Driving efficiency and sustainability

Three Phase Induction Motors

T Line - Squirrel Cage Rotor

Installation, Operation and Maintenance Manual

Installation, Operation, and Maintenance Manual

Types: TGA, TGV

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Dear Customer,

Thank you for purchasing a WEG motor. Our products are developed with the highest standards of quality and efficiency which ensures outstanding performance.
Since electric motors play a major role in the comfort and well-being of mankind, it must be identified and treated as a driving machine with characteristics that involve specific care, such as proper storage, installation and maintenance
All efforts have been made to ensure that the information contained in this manual is faithful to the configurations and applications of the motor.
Therefore, we recommend that you read this manual carefully before proceeding with the installation, operation or maintenance of the motor in order to ensure safe and reliable operation of your equipment and facility. If you need any further information, please contact WEG.
Always keep this manual close to the motor, so that it can be consulted whenever necessary.

ATTENTION

1. It is imperative to follow the procedures contained in this manual for the warranty to be valid;
2. The motor installation, operation and maintenance procedures must be performed only by qualified personnel.

NOTES

1. The total or partial reproduction of information supplied in this manual is authorized, provided that reference is made to its source.
2. If this manual is lost, an electronic PDF file is available at www.weg.net or another printed copy may be requested.
3. All machines are equipped with a unique QR code located next to the machine's nameplate. This QR code provides quick and easy access to various services, including:
   - Technical support
   - Spare parts
   - Commissioning
   - General and maintenance services in the field and at the factory

   To use this feature, simply scan the QR code with your mobile device. Be sure to keep this manual on hand for future reference and to ensure the correct and safe use of the electric motor.

WEG EQUIPAMENTOS ELÉTRICOS S.A.

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1 INTRODUCTION

This manual provides basic instructions for installation, operation and maintenance for three phase induction motors – T line
Motors are provided with specific documents (dimensional, connection diagram, data sheet, 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 order to use a frequency inverter, it is mandatory to follow the instructions contained in the specific technical documentation of the motor and in the manual of the frequency inverter.
If any additional explanation about motors with major special features is necessary, consult WEG. All procedures and standards contained in this manual must be observed in order to ensure proper operation of the motor and the safety of the personnel involved in its operation. Following these procedures is also important to ensure the validity of the motor warranty. Thus, we recommend the careful reading of this manual before the installation and operation of the motor. If any further information is still necessary, consult WEG.

1.1 FUNCTIONAL DESCRIPTION

1.1.1 TGV model

The model **TGV model** is a three–phase alternating–current induction motor.
The direction of rotation of the motor rotor is changed by reversing the phase rotation in the motor stator.
The motor is force-ventilated by a blower assembly that meets IP44 in the rig installation.

1.1.2 TGA model

The WEG **TGA model** is a form-wound squirrel-cage inverter-rated AC induction motor designed and manufactured for use in oil and gas industry services and other application.
TGA motors are built to endure the severe conditions. It´s vertical mounted
The direction of rotation of the motor rotor is changed by reversing the phase rotation in the motor stator.

1.2 SAFETY WARNINGS

The following safety warnings are used in this manual:

DANGER

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

ATTENTION

Non compliance 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 be 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 normal operation of this equipment, a hazard associated with energized or rotating components with high voltage or elevated temperatures exists.
Thus, the operation with open terminal boxes, unprotected couplings, improper handling, or failure to comply with the operating standards, may cause severe personal injuries and material damages.

ATTENTION

When devices and equipment are used outside the industrial environment, the user must ensure the safety of the equipment by adopting proper protection and safety measures during installation (for example, keep people away, avoid contact of children, etc.).

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

Only qualified personnel install and operate the equipment;
They have this manual and all other documents supplied with the motor at hand, as well as that they perform the tasks in strict compliance with the service instructions, relevant standards and specific product documentation;

ATTENTION

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 at the work site.

