3 | 330 | 218 | 240 | 318 |
| M27 | 3 | 510 | 320 | 390 | 466 |
| M30 | 3,5 | 640 | 433 | 480 | 632 |
| M33 | 3,5 | 950 | 590 | 710 | 860 |
| M36 | 4 | 1130 | 758 | 840 | 1105 |
| M42 | 4,5 | 1800 | 1213 | 1360 | 1770 |
| M48 | 5 | 2970 | 1822 | 2230 | 2657 |

## 7.6 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.

## 7.7 MAINTENANCE PLAN

The maintenance plan detailed in Table 7.1 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 7.1: Maintenance plan*

| | |
|---|---|
| **DAILY** | |
| ▪ Whole alternator | ▪ Inspect noise, vibration, bearing and winding temperature |
| **MONTHLY** | |
| ▪ Whole alternator | ▪ Measure noise, vibration, bearing and winding temperature<br>▪ Inspect cooling system – air and water flow |
| ▪ Bearings | ▪ Inspect the bearings visually<br>▪ Inspect and, if necessary, relubricate the bearings |
| ▪ Protection and control equipment | ▪ Verify the operation<br>▪ Record the measurement values<br>▪ 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<br>▪ Inspect and, if necessary, clean the alternator internally and externally<br>▪ Alternator whole inspection<br>▪ 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<br>▪ Inspect diodes and varistors<br>▪ Verify winding insulation resistance |
| ▪ Air-water heat exchanger | ▪ Inspect the coolers,<br>▪ Inspect the sacrificial anodes (if any)<br>▪ 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<br>▪ 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<br>▪ Inspect the electrical connections of the voltage regulator<br>▪ Inspect the accessories electrical connections |
| ▪ Grounding | ▪ Inspect and retighten the grounding connections<br>▪ Inspect the shaft grounding brush and replace it, if necessary |
| **EVERY 3 YEARS (TOTAL REVISION)** | |
| ▪ Rotor, stator and exciter windings | ▪ Clean the windings<br>▪ Inspect windings and check the fastening of the wedges on slots<br>▪ Inspect the winding electrical connections |
| ▪ Rotor | ▪ Inspect the shaft (wear, fouling) |
| ▪ Rolling bearings | ▪ Replace the bearings<br>▪ Inspect shaft seat and, if necessary, restore |
| ▪ Sleeve Bearings | ▪ Inspect bearings and shaft track. |
| ▪ Protection, monitoring and control equipment | ▪ 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 | ▪ Verify the power supply of the voltage regulator |
| Field signal inverted | ▪ Verify the field signal (F+ e F-) |
| Driving speed is not correct | ▪ Measure the speed and regulate it |
| Interruption in the main excitation circuit | ▪ Check the continuity of exciter connection cables<br>▪ Perform measurements on all the diodes and replace defective diodes. |
| Voltage regulator defective | ▪ Replace the voltage regulator. |
| Varistor defective | ▪ 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 | ▪ Replace the diodes. |
| Incorrect speed | ▪ 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. | ▪ Check the power supply of the voltage regulator. |
| **VOLTAGE BELOW RATED WITH NO LOAD** | |
| **CAUSE** | **CORRECTIVE PROCEDURE** |
| Speed below rated | ▪ Measure the drive machine speed and adjust |
| Voltage regulator no adjusted | ▪ Check the voltage reading of the voltage regulator software with the alternator phases voltage<br>▪ Check the PT sensing voltage to the alternator<br>▪ Adjust the PT ratio<br>▪ Adjust the sensing voltage of the voltage regulator |
| Rotating diodes defective | ▪ Replace the diodes |
| **OVERVOLTAGE WITH NO LOAD** | |
| **CAUSE** | **CORRECTIVE PROCEDURE** |
| Power thyristor of the regulator defective. | ▪ Replace the regulator. |
| Sensing transformer of the regulator defective | ▪ Measure the sensing voltage at the voltage regulator terminals |
| Voltage regulator no adjusted | ▪ Check the PT ratio<br>▪ Check the voltage reading of the voltage regulator software with the alternator voltage<br>▪ Adjust the PT ratio<br>▪ Adjust the sensing voltage of the voltage regulator |
| Incompatible voltage regulator software | ▪ 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 | ▪ Check signal stability for the field generated by the voltage regulator and adjust PID gains |
| Oscillations in the speed of the drive machine | ▪ Check and eliminate speed oscillations |
| **SHARP VOLTAGE DROP WITH LATER RECOVERY: (BLINKS)** | |
| **CAUSE** | **CORRECTIVE PROCEDURE** |
| Incorrect setting of the stability | ▪ Adjust the instability correctly in the voltage regulator |
| Alternator operating in single mode with the parallelism system activated. | ▪ Shut down the parallelism system |
| Momentary overload | ▪ 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 | ▪ Invert the CT connection |
| **LARGE VOLTAGE DROP WHEN SUBJECT TO LOAD** | |
| **CAUSE** | **CORRECTIVE PROCEDURE** |
| Speed drop of the drive machine | ▪ Observe the speed comportment of the diesel engine |
| Voltage regulator no adjusted | ▪ Check the PID gain adjust of the voltage regulator<br>▪ Check the actuation of the voltage regulator limiters |
| Diodes defectives | ▪ Check the diodes and replace them, if necessary |
| Field winding defective | ▪ Check the field winding |

## 8.2 MECHANICAL ANOMALIES

| OVERHEATING OF THE BEARING | |
|---|---|
| **CAUSE** | **CORRECTIVE PROCEDURE** |
| Bearing defective | ▪ Replace the bearing |
| Excess or lack of lubrication in the bearing | ▪ Check the lubrication of the bearing |
| Incorrect lubricant | ▪ Use the lubricant according to bearing nameplate |
| Excessive axial clearance | ▪ Correct the axial clearance |
| **OVERHEATING ON ALTERNATOR WINDINGS** | |
| **CAUSE** | **CORRECTIVE PROCEDURE** |
| Air input or output partially blocked | ▪ Clear the air passages |
| Hot air is returning to the alternator | ▪ Direct the hot air out of the alternator installation environment |
| Overload on the alternator | ▪ Check the load and adjust the rated data of the alternator |
| Over excitation. | ▪ Check the alternator excitation current and compare with the rated data. Correct it (if necessary). |
| Radiator with incorrect temperature, flow or pressure | ▪ Check and adjust the water characteristics of the radiator |
| **EXCESSIVE VIBRATION** | |
| **CAUSE** | **CORRECTIVE PROCEDURE** |
| Misalignment | ▪ Adjust the alignment of the alternator with the driving machine |
| Assembly defect | ▪ Check for assembly problems of the alternator and correct them (feet fixation, coupling, flange, etc.) |
| Excessive clearance in the coupling | ▪ 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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