Low and high voltage three phase induction motors
M line - Squirrel cage rotor - Horizontal

Installation, Operation and Maintenance Manual
Installation, Operation, and Maintenance Manual

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Dear Customer,

Thank you for acquiring a WEG motor. This is a product developed with levels of quality and efficiency that ensure an excellent performance.

Since electric motors play an important role in comfort and wellbeing, they need to be identified and treated as driving machines, whose features include certain handling procedures such as storage, installation, and maintenance.

All efforts were employed in order to ensure that all of the information provided in this manual is accurate regarding the configurations and applications of the motor.

Therefore, careful reading of this manual before proceeding with the motor installation, operation or maintenance is highly recommended in order to ensure safe and continuous motor operation, ensuring its safety and that of its installations. In case of any remaining doubts, please contact WEG. Maintain this manual close to the motor at all times so it can be consulted whenever necessary.

ATTENTION

1. Following the procedures provided in this manual is mandatory to maintain a valid product warranty;
2. Motor installation, operation, and maintenance procedures must be performed only by qualified personnel.

NOTES

1. Total or partial reproduction of the information provided herein is allowed, provided that the source is properly referenced;
2. If this manual is lost, a PDF copy may be downloaded from the www.weg.net website, or an extra copy may also be provided by WEG.

WEG EQUIPAMENTOS ELÉTRICOS S.A.
TABLE OF CONTENTS

1 INTRODUCTION ........................................................................................................... 11
  1.1 TERMINOLOGY ........................................................................................................ 11
  1.2 SAFETY WARNINGS ................................................................................................. 11

2 GENERAL INSTRUCTIONS ......................................................................................... 13
  2.1 QUALIFIED PERSONNEL ....................................................................................... 13
  2.2 SAFETY INSTRUCTIONS ......................................................................................... 13
  2.3 MOTORS APPLIED IN HAZARDOUS AREAS ....................................................... 13
      2.3.1 General Precautions ......................................................................................... 13
      2.3.2 Additional Precautions ..................................................................................... 13
  2.4 STANDARDS ............................................................................................................ 14
  2.5 ENVIRONMENT CHARACTERISTICS ..................................................................... 14
  2.6 OPERATION CONDITION ......................................................................................... 14
  2.7 VOLTAGE AND FREQUENCY .................................................................................. 15

3 RECEIVING, STORAGE AND HANDLING ................................................................. 15
  3.1 RECEIVING ............................................................................................................. 15
  3.2 STORAGE ................................................................................................................. 15
      3.2.1 Indoor storage .................................................................................................... 16
      3.2.2 Outdoor storage ............................................................................................... 16
      3.2.3 Extended storage ............................................................................................. 16
      3.2.3.1 Storage location ........................................................................................... 16
          3.2.3.1.1 Indoor storage ....................................................................................... 16
          3.2.3.1.2 Outdoor storage .................................................................................... 16
          3.2.3.2 Separate parts .......................................................................................... 16
          3.2.3.3 Space heaters ........................................................................................... 17
          3.2.3.4 Insulation resistance ............................................................................... 17
          3.2.3.5 Exposed machined surfaces ..................................................................... 17
          3.2.3.6 Bearings ................................................................................................. 17
              3.2.3.6.1 Grease-lubricated bearings ................................................................. 17
              3.2.3.6.2 Oil-lubricated Bearings ..................................................................... 17
              3.2.3.6.3 Sleeve bearing .................................................................................. 17
          3.2.3.7 Terminal box ............................................................................................. 17
          3.2.3.8 Preparation for commissioning ................................................................. 18
              3.2.3.8.1 Cleaning ............................................................................................. 18
              3.2.3.8.2 Bearing lubrication ............................................................................ 18
              3.2.3.8.3 Checking the insulation resistance .................................................... 18
              3.2.3.8.4 Others ............................................................................................... 18
          3.2.3.9 Inspections and records during storage ..................................................... 18
              3.2.3.10 Maintenance Plan During Storage ....................................................... 19
  3.3 HANDLING .............................................................................................................. 20

4 INSTALLATION ........................................................................................................... 21
  4.1 INSTALLATION SITE .............................................................................................. 21
  4.2 DIRECTION OF ROTATION .................................................................................... 21
  4.3 INSULATION RESISTANCE ...................................................................................... 21
      4.3.1 Safety instructions ............................................................................................ 21
      4.3.2 General considerations .................................................................................... 21
      4.3.3 Measuring stator windings ............................................................................... 21
      4.3.4 Minimum insulation resistance ....................................................................... 22
      4.3.5 Polarization index ............................................................................................ 22
      4.3.6 Conversion of measured values ....................................................................... 22
4.4 PROTECTIONS ................................................................. 22
  4.4.1 Thermal protection ................................................. 23
    4.4.1.1 Temperature sensors ..................................... 24
    4.4.1.2 Winding temperature limits ............................... 24
    4.4.1.3 Alarm and shutdown temperatures ....................... 24
    4.4.1.4 Temperature and ohmic resistance of Pt100 thermoresistors 25
    4.4.1.5 Space heater .................................................. 25
  4.4.2 Water leak sensor .................................................. 25
4.5 COOLING .................................................................. 26
  4.5.1 Closed Motors ........................................................ 26
  4.5.2 Open Motors .......................................................... 26
  4.5.3 Water Radiators ...................................................... 27
    4.5.3.1 Radiators for seawater applications .................... 27
  4.5.4 Independent fans ..................................................... 27
4.6 ELECTRICAL CHARACTERISTICS .................................... 27
  4.6.1 Electric connections .................................................. 27
    4.6.1.1 Main connection .............................................. 27
    4.6.1.2 Grounding ....................................................... 28
  4.6.2 Connection diagram ................................................. 29
    4.6.2.1 IEC60034-8 connection diagram ......................... 29
    4.6.2.2 NEMA MG1 connection diagram .......................... 30
      4.6.2.2.1 Direction of rotation .................................. 30
      4.6.2.2.2 Accessory connection diagram ....................... 30
4.7 MECHANICAL CHARACTERISTICS ...................................... 31
  4.7.1 Foundations .......................................................... 31
  4.7.2 Stress on foundations ............................................. 31
  4.7.3 Types of bases ....................................................... 31
    4.7.3.1 Concrete base ................................................. 31
    4.7.3.2 Sliding base ..................................................... 31
    4.7.3.3 Metal base ........................................................ 32
    4.7.3.4 Anchors ........................................................... 32
  4.7.4 Anchor plate set ..................................................... 33
  4.7.5 Natural frequency of the foundation ........................... 34
  4.7.6 Alignment and leveling ............................................ 34
  4.7.7 Couplings .............................................................. 34
    4.7.7.1 Direct coupling .............................................. 35
    4.7.7.2 Gear coupling .................................................. 35
    4.7.7.3 Coupling by pulleys and belts ............................. 35
    4.7.7.4 Coupling of motors equipped with sleeve bearings clearance 35
5 START-UP .................................................................. 37
  5.1 DOL STARTING ......................................................... 37
  5.2 DOL STARTING FREQUENCY ...................................... 37
  5.3 BLOCKED-ROTOR CURRENT (Ip/In) ............................ 37
  5.4 REDUCED CURRENT START-UP .................................... 37
6 COMMISSIONING ......................................................... 38
  6.1 PRELIMINARY INSPECTION ....................................... 38
  6.2 INITIAL START UP .................................................... 38
  6.3 OPERATION .............................................................. 38
    6.3.1 General ............................................................... 38
    6.3.2 Temperatures ....................................................... 39
    6.3.3 Bearings .............................................................. 39
    6.3.4 Radiators ............................................................. 39
    6.3.5 Vibration .............................................................. 39
    6.3.6 Shaft Vibration Limits .......................................... 39
    6.3.7 Shutdown ............................................................. 40
7 MAINTENANCE ............................................................ 41
  7.1 GENERAL ............................................................... 41
  7.2 GENERAL CLEANING ................................................. 41
  7.3 WINDING INSPECTION .............................................. 41
  7.4 WINDING CLEANING ................................................. 41
  7.5 COOLING SYSTEM MAINTENANCE .......................... 42
    7.5.1 Radiator maintenance .......................................... 42
  7.6 SHUTDOWN MOTOR .................................................... 42
7.7 SHAFT GROUNDING DEVICE ........................................................................ 42
7.8 BEARING MAINTENANCE ........................................................................... 43
  7.8.1 Grease-lubricated rolling bearings .......................................................... 43
    7.8.1.1 Lubrication instructions ..................................................................... 43
    7.8.1.2 Procedures for bearing re-lubrication ................................................. 43
    7.8.1.3 Lubrication of bearings with spring device for grease removal ........ 43
    7.8.1.4 Grease type and quantify ................................................................... 43
    7.8.1.5 Alternative greases ............................................................................ 44
    7.8.1.6 Grease changing procedure ............................................................... 45
    7.8.1.7 Low temperature grease .................................................................... 45
    7.8.1.8 Grease compatibility ......................................................................... 45
    7.8.1.9 Bearing disassembly / assembly ....................................................... 46
  7.8.2 Oil-lubricated rolling bearings ................................................................. 47
    7.8.2.1 Lubrication instructions ..................................................................... 47
    7.8.2.2 Oil types ............................................................................................ 47
    7.8.2.3 Oil change ........................................................................................ 47
    7.8.2.4 Bearing operation ............................................................................. 47
    7.8.2.5 Bearing assembly and disassembly ................................................... 48
  7.8.3 Sleeve bearings ...................................................................................... 49
    7.8.3.1 Bearing data ...................................................................................... 49
    7.8.3.2 Bearing installation and operation ..................................................... 49
    7.8.3.3 Water flow cooling .......................................................................... 49
    7.8.3.4 Oil change ........................................................................................ 49
    7.8.3.5 Sealing ............................................................................................. 49
    7.8.3.6 Sleeve bearing operation ................................................................. 49
    7.8.3.7 Sleeve bearing maintenance .............................................................. 50
    7.8.3.8 Bearing assembly and disassembly ................................................... 51
  7.8.4 Bearing protection ................................................................................. 53
    7.8.4.1 Protection settings ............................................................................ 53
    7.8.4.2 Bearing temperature sensor disassembly/assembly ......................... 53

8 MOTOR ASSEMBLY AND DISASSEMBLY ......................................................... 54
  8.1 DISASSEMBLY ......................................................................................... 54
  8.2 ASSEMBLY ............................................................................................... 54
  8.3 AIR-GAP MEASUREMENT ....................................................................... 54
  8.4 GENERAL RECOMMENDATIONS ............................................................. 54
  8.6 SPARE PARTS .......................................................................................... 54

9 MAINTENANCE PLAN .................................................................................. 55

10 ABNORMALITIES, CAUSES AND SOLUTIONS ........................................... 56
  10.1 MOTORS ................................................................................................. 56
  10.2 BEARINGS ............................................................................................. 58

11 WARRANTY .................................................................................................. 59
1 INTRODUCTION

This manual covers standard motors. Motors with specialties may be provided with specific documents (designs, connection diagram, characteristic curves, etc.). Along with this manual, such documents must be carefully evaluated before proceeding to the installation, operation or maintenance of the motor.

In case of any additional clarifications regarding motors with constructive specialties, please contact WEG. All procedures and standards provided in this manual must be followed in order to ensure proper motor operation and safety of all personnel involved in its operation. Compliance to these procedures is equally important in order to ensure motor warranty. Therefore, careful reading of this manual before installing and operating the motor is recommended. In case of any additional clarifications, please contact WEG.

1.1 TERMINOLOGY

<table>
<thead>
<tr>
<th>MOTOR LINE</th>
<th>M</th>
<th>G</th>
<th>F</th>
<th>560</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>M - Master Line</td>
<td></td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

| TYPE OF ROTOR | G - Cage |

<table>
<thead>
<tr>
<th>COOLING SYSTEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>A - Open, self-ventilated - IP23W</td>
</tr>
<tr>
<td>P - Open, self-ventilated - IP24W</td>
</tr>
<tr>
<td>D - Self-ventilated, air input and output by ducts</td>
</tr>
<tr>
<td>T - Forced ventilation, air input and output by ducts</td>
</tr>
<tr>
<td>V - Forced ventilation, ventilation over the motor and output by ducts</td>
</tr>
<tr>
<td>F - Self-ventilated with air-air heat exchanger on the motor</td>
</tr>
<tr>
<td>R - Self-ventilated with air-air heat exchanger around the motor</td>
</tr>
<tr>
<td>I - Forced ventilation on the internal and external air circuit, air-air heat exchanger</td>
</tr>
<tr>
<td>W - Air-water heat exchanger</td>
</tr>
<tr>
<td>L - Air-water heat exchanger, forced ventilation in the internal air system</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IEC FRAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shaft end height in mm (450 to 5000)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FOOT HOLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABNT / IEC (S, M, L, A, B, C, D, E)</td>
</tr>
</tbody>
</table>

1.2 SAFETY WARNINGS

The following safety warnings are used in this manual:

**DANGER**

Noncompliance with the recommended procedures in this warning may lead to death, severe injuries and substantial property damage.

**ATTENTION**

Noncompliance with the recommended procedures in this warning may lead to property damage.
NOTE

This provides relevant information for appropriate product operation and service.
2 GENERAL INSTRUCTIONS

All personnel working in the assembly, operation or maintenance of electrical installations, must be constantly informed and updated on the service safety instructions and standards and are advised to strictly comply with them. Before initiating any tasks, the personnel in charge is responsible for making sure that all points were duly observed and for alerting the respective staff about the dangers inherent to the task to be performed. When inappropriately applied, target of deficient maintenance, or even when handled by non-qualified personnel, such motors may cause severe personal and/or property damage. Therefore, it is recommended that these services are always performed by qualified personnel.

2.1 QUALIFIED PERSONNEL

The term qualified personnel represents those who, due to their training, experience, education level, knowledge of applicable standards, safety standards, accident prevention and knowledge of operating conditions, have been authorized by those in charge to execute all necessary tasks, and to recognize and avoid any possible danger.

Such qualified personnel must also know first aid procedures and must be able to provide such services, if necessary.

All operation, maintenance, and repair tasks are to be exclusively performed by qualified personnel.

2.2 SAFETY INSTRUCTIONS

DANGER

During operation, this equipment exposes energized or spinning parts that may present high voltage or high temperatures. Therefore, operation with open terminal boxes, unprotected couplings or incorrect handling, failing to comply with operating standards, may cause severe personal and property damage.

The personnel in charge of installation safety must ensure that:
- Only qualified personnel install and operate the equipment;
- Such personnel must have immediate access to this manual and other documents provided with the motor as well as perform tasks in strict compliance to the service instructions, relevant standards, and specific product documentation;

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

Firefighting equipment and first aid notices must be available in visible and easily-accessible locations within the work site.

All qualified personnel must also observe:
- All technical data regarding allowed applications (operating conditions, connections and installation environment), provided in the catalog, purchase order documents, operating instructions, manuals, and other documentation;
- The specific determinations and conditions for local installation;
- The use of appropriate tools and equipment for handling and transportation;
- That the individual component protection devices are removed before the installation.

Individual parts must be stored in vibration-free environments, avoiding falls and ensuring their protection against aggressive agents and/or do not present risks to the safety of personnel.

2.3 MOTORS APPLIED IN HAZARDOUS AREAS

The specific hazardous area operation motors possess additional safety characteristics which are defined in specific rules for every type of risk area according to their classification.