Qualified personnel must also observe:
All the technical data regarding the allowed applications (operating conditions, connections and installation environment), included in the catalog, in the purchase order documents, in the operating instructions, in manuals and all other documentation;
The specific regulations and conditions for the local installation;
The use of suitable tools and equipment for handling and transportation;
That the protective devices of the individual components are removed shortly before installation.
Individual parts must be stored in vibration-free environments, avoiding falls and ensuring their protection against aggressive agents and/or that they do not jeopardize people.

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:

- **EN/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;
- **EN/IEC 60034-1** - Rotating Electrical Machines - Part 1: Rating and Performance;
- **EN/IEC 60079- 2** - Electrical Apparatus for Explosive Gas Atmospheres. Part 2: Pressurized Enclosures 'p';
- **ABNT NBR IEC 60079-2** - Atmosferas Explosivas - Parte 2: Proteção de Equipamento por Invólucro Pressurizado ‘p’;
- **EN/IEC 60079- 7** - Electrical Apparatus for Explosive Gas Atmospheres - Part 7: Increased Safety 'e';
- **ABNT NBR IEC 60079-7** - Atmosferas Explosivas - Parte 7: Proteção de Equipamentos por segurança Aumentada "e";
- **ABNT NBR IEC 60079-11** – Atmosferas Explosivas – Parte 11 - Proteção de equipamento por segurança intrínseca "i";
- **EN/IEC 60079-11** - Explosive atmospheres - Part 11: Equipment protection by intrinsic safety “I”;
- **ABNT NBR IEC 60079-14** – Atmosferas Explosivas – Parte 14 - Seleção e montagem de instalações elétricas;
- **EN/IEC 60079-14** – Electrical apparatus for gas explosive atmospheres – Part 14 – Electrical installation in hazardous areas (others than mines);
- **ABNT NBR IEC 60079-14** – Equipamentos elétricos para atmosferas explosivas – Parte 14 – Instalação elétrica em áreas classificadas (exceto minas);
- **EN/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’;
- **EN/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;
- **EN/IEC 60079-19** - Explosive atmospheres - Part 19: Equipment repair, overhaul and reclamation.
- **ABNT NBR IEC 60079-19** – Atmosferas Explosivas – Parte 19 - Revisão e recuperação de equipamentos.

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

- Shut down the motor and wait until it comes to a complete stop before performing any maintenance, inspection or repair.
- All the existing protections must be installed and properly adjusted before starting the motor.
- Make sure the motor is properly grounded;
- The terminals must be properly connected in order to prevent any kind of poor contact that may cause heating or sparking.

NOTE

Observe all other instructions regarding storage, handling, installation and maintenance contained in this manual and applicable to the relevant motor type.

2.4 STANDARDS

The motors are specified, designed, manufactured and tested according to the standards described in Table 2.1. The applicable standards are specified in the commercial contract, which may indicate other national or international standards, depending on the application or installation location:

Table 2.1: Standards applicable to three-phase induction motors

	IEC / NBR	NEMA
Specification	IEC60034-1 / NBR 17094	MG1-1,10,20
Dimensions	IEC60072 / NBR 15623	MG1-4,11
Tests	IEC60034-2 / NBR 5383	MG1-12
Levels of protection	IEC60034-5 / NBR IEC 60034-5	MG1-5
Cooling	IEC60034-6 / NBR IEC 60034-6	MG1-6
Mounting	IEC60034-7 / NBR IEC 60034-7	MG1-4
Noise	IEC60034-9 / NBR IEC 60034-9	MG1-9
Mechanical Vibration	IEC60034-14 / NBR IEC 60034-14	MG1-7
Terminal marking	IEC60034-8 / NBR 15367	MG1-2
Mechanical Tolerances	ISO286 / NBR6158	MG1-4
Balancing	ISO1940	MG1-7

2.5 ENVIRONMENT CHARACTERISTICS

The motor was designed according to the specific environmental conditions (temperature and altitude) of your application, and are described on the nameplate and in the motor datasheet.
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 OPERATING CONDITIONS

In order for the product warranty to be valid, the motor must be operated according to nominal data indicated on its nameplate, observing all applicable standards and information contained in this manual.

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.

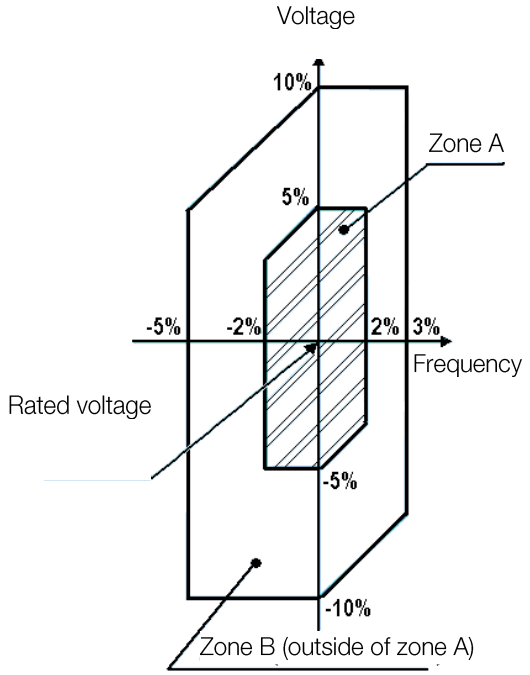


Figure 2.1: **Voltage and frequency variation limits**

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 RECEIVING, HANDLING AND STORAGE

3.1 RECEIVING

All motors were tested and are in perfect operating conditions. The machined surfaces are protected against corrosion. The package must be inspected upon receipt for occasional damages during transportation.

ATTENTION

Any damage must be photographed, documented and reported immediately to the carrier, the insurer and WEG. The non-communication of this damage will void the warranty.

ATTENTION

Parts supplied in additional packages must be checked upon receipt.

- When lifting the package (or container), the proper hoisting points, the weight indicated on the package or on the nameplate and the operating capacity and conditions of the hoisting equipment must be observed;
- Motors packed in wooden crates must always be lifted by their own lifting lugs or by a proper forklift; they must never be lifted by the package;
- The package can never be overturned. Place it on the floor carefully (without impact) in order to avoid damage to the bearing;
- Do not remove the grease for protection against corrosion from the shaft end, or the closing plugs present in the terminal box holes. These protections must remain in place until the moment of the final assembly.
- A complete visual inspection of the motor must be carried out after removing the package;
- The shaft locking system must be removed just before the installation and stored to be used in future transportation of the motor.

3.2 HANDLING

1. In order to move the motor, the shaft must be locked with the locking device supplied with the motor;
2. Use only the specific lifting lugs. provided for this purpose. If necessary, use a crossbeam to protect motor parts;
3. Never use the blower lifting lugs to lift the motor (if applicable);
4. Rated motor weight must be observed.
5. Do not jolt the motor when lifting it or drop it abruptly as that may cause damage to the bearings;
6. The eyebolts in the blowers, covers, terminal boxes, etc., are specifically designed for their respective component only;
7. Never lift the motor by the shaft;

ATTENTION

In order to move or transport the motor, the shaft must be locked with the locking device supplied with the motor.

Lifting equipment and devices must be able to withstand the motor weight.

3.3 STORAGE

If the Motor is not installed immediately after reception, it must remain inside the package and stored in a location protected against moisture, vapors, sudden changes in temperature, rodents and insects.
The motor must be stored in vibration-free locations in order to avoid bearing damage.

ATTENTION

Space heaters (if any) must remain powered during storage in order to avoid moisture condensation inside the motor.

Any damage to the paint or corrosion protection of the machined parts must be repaired.

3.3.1 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.

3.3.2 Extended storage

When the motor is stored for a long period of time (two months or more) before start-up, it is exposed to external agents, such as temperature variations, moisture, aggressive agents, etc.
The empty spaces inside the motor – such as rolling 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 periods of storage, the winding insulation resistance may drop below the acceptable values, internal components, such as rolling bearings, may oxidize, and the lubricant power of the lubricant agent in the bearings may be adversely affected.
All of these influences increase the risk of damages before starting the motor.