The general requirements for equipment operating in hazardous areas are described in the following Brazilian and international standards, respectively:
- IEC 60034-1 - Rotating Electrical Machines - Part 1: Rating and Performance
- IEC 60079-0 - Electrical Apparatus for Explosive Gas Atmospheres - Part 0: General Requirements
- ABNT NBR IEC 60079-0 - Atmosferas Explosivas - Parte 0: Equipamentos - Requisitos Gerais
- IEC 60079-1 - Explosive Atmospheres - Part 1: Equipment Protection by Flameproof Enclosures 'd'
- ABNT NBR IEC 60079-1 - Atmosferas Explosivas - Parte 1 - Proteção de Equipamento por Invólucro à Prova de Explosão ‘d’
- IEC 60079-15 - Explosive Atmospheres - Part 15 - Protection by Type of Protection ‘n’
- ABNT NBR IEC 60079-15 - Equipamentos Elétricos para Atmosferas Explosivas - Parte 15: Construção, Ensaio e Marcação de Equipamentos Elétricos com Tipo de Proteção ‘n’
- ABNT IEC 60079-7 - Electrical Apparatus for Explosive Gas Atmospheres - Part 7: Increased Safety ‘e’
- ABNT NBR IEC 60079-7:2008 - Atmosferas Explosivas - Parte 7: Proteção de Equipamentos por segurança Aumentada “e”
- ABNT NBR IEC 60079-2 - Atmosferas Explosivas - Parte 2: Proteção de Equipamento por Invólucro Pressurizado ‘p’
- IEC 60079-17 - Explosive Atmospheres - Part 17: Electrical Installations Inspection and Maintenance
- ABNT NBR IEC 60079-17 - Atmosferas Explosivas - Parte 17: Inspeção e Manutenção de Instalações Elétricas

2.3.1 General Precautions

Before installing, operating, or performing maintenance in electric motors in hazardous areas, the following precautions must be adopted:
- Study and understand the standards provided in the “Motors applied in hazardous areas” item;
- Comply with all requirements established in the applicable standards.

2.3.2 Additional Precautions
• Shutdown the motor and wait until it comes to a complete halt before performing any maintenance, inspection, or reparation services;
• All existing protections must be installed and properly set before operating;
• Ensure that motors are duly grounded;
• Connection terminals must be duly connected, avoiding any type of poor contact that might generate heating or sparking.

NOTE
Comply with all other storage, transportation, installation and maintenance instructions provided in this manual and applicable to the type of motor at hand.

2.4 STANDARDS

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

Table 2.1: Standards applicable to three-phase induction motors

<table>
<thead>
<tr>
<th>Specification</th>
<th>IEC</th>
<th>NBR</th>
<th>NEMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions</td>
<td>60072</td>
<td>5432</td>
<td>MG1-4,11</td>
</tr>
<tr>
<td>Tests</td>
<td>60034-2</td>
<td>5383</td>
<td>MG1-12</td>
</tr>
<tr>
<td>Levels of protection</td>
<td>60034-5</td>
<td>9884</td>
<td>MG1-5</td>
</tr>
<tr>
<td>Cooling</td>
<td>60034-6</td>
<td>5110</td>
<td>MG1-6</td>
</tr>
<tr>
<td>Constructive Forms</td>
<td>60034-7</td>
<td>5031</td>
<td>MG1-4</td>
</tr>
<tr>
<td>Noise</td>
<td>60034-9</td>
<td>7565</td>
<td>MG1-9</td>
</tr>
<tr>
<td>Mechanical vibration</td>
<td>60034-14</td>
<td>7094</td>
<td>MG1-7</td>
</tr>
</tbody>
</table>

2.5 ENVIRONMENT CHARACTERISTICS

The motors were designed for the following operating conditions:
• Ambient temperature -15°C to +40°C;
• Altitude: 1,000 m;
• Environment according to the motor protection level.

ATTENTION
Ambient temperature must not be below +5°C for water-cooled motors. Antifreeze fluid must be added to the water for temperatures below +5°C.

Special operating conditions may be provided upon request, which must be specified in the purchase order and described on the nameplate and specific data sheet of every motor.

2.6 OPERATION CONDITION

In order for the product warranty to remain valid, the motor must be operated according to the rated data
2.7 VOLTAGE AND FREQUENCY

It is very important to ensure correct power supply to the motor. The conductors and the entire protection system must guarantee a power quality within established parameters to the motor terminals, according to the IEC60034-1 standard:

- Voltage: may vary within a ±10% range of rated value;
- Frequency: may vary within -5% to +3% range of rated value.

The motor must be capable of performing its main function in Zone A continuously, but it may not completely meet its rated voltage and frequency performance characteristics (see rated characteristics point in Figure 2.1), when it may show some deviations. Increase in temperature may be greater than those from rated voltage and frequency.

The motor must be capable of performing its main function in Zone B. However, regarding rated voltage and frequency performance characteristics, it may show greater deviations than those in Zone A. Temperature increase may be higher than those identified in rated voltage and frequency and, most likely, greater than in Zone A. Extended operation in the boundaries of Zone B is not recommended.

3 RECEIVING, STORAGE AND HANDLING

3.1 RECEIVING

All motors are tested and provided in perfect operating conditions. All machined surfaces must be protected against corrosion. Packages must be checked upon receipt for eventual damages during transportation.

![Voltage and Frequency Variation Limits](image)

**Figure 2.1: Voltage and frequency variation limits**

The motor must be capable of performing its main function in Zone A continuously, but it may not completely meet its rated voltage and frequency performance characteristics (see rated characteristics point in Figure 2.1), when it may show some deviations. Increase in temperature may be greater than those from rated voltage and frequency.

The motor must be capable of performing its main function in Zone B. However, regarding rated voltage and frequency performance characteristics, it may show greater deviations than those in Zone A. Temperature increase may be higher than those identified in rated voltage and frequency and, most likely, greater than in Zone A. Extended operation in the boundaries of Zone B is not recommended.

3.2 STORAGE

Any damage to the painting or to the protections against rust in the machined parts must be corrected.

- Motors packed in wooden crates must always be lifted by their own eyebolts/lifting lugs or by a proper forklift, and must never be lifted by its wooden parts;
- The package must never be dropped. Carefully place it on the floor (without impact) to avoid bearing damage;
- Do not remove the grease-based corrosion protection from the shaft end, nor the closing plugs in junction box holes;
- These protections must remain in place until the final assembly. A complete visual inspection of the motor must be performed after removing the package;
- The shaft locking device must only be removed shortly before installing and storing the motor in a safe location for future transportation.

![Attention](image)

**Attention**

Space heaters must remain active during storage in order to avoid water.
In order to ensure the best storage conditions for the motor during long periods of time and/or were idle for two or more months before being operated, the motor must be stored in vibration-free locations in order to avoid bearing damage.

3.2.2 Outdoor storage

The motor must be stored in a dry location, free of flooding and vibrations. Repair all damages to the packaging before storing the motor, which is necessary to ensure proper storage conditions.

Place the motor on platforms or foundations to protect it against land humidity and keep it from sinking into the soil. Free air circulation underneath the motor must be assured.

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

3.2.3 Extended storage

When the motor is stored for a long period of time before being operated, it is exposed to external agents, such as temperature fluctuations, moisture, aggressive agents, etc. Empty spaces inside the motor, such as bearings, terminal boxes, and windings, are exposed to humidity, which can cause condensation and, depending on the degree of air contamination, aggressive substances may also penetrate these empty spaces.

Consequently, after long storage periods, the winding insulation resistance may drop below acceptable values. Internal components, such as rollers, may oxidize, and the lubricant power of the lubricant agent in the rollers may be adversely affected. All of these influences increase the risk of damages before starting up the motor.

ATTENTION

All preventive measures described in this manual, such as constructive aspects, maintenance, packaging, storage, and periodical inspections, must be followed and recorded, in order to maintain the product warranty.

The following instructions are valid for motors stored for long periods of time and/or were idle for two or more months before being operated.

3.2.3.1 Storage location

In order to ensure the best storage conditions for the motor during long periods of time, the chosen location must strictly meet the criteria described below.

3.2.3.1.1 Indoor storage

- The storage room must be closed and covered;
- The location must be protected against moisture, vapors, aggressive agents, rodents, and insects;
- The location must be free of corrosive gases, such as chlorine, sulphur dioxide, or acids;
- The environment must be free of continuous or intermittent vibrations;
- The environment must present an air-filtered ventilation system;
- Ambient temperature between 5°C and 60°C, and must not be subject to sudden temperature variations;
- Relative humidity <50%;
- Protection against dirt and dust accumulation;
- Fire detection system;
- The location must have power to supply the space heaters.

In case the storage location does not meet any of these requirements, WEG recommends that additional protections are incorporated to the motor packaging during the storage period, as follows:

- Closed wooden crate or similar with proper electrical installation, providing power to the space heaters.
- If there is risk of infestation and fungus growth, the package must be protected on the site by spraying or painting it with proper chemical agents;
- Package preparation must be carefully executed by experienced personnel.

3.2.3.2 Separate parts

In case separate parts have been supplied (terminal boxes, covers, etc.), these must be packed as specified in items Indoor Storage and Outdoor Storage of this manual;

Air relative humidity inside package must not exceed 50%.
3.2.3.3 Space heaters

The motor space heaters must remain powered during storage to avoid moisture condensation inside the motor and ensuring that the windings insulation resistance remains within acceptable levels.

ATTENTION
The motor space heater must be powered on while it is stored in a place with temperatures < 5°C and air relative humidity >50%.

3.2.3.4 Insulation resistance

During the storage period, motor windings’ insulation resistance must be measured and recorded quarterly, before the motor is installed. Any eventual insulation resistance reduction must be investigated.

3.2.3.5 Exposed machined surfaces

All exposed machined surfaces (e.g. shaft end and flanges) are factory-protected with a temporary rust inhibitor. This protection film must be reapplied at least twice a year or when removed and/or damaged.

Recommended Products:
Name: Dasco Guard 400 TX AZ, Manufacturer: D.A. Stuart Ltda
Name: TARP, Manufacturer: Castrol.

3.2.3.6 Bearings

3.2.3.6.1 Grease-lubricated bearings

The bearings are lubricated at the factory, in order to perform motor tests. During the storage period, every two months, the shaft lock device must be removed and the shaft must be manually revolved in order to distribute grease inside the bearing and preserving good bearing conditions. After 6 months of storage and before operating the motor, the bearings must be lubricated again. If the motor remains stored for over 2 years, the bearings must be disassembled, cleaned, inspected, and lubricated.

3.2.3.6.2 Oil-lubricated bearings

- Depending on the assembly position, the motor may be transported with or without oil in the bearings;
- The motor must be stored in its original operating position and with properly lubricated bearings;
- Oil levels must be respected, remaining in the middle of the oil level sight glass;
- During the storage period, every two months, the shaft locking device must be removed and the shaft must be manually revolved in order to uniformly distribute the oil inside the bearing and maintaining good bearing conditions.
- After 6 months of storage and before operating the motor, the bearings must be lubricated again;
- If the motor remains stored for over 2 years, the bearing must be disassembled, cleaned, inspected, and lubricated;

3.2.3.6.3 Sleeve bearing

- Depending on the assembly position, the motor may be transported with or without oil in the bearings and must be stored in its original operating position with oil in the bearings;
- Oil levels must be respected, remaining in the center of the oil level sight glass.

ATTENTION
During the storage period, every two months, the shaft locking device must be removed and the shaft must be turned at 30 rpm in order to circulate the oil and maintain good bearing operation conditions.

If it is not possible to rotate the motor shaft, the following procedure must be adopted in order to protect the inner part of the bearing and the contact surfaces against corrosion:

- Drain all oil from the bearing;
- Disassemble the bearing;
- Clean the bearing;
- Apply anticorrosive material (e.g.: TECTIL 511 Valvoline or Dasco Guard 400TXAZ) on the upper and lower bearing bushing halves and on the motor shaft contact surface;
- Assemble the bearing;
- Close all threaded holes with plugs;
- Seal the gaps between the shaft and the bearing seal in the shaft by applying a water proof adhesive tape;
- All flanges (e.g.: oil inflow and outflow) must be closed with blind caps;
- Remove the upper-half of the bearing and apply an anticorrosive fluid inside the bearing;
- Place some dehumidifier bags (silica-gel) inside the bearing. The dehumidifier absorbs moisture and prevents water condensation within the bearing;
- Close the bearing with the upper bearing half.

If the storage period is greater than 6 months:

- Repeat the procedures described above;
- Replace the dehumidifier bags (silica-gel) inside the bearing.

If the storage period is greater than 2 years:

- Disassemble the bearing;
- Preserve and store all bearing parts.

3.2.3.7 Terminal box

When the insulation resistance in the motor windings is measured, the main junction box and the other terminal boxes must also be inspected, especially considering the following aspects:

- The inner part must be dry, clean, and free of any dust accumulation;
The contact elements cannot be corroded;
The sealing must remain under appropriate conditions;
The cable inlets must be correctly sealed. If any of these items is not correct, the parts must be cleaned or replaced.

3.2.3.8 Preparation for commissioning

3.2.3.8.1 Cleaning

- Motor inner and outer parts must be free of oil, water, dust, and dirt. Motor inner part must be cleaned with compressed air at reduced pressure;
- 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. Oxidation and marks on bearing seats and on the shaft must be carefully removed.

3.2.3.8.2 Bearing lubrication

Use the specified lubricant to lubricate the bearings. Information on bearings and lubricants are indicated in the bearings’ nameplate, and lubrication must be performed as described in item Bearing maintenance of this manual, always considering the proper type of bearing.

NOTE

Sleeve bearings in which anticorrosive material and dehumidifier were applied, must be disassembled, washed, and the dehumidifiers must be removed.

3.2.3.8.3 Checking the insulation resistance

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

3.2.3.8.4 Others

Follow the remaining procedures described in item Commissioning of this manual before operating the motor.

3.2.3.9 Inspections and records during storage

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

The following points must be inspected:
1. Physical damage;
2. Cleanliness;
3. Signs of water condensation;
4. Protective coating conditions;
5. Paint conditions;
6. Signs of vermin or insect activity;
7. Satisfactory operation of space heaters. It is recommended that a signaling system or alarms installed in the location in order to detect power interruption in the space heaters;
8. Record ambient temperature and air relative humidity around the motor, winding temperature (using RTDs), insulation resistance and index;
9. The storage location must also be inspected to assert its compliance with the criteria described in the Storage plan item.
### Table 3.1: Storage plan

<table>
<thead>
<tr>
<th>Storage Location</th>
<th>Monthly</th>
<th>Every 2 months</th>
<th>Every 6 months</th>
<th>Every 2 years</th>
<th>Before operating</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspect cleanliness conditions</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inspect humidity and temperature conditions</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check for signs of insect infestation</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measure vibration levels</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Packaging</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inspect physical damages</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inspect the relative humidity inside the motor</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replace dehumidifier in the package (if any)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Whenever necessary</td>
</tr>
<tr>
<td>Space heater</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check operation conditions</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete motor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perform external cleaning</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check paint conditions</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check oxidation inhibitor on exposed machined parts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replace the oxidation inhibitor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Windings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measure the insulation resistance</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measure the polarization index</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>terminal box and grounding terminals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clean the boxes’ inner parts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inspect seals and sealing</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grease or Oil lubricated bearings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotate the shaft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relubricate the bearing</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disassemble and clean the bearing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleeve bearings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotate the shaft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apply anticorrosive and dehumidifier</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clean and relubricate the bearings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Disassemble and store bearing parts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.3 HANDLING

Figure 3.1: Handling motors

1. Never use the heat exchanger eyes/lifting lugs to lift the motor (if applicable);
2. Lift the motor as indicated in the nameplate or motor documentation. If necessary, remove the heat exchanger in order to lift the motor;
3. If the center of gravity is not exactly located in the center of the eyebolts/lifting lugs, use one of the forms indicated in item 3 of Figure 3.1.

NOTES
- Rated motor weight must be observed. Do not jolt the motor when lifting it or drop it abruptly as that may cause damage to the bearings;
- In order to lift the motor, use only the specific eyes/lifting lugs provided for this purpose. If necessary, use a crossbeam to protect motor parts;
- The eyes/lifting lugs in the heat exchanger, covers, bearings, radiator, terminal boxes, etc., are specifically designed for their respective component only;
- Never lift the motor by the shaft;
- In order to move the motor, the shaft must be locked with the locking device supplied with the motor.

ATTENTION
Steel cables, clevises and hoisting equipment must have capacity to bear the motor weight.
4 INSTALLATION

4.1 INSTALLATION SITE

Motors must be installed in easily accessible places, allowing periodic inspections, local maintenance and, if necessary, removal for external services. The following environment characteristics must be ensured:

- Clean and well-ventilated location;
- Other equipment or building must not block the motor ventilation;
- The area around and above the motor must be sufficient for its maintenance or handling;
- The environment must be in accordance with the motor protection level.