ATTENTION

To assure that the motor warranty be valid, it is necessary to make sure that all preventive measures described in this manual, such as constructive aspects, maintenance, packaging, storage, and periodical inspections, are followed and recorded.

The extended storage instructions are valid for motors that remain stored for long periods (two months or more) before start-up or motors already installed that are in a prolonged stoppage, considering the same period.

3.3.2.1 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.

3.3.2.1.1 Indoor storage

In order to ensure better storage conditions for the motor, the storage site must comply strictly with the criteria described below:

- The storage site must be closed, covered, dry, free of air contaminants (moisture, vapor, dust, particles and aggressive fumes) and free of flooding;
- The site should be protected against sudden temperature variations, humidity, rodents and insects;
- Vibration-free location, to avoid damaging to the motor bearings;
- The floor must be of leveled concrete with resistant structure to support the motor weight;
- Must have system to fire detection and extinguishing;
- Be provided with electricity for supplying the space heaters with power failure detection system;
- Exclusive site to store electrical machines (do not mix with other equipment and/or products that could prejudice the correct motor storage);
- Site with facilities of cargo handling services, suitable to allow the motor handling and removal;
- There must be no gas present, such as chlorine, sulfur dioxide or acids;
- The site must have ventilation system with air filter;
- Ambient temperature between 5°C and 50°C, and should not present sudden temperature variation;
- Relative air humidity <50%;
- Must have prevention against dirt and dust deposition;
- The motor should be stored on a suitable metal base that prevents the absorption of moisture from the floor.

If any of these requirements is not met in the storage site, WEG suggests that additional protections be added to the motor package during the storage period, as follows:

- A closed wooden crate or the like with an electrical installation that allows the energization of the space heaters;
- If there is a risk of infestation and fungus formation, the package must be protected in the storage place by spraying it or painting it with appropriate chemicals;
- The package preparation must be prepared carefully by an experienced person.

3.3.2.1.2 Outdoor storage

ATTENTION

Outdoor storage of the motor is not recommended.

In case outdoor storage is unavoidable, the motor must be packed in specific packaging for such conditions, as follows:

- For outdoor storage (exposed to the weather), besides the packaging recommended for indoor storage, the package must be covered with protection against dust, moisture and other odd materials, using resistant canvas or plastic.
- The package must be placed on platforms or foundations that ensure protection against dirt and moisture and prevent it from sinking into the soil;
- After the package is covered, a shelter must be erected to protect it against direct rain, snow and excessive sun heat.

ATTENTION

In case the motor remains stored for long periods (two months or more), it is recommended to inspect it regularly as specified in the section Maintenance plan during storage of this manual.

3.3.2.2 Separate parts

- If parts are supplied separately (terminal boxes, heat exchanger, end shields, etc.), these parts must be mounted on motor to store it;
- Spare parts must be stored in an adequate place, as specified in sections 3.3.2.1.1 and 3.3.2.1.2 of this manual.
- The relative humidity inside the package must not exceed 50%.
- Rolling bearings must not be subject to shocks, falls or storage with vibration or humidity, which can cause marks on the internal tracks or on the balls, reducing their useful life.

3.3.2.3 Space heaters

Space heaters (if any) must remain powered during storage to avoid moisture condensation inside the motor and ensure that the winding insulation resistance remains within acceptable levels.
The space heaters drive circuit must be unique and the voltage and current of this circuit must be measured and recorded monthly.
It is recommended that a signal be installed near the motor to indicate that the space heaters are energized.

3.3.2.4 Insulation resistance

During the storage period, the insulation resistance of the motor windings must be measured and recorded every two months, and before the motor installation or eventually if there is any change in the preservation process (E.g. prolonged lack of electricity).
The measurement procedures and the criteria for acceptance of the results shall be according to IEEE-43 Standard.
Any insulation resistance reduction must be investigated.