4.2 DIRECTION OF ROTATION

The motor rotation direction is indicated on a plate fixed to the drive end frame.

ATTENTION

Motors supplied with a single direction of rotation must not operate in the opposite direction. In order to operate the motor in the opposite direction, please contact WEG

4.3 INSULATION RESISTANCE

4.3.1 Safety instructions

DANGER

In order to measure the insulation resistance, the motor must be shutdown. The winding being tested must be connected to the frame and grounded until all residual electrostatic charges are removed. The capacitors must also be grounded (if any) before disconnecting and separating the terminals, and measure the insulation resistance with a megohmmeter. Noncompliance with these procedures may result in personnel injuries.

4.3.2 General considerations

When motor is not immediately operated, it must be protected against moisture, high temperatures, and dirt, avoiding impacts to the insulation resistance. Winding insulation resistance must be measured before operating the motor.

If the environment is too humid, the insulation resistance must be measured periodically during storage. It is difficult to establish fixed rules for the actual value of a motor insulation resistance, as it varies according to environmental conditions (temperature, humidity), machine cleanliness conditions (dust, oil, grease, dirt), and quality and condition of the insulating material used.

Evaluating periodical follow-up records is useful to conclude whether the motor is able to operate.

4.3.3 Measuring stator windings

The insulation resistance must be measured with a megohmmeter. Test voltage for motor windings must be in accordance with Table 4.1 and the IEEE43 standard.

Table 4.1: Winding insulation resistance test voltage

<table>
<thead>
<tr>
<th>Winding rated voltage (V)</th>
<th>Insulation resistance test - continuous voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1000</td>
<td>500</td>
</tr>
<tr>
<td>1000 - 2500</td>
<td>5000 - 1000</td>
</tr>
<tr>
<td>2501 - 5000</td>
<td>1000 - 2500</td>
</tr>
<tr>
<td>5001 - 12000</td>
<td>2500 - 5000</td>
</tr>
<tr>
<td>&gt; 12000</td>
<td>5000 - 1000</td>
</tr>
</tbody>
</table>

Before measuring the stator winding insulation resistance, verify if:
- the CTs secondary connections are not open (if applicable);
- All power cables are disconnected;
- The motor frame is grounded;
- The winding temperature was measured;
- All temperature sensors are grounded;

The stator windings’ insulation resistance measurement must be carried out in the main terminal box. The instrument (megohmmeter) must be connected between the motor frame and the winding. The frame must be grounded.

ATTENTION

Much higher values may be frequently obtained in motors being operated for a long period of time. Comparison with values obtained in previous tests in the same motor, under similar load, temperature, and humidity conditions, may be an excellent parameter to evaluate the winding insulation conditions, instead of exclusively using the value obtained in a single test as basis. Significant or abrupt reductions are considered suspicious.
Table 4.2: Insulation resistance referential limits in electric machines

<table>
<thead>
<tr>
<th>Insulation resistance value</th>
<th>Insulation evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2MΩ or less</td>
<td>Bad</td>
</tr>
<tr>
<td>&lt; 50MΩ</td>
<td>Dangerous</td>
</tr>
<tr>
<td>50...100MΩ</td>
<td>Regular</td>
</tr>
<tr>
<td>100...500MΩ</td>
<td>Good</td>
</tr>
<tr>
<td>500...1000MΩ</td>
<td>Very good</td>
</tr>
<tr>
<td>&gt; 1000MΩ</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

4.3.4 Minimum insulation resistance

If the insulation resistance measured is less than 100MΩ at 40°C before operating the motor, the windings must be dried according to the following procedure:
- Disassemble the motor and remove the rotor and bearings;
- Heat the frame with the stator winding up to 130°C in an industrial oven for at least 8 hours (for motors above the 630 IEC or 104 frame NEMA series, at least 12 hours). Please contact WEG before employing other methods;
- Check if the insulation resistance is within acceptable values, according to Table 4.2. If not, please contact WEG.

4.3.5 Polarization index

The polarization index is traditionally defined by the relation between the insulation resistance measured for 10 min. and the insulation resistance measured for 1 min. This measurement procedure is always carried out at relatively constant temperatures. The polarization index allows the evaluation of the motor insulation conditions according to Table 4.3.

Table 4.3: Polarization index (relation between 10 minutes and 1 minute)

<table>
<thead>
<tr>
<th>Polarization index</th>
<th>Insulation evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 or less</td>
<td>Bad</td>
</tr>
<tr>
<td>&lt; 1.5</td>
<td>Dangerous</td>
</tr>
<tr>
<td>1.5 to 2.0</td>
<td>Marginal</td>
</tr>
<tr>
<td>2.0 to 3.0</td>
<td>Good</td>
</tr>
<tr>
<td>3.0 to 4.0</td>
<td>Very good</td>
</tr>
<tr>
<td>&gt; 4.0</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

**DANGER**

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

4.3.6 Conversion of measured values

The insulation resistance must be kept at 40°C. If the measurement is performed at a different temperature, it will be necessary to convert the reading at 40°C using an insulation resistance variation curve related to the temperature obtained from the motor itself. If this curve is not available, the approximate correction provided by the curve in Figure 4.2, according to the NBR 5383 / IEEE43 standard, may be employed.

![Figure 4.2: Insulation resistance variation coefficient according to the temperature](image)

4.4 PROTECTIONS

Primarily, motor circuits have two types of protection: motor protection against overload/blocked rotor and circuit protection (terminal and distribution) against shorts.

Motors used on a continuous basis must be protected against overload through a device integrated to the motor, or an independent protection device, that usually is a thermal relay with rated current equal or less than the value obtained by multiplying the supply rated current at the motor full load by:
- 1.25 for motors with service factor equal or greater than 1.15;
- 1.15 for motors with service factor equal to 1.0.

The motors also possess protection devices against overheating (in case of overload, motor locking, low voltage, lack of motor ventilation).
4.4.1 Thermal protection

Protection devices against overheating are installed in the main stator, bearings and in other components that require temperature monitoring and thermal protection.
These devices must be connected to an external temperature monitoring and protection system.
4.4.1.1 Temperature sensors

Thermostat (bimetallic) - Bimetallic thermal detectors, usually with normally closed silver contacts. They open at a certain temperature. Thermostats are connected in series or independently, according to the connection diagram.

Thermistors (PTC or NTC type) - Thermal detectors composed of semiconductors that suddenly vary their resistance when reaching a certain temperature. Thermostats are connected in series or independently, according to the connection diagram.

Thermoresistance (Pt100) - A calibrated resistance element. Its operation is based on the principle that a metallic conductor electric resistance varies linearly according to the temperature. The detector terminals must be connected to a control panel with a temperature meter.

NOTE
Thermostats and thermistors must be connected to a control unit that will shutdown the motor power supply or will activate a signaling device.

RTD thermoresistances allow monitoring through the absolute temperature informed by its instant resistance value. With this information, the relay may perform the reading of the temperature, as well as the alarm and shutdown parameterization, according to predetermined temperatures.

ATTENTION
If the motor is operating at temperatures above the limit values of the insulation thermal class, insulation useful life and, consequently, motor useful life will be significantly reduced or it may even result in motor blow out.

4.4.1.2 Winding temperature limits

The temperature at the winding hottest point must be kept below the insulation thermal class limit. The total temperature is composed by the ambient temperature plus temperature elevation (T), plus the difference between the average winding temperature and the winding hottest point temperature.

Ambient temperature is, by rule, 40°C at most. Working conditions above this value are considered special.

Table 4.4 displays the numeric values and the composition of the acceptable temperature at the winding hottest point.

4.4.1.3 Alarm and shutdown temperatures

The temperature level to trigger alarm and shutdown must be parameterized at the lowest value possible. This temperature level may be determined by test results or through motor operating temperatures. Alarm temperature may be set at 10°C, above the machine full load operating temperature, always considering the local ambient temperature. Shutdown temperatures must not exceed maximum acceptable temperature for the stator winding insulation class and for the bearings (considering lubrication type and system).

Table 4.5: Maximum stator temperature

<table>
<thead>
<tr>
<th>Temperature Class</th>
<th>Maximum adjustment temperatures for the protections (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alarm</td>
</tr>
<tr>
<td>F</td>
<td>130</td>
</tr>
<tr>
<td>H</td>
<td>155</td>
</tr>
</tbody>
</table>

Table 4.6: Maximum bearing temperature

<table>
<thead>
<tr>
<th>Maximum adjustment temperatures for the protections (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alarm</td>
</tr>
<tr>
<td>110</td>
</tr>
</tbody>
</table>

ATTENTION
Alarm and shutdown values may be defined based on experience. However, they must not exceed the maximum values indicated in Table 4.5 and Table 4.6.

ATTENTION
Motor protection devices are listed in the WEG diagram - Specific connection diagram for each motor. Failure to use such devices is the user’s exclusive responsibility and, in case of damages, may void the product warranty.
4.4.1.4 Temperature and ohmic resistance of Pt100 thermoresistors

Table 4.7 shows temperature values in function of the ohmic resistance measured for Pt100 thermoresistors.

Table 4.7: Temperature X Resistance (Pt100)

<table>
<thead>
<tr>
<th>°C</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100.00</td>
<td>100.39</td>
<td>100.78</td>
<td>101.17</td>
<td>101.56</td>
<td>101.95</td>
<td>102.34</td>
<td>102.73</td>
<td>103.12</td>
<td>103.51</td>
</tr>
<tr>
<td>10</td>
<td>103.90</td>
<td>104.29</td>
<td>104.68</td>
<td>105.07</td>
<td>105.46</td>
<td>105.90</td>
<td>106.50</td>
<td>107.02</td>
<td>107.40</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>107.79</td>
<td>108.18</td>
<td>108.57</td>
<td>108.96</td>
<td>109.35</td>
<td>109.73</td>
<td>110.06</td>
<td>110.31</td>
<td>111.28</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>111.67</td>
<td>112.06</td>
<td>112.45</td>
<td>112.83</td>
<td>113.22</td>
<td>113.60</td>
<td>114.01</td>
<td>114.38</td>
<td>114.77</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>115.54</td>
<td>115.93</td>
<td>116.31</td>
<td>116.69</td>
<td>117.08</td>
<td>117.47</td>
<td>117.85</td>
<td>118.24</td>
<td>118.62</td>
<td></td>
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<tr>
<td>50</td>
<td>119.40</td>
<td>119.78</td>
<td>120.16</td>
<td>120.55</td>
<td>120.93</td>
<td>121.32</td>
<td>121.70</td>
<td>122.09</td>
<td>122.47</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>123.24</td>
<td>123.62</td>
<td>124.00</td>
<td>124.39</td>
<td>124.77</td>
<td>125.16</td>
<td>125.53</td>
<td>125.92</td>
<td>126.31</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>127.07</td>
<td>127.45</td>
<td>127.84</td>
<td>128.22</td>
<td>128.60</td>
<td>128.98</td>
<td>129.37</td>
<td>129.75</td>
<td>130.13</td>
<td></td>
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<tr>
<td>80</td>
<td>130.89</td>
<td>131.27</td>
<td>131.66</td>
<td>132.04</td>
<td>132.42</td>
<td>132.80</td>
<td>133.18</td>
<td>133.56</td>
<td>134.32</td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>134.70</td>
<td>135.08</td>
<td>135.46</td>
<td>135.84</td>
<td>136.22</td>
<td>136.60</td>
<td>136.98</td>
<td>137.36</td>
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</tr>
<tr>
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<td>138.50</td>
<td>138.88</td>
<td>139.26</td>
<td>139.64</td>
<td>140.02</td>
<td>140.39</td>
<td>140.77</td>
<td>141.15</td>
<td>141.53</td>
<td></td>
</tr>
<tr>
<td>110</td>
<td>142.29</td>
<td>142.66</td>
<td>143.04</td>
<td>143.42</td>
<td>143.80</td>
<td>144.17</td>
<td>144.55</td>
<td>144.93</td>
<td>145.31</td>
<td></td>
</tr>
<tr>
<td>120</td>
<td>146.06</td>
<td>146.44</td>
<td>146.81</td>
<td>147.19</td>
<td>147.57</td>
<td>147.94</td>
<td>148.32</td>
<td>148.70</td>
<td>149.07</td>
<td></td>
</tr>
<tr>
<td>130</td>
<td>149.82</td>
<td>150.20</td>
<td>150.57</td>
<td>150.95</td>
<td>151.33</td>
<td>151.70</td>
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</tbody>
</table>

4.4.1.5 Space heater

When the motor is equipped with a space heater to prevent water condensation in its interior during long idle periods, it must be assured that this space heater is activated immediately after the motor is shutdown and that it is turned off as soon as motor resumes operation.

Installed resistance supply voltage and power values are informed in the motor connection diagram and in the specific nameplate fixed to the motor.

4.4.2 Water leak sensor

Motors with air-water heat exchanger possess a water leaking sensor that detects eventual water leaks from the radiator to the inner part of the motor. This sensor must be connected to the control panel according to the motor connection diagram. This sensor signal must be used to trigger the alarm.

When this protection becomes active, a heat exchanger inspection must be carried out and, in case of verified water leak in the radiator, the motor must be disconnected and the problem must be corrected.
## 4.5 COOLING

Only a correct motor and cooling system installation can ensure continuous operation without overheating.

### 4.5.1 Closed Motors

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MGF</td>
<td>Air-air heat exchanger, self-ventilated</td>
</tr>
<tr>
<td>MGD</td>
<td>Self-ventilated, air inlet and outlet through ducts</td>
</tr>
<tr>
<td>MGW</td>
<td>Air-water heat exchanger, self-ventilated</td>
</tr>
<tr>
<td>MGT</td>
<td>Independent ventilation, air inlet and outlet through ducts</td>
</tr>
<tr>
<td>MGL</td>
<td>Air-water heat exchanger, with independent ventilation</td>
</tr>
<tr>
<td>MGI</td>
<td>Air-air heat exchanger, with independent ventilation</td>
</tr>
<tr>
<td>MGR</td>
<td>Self-ventilated, with air-air heat exchanger around the motor</td>
</tr>
</tbody>
</table>

### 4.5.2 Open Motors

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MGA or MGP</td>
<td>Self-ventilated</td>
</tr>
<tr>
<td>MGV</td>
<td>Independent ventilation</td>
</tr>
<tr>
<td>MGV</td>
<td>Independent ventilation</td>
</tr>
</tbody>
</table>
4.5.3 Water Radiators

The water radiator (when used) is a surface heat transmitter designed to indirectly dissipate electric equipment heat, in a way that the air flowing in a closed circuit is cooled by the radiator after having removed the heat generated by equipment that require cooling.
Therefore, heat flows from the equipment to the air, and from the air to the water.

**NOTE**
The cooling system protection devices must be periodically monitored.

**NOTE**
Air and water inlets and outlets must not be obstructed as they may cause overheating or even motor blow out.

Clean water with the following characteristics must be used as cooling fluid:
- PH: between 6 and 9
- Chlorides: maximum 25.0 mg/l;
- Sulphates: maximum 3.0 mg/l;
- Manganese: maximum 0.5 mg/l;
- Solids in suspension: maximum 30.0 mg/l;
- Ammonia: no traces

**ATTENTION**
Radiator data related to the air-water heat exchanger is indicated in the motor connection diagram and nameplate. Such data must be observed for the correct operation of the motor cooling system in order to avoid overheating.

4.5.3.1 Radiators for seawater applications

**ATTENTION**
In case of radiators for seawater applications, materials in contact with water (pipes and flush plates) must be resistant to corrosion. Additionally, radiators may be equipped with sacrificial anodes (e.g.: zinc or magnesium), as shown in Figure 4.3. In this application, anodes are corroded during the operation, protecting the exchanger heads. In order to maintain the integrity of the radiator heads, these anodes must be periodically replaced, always considering the current level of corrosion.

4.5.4 Independent fans

Independent fans (when used) usually possess three-phase asynchronous motor drivers. This motor terminal box is usually located on its frame. The characteristic data (frequency, voltage) is indicated in the motor nameplate, whereas the direction of rotation is indicated by an indicative plate on the fan housing or near it.

**NOTE**
Visually check the independent fan direction of rotation before starting the machine. If the fan is running in the wrong direction, the connection between the 2 phases must be inverted.

Air filters protecting the inner part of the motor against contamination must also be periodically inspected. Filters must be maintained in perfect operating conditions in order to ensure the correct operation of the cooling system and safety of the motor inner parts.

4.6 ELECTRICAL CHARACTERISTICS

4.6.1 Electric connections

4.6.1.1 Main connection

Depending on the motor constructive form, stator terminals are fixed to insulators or through copper terminals in the main terminal box. The location of power terminal boxes, neutral, and rotor is identified in the motor specific dimension drawing. Connections to terminals must be made according to the connection diagram of the motor-specific stator. Ensure that the power cables cross-section and...
insulation are appropriate for the motor current and voltage.
Stator and rotor terminal identifications and the corresponding connections are indicated in the motor-specific connection diagram, in compliance with the IEC60034-8 or NEMA MG1 standards. The motor rotation direction may be altered by the inversion of any two phases. However, the motor must turn in the direction specified in the connection plate and in the nameplate fixed to the motor.

**NOTE**
The direction of rotation is decided by looking at the shaft end on the drive end of the motor. Motors with a single direction of rotation must only turn in the indicated direction, since fans and other devices are unidirectional. In order to operate the motor in the opposite direction, please contact WEG.

**ATTENTION**
Before connecting the motor to the power network, it is necessary to carefully measure the winding insulation resistance.

In order to connect the motor main power supply cables, unscrew the stator terminal box cover, cut the sealing rings (normal motors without cable glands) according to the diameters of the cables to be used, and insert the cables inside the sealing rings. Cut the power supply cables to the desired length, strip the ends and insert terminals to be used.

4.6.1.2 Grounding

The motor frame and main terminal box must be grounded before connecting the motor to the power supply system. Connect the cable metallic coating (if any) to the common grounding conductor. Cut the appropriate length of the grounding conductor and connect it to the existing terminal in the terminal box and/or the one in the frame. Firmly fix all connections.

**ATTENTION**
Do not use steel washers or washers made of low electric conductivity materials to fix the terminals.

Before making the connections, apply protective grease in all connection contacts. Insert all sealing rings in the respective grooves. Close the terminal box cover making sure that the sealing rings are placed correctly.
4.6.2 Connection diagram

4.6.2.1 IEC60034-8 connection diagram

The connection diagrams below identify the terminals in the terminal box, and all possible connections to stator (phases) and rotor in three-phase ring induction motors. The numbers described in each diagram allow the identification of the connection diagram through a nameplate fixed to the motor including code numbers corresponding to the connection diagrams for stator and accessories.

<table>
<thead>
<tr>
<th>3 ELECTRICAL TERMINALS</th>
<th>6 ELECTRICAL TERMINALS</th>
<th>6 ELECTRICAL TERMINALS - DAHLANDER</th>
</tr>
</thead>
<tbody>
<tr>
<td>9100</td>
<td>9101</td>
<td>9102</td>
</tr>
<tr>
<td>*</td>
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<td>1W 1V 1W</td>
</tr>
<tr>
<td>U  V  W</td>
<td>Y</td>
<td>U  L  L  L</td>
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<tr>
<td>L1  L2  L3</td>
<td></td>
<td>L1  L2  L3</td>
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<td></td>
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<td>HIGHEST SPEED</td>
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<td></td>
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</tr>
<tr>
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<td>L1  L2  L3</td>
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</tr>
<tr>
<td>U1  V1  W1</td>
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<tr>
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</tr>
<tr>
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</tr>
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<tr>
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</tr>
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</tr>
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<tr>
<td>V2  W2  U2</td>
</tr>
<tr>
<td>V3  W3  U3</td>
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<td>9118</td>
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<tr>
<td>V2  W2  U2</td>
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<td>V3  W3  U3</td>
</tr>
</tbody>
</table>

**NOTE**

When 2 or more of the connection cables are used in parallel with the purpose of dividing the electric current, they will be identified by an additional suffix separated by a hyphen, as shown in the following example:
4.6.2.2 NEMA MG1 connection diagram

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<tr>
<td>T</td>
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<td>L2</td>
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<td>3 ELECTRICAL TERMINALS + NEUTRAL</td>
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9 ELECTRICAL TERMINALS

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12 ELECTRICAL TERMINALS

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</tr>
</thead>
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12 ELECTRICAL TERMINALS - (part winding)

<table>
<thead>
<tr>
<th>9215</th>
<th>9216</th>
<th>9217</th>
<th>9218</th>
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</thead>
</table>

NOTE

When 2 or more of the connection cables are used in parallel with the purpose of dividing the electric current, they will be identified by an additional suffix separated by a hyphen, as shown in the following example:

4.6.2.2.1 Direction of rotation

- The direction of rotation is indicated in the nameplate and may be noted by looking at the shaft end on the drive end of the motor. The direction of rotation must be checked before coupling the motor to the driven machine;
- Motors with connection and terminal identification described in items 4.6.2.1 and 4.6.2.2 of this manual have a clockwise direction of rotation;
- In order to reverse the direction of rotation, the connection of any of the two phases must be inverted;
- Motors with a single direction of rotation, as indicated on the nameplate and through an indicative plate fixed to the frame, have a unidirectional fan and must be operated only in the specified direction of rotation. To reverse direction of rotation of unidirectional motors, please contact WEG.

4.6.2.3 Accessory connection diagram

For correct installation of the accessories, please see the specific drawing of the connection diagram of the motor.
4.7 MECHANICAL CHARACTERISTICS

4.7.1 Foundations

- The foundation or structure in which the motor is installed must be sufficiently rigid, flat, free of external vibrations and capable of resisting the mechanical stress to which it will be submitted during start-up, or in case of short-circuit in the motor.
- Choosing the type of foundation will depend on the nature of the soil at the assembly site or floor resistance.
- If the foundation dimensioning is not carefully performed, serious vibration issues in the foundation block, motor, and driven machine may appear.
- The structural dimensioning of the foundation must be performed based on the dimension drawing, the information regarding mechanical stress on the foundations, and on the motor fixing form.

ATTENTION
Place shims with different thickness (total thickness of approximately 2mm) between the motor feet and the foundation support surfaces, in order to perform a precise vertical alignment.

NOTE
The user is responsible for the foundation dimensioning and construction.

4.7.2 Stress on foundations

Based on Figure 4.4, the stress on the foundation may be calculated by the following equations:

\[ F_1 = +0.5 \cdot m \cdot g + \frac{(4C_{\text{max}})}{A} \]
\[ F_2 = +0.5 \cdot m \cdot g - \frac{(4C_{\text{max}})}{A} \]

Where:
- \( F_1 \) and \( F_2 \) - Feet reaction on base (N)
- \( t \) - Gravity acceleration (9.81m/s²)
- \( m \) - Motor mass (kg)
- \( C_{\text{max}} \) - Maximum torque (Nm)
- \( A \) - Obtained in the motor dimension drawing (m)

Figure 4.4: Stress on the foundations

4.7.3 Types of bases

4.7.3.1 Concrete base

Concrete bases are the most used for these motors’ installations.

The foundation type and size, screws, and anchor plates depend on the size and type of motor.

Preparation example:
- Remove all dirt from the foundation in order to ensure an adequate anchoring between the foundation blocks and the motor.
- Fix the foundation blocks to the motor feet with bolts.
- Place shims with different thickness (total thickness of approximately 2mm) between the motor feet and the foundation support surfaces, in order to perform an accurate vertical alignment.
- In order to ensure bolt centering relative to the foot holes, bush them with a metal sheet or rigid paper (prespan), enabling an accurate horizontal alignment.
- Place leveling shims or bolts under the foundation blocks in order to ensure appropriate leveling and perfect alignment of the motor with the driven machine. After adding the cement, it is necessary to precisely control the alignment. Eventual small corrections may be carried out with washers or metal sheets, or by readjusting the fixing bolts’ tightening.
- Firmly tighten all fixing bolts. Care must be taken so that motor feet support surfaces are uniformly supported without distorting the motor frame. For the correct fixation, introduce two taper pins after test completion. Pre-threaded holes on the motor feet must be used.

4.7.3.2 Sliding base

In case of pulley operation, the motor must be assembled on a sliding base (rails) and the lower part of the belt must be tensioned.

The rail closest to the drive pulley is assembled in a way that the positioning screw lies between the motor and the driven machine. The other rail must be assembled with the screw placed in the opposite position, as shown in Figure 4.5.

The motor is screwed on the rails and positioned on the foundation.

The drive pulley is then aligned in a way that its center is located on same plane as the center of the moving pulley, while the motor and machine shafts are perfectly parallel to each other. The belt must not be excessively stretched. After the alignment, the rails are fixed.

Figure 4.5: Sliding base
4.7.3.3 Metal base

The motor feet must be uniformly supported on the metal base in order to avoid deformations on the frame. Eventual height errors in the motor feet support surface may be corrected with shims (a 2mm maximum height is recommended). Do not remove the machines from the common base for the alignment. The base must be leveled on the foundation itself by using a spirit level or other leveling instruments. When a metal base is used to adjust the motor shaft end height with the driven machine shaft end, it must be leveled on the concrete base. After base has been leveled, anchors tightened and couplings checked, the metal base and anchors are cemented.

4.7.3.4 Anchors

Anchors are devices for anchoring motors directly to the foundation when the motors are fitted with a flexible coupling. This type of coupling is characterized by the absence of stress on the bearings, besides presenting lower investment costs. Anchors must not be painted and must be free of rust, since that would be harmful for the concrete adherence and would cause them to loosen.

Figure 4.6: Anchors
4.7.4 Anchor plate set

The anchor plate set comprises an anchor plate, leveling screws, leveling shims, alignment screws, and anchors. Whenever the use of an anchor plate is necessary for the motor fixation and alignment, it will be supplied with the motor.

Procedure for the anchor plates’ assembly, leveling, and anchoring

Step 1
Build the foundation (1) with the anchor bars (2) according to the dimension drawing, considering the stress to which the base will be submitted.

Step 2
Place the anchors (3) on the anchor bars and support the leveling screws on the primary concrete.

Step 3
Support the anchor plates (5) on the leveling screws (4).

Step 4
Level the anchor plates, using the necessary instruments, considering that there must be a clearance of up to 2mm between the anchor plates and the motor base for the placement of shims necessary for the motor vertical alignment.

Step 5
After leveling the anchoring plates, they must be anchored (6) with the anchors in their definitive fixation.

Step 6
After curing the grouting, support the motor on the anchoring plates, align it with the horizontal alignment screws (7 and 8), and fix it to the anchors through the holes on its base.

Leveling and grouting with the anchor plates fixed to the motor.
Leveling and grouting the anchor plates may also be done after they have been fixed to the motor base with shims of up to 2 mm between the motor base and the anchor plates. Therefore, the motor with anchor plates must be supported by the leveling screws (4). Proceed with the leveling process, with these leveling screws, and execute the motor pre-alignment, using alignment screws (7 and 8).
4.7.5 Natural frequency of the foundation

In order to ensure a safe operation, in addition to a stable foundation, the motor must be accurately aligned with the coupled equipment and components assembled on its shaft, which need to be properly balanced.

After the motor is assembled and coupled, the relation between the natural foundation frequency is:

- Motor rotation frequency;
- Twice as much as the rotation frequency;
- Twice as much as the line frequency;

These natural frequencies must be as specified below:

- The foundation natural frequency $\geq +25\%$ or $\leq -20\%$ related to the frequencies provided above.
- The foundation higher order natural frequencies $\geq +10\%$ or $\leq -10\%$ related to the frequencies provided above.

4.7.6 Alignment and leveling

The motor must be correctly aligned with the driven machine, especially when direct coupling is used.

Incorrect alignment may result in bearing damage, generate excessive vibration and even in shaft rupture.

The alignment must be carried out according to the coupling manufacturer’s recommendations.

Particularly for direct coupling, the motor and driven machine shafts must be axially and radially aligned, as illustrated in Figure 4.8 and Figure 4.9.

![Figure 4.8: Parallel alignment](image)

Figure 4.8 shows parallel misalignment of both shaft ends and the practical measuring procedure using adequate dial indicators.

Measurement is performed in 4 points with a 90° displacement from each other and with the two half-couplings spinning together in order to eliminate the effects due to support surface irregularities in the extremity of the dial indicator. Choosing a vertical point greater than 0°, half of the dial indicator measurement difference in the 0° and 180° points represents a vertical misalignment. In case of deviation, it must be adequately corrected by adding or removing assembly shims under the motor feet.

Half of the dial indicator maximum measurement difference in the 0° and 270° points represents a horizontal misalignment which must be adequately corrected by displacing the motor laterally/axially.

Half of the dial indicator maximum measurement difference in a complete rotation represents the maximum angular misalignment found.

Misalignment in the shaft complete spin for rigid or semi-flexible coupling cannot be greater than 0.03mm. When flexible couplings are used, values that are greater than those indicated above are acceptable, provided that they do not exceed the acceptable value provided by the coupling manufacturer. Maintaining a safety margin for these values is recommended.

In the alignment /leveling process, the influence of the temperature over the motor and driven machine must be considered. Varying thermal expansions in components may alter the alignment /leveling status during the operation.

4.7.7 Couplings

Only appropriate couplings transmitting torque without generating transversal forces must be used.

For both flexible and rigid couplings, motor and driven machine shaft centers must be placed in a single line.

Flexible coupling allows mitigation of residual misalignment effects and avoids vibration transferring between the coupled machines, which do not happen when rigid couplings are used.

Coupling must always be assembled or removed with the help of appropriate devices and never through rough devices such as hammers, mallets, etc.

**ATTENTION**

The pins, nuts, washers, and leveling shims may be supplied with the motor, when requested in the purchase order.
4.7.7.1 Direct coupling

For the purposes of cost, space saving, absence of belt sliding, and increased safety against accidents, direct coupling would be preferable, whenever possible. Also, in case of transmission by turbo gear, direct coupling must be the preferred choice.

4.7.7.2 Gear coupling

Badly aligned gear couplings generate vibrations in the motor transmission itself. Therefore, one must ensure that the shafts are perfectly aligned, and, in case of transmissions by taper or helical gear, strictly parallel in case of transmissions by gears that are straight and in a correctly adjusted angle. Gear teeth meshing may be controlled by the insertion of a paper strip in which, after the gear spins once, the mark of all of the teeth will show.

4.7.7.3 Coupling by pulleys and belts

When a speed reduction or increase is required, pulley transmission is indicated. In order to avoid unnecessary radial stress on the bearings, the shafts and pulleys have to be perfectly aligned with each other. Biased working belts transmit alternating direction beats on the rotor, which may cause bearing damage. Belt sliding may be avoided by applying a resinous material such as tar. There must only be enough belt tension to avoid sliding during operation.

4.7.7.4 Coupling of motors equipped with sleeve bearings clearance

Motors equipped with sleeve bearings must operate with direct coupling to the driven machine or through a reducer. This type of bearing does not allow coupling through pulleys and belts. Motors equipped with sleeve bearings have three marks in the shaft end, being the central mark (red) the indication of the magnetic center, and the two external marks the acceptable rotor axial movement limits.
For motor coupling, the following factors must be considered:

- Bearing axial clearance;
- Shaft displacement in driven machine (if any);
- Maximum axial clearance allowed by the coupling.

**ATTENTION**

- Displace shaft to the front and then correctly measure the axial clearance;
- Carefully align the shaft ends and, whenever possible, use flexible coupling, leaving a minimum 3 to 4 mm of axial clearance between couplings.

**NOTE**

In case it is impossible to move the shaft, consider the shaft position, the displacement of shaft forward (according to marks on the shaft), and the axial clearance recommended for the coupling.