3.3.2.5 Exposed machined surfaces

All exposed machined surfaces (e.g., shaft end and flanges) are protected at the factory with a temporary protective agent (rust inhibitor).
This protection coating must be reapplied at least every six months or when removed and/or damaged.
Recommended Product: Protective agent Anticorit BW
Supplier: Fuchs

3.3.2.6 Bearings

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

ATTENTION

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

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

3.3.2.7 Terminal boxes

When the insulation resistance in the motor windings is measured, the main junction box and the other terminal boxes (if any) 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.

ATTENTION

If any of these items are not in proper condition, proceeds the adequate maintenance and, if necessary, replace damaged parts.

3.3.2.8 Cleanliness and conservation of the motor during storage

The motor should be free of oil, water, dust and dirt.
The motor outside must be cleaned with compressed air under reduced pressure;
Remove the removable rust signs with a clean cloth soaked in petroleum solvent.
Check that the bearings and lubrication hollows are free of dust and dirt and if the bearing plugs are properly tightened.
Risks, marks or rust on the shaft-end should be carefully removed.

3.3.2.9 Inspections and records during storage

The stored motor must be inspected periodically and inspection records must be filed.
The following items must be inspected:
1. Check the motor for physical damages and repair it, if necessary;
2. Inspection of the cleanliness conditions;
3. Check for signs of water condensation inside the motor;
4. Check of the protective coating conditions of the exposed machined parts;
5. Check the paint conditions, and repair if necessary;
6. Check for aggressive agents signs;
7. Check the operation of the space heaters (if any);
8. Measure and record the ambient temperature and relative humidity around the motor;
9. Measure and record the temperature, insulation resistance and polarization index of the stator winding;
10. Make sure that the storage location complies with the criteria described in section 3.3.2.1.

3.3.2.10 Predictive / preventive maintenance

WEG recommends that, every 3 years of storage, the stored motor be sent to a WEG Authorized Repair Shop or to WEG own factory, in order to perform a complete predictive maintenance.
The complete predictive maintenance procedure comprises disassembling the complete motor for inspection and, after assembly, performing a routine test in the laboratory.

3.3.2.11 Maintenance Plan During Storage

During the storage period, motor maintenance must be performed and recorded in accordance with the plan described in Table 3.1.

Table 3.1: **Storage plan**

	Monthly	Every 2 months	Every 6 months	Every 2 years	Before operating	Note
STORAGE LOCATION						
Inspect cleanliness conditions		X			X	
Inspect humidity and temperature conditions		X				
Check for signs of insect infestation		X				
Measure vibration levels	X					
PACKAGING						
Inspect physical damages			X			
Inspect the relative humidity inside the motor		X				
Replace dehumidifier in the package (if any)			X			Whenever necessary
SPACE HEATER (IF ANY)						
Check operation conditions	X					
COMPLETE MOTOR						
Perform external cleaning			X		X	
Check paint conditions			X			
Check oxidation inhibitor on exposed machined parts			X			
Replace the oxidation inhibitor			X			
WINDINGS						
Measure the insulation resistance		X			X	
Measure the polarization index		X			X	
TERMINAL BOX AND GROUNDING TERMINALS						
Clean the terminal boxes' inner parts				X	X	TGV model
Inspect seals and sealing				X	X	
Inspect and retighten the grounding terminals				X	X	
BEARINGS						
Rotate the shaft		X				
Relubricate the bearing					X	
Disassemble, clean an relubricate the bearing						If the storage period exceeds 2 years.

3.3.3 Preparation for commissioning

3.3.3.1 Cleaning

- The internal and external parts of the motor must be free of oil, water, dust and dirt.
- Remove the rust inhibitor from the exposed surfaces with a cloth damped in a petroleum-based solvent;
- Make sure that the bearings and cavities used for lubrication are free of dirt and that the cavity plugs are correctly sealed and tightened. Oxidation and marks on the bearing seats and on the shaft must be carefully removed.

3.3.3.2 Bearing lubrication

Use the specified lubricant to lubricate the bearings. Information on bearings and lubricants are indicated on the bearings' nameplate, and lubrication must be performed as described in item 7.5 of this manual, always considering the proper type of bearing.

3.3.3.3 Insulation resistance verification

Before putting the motor into operation, the insulation resistance must be measured according to section 4.4 of this manual.