- Before operating, verify whether the motor shaft allows free axial movement within the clearance conditions provided.
- While operating, the arrow must be positioned on the central mark (red) indicating that motor is in its magnetic center;
- During start-up or operation, the motor may freely move between the two external limit marks;

**ATTENTION**

The motor may not be continuously operated with shaft stress on the bearing under no circumstances.

- The sleeve bearings used are not designed to support constant shaft stress.
5 START-UP

5.1 DOL STARTING

Whenever possible, the start-up of a three-phase wound rotor induction motor must be direct (at full voltage) through a contactor. This start-up method is the simplest and most viable method, though it must only be used when the start-up current does not disrupt the power supply.

It is important to consider that the starting current in induction motors reaches values at the rate of 6 to 7 times the rated current. It is vital to ensure that such current (Ip) does not affect other consumers' power supplies, due to a higher voltage drop in the power supply.

This scenario is identified during one of the following three conditions:

a) When the power supply is "strong" enough and the motor starting current is insignificant related to the power supply capacity.

b) Motor start-up is always performed without any load, reducing start-up time and, consequently, the duration of the starting current and voltage drop, which is tolerable for other consumers.

c) When the direct start-up is properly authorized by the local power utility company.

Extremely high starting currents during the start-up may generate the following hazardous consequences:

a) High voltage drop in the power grid energy supply system, causing interferences in the equipment installed in this system;

b) Electric installation components (cables, contactors) must be over dimensioned, which generates high costs;

c) Fines applied by the power utility company that limit voltage drops in the power grid.

5.2 DOL STARTING FREQUENCY

Since induction motors have an elevated starting current, the time spent to accelerate high inertial charges results in a rapid motor temperature increase. If the interval between successive start-ups is too short, that would lead to a rapid winding temperature increase, reducing their useful life or even burning the windings. The NBR 7094 Standard establishes a minimum start-up regime which motors must be capable of meeting.

a) Two successive start-ups, being the first one with a cold motor, i.e. with its windings at ambient temperature, and the second one immediately after, but only after the motor has idled until rest;

b) A warm start up, i.e. with the windings at regime temperature.

The first condition simulates a scenario in which the motor first start-up is aborted, for instance, because of turning it off using the motor protection, when a second motor start-up is immediately allowed.

The second condition simulates a scenario of accidental motor shutdown while in normal operation, for instance, due to lack of energy in the power grid, when starting up the motor right after energy recovery is allowed.

5.3 BLOCKED-ROTOR CURRENT (Ip/In)

According to standard NBR 7094, the motor nameplate must indicate the Ip/In value, which is the relation between the blocked-rotor current and the rated current.

5.4 REDUCED CURRENT START-UP

In case a direct start-up is not possible, the following indirect start-up systems may be used to reduce the start-up current:

- With a star-delta starter;
- With a series-parallel switch;
- With a compensating switch or auto-transformer;
- With a static starter or soft starter;
- With a frequency inverter.
6 COMMISSIONING

6.1 PRELIMINARY INSPECTION

Before a motor initial start-up or after a long period of inactivity, the following items must be verified:
1. Motor fixation bolts must be tightened.
2. Measure the windings' insulation resistance, ensuring it is within recommended limits;
3. Check if the motor is clean and if the packaging, measuring instruments and aligning devices have been removed from the motor working area;
4. Coupling connecting components must be in perfect operating conditions, duly tightened and greased (if required);
5. The motor must be adequately aligned;
6. Ensure that the bearings are properly lubricated. The lubricant used must be the one recommended on the nameplate. Check oil levels in motors with oil-lubricated bearing. Forced lubrication must present oil pressure and flow values as described in the nameplate;
7. Inspect the accessories' cable connections (thermal protectors, grounding, space heaters, etc.);
8. Ensure all electrical connections are in accordance with the motor connection diagram;
9. Ensure that the conductors are connected to the motor main terminals, and adequately tightened to prevent them from loosening or to avoid the occurrence of short-circuits;
10. Inspect the cooling system. Inspect the operation of the radiator water supply system in water cooled motors. Check the fans' direction of rotation in independent ventilation motors;
11. The motor water inlet and outlet must be unobstructed;
12. Mobile parts of the motor must be protected to prevent accidents;
13. Terminal box covers must be properly fitted;
14. All motor screws must be properly tightened;
15. Verify if the power supply voltage and frequency are in accordance with the motor nameplate.

6.2 INITIAL START UP

After having performed all instructions provided above, the following procedure to perform the motor initial start-up must be followed:
1. Disconnect all space heaters;
2. Adjust all protections in the control panel;
3. Check oil levels in oil-lubricated bearings;
4. In bearings with forced lubrication, activate the oil circulation system and verify the oil levels, flow and pressure, ensuring that they are in accordance with the data provided on the nameplate;
5. In case the system presents oil flow detection equipment, the oil flow return signal in the circulation system of both bearings must be awaited, which assures that the oil has reached the bearings;
6. Turn on the cooling industrial water system, verifying the necessary flow and pressure (motors with air-water heat exchanger);
7. Turn on the fans (motors with forced ventilation);
8. Slowly rotate the motor shaft to check if there are any parts being dragging and to identify unusual noises;
9. After the previous steps have been concluded, the motor start-up sequence may be initiated;
10. Check the direction of rotation with uncoupled motor;
11. In order to reverse the direction of rotation, the connection of any of the two phases must be inverted;

ATTENTION

In order to reverse the motor rotation direction with single direction of rotation, it is necessary to contact WEG.

12. Keep the motor turning at a rated rotation speed and record bearing temperatures in 1 minute intervals until they become constant. Any sudden increase in bearing temperature indicates lubrication or friction surface issues.
13. Monitor the temperature, oil levels in the bearings and vibration levels. In case there is a significant variation in any of these values, shutdown the motor start-up process, identify possible causes and implement all appropriate corrections;
14. When the bearings' temperature stabilizes, the motor operation process may be resumed.

ATTENTION

Noncompliance with the procedures provided above may compromise the motor performance, cause damages and even lead to a motor blow out, voiding the product warranty.

6.3 OPERATION

Operation procedures vary significantly depending on the motor application and the type of control equipment used.
This manual described only general procedures. For control system operation procedures, please consult the specific equipment manual.

6.3.1 General

* After successful first start-up test, couple the motor to the driven load and resume the motor start-up procedure, as described below:
  * Drive the coupled motor under load until it reaches its thermal stability and verify whether there are unusual noises or vibrations or excessive heating. If significant variations are identified in the vibrations between the initial operating condition and the condition upon reaching thermal stability, the alignment and leveling must be checked;
  * Measure the absorbed electric current and compare it with the value indicated on the nameplate;
  * In a continuous regime, with no load variation, the current value measured must not exceed the value indicated on the nameplate multiplied by the service factor;
  * All measuring and control instruments and devices must be permanently monitored in order to detect
occasional changes, determine the causes, and implement the appropriate corrections.

6.3.2 Temperatures

- Bearing, stator winding and cooling air temperatures must be monitored while the motor is operating;
- Bearing and stator winding temperatures must be stable within 4 to 8 hours of operation;
- Stator winding temperatures depend on the load. Therefore, the activated load power must also be monitored while the motor is operating.

6.3.3 Bearings

The system start-up, as well as the first hours of operation, must be carefully monitored.

Before starting the motor, verify:
- If the external lubrication system (if applicable) is operational;
- If the lubricant used complies with all specifications;
- Lubricant characteristics;
- Oil levels (oil-lubricated bearings);
- If the bearing alarm and shutdown temperatures are set;
- During the first system start-up, it is important to inspect for unusual vibrations or noises;
- If the bearing is not running silently and smoothly, the motor must be immediately shutdown;
- The motor must operate for several hours until bearing temperatures stabilize within the previously mentioned limits
- If the temperature rises above the limits, the motor must be immediately shutdown; bearings and temperature sensors must be inspected and the appropriate corrections must employed;
- After bearing temperatures stabilize, verify if there are any leaks in the plugs, gaskets and in the shaft end.

6.3.4 Radiators

- Control and the radiator inlet and outlet temperatures and adjust the water flow, if necessary;
- Regulate water pressure just enough to overcome pipeline and radiator resistances;
- Installing thermometers in the radiator air and water inlets and outlets and recording the temperatures in certain timeframes are recommended for controlling the motor operation;
- Along with the thermometers, recording or signaling (sirens and lamps) instruments may also be installed in certain locations.

Radiator performance verification

- For better control of the operation, it is recommended to periodically measure and record radiator air and water inlet and outlet temperatures.
- Radiator performance is measured by the difference in temperature between the cold water and the cold air during regular operation. This difference must be routinely monitored. Increases in such difference after long periods of regular operation may indicate that the radiator must be cleaned.
- A reduction in performance or damage to the radiator may also indicate air build up in the radiator. If so, removing the air from the radiator and water pipes may solve the problem;
- The differential pressure on the water side may be regarded as an indicator that the radiator needs to be cleaned.
- It is also recommended to measure and record differential water pressures before and after the radiator. New measurements must be routinely compared to the initial measurement. Differential pressure increases indicate that the radiator needs to be cleaned.

6.3.5 Vibration

Motors are balanced by the manufacturer according to the vibration thresholds established in the IEC60034-14, NEMA MG1 - Parte 7 and NBR 11390 standards (except when the purchase agreement specifically provides different thresholds).

Vibrations are measured vertically, horizontally and axially at the end and front bearings.

When a client sends the half coupling to WEG, the motor is balanced with the half coupling attached to the shaft. If not, according to the aforementioned standards, the motor is balanced using a half-key (that is, a bar of same width, length and height is used to fill the key groove during balancing).

Maximum motor operation vibration levels met by WEG are specified in Table 6.1. These values are for general and guidance purposes only, and the specific application conditions must be considered.

<table>
<thead>
<tr>
<th>Rated rotation speed (rpm)</th>
<th>Vibration Levels (mm/s RMS)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frame</td>
</tr>
<tr>
<td>600 ≤ n ≤ 1800</td>
<td>Alarm</td>
</tr>
<tr>
<td></td>
<td>Shutdown</td>
</tr>
<tr>
<td>1800 &lt; n ≤ 3600</td>
<td>Alarm</td>
</tr>
<tr>
<td></td>
<td>Shutdown</td>
</tr>
</tbody>
</table>

The most frequent causes for vibrations are:
- Misalignment between the motor and the driven equipment;
- Inadequate fixation of the motor to the base, with "loose shims" under one or more of the motor feet, and loose fixation screws;
- Inadequate or not sufficiently strong base;
- External vibrations from other devices.

ATTENTION

Operating the motor with vibration levels above the values provided in table 6.3 may damage its useful life and/or performance.

6.3.6 Shaft Vibration Limits

In motors equipped with or programmed for the installation of a proximity sensor (normally used in sliding bearings), the shaft surfaces are prepared with a special finishing in the areas adjacent to the
bearings, with the purpose of ensuring a correct shaft vibration measurement. The shaft vibration measured in these motors must comply with the IEC 60034-14 or NEMA MG 1 standards. The alarm and shutdown values in Table 6.2 represent acceptable shaft vibration values for coupled electric machines, according to the ISO7919-3 standard. These are referential and generic values, considering the application specific conditions, specially the diametric clearance between the shaft and the bearing.

Table 6.2: Shaft vibration

<table>
<thead>
<tr>
<th>Rated rotation (rpm)</th>
<th>Shaft vibration (peak-to-peak μm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frame 280 to 315</td>
</tr>
<tr>
<td>1800</td>
<td>Alarm 110</td>
</tr>
<tr>
<td></td>
<td>Shutdown 140</td>
</tr>
<tr>
<td>3600</td>
<td>Alarm 85</td>
</tr>
<tr>
<td></td>
<td>Shutdown 100</td>
</tr>
</tbody>
</table>

**ATTENTION**

Operating the motor with shaft vibration values close to the alarm or shutdown values may cause damage to the bearing shell.

The main causes for shaft vibration increase are:
- Coupling unbalance issues or other problems that may generate vibration in the machine;
- Problems with the shaft shape in the measurement area, minimized during the manufacturing process;
- Residual voltage or magnetism in the shaft surface where the measurement is performed;
- Scratches, bumps or variations in the shaft finishing in the measurement area.

### 6.3.7 Shutdown

Motor shutdown depends on its application, but the main recommendations are:
- Reduce the driven equipment load, if possible;
- Open the main circuit breaker;
- Turn on the space heaters (if any) in case that is not automatically performed by command devices;
- Shutdown the bearing oil circulation system (if any);
- Shutdown the heat exchanger radiator water supply system (if any).

**DANGER**

While the rotor is operating, and even after it is shutdown, touching any of its active parts is life threatening.

**ATTENTION**

The terminal boxes of motors equipped with capacitors must not be opened before full discharge. Capacitor discharge time: 5 minutes after the motor is shutdown.
7 MAINTENANCE

7.1 GENERAL

When used appropriately, an adequate maintenance program for electric motors includes the following recommendations:
- Keep the motor and all related equipment clean;
- Routinely measure insulation levels;
- Routinely measure temperature rises (windings, bearings and cooling system);
- Check for occasional wearing effects, the operation of the lubrication system and the bearings’ useful life;
- Check ventilation systems to ensure air is flowing correctly;
- Check the heat exchanger;
- Measure the machine vibration levels;
- Check all related devices (hydraulic unit, water system, etc.)
- Check all of the motor accessories, protections and connections, ensuring that they are operating properly.
- In order to facilitate the heat exchange process with the environment, the frame must be kept clean and free of oil or dust accumulation in the external area;
Failure to comply with one of the recommendations provided above may result in unexpected equipment downtime. The frequency with which such inspections are performed depends on local application conditions. The frequency with which such inspections are performed depends on local application conditions.
If the motor requires reconditioning or replacement of any damaged parts, please contact WEG.

ATTENTION
Whenever the motor needs to be moved, ensure that the shaft is properly locked to prevent bearing damage. Use the device provided with the motor to lock the shaft.

7.2 GENERAL CLEANING

- In order to facilitate the heat exchange process with the environment, the frame must be kept clean and free of oil or dust accumulation in the external area; The interior of the motor must also be kept clean, and free from dust, debris and oils.
- Use brushes or clean cotton cloths to clean. If the dust is not abrasive, an industrial vacuum cleaner must be used to remove the dirt from the fan cover and the excess dust on fan blades and on the frame.
- Debris impregnated with oil or moisture may be removed with a cloth soaked in the appropriate solvents.
- Cleaning the terminal boxes is also recommended. Terminals and connectors must be kept clean, rust-free and in perfect operating conditions. Avoid contact between connecting parts and grease or verdigris.

7.3 WINDING INSPECTION

The windings’ insulation resistance must be regularly measured, especially during damp weathers or after prolonged motor shutdown. The windings must regularly undergo complete visual inspections, recording and repairing each and every damage or fault identified. Low values or sudden variations in the insulation resistance must be carefully investigated.
At points where insulation resistance may be low (due to an excess of dust or moisture), it may be increased back to the required values by removing the dust and drying up humidity on the windings.

7.4 WINDING CLEANING

For satisfactory operation and longer useful life of insulated windings, it is recommended to keep them free of dirt, oil, metallic dust, contaminants, etc. Therefore, the windings must be routinely inspected and cleaned, and must operate with clean air. If re-impregnation is required, please contact WEG.
The windings may be cleaned with an industrial vacuum cleaner equipped with a narrow, non-metallic tip or simply with a dry cloth.
For extremely dirty conditions, an adequate liquid solvent may be required for cleaning. This procedure must be quick to prevent prolonged exposure of the windings to solvent effects.
After being cleaned with solvents, the windings must be completely dried.
Measure insulation resistance and polarization index to ensure the windings are completely dry.
Winding drying time after cleaning varies depending on weather conditions such as temperature, humidity, etc.

DANGER
Most solvents used are highly toxic, flammable or both. Solvents must not be applied to the flat parts of high voltage motor coils, as it may affect their protection against the corona effect.