3.3.3.4 Others

Follow the remaining procedures described in item 6 of this manual before operating the motor.

4 INSTALLATION

4.1 INSTALLATION SITE

Electric motors must be installed in easily accessible places, allowing periodic inspections, on-site maintenance and, if necessary, removal for external services.
The following environmental conditions must be ensured:

- Clean and well-ventilated location;
- The installation of other equipment or walls must not block or hinder the motor ventilation;
- The area around and above the motor must be sufficient for maintenance or handling;
- The environment must be in accordance with the motor protection degree.

4.2 SHAFT LOCK

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

ATTENTION

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

4.3 ROTATION DIRECTION

The motor rotation direction is indicated by a plate affixed to the frame on the drive end and in the motor specific documentation.

ATTENTION

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

4.4 INSULATION RESISTANCE

4.4.1 Safety instructions

DANGER

In order to measure the insulation resistance, the motor must be turned off and stopped.
The winding being tested must be connected to the frame and grounded until all residual electrostatic charges are removed. Capacitors (if any) must also be grounded before disconnecting and separating the terminals to measure the insulation resistance.
Failure to comply with these procedures may result in personal injury.

4.4.2 General considerations

When the motor is not immediately put into operation, it must be protected against moisture, high temperatures, and dirt, thus avoiding impacts on the insulation resistance.
The winding insulation resistance must be measured before putting the motor into operation.
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 winding insulation resistance, as it varies according to the environmental conditions (temperature, humidity), machine cleanliness conditions (dust, oil, grease, dirt) and quality and condition of the insulating material used. The evaluation of the periodical follow-up records is useful to conclude whether the motor is able to operate.

4.4.3 Measuring stator windings

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

Table 4.1: **Winding insulation resistance test voltage**

Winding rated voltage (V)	Insulation resistance test - continuous voltage (V)
< 1000	500
1000 - 2500	500 - 1000
2501 - 5000	1000 - 2500
5001 - 12000	2500 - 5000
> 12000	5000 - 10000

Before measuring the stator winding insulation resistance:

- Disconnect all connections to the stator terminals;
- Disconnect and insulate all CTs and PTs (if any);
- Ground the motor frame;
- Measure the winding temperature;
- Ground all temperature sensors;
- Check the humidity.

The insulation resistance measurement of the stator windings must be done in the main terminal box.
The megohmmeter must be connected between the motor frame and the winding.
The frame must be grounded and the three phases of the stator winding must remain connected to the neutral point, according to Figure 4.1.

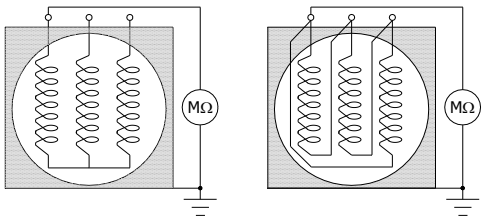


Figure 4.1: Megohmmeter connection

Whenever possible, each phase must be isolated and tested separately. The separate test allows the comparison between the phases. When a phase is tested, the other two phases must be grounded to the same ground of the frame, according to Figure 4.2.

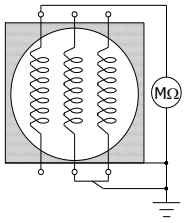


Figure 4.2: Connection of the megohmmeter to separate phases

If the total winding measurement presents a value below the recommended, the neutral connections must be opened and the insulation resistance of each phase must be measured separately.

ATTENTION

Much higher values may be frequently obtained from motors in operation for long periods of time. Comparison with values obtained in previous tests on the same motor - under similar load, temperature and humidity conditions – may be an excellent parameter to evaluate the winding insulation conditions, instead of using the value obtained in a single test as the basis. Significant or sudden reductions are considered suspicious.

4.4.4 Additional Information

ATTENTION

After measuring the insulation resistance, ground the tested winding in order to discharge it.
The testing voltage to measure the insulation resistance of the space heater must be 500 Vdc and for the other accessories, 100 Vdc.
It is not recommended to measure the insulation resistance of thermal protectors.