Inspections
The following inspections must be performed after the windings are carefully cleaned:
- Check the connections and windings’ insulation.
- Check if spacers, bindings, groove wedges, bandages and supports are fixed correctly.
- Check if there haven't been any ruptures; if there aren't damaged welds, short-circuits between turns and against the grounding on coils and connections. If any irregularities are identified, immediately contact WEG.
- Ensure that all cables are properly connected and that terminal fixation components are duly tightened. If required, re-tighten them.

Re-impregnation
If any layer of resin on the windings is damaged during cleaning or inspection, they must be corrected with adequate material (in this event, please contact WEG).
Insulation Resistance
Insulation resistance must be measured after all maintenance procedures have been performed.

ATTENTION
Before re-powering the motor, if it has not been operated for a long period, measuring the stator windings’ insulation resistance and ensure that values measured are within the specified values.

7.5 COOLING SYSTEM MAINTENANCE

- Air-air heat exchanger pipes (if any) must be kept clean and unobstructed to ensure a perfect heat exchange. To remove dirt from the pipes, a round brush may be used attached to the tip of a rod.
- For air-water heat exchangers, a periodical cleaning process is required for radiator pipelines in order to completely remove any fouling.

NOTE
If the motor is equipped with filters on the air inlets and outlets, these must be cleaned with compressed air.
If the dust is hard to remove, wash the filters with cold water and neutral detergent and then dry them in a horizontal position.

7.5.1 Radiator maintenance

If clean water is used, the radiator may operate continuously for several years with no need for cleaning. If unclean water is used, the radiator must be cleaned every 12 months.
The amount of dirt in the radiator may be detected when the outlet air temperature increases. When the cold air temperature, in similar operating conditions rises above the acceptable values, this may be an indication that pipes are dirty.
If corrosion is detected, an appropriate corrosion protection must be applied (such as, zinc anodes, plastic cover, epoxy paint or other similar protection products) to prevent further damage to the affected parts.
The outer coating of all radiator parts must be kept clean and in good conditions.

Instructions for radiator removal and maintenance
Removal of the heat exchanger for maintenance must follow the steps below:
1. Close all water inlet and outlet valves after shutting down the ventilation;
2. Drain the water through drain plugs;
3. Unscrew the cylinder heads, keeping screws, nuts, washers and gaskets in a safe location;
4. Carefully brush inside the pipes with nylon brushes to remove residues. If during the cleaning process, damage to radiator pipes is detected, they must be repaired;
5. Re-attach the cylinder heads, replacing gaskets if necessary.

7.6 SHUTDOWN MOTOR

- The following procedures must be adopted if the motor is de-commissioned for a long period of time:
  Activate the space heaters in order to maintain the temperature inside the motor slightly above ambient temperature, thus avoiding humidity condensation and a subsequent drop in the winding insulation resistance and oxidation of metallic parts.
- The radiators and all water tubing (if any) must be drained in order to reduce corrosion and suspended materials in cooling water.
Follow the remaining procedures described in the item Prolonged Storage, provided in this manual.

Radiator storage after operation
When the radiator is de-commissioned for a long period of time, it must be drained and dried. The drying process may be carried out with pre-heated compressed air. During the Winter, if there is risk of freezing, the radiator must be drained, even if it is not operating for a short period of time, in order to avoid damages or deformations.

NOTE
During short shutdown periods, it is preferable to maintain the water flow in low speed than to interrupt its flow through the heat exchanger without draining it, thus ensuring that harmful products such as ammonium compounds and hydrogen sulfide are carried outside the radiator and do not remain in its interior.

7.7 SHAFT GROUNDING DEVICE

In some induction Motors, especially when it is necessary to use a frequency inverter to control the speed, a brush is used for shaft grounding. Such device avoids the electric current to flow through the bearings, which is extremely harmful to its operation.
The brush is placed in contact with the shaft and connected by a cable to the motor frame, which must be grounded. Ensure that the brush holder fixation and connection to the frame are performed correctly.

Figure 7.1: Shaft grounding brush

In order to avoid damage to the motors’ shafts during transportation, they are protected with synthetic oil. In order to ensure a perfect grounding brush operation, this oil, as well as any residue between the shaft and
the brush, must be removed before the motor is operated. The brush must be constantly monitored during its operation and, when it reaches the end of its useful life, it must be replaced by another brush with the same quality (granulation).

7.8 BEARING MAINTENANCE

7.8.1 Grease-lubricated rolling bearings

Figure 7.2: Grease lubricated rolling bearing

7.8.1.1 Lubrication instructions

The lubrication system was designed so that, during the bearing re-lubrication process, all old grease is removed from the ball races and expelled through a drain that allows grease drainage, but keeps dust or other harmful contaminants from getting inside the bearing. This drain also avoids rolling bearing damage by the well-known excessive re-lubrication problem. It is recommended to perform the lubrication process while the motor is running, in order to ensure grease renewal in the rolling bearing lodging. If that is not possible due to the presence of turning pieces near the grease gun (pulleys, etc.) that may risk the operator’s physical integrity, proceed as follows:

- With the motor shutdown, inject approximatively half of the total grease quantity to be used and operate the motor for approximately 1 minute in full rotation speed;
- Shutdown the motor and inject the remaining grease. The injection of the entire amount of grease in an idle motor may cause part of the lubricant to penetrate into the inner part of the motor through the internal sealing of the bearing cover.

ATTENTION

It is important to clean the grease fittings before the lubrication process in order to avoid foreign materials from being dragged inside the rolling bearing.

For lubrication, use only a hand-held grease gun.

NOTE

Rolling bearing data, type and amount of grease and lubrication intervals are informed in the nameplate fixed to the motor. Check this information before initiating the lubrication process.

- The lubrication intervals informed on the nameplate consider a rolling bearing operating temperature of 70°C.
- Based on the operating temperature rates listed below, apply the following correction factors to the rolling bearing lubrication intervals:
  - Operating temperature over 60°C: 1.59.
  - Operating temperature from 70°C to 80°C: 0.63.
  - Operating temperature from 80°C to 90°C: 0.40.
  - Operating temperature from 90°C to 100°C: 0.25.
  - Operating temperature from 100°C to 110°C: 0.16.

7.8.1.2 Procedures for bearing re-lubrication

1. Remove the drain cover;
2. Use a cotton cloth to clean the grease fitting hole;
3. While the rotor is running, inject the grease through a hand-held grease gun until the grease starts to come out through the drain or until the amount of grease informed in Table 7.2 is reached;
4. Operate the motor for as long as necessary for the grease excess to leak through the drain;
5. Inspect the bearing temperature in order to assure that there was no significant alteration;
6. Place the drain cover back.

7.8.1.3 Lubrication of bearings with spring device for grease removal

In order to perform bearing re-lubrication, old grease removal is carried out by the grease removal spring device installed in each bearing.

Lubrication procedures:

1. Before initiating the bearing lubrication process, clean the grease fitting with a cotton cloth;
2. Remove the spring rod to remove the old grease, clean the spring and place it back;
3. While the motor is operating, inject the amount of grease specified in the rolling bearings’ nameplate with a hand-held grease gun;
4. The grease excess comes out through the lower drain and precipitates on the spring;
5. Maintain the motor under operation for as long as necessary for all of the grease excess to be drained;
6. Such grease must be removed by pulling the spring small rod and cleaning the spring. This procedure must be repeated as many times as necessary for the spring not to retain any grease;
7. Inspect the bearing temperature to ensure that there was no significant alteration.

7.8.1.4 Grease type and quantity

Bearing re-lubrication must always be done with the original grease, specified on the bearing nameplate and in the motor documentation.

ATTENTION

WEG does not recommend the use of different types of greases, other than the motor original grease type.
7.8.1.5 Alternative greases

If it’s not possible to use the original grease, the alternative greases listed on Table 7.2 may be used as long as the following conditions are respected:

1. It is necessary to check if the motor rotation does not exceed the limit established for each type of bearing grease, according to Table 7.2;
2. Bearing lubrication intervals must be corrected by multiplying the interval informed on the bearing nameplate by the multiplication factor informed on Table 7.1;
3. Follow the correct procedure for grease changing according to the Grease Changing Procedure provided in this manual.

Table 7.1: Alternative grease options and characteristics for normal applications

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Grease</th>
<th>Constant working temperature (°C)</th>
<th>Multiplication factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exxon Mobil</td>
<td>UNIREX N3 (Lithium Complex Soap)</td>
<td>(-30 to +150)</td>
<td>0.90</td>
</tr>
<tr>
<td>Shell</td>
<td>ALVANIA RL3 (Lithium Soap)</td>
<td>(-30 to +120)</td>
<td>0.85</td>
</tr>
<tr>
<td>Petrobras</td>
<td>LUBRAX INDUSTRIAL GMA-2 (Lithium Soap)</td>
<td>(0 to +130)</td>
<td>0.85</td>
</tr>
<tr>
<td>Shell</td>
<td>STAMINA RL2 (Diurea Soap)</td>
<td>(-20 to +180)</td>
<td>0.94</td>
</tr>
<tr>
<td>SKF</td>
<td>LGHP 2 (Poliourea Soap)</td>
<td>(-40 to +150)</td>
<td>0.94</td>
</tr>
</tbody>
</table>

Table 7.2 displays the most used bearing types in horizontal Motors, the amount of grease, and the rotation limits of optional grease use.

Table 7.2: Optional Grease application

<table>
<thead>
<tr>
<th>Bearing</th>
<th>Grease amount (g)</th>
<th>Grease rotation limits [rpm]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stamina RL2</td>
<td>LGHP 2</td>
</tr>
<tr>
<td>6220</td>
<td>30</td>
<td>3000</td>
</tr>
<tr>
<td>6222</td>
<td>30</td>
<td>1800</td>
</tr>
<tr>
<td>6224</td>
<td>105</td>
<td>1200</td>
</tr>
<tr>
<td>6226</td>
<td>120</td>
<td>1200</td>
</tr>
<tr>
<td>6252</td>
<td>100</td>
<td>1000</td>
</tr>
<tr>
<td>6315</td>
<td>85</td>
<td>3000</td>
</tr>
<tr>
<td>6316</td>
<td>35</td>
<td>3000</td>
</tr>
<tr>
<td>6317</td>
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<td>3000</td>
</tr>
<tr>
<td>6319</td>
<td>45</td>
<td>1800</td>
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<tr>
<td>6320</td>
<td>50</td>
<td>1800</td>
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<td>6322</td>
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<td>1800</td>
</tr>
<tr>
<td>6324</td>
<td>75</td>
<td>1800</td>
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<td>6326</td>
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<td>1800</td>
</tr>
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<td>6328</td>
<td>95</td>
<td>1800</td>
</tr>
<tr>
<td>6330</td>
<td>105</td>
<td>1500</td>
</tr>
<tr>
<td>NU 232</td>
<td>70</td>
<td>1500</td>
</tr>
<tr>
<td>NU 236</td>
<td>85</td>
<td>1500</td>
</tr>
<tr>
<td>NU 238</td>
<td>95</td>
<td>1200</td>
</tr>
<tr>
<td>NU 240</td>
<td>105</td>
<td>1200</td>
</tr>
<tr>
<td>NU 248</td>
<td>105</td>
<td>1000</td>
</tr>
<tr>
<td>NU 252</td>
<td>195</td>
<td>1000</td>
</tr>
<tr>
<td>NU 256</td>
<td>60</td>
<td>1800</td>
</tr>
<tr>
<td>NU 258</td>
<td>75</td>
<td>1800</td>
</tr>
<tr>
<td>NU 262</td>
<td>85</td>
<td>1800</td>
</tr>
<tr>
<td>NU 264</td>
<td>95</td>
<td>1500</td>
</tr>
<tr>
<td>NU 268</td>
<td>105</td>
<td>1500</td>
</tr>
<tr>
<td>NU 332</td>
<td>145</td>
<td>1200</td>
</tr>
</tbody>
</table>

* For vertical Motors, please contact WEG
7.8.1.6 Grease changing procedure

In order to change the POLYREX EM103 grease for one of the alternative grease types, the bearings must be open to remove the old grease and to fill it up with the new grease. If it is not possible to open the bearing, all of the old grease must be purged, applying the new grease until it starts to show in the outlet drawer while the motor is operating.

To change the STABURAGS N12MF grease for one of the alternative grease types, it is necessary to open the bearings and completely remove the old grease, and then add the new grease.

**ATTENTION**

Since there is no compatible grease with STABURAGS N12MF, no other greases must be applied in an attempt to purge it. It is not possible to expel all of the old grease through this procedure, at the risk of mixing the old types of grease, which may damage the bearings.

7.8.1.7 Low temperature grease

Table 7.3: Grease for low-temperature applications

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Grease</th>
<th>Constant work temperature (°C)</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exxon Mobil</td>
<td>MOBILITH SHC 100 (Lithium Complex Soap and synthetic oil)</td>
<td>(-50 to +150)</td>
<td>Low temperature</td>
</tr>
</tbody>
</table>

**NOTE**

Before using alternative grease types for low-temperature applications, other than MOBILITH SHC 100, please contact WEG.

**ATTENTION**

1. When the bearing is open, inject the new grease through the grease fitting in order to expel the old grease found in the grease inlet tube and apply the new one on the bearing, onto the inner outer fixing rings, filling ¾ of the empty spaces. In the case of double bearings (Ball bearing + rolling bearing), fill up 3/4 of the empty spaces between the intermediate rings.
2. Never clean bearing with cotton based cloths, as they may release lint, serving as a solid particle.
3. It is important to make a correct lubrication, i.e. to apply the proper amount of grease, because an deficient lubrication, as well as an excessive lubrication have harmful effects on the bearing.
4. Excessive lubrication leads to the increase of temperature, due to the great resistance it offers to the rotational parts and, mainly, due to grease beating, which leads to a complete loss of its lubrication features.

**NOTE**

WEG is not responsible for grease exchange or any eventual damages deriving from grease exchange.

**ATTENTION**

Grease with different basic components must never be mixed. Example: Lithium-based grease must never be mixed with other sodium or calcium based greases.

7.8.1.8 Grease compatibility

Compatibility between several types of grease may eventually present an issue. One may say that different types of grease are compatible when the properties of the mix are within individual grease property categories.

Generally, greases with the same type of soap are compatible; however, depending on the proportion of the mix, there may be incompatibility. Therefore, mixing different types of grease is not recommended without previously contacting the grease supplier or WEG.

Some thickening agents and basic oils cannot be mixed since they do not form a homogeneous mixture. In this case, a tendency to hardening, or, otherwise, grease softening, or a fall in the resulting mix melting point cannot be ignored.
7.8.1.9 Bearing disassembly / assembly

Before Disassembly:
1. Remove the grease inlet and outlet extension tubes;
2. Thoroughly clean the external part of the bearing;
3. Remove the grounding brush (if any);
4. Remove the temperature sensors from the bearing and, to avoid any damage to the bearing, arrange a support for the shaft.

Disassembly
Be particularly careful not to cause any damage to the balls, rollers and bearing surfaces and shafts. For bearing disassembly, carefully follow the instructions below, keeping all parts in a clean and safe location:
1. Remove the screws (4) that fasten the closing disc (13);
2. Remove the taconite seal (6);
3. Remove the screw (3) from the fixing rings (1 and 5);
4. Remove the outer fixing ring (5);
5. Remove the screw (7) that fixates the grease flinger (8);
6. Remove the grease flinger (8);
7. Remove front cover;
8. Remove the bearing (10);
9. Remove the internal bearing cap (1), if necessary.

Assembly
1. Thoroughly clean the bearings and inspect the disassembled parts and the interior of the fixing rings;
2. Ensure that the bearing surfaces, shafts and fixing rings are perfectly smooth;
3. Fill ¾ of the inner and outer fixing rings reservoir with the recommended grease (Figure 7.16) and lubricate the bearing with enough grease before assembling it;
4. Before assembling bearing on the shaft, heat it up to a temperature between 50°C and 100°C;
5. For a complete bearing assembly, follow the disassembly instructions in the opposite order.

Figure 7.3: Rolling bearing grease

Figure 7.4: External bearing fixating ring

Bearing Replacement
the bearing disassemble process must always be performed with the appropriate tool (bearing puller). The puller clips must be applied over the inner ring side face or over an adjacent part.

Figure 7.5: Bearing puller device
7.8.2 Oil-lubricated rolling bearings

1. Oil inlet
2. Oil level Sight glass
3. Oil outlet

Figure 7.6: Oil-lubricated rolling bearing

7.8.2.1 Lubrication instructions

Oil removal: To replace the oil in the bearing, remove the oil outlet cover (3) and completely drain the oil

Oil inlet in the bearing:
- Close oil outlet with the cover (3);
- Remove the oil inlet cover or filter (1);
- Pour the specified oil up to the level indicated in the oil sight glass

NOTES

1. All threaded holes must be sealed with plugs and there may be no leaks in any of the connections;
2. The oil level is reached when the lubricant fills up to about half of the level sight glass;
3. Using a larger volume of oil does not damage the bearing, but it may cause leaks through the shaft seals;
4. Hydraulic oil may never be used or mixed with bearing lubricating oil.

7.8.2.2 Oil types

Lubricating oil type and volume to be used are specified in the nameplate attached to the motor.

7.8.2.3 Oil change

Bearing oil change must be carried out in accordance with the following table, always considering the bearing operating temperature:

<table>
<thead>
<tr>
<th>Temperature Range</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 75°C</td>
<td>20,000 hours</td>
</tr>
<tr>
<td>Between 75°C and 80°C</td>
<td>16,000 hours</td>
</tr>
<tr>
<td>Between 80°C and 85°C</td>
<td>12,000 hours</td>
</tr>
<tr>
<td>Between 85°C and 90°C</td>
<td>8,000 hours</td>
</tr>
<tr>
<td>Between 90°C and 95°C</td>
<td>6,000 hours</td>
</tr>
<tr>
<td>Between 95°C and 100°C</td>
<td>4,000 hours</td>
</tr>
</tbody>
</table>

The bearings useful life depends on their operating conditions, on the motor operating conditions and maintenance procedures.

The following recommendations must be observed:
- The viscosity of the oil selected must be appropriate regarding the bearing temperature. The type of oil recommended by WEG takes these criteria into account;
- Insufficient oil may damage the bearing;
- The minimum oil level recommended is reached when the lubricant can be seen on the lower portion of the oil level sight glass, while the motor is not operating.

ATTENTION

Oil levels must be checked daily and must remain up to the middle of the oil level sight glass.

7.8.2.4 Bearing operation

The system start-up, as well as the first hours of operation, must be closely monitored.

Before the system start-up, verify:
- If the oil being used complies with the specifications on the nameplate;
- Lubricant specifications;
- Oil levels;
- If the alarm and shutdown temperatures are set for the bearing.

During the first system start-up, it is important to inspect for occasional vibrations or noises. If the bearing is not running silently and smoothly, the motor must be immediately shutdown.

The motor must operate for several hours until the bearing temperature stabilizes within the previously stated limits. If the temperature rises above recommended limits, the motor must be shutdown and the bearings and sensors must be inspected.

Once the bearing operating temperature is reached, check if there are no oil leaks through plugs, gaskets or at the shaft end.
To disassemble the bearing, follow the instructions below:

**Before disassembly:**
- Clean all external bearing surfaces;
- Completely remove all oil from the bearing;
- Remove the bearing temperature sensor (10);
- Remove the grounding brush (if applicable);
- Arrange a shaft support to support the rotor during disassembly.

**Bearing disassembly:**
Be particularly careful not to cause any damage to the balls, rollers and surfaces of the bearing and shaft.

For bearing disassembly, carefully follow the instructions below, keeping all parts in a safe and clean location:

1. Remove the screw (9) securing the taconite seal (8);
2. Remove the taconite seal (8);
3. Remove the screws (11) securing the bearing protective cover (14);
4. Remove the protective cover (14);
5. Remove the screws (5) securing the oil flinger (4) and remove the flinger;
6. Remove the screws (11) from the outer fixing ring (3);
7. Remove the outer fixing ring (3);
8. Unscrew the screws (12 and 13);
9. Remove the external oil reservoir (1);
10. Remove the bearing (7);
11. If a complete bearing disassembly is required, remove the internal bearing cap (6) and the internal oil reservoir (2).

**Bearing assembly**

Thoroughly clean the roller, oil reservoirs and check all parts for damage before assembling the bearing.

- Ensure all bearing contact surfaces are smooth and free of scratches or signs of corrosion.
- Before assembling the bearing onto the shaft, heat it up to between 50ºC and 100ºC;
- For a full bearing assembly, follow the disassembly instructions in the reverse order.

**ATTENTION**

Oil levels must be checked daily and must remain up to the middle of the oil level sight glass.
7.8.3 Sleeve bearings

7.8.3.1 Bearing data

Characteristic information such as oil type, volume and flow, are described in the bearings' nameplate and must be strictly followed to prevent bearing overheating and damage. The users are responsible for the hydraulic installation (for forced lubrication bearings) and oil feed for motor bearings.

7.8.3.2 Bearing installation and operation

For information on components, assembly and disassembly instructions and maintenance information please check the specific bearing installation and operation manual.

7.8.3.3 Water flow cooling

Sleeve bearings with water flow cooling have a coil inside the reservoir through which water flows. To ensure efficient bearing cooling, the flowing water must be at ambient temperature or lower. Water pressure must be 0.1 Bar and the flow must be 0.7 l/s. The pH must be neutral.

NOTE
There must not be any water leaks inside the oil reservoir under any circumstances, since it may contaminate the lubricant.

7.8.3.4 Oil change

Self-lubricating bearings

Bearing oil change must take place according to the table below, always considering the bearing operating temperature:

<table>
<thead>
<tr>
<th>Bearing Temperature</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 75°C</td>
<td>20,000 hours</td>
</tr>
<tr>
<td>Between 75°C and 80°C</td>
<td>16,000 hours</td>
</tr>
<tr>
<td>Between 80°C and 85°C</td>
<td>12,000 hours</td>
</tr>
<tr>
<td>Between 85°C and 90°C</td>
<td>8,000 hours</td>
</tr>
<tr>
<td>Between 90°C and 95°C</td>
<td>6,000 hours</td>
</tr>
<tr>
<td>Between 95°C and 100°C</td>
<td>4,000 hours</td>
</tr>
</tbody>
</table>

Bearing operation:

Operating motors with sliding bearings is similar to operating motors equipped with rolling bearings. The system start-up, as well as the first hours of operation, must be closely monitored.

Before the start-up, verify:

- If the oil used complies with all specifications;
- Lubricant specifications;
- Oil levels;
- If the alarm and shutdown temperatures are set for the bearing.

During the first system start-up, it is important to inspect for vibrations or noises. If the bearing is not running silently and smoothly, the motor must be immediately shutdown and all appropriate correction measures must be employed. The motor must operate for several hours until the bearing temperature stabilizes within the previously stated limits. If the temperature rises above the recommended limits, the motor must be shutdown and the bearings and sensors must be inspected.

7.8.3.5 Sealing

During bearing maintenance, when re-regulating bearings, both halves of the sealing taconite seal must be joined by a garter spring. This spring must be placed in the ring case so that the locking pin recess is fitted to the upper half of the frame. Inaccurate installation will destroy the seal. Before assembling the seals, carefully clean the ring contact surfaces and case, and re-coat seals with a non-hardening sealant. Drain holes are disposed in the lower half of the ring and must be kept clean and free. When installing this half of the sealing ring, gently press it against the lower part of the shaft.

7.8.3.6 Sleeve bearing operation

- Oil levels are reached when the lubricant fills up to about half of the level sight glass. Using a larger volume of oil does not damage the bearing, but it may cause leaks through the shaft seals.

ATTENTION

The bearing useful life, as well as motor security, is determined by the lubrication measures taken. Therefore, it is important to comply with the following recommendations:

- The chosen lubricating oil must have the adequate viscosity regarding the bearing operating temperature. This must be checked when the oil is replaced or during routine maintenance.
- Never use or mix hydraulic oil with bearing lubricating oil.
- Insufficient lubricant, due to failure to fill up the reservoir or to monitor oil levels, may damage the bearing shells.
- The minimum recommended oil level is reached when the lubricant can be seen in the lower portion of the oil level sight glass, when the motor is not running.
Once the bearing operating temperature is reached, check if there are no oil leaks through plugs, gaskets or shaft ends.

7.8.3.7 Sleeve bearing maintenance

Sleeve bearing maintenance involves:
- Routinely checking oil levels and lubricant characteristics;
- Checking the bearing noise and vibration levels;
- Monitoring the operating temperature and tightening fixating and assembly screws;
- Keeping the frame clean, free from oil or dust accumulation, to facilitate the heat exchanging process with the environment;
- The end bearing is electrically insulated. The round surfaces, in which the bearing shell is fitted into the frame, are covered with an insulating material. Never remove this cover;
- The anti-rotation pin is also insulated, and all seals are made of non-conductive material.
- Temperature control devices in contact with the bearing shell must also be insulated.
7.8.3.8 Bearing assembly and disassembly

Figure 7.8: Sliding bearing components

1. Drain plug;
2. Bearing frame;
3. Motor frame;
4. Fixation screws;
5. Bearing frame cover;
6. Split bearing cover screws;
7. Machine seal;
8. Machine seal screws;
9. Eyebolt;
10. Outer cover screws;
11. Outer cover;
12. Lower bearing shell;

**Disassembly**

To disassemble the bearing and gain access to the bearing shells, as well as other components, carefully follow the instructions below. Keep all disassembled parts in storage safe location (Figure 7.27).

**Drive End:**
- Thoroughly clean the external surface of the frame. Unscrew and remove the oil drain plug (1) in the lower part of the frame, allowing the lubricant to drain thoroughly.
- Remove the screws (4) securing the top half of the frame (5) to the motor (3).
- Remove the screws (6) attaching the split sides of the frame (2 and 5).
- Use the eyebolt screws (9) to lift the top half of the frame (5), completely separating it from the bottom halves of the external sealing (11), the sealing taconite, the taconite frame (20) and the bearing shell (12).
- Disassemble the top half of the frame on a workbench. Unscrew the bolts (19) and remove the top half of the external protection. Remove the screws (10) and separate the top half of the taconite frame (20).
- Detach and remove the top half of the bearing shell (13).
- Remove the screws joining both halves of the loose oil ring (14), and carefully separate and remove them.

13. Upper bearing shell;
14. Loose oil ring;
15. Oil inlet;
16. Temperature sensor connection;
17. Oil level sight glass or lubricating oil outlet;
18. Tube plug;
19. External protection screws;
20. Taconite seal lodging;
21. Lower half of the taconite seal lodging;
22. Breather tube.

- Remove garter springs from the taconite seals and remove the top part of each ring. Rotate the bottom parts of the rings out of their casing and remove them.
- Unplug and remove the temperature sensor in the bottom part of the bearing shell.
- Using a hoist or jack, lift the shaft up a few millimeters in order to unscrew the bottom half of the bearing shell out of its seat. In order to do that, loosen screws 4 and 6 of the other half of the bearing.
- Carefully unscrew the bottom half of the bearing shell and remove it.
- Unscrew bolts (19) and remove the bottom half of the external protection (11).
- Unscrew screws (10) and remove the lower half of the taconite seal frame (21);
- Remove screws (4) and remove the bottom half of the frame (2).
- Unscrew screws (8) and remove the machine seal (7). Clean and inspect all parts removed and the interior of the frame.
- To assemble the bearing, follow the instructions above in reverse order.

**NOTE**
Motor bearing fixating screw tightening torque = 10 Kgfm.
Non-Drive End:

- Thoroughly clean the external surfaces of the frame. Unscrew and remove the oil drain plug (1) in the bottom part of the frame, allowing the lubricant to drain thoroughly.
- Unscrew the bolts (19) and remove the bearing cover (11).
- Unscrew screws (4) securing the top half of the frame (5) to the motor (3). Remove the screws (6) attaching the split sides of the bearing frame (2 and 5).
- Use the eyebolt screws (9) to lift the top half of the frame (5), completely detaching it from the bottom halves of the frame (2), the sealing taconite and the bearing shell (12).
- Detach and remove the top half of the bearing shell (13).
- Remove the screws joining both halves of the loose oil ring (14), and carefully separate and remove them.
- Remove the garter spring from the taconite seal and remove the top of the ring. Rotate the bottom half of the taconite seal out of its casing and remove it.
- Unplug and remove the temperature sensor in the bottom half of the bearing shell.
- Using a hoist or a jack to lift the shaft up a few millimeters in order to unscrew the bottom half of the bearing shell out of its seat.
- Carefully rotate the bottom half of the bearing shell (12) and remove it.
- Remove the screws (4) and remove the bottom half of the frame (2).
- Unscrew the screws (8) and remove the machine seal (7).
- Thoroughly clean and inspect all parts removed and the interior of the frame.
- To assemble the bearing, follow the instructions above in reverse order.

**NOTE**

Motor bearing fixating screw tightening torque = 10 Kgf.m.

Assembly

- Inspect the flange socketing surfaces, ensuring that they are clean, flat and smooth.
- Check if the shaft measurements are in compliance with the manufacturer’s specifications and if rugosity is compliant with the requirements (< 0.4μm).
- Remove the top half of the frame (2) and bearing shells (12 and 13), ensure that there were no damages during transportation, and thoroughly clean the contact surfaces.
- Lift the shaft a few millimeters and attach the flange of the bottom half of the bearing to the machined recess on the device cover, and screw it in this position.
- Apply oil to the round seat of the frame and onto the shaft. Place the lower bearing shell (12) onto the shaft and rotate it into position, carefully avoiding damages to the shaft positioning surfaces. After carefully aligning the surfaces of the bottom half of the bearing shell and frame, slowly lower the shaft to its operating position. With a hammer, gently tap the frame so that the bearing shell is correctly positioned in relation to its seat and to the shaft. This procedure produces high frequency vibrations, which reduces friction between the bearing shell and the frame, and facilitates their correct alignment.
- The bearing self-aligning capacity is meant only to compensate normal shaft deflection during assembly. Next, the loose oil ring must be carefully installed, since the flawless functioning of the bearing depends on the lubrication provided by the ring. The screws must be slightly tightened and burrs must be carefully removed to enable the ring to function smoothly and gently. During maintenance, care must be employed to ensure that the geometry of the ring is unaltered.
- Bottom and top halves of the bearing shell display identification numbers or markings to guide their placement. Place the top half of the bearing shell, aligning its markings to their corresponding markings on the bottom half. Incorrect assembly may lead to serious damage to the bearing shell.
- Ensure that the loose oil ring rotates freely on the shaft. Once the bottom half of the bearing shell is positioned, install the seal on the flanged side of the bearing. (see item Sealing);
- After coating the frame split surfaces with a non-hardening sealant, assemble the top part of the frame (5), ensuring that the gasket seals are perfectly fitted to their sockets. Also ensure that the anti-rotation pin is attached and is not in contact with the corresponding bearing shell hole.
7.8.4 Bearing protection

7.8.4.1 Protection settings

ATTENTION
The following temperatures must be set in the bearing protection system:
Alarm 110ºC – Shutdown 120ºC
The alarm temperature must be set to 10ºC above the working temperature, and must never be higher than 110ºC.

7.8.4.2 Bearing temperature sensor disassembly/assembly

Figure 7.9: PT100 on the bearings

Disassembly instructions:
If the Pt100 must be removed for bearing maintenance, follow the procedures below:
 Carefully remove the Pt100, locking the locknut (3) and unscrewing only the bulb fitting (4);
 Parts (2) and (3) must not be disassembled.

Assembly instructions:
Before assembling the Pt100 in the bearing, check if it is free of impact marks or any other damages which may compromise a smooth operation.
 Insert the Pt100 in the bearing;
 Lock the locknut (3) with a key;
 Screw the bulb (4), adjusting it so that the end of the Pt100 touches the bearing outer surface.

NOTES
 The Pt100 must be directly assembled onto non-insulated bearings, not requiring insulating adaptors (4).
 The tightening torque for the Pt100 and adaptor assembly must not exceed 10Nm.
8 MOTOR ASSEMBLY AND DISASSEMBLY

All repair, disassembly, and assembly services must only be performed by duly qualified and trained personnel. The disassembly and assembly sequence depends on the motor type.

8.1 DISASSEMBLY

A list of precautions to be taken when disassembling cage electric motors is provided below:

1. Always use proper tools and devices for motor disassembly;
2. Before disassembling the motor, disconnect the water cooling and lubrication pipes (if any);
3. Disconnect electric and accessory connections;
4. Remove the heat exchanger and noise suppressor (if any);
5. Remove the temperature sensors from the bearings and grounding brush;
6. In order to prevent damage to the rotor, set up a bracket to support the shaft on both front and rear sides;
7. For bearing disassembly, follow the procedures described in this manual;
8. Rotor removal must be performed by using an appropriate device and as carefully as possible in order not to draw the rotor over the stator plate pack or over the coil heads, in order to avoid damage.

8.2 ASSEMBLY

A list of procedures to be followed during the assembly of an electric motor is provided below:

1. Use proper tools and devices for motor assembly;
2. Follow the disassembly procedures in the opposite order for motor assembly;
Any damaged part (cracks, dents in machined parts, defective threads), must be preferentially replaced, always avoiding repairing.

Table 8.1 displays the recommended bolt-tightening torques for the assembly of the motor or its parts:

<table>
<thead>
<tr>
<th>Resistance class</th>
<th>4.6</th>
<th>5.8</th>
<th>8.8</th>
<th>12.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter</td>
<td>Nm</td>
<td>Nm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M6</td>
<td>1.9</td>
<td>3.2</td>
<td>5.1</td>
<td>8.7</td>
</tr>
<tr>
<td>M8</td>
<td>4.6</td>
<td>7.7</td>
<td>12.5</td>
<td>20</td>
</tr>
<tr>
<td>M10</td>
<td>9.1</td>
<td>15</td>
<td>25</td>
<td>41</td>
</tr>
<tr>
<td>M12</td>
<td>16</td>
<td>27</td>
<td>42</td>
<td>70</td>
</tr>
<tr>
<td>M16</td>
<td>40</td>
<td>65</td>
<td>100</td>
<td>175</td>
</tr>
<tr>
<td>M20</td>
<td>75</td>
<td>125</td>
<td>200</td>
<td>340</td>
</tr>
<tr>
<td>M24</td>
<td>130</td>
<td>220</td>
<td>350</td>
<td>590</td>
</tr>
</tbody>
</table>

NOTE
• The resistance class is usually indicated on the head of the hex screws.
• When the class is not indicated on the screw head, the bolt resistance class is 4.6.
• Inner “Allen”-type hex screws have a resistance class of 12.9.

8.3 AIR-GAP MEASUREMENT

After motor assembly and disassembly, it is necessary to measure the air-gap in order to check the motor concentricity.
The difference between air-gap measurements in two diametrically opposed points must be less than 10% of the average air-gap.

8.4 GENERAL RECOMMENDATIONS

ATTENTION
All services described herein must be performed by qualified and experienced personnel, in order to avoid damage to the equipment and personnel injuries. In case of doubts, please contact WEG.

8.6 SPARE PARTS

WEG recommends that the following spare parts are kept in stock:
• Front and rear bearing (motor with rolling bearings);
• Bearing shell for front and rear bearing (motor with sliding bearings);
• Temperature sensors for each bearing;
• Space heater;
• Filter felts (if any);
Spare parts must be stored in clean, dry, and well ventilated locations; and, if possible, at constant temperatures.
9 MAINTENANCE PLAN

The maintenance plan described in Table 9.1 is only referential, considering that the intervals between each maintenance intervention may vary according to the motor location and operation conditions.

Table 9.1: Maintenance plan

<table>
<thead>
<tr>
<th>EQUIPMENT</th>
<th>Weekly</th>
<th>Monthly</th>
<th>Every 3 months</th>
<th>Every 6 months</th>
<th>Yearly</th>
<th>Every 3 years</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>STATOR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stator visual inspection .</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Cleaning control.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Groove wedges inspection.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>x</td>
</tr>
<tr>
<td>Stator terminals control.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Measure the winding insulation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>resistance.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>ROTOR</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Cleaning control.</td>
<td></td>
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<td>x</td>
</tr>
<tr>
<td>Visual inspection.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Shaft (wearing, incrustations)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>inspection.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BEARINGS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise, vibration, oil flow, leaking, and temperature control.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>x</td>
</tr>
<tr>
<td>Lubricant quality control.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Inspection of bearing shells and shaft race. (sliding bearing).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Lubricant change.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>According to the period indicated on bearing nameplate.</td>
</tr>
<tr>
<td>AIR-WATER HEAT EXCHANGER</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radiator inspection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Radiator cleaning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Radiator sacrificial anodes (if any) inspection1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Sacrificial anodes are used in radiators for use with seawater.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Radiator head gasket replacement.</td>
<td></td>
<td></td>
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<td>x</td>
</tr>
<tr>
<td>AIR-AIR HEAT EXCHANGER</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Ventilation pipe cleaning.</td>
<td></td>
<td></td>
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<td></td>
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<td>x</td>
</tr>
<tr>
<td>Ventilation inspection.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>x</td>
</tr>
<tr>
<td>AIR FILTER(S)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Inspection and replacement, if necessary.</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td>x</td>
</tr>
<tr>
<td>PROTECTION AND CONTROL EQUIPMENT</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Operation test.</td>
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<td></td>
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</tr>
<tr>
<td>Value recording.</td>
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<td>x</td>
</tr>
<tr>
<td>Disassembly and operation test.</td>
<td></td>
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<td>x</td>
</tr>
<tr>
<td>COUPLING</td>
<td></td>
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</tr>
<tr>
<td>Alignment inspection.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Check it after the first week of operation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixation inspection.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Check it after the first week of operation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENTIRE MOTOR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cleaning and vibration inspection.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Condensed water draining.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Screw tightening.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>terminal box cleaning.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Electrical and grounding connection tightening.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>

1) In the event excessive oxidation of the sacrificial anode is ascertained, its inspection frequency must be increased in order to determine the time of oxidation and to create a plan for a replacement schedule.
### 10 ABNORMALITIES, CAUSES AND SOLUTIONS

#### 10.1 MOTORS

**NOTE**

The instructions in Table 10.1 merely present a basic list of abnormalities, causes and corrective measures. In case of doubts, please contact WEG.

<table>
<thead>
<tr>
<th>ABNORMALITY</th>
<th>POSSIBLE CAUSES</th>
<th>CORRECTIVE MEASURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor does not start, coupled or uncoupled.</td>
<td>At least two power cables are interrupted, with no voltage.</td>
<td>Check the control panel, power supply cables, terminals and brush seating.</td>
</tr>
<tr>
<td></td>
<td>Locked rotor.</td>
<td>Unlock the rotor;</td>
</tr>
<tr>
<td></td>
<td>Damaged bearing.</td>
<td>Replace the bearing.</td>
</tr>
<tr>
<td>The motor starts at no-load, but fails when load is applied. It starts very slowly and does not reach the rated rotation.</td>
<td>Load torque is too high during start-up.</td>
<td>Do not apply load to the driven machine during start-up.</td>
</tr>
<tr>
<td></td>
<td>Power supply voltage is too low.</td>
<td>Measure the power supply voltage and adjust the value correctly.</td>
</tr>
<tr>
<td></td>
<td>Large voltage drop in the power cables.</td>
<td>Check the installation dimensioning (transformer, cable section, check relays, circuit breakers, etc.).</td>
</tr>
<tr>
<td></td>
<td>Rotor with defective or interrupted bars.</td>
<td>Check and fix the rotor winding.</td>
</tr>
<tr>
<td></td>
<td>One power cable was interrupted after the start-up.</td>
<td>Check the power cables.</td>
</tr>
<tr>
<td>After applying a load, the stator current varies with twice as much as the build-up frequency. The motor hums during start-up.</td>
<td>The rotor winding is interrupted.</td>
<td>Check and fix the rotor winding.</td>
</tr>
<tr>
<td>The motor starts at no-load, but fails when load is applied. It starts very slowly and does not reach the rated rotation.</td>
<td>Load torque is too high during start-up.</td>
<td>Do not apply load to the driven machine during start-up.</td>
</tr>
<tr>
<td>Very high no-load current.</td>
<td>Power supply voltage is too high.</td>
<td>Measure the power supply and adjust the value correctly.</td>
</tr>
<tr>
<td>Localized hot spots on the stator winding.</td>
<td>Short circuit between turns.</td>
<td>Rewind.</td>
</tr>
<tr>
<td></td>
<td>Interruption of stator winding phases or parallel wires.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Poor connection.</td>
<td>Remake the connection.</td>
</tr>
<tr>
<td>Localized hot spots on the rotor.</td>
<td>Rotor winding interruptions.</td>
<td>Fix or replace the rotor windings.</td>
</tr>
<tr>
<td>Unusual noise during operation with load.</td>
<td>Mechanical causes.</td>
<td>The noise normally reduces when the motor speed decreases; see also: &quot;noisy operation when uncoupled&quot;.</td>
</tr>
<tr>
<td></td>
<td>Electrical causes.</td>
<td>The noise disappears when the motor is shutdown. Contact WEG.</td>
</tr>
<tr>
<td>When coupled, the noise appears. When uncoupled, the noise disappears.</td>
<td>Defective transmission or driven machine components.</td>
<td>Check the power transmission, coupling and alignment.</td>
</tr>
<tr>
<td></td>
<td>Gear transmission defect.</td>
<td>Align the drive.</td>
</tr>
<tr>
<td></td>
<td>Unaligned/unlevelled base.</td>
<td>Realign/level the motor and the driven machine.</td>
</tr>
<tr>
<td></td>
<td>Incorrect balancing of the driven machine components.</td>
<td>Perform a new balancing process.</td>
</tr>
<tr>
<td></td>
<td>Defective coupling.</td>
<td>Repair the coupling.</td>
</tr>
<tr>
<td></td>
<td>Wrong motor rotation direction.</td>
<td>Invert the 2-phase connection.</td>
</tr>
<tr>
<td>ABNORMALITY</td>
<td>POSSIBLE CAUSES</td>
<td>CORRECTIVE MEASURE</td>
</tr>
<tr>
<td>-------------</td>
<td>-----------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>The stator winding heats up when operating under load.</td>
<td>Insufficient cooling due to obstructed air pipes.</td>
<td>Open and clean the air pipes.</td>
</tr>
<tr>
<td></td>
<td>Overloading</td>
<td>Measure the stator current and reduce the load. Analyze the motor application.</td>
</tr>
<tr>
<td></td>
<td>High number of start-ups or very high moment of inertia.</td>
<td>Reduce the number of start-ups.</td>
</tr>
<tr>
<td></td>
<td>Very high voltage with a subsequent increase in iron losses.</td>
<td>Do not exceed the rated voltage by 110%, unless specifically stated on the nameplate.</td>
</tr>
<tr>
<td></td>
<td>Very low voltage and very high current</td>
<td>Check the power supply voltage and the motor voltage drop.</td>
</tr>
<tr>
<td></td>
<td>Interruption on a power cable or winding phase.</td>
<td>Measure the current in all phases and correct it, if necessary.</td>
</tr>
<tr>
<td></td>
<td>Rotor drags against the stator.</td>
<td>Check the air gap, operating conditions (vibrations, etc.) and bearing conditions.</td>
</tr>
<tr>
<td></td>
<td>Operating conditions are not in compliance with the data provided in the nameplate.</td>
<td>Maintain the operating conditions according to the nameplate or reduce the load.</td>
</tr>
<tr>
<td></td>
<td>Unbalance in the power supply voltage (burnt fuse, incorrect command).</td>
<td>Check for voltage unbalancing or operate with only two phases and correct the issue.</td>
</tr>
<tr>
<td></td>
<td>Dirty windings.</td>
<td>Clean.</td>
</tr>
<tr>
<td></td>
<td>Obstructed air ducts.</td>
<td>Clean the filtering device.</td>
</tr>
<tr>
<td></td>
<td>Dirty air filters.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Direction of rotation not compatible with the fan being used.</td>
<td>Analyze the fan regarding the motor direction of rotation.</td>
</tr>
<tr>
<td>Noisy operation when uncoupled.</td>
<td>Unbalance.</td>
<td>The noise continues during deceleration after voltage is turned off; Execute a new balancing process.</td>
</tr>
<tr>
<td></td>
<td>Interruption in one phase of the stator winding.</td>
<td>Measure all connection cables’ currents.</td>
</tr>
<tr>
<td></td>
<td>Loose fixation screws.</td>
<td>Tighten and lock the screws.</td>
</tr>
<tr>
<td></td>
<td>The balancing conditions of the rotor get worse after the coupling is mounted.</td>
<td>Balance the coupling.</td>
</tr>
<tr>
<td></td>
<td>Foundation resonance.</td>
<td>Adjust the foundation.</td>
</tr>
<tr>
<td></td>
<td>Deformed motor frame</td>
<td>Check the base flatness.</td>
</tr>
<tr>
<td></td>
<td>Bent shaft.</td>
<td>The shaft may have been bent; Check rotor balancing and run-out.</td>
</tr>
<tr>
<td></td>
<td>Non-uniform air gap.</td>
<td>Check for shaft bending or bearing wearing.</td>
</tr>
</tbody>
</table>
10.2 BEARINGS

NOTE
The instructions in Table 10.2 merely present a basic list of issues related to bearings. In certain cases, a bearing analysis from the manufacturer is required in order to ascertain the cause of the defect.

Table 10.2: Basic list of issues related to bearings

<table>
<thead>
<tr>
<th>DEFECT</th>
<th>POSSIBLE CAUSES</th>
<th>DETERMINATION AND ELIMINATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate noises in the bearings, dull points, formation of grooves on the races.</td>
<td>* Bearing mounted in a diagonal position.</td>
<td>* Recover the shaft seating and replace the bearing.</td>
</tr>
<tr>
<td>Bearing presents loud noises and increased heating.</td>
<td>* Cage corrosion, small chips in the grease, formation of cracks in the races due to the lack of grease, or any inadequate clearance in the bearing.</td>
<td>* Clean and re-apply grease according to the requirements.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>* Replace the bearings.</td>
</tr>
<tr>
<td>Bearings heating up.</td>
<td>* Excessive grease.</td>
<td>* Remove the grease drainage plug and run the motor until the excess grease has been removed.</td>
</tr>
<tr>
<td></td>
<td>* Excessive axial or radial belt strain.</td>
<td>* Reduce the belt strain.</td>
</tr>
<tr>
<td></td>
<td>* Sagged shaft/excessive vibration.</td>
<td>* Correct the shaft and check the rotor balancing. Check the cause of the vibration and correct it.</td>
</tr>
<tr>
<td></td>
<td>* Lack of grease.</td>
<td>* Add grease to the bearings.</td>
</tr>
<tr>
<td></td>
<td>* Hardened grease causing the ball bearings to lock up.</td>
<td>* Replace the bearings.</td>
</tr>
<tr>
<td></td>
<td>* Foreign bodies in the grease.</td>
<td>* Wash and lubricate the bearings.</td>
</tr>
<tr>
<td>Dark stains on one side of the ball race.</td>
<td>* Excessive axial strain.</td>
<td>* Examine driving and coupling connections.</td>
</tr>
<tr>
<td>Dark lines close together or transversal grooves in the races; Punctiform markings in the case of ball bearings.</td>
<td>* Current flow through bearings.</td>
<td>* Clean and replace the bearing insulation. Apply insulation, if applicable.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>* Redirect the current to prevent it from passing through the bearing.</td>
</tr>
<tr>
<td>Grooves in the races. Dent in the division of cylindrical elements.</td>
<td>* External vibrations, especially when the motor has not been decommissioned for long periods of time.</td>
<td>* Occasionally rotate the rotor to another position, especially on spare motors.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>* Lack of maintenance during storage.</td>
</tr>
</tbody>
</table>

ATTENTION
The motors described in this manual are constantly being improved; therefore, the information provided herein is subject to modification without prior notice.
11 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.