4.4.5 Conversion of measured values

T The insulation resistance measured on the windings shall be converted to 40 ° C using the correction factor provided in Figure 4.3 (IEEE43 standard) and applying the following formula:

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

Where:
R40 = referred insulation resistance at 40 ° C
Kt = Insulation resistance correction factor as a function of temperature, as shown in Figure 4.3,
Rt = measured insulation resistance.

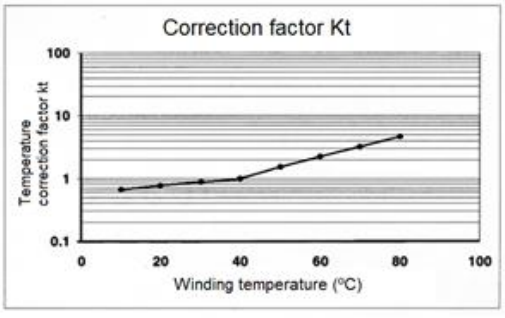


Figure 4.3: Insulation resistance correction factor due to temperature

The values used to generate the curve of Figure 4.3 are shown in Table 4.1.

Table 4.1: Correction factors (Kt) due to temperature

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

4.4.6 Polarization Index (P.I.)

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

DANGER

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

4.4.7 Recommended Minimum Values

According to IEEE-43 Standard, the recommended minimum values for winding insulation resistance (R.I.) and Polarization Index (I.P.) are shown in Table 4.3:

Table 4.2: Minimum R.I. e I.P values

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

4.5 PROTECTIONS

Motors used in continuous duty must be protected against overloads by means of a motor integral device, or an independent protection device, which is generally a thermal relay with rated or adjustable current equal to or below the value obtained by multiplying the full load motor supply current by:
1.25 for motors with service factor equal to or above 1.15;
1.15 for motors with service factor equal to 1.0.
Motors also have protection devices against overheating (in cases of overloads, locked rotor, low voltage, lack of motor ventilation).

4.5.1 Protections – explosive atmospheres

Protection devices for explosive atmosphere motors must always remain switched on and adjusted according to EN 60079-14, DIN VDE0165 and NBR5410 standards. If not indicated otherwise, the motors are designed for S1 duty (continuous).
All protections, including those for overcurrent, must be set based on the motor rated conditions. This protection must also protect the motor in case of short-circuit (i.e., in case of locked rotor).
Windings in delta (Δ) connection must be protected against phase loss. To do so, connect the relay in series with the winding phases and set it for 0.58 times the rated current.
All the winding and bearing protections must always be on and adjusted correctly.
Heavy starts: motors that will be submitted to conditions with acceleration time > 1.7 x t_E time must be protected with an overcurrent protection device as the indications in the certificate of conformity.

EX

For explosive atmosphere motors, the maximum tripping time of the protection device must not, in case of overload or locked rotor, exceed the time indicated in the certificate of conformity and the t_E time indicated on the motor nameplate.

4.5.2 Thermal protections

The over-temperature protections devices are installed on the main stator, bearings and other parts that require temperature monitoring and thermal protection.
These sensors must be connected to an external temperature monitoring and protection system.
The type of temperature sensor, the connection terminals and the setting temperatures for alarm and shutdown are given in the motor CONNECTION DIAGRAM.

4.5.2.1 Temperature sensors for explosive atmospheres

EX

Motors for explosive atmospheres are supplied with Pt100 sensors in order to accurately measure and monitor the temperature of the windings, bearings and other parts of the motor, as needed.
The references from the respective certificates of conformity must be taken into account.
When used in the motor protection circuit, the thermal protections must be connected as simple apparatus in intrinsically safe circuits.

4.5.2.2 Temperature limits for the windings

The temperature of the hottest spot of the winding must be kept below the limit of the insulation thermal class. The total temperature is obtained by the sum of the ambient temperature and the temperature rise (T), plus the difference between the average temperature of the winding and the hottest spot of the winding.
The ambient temperature must not exceed 40 °C, in accordance with NBR IEC60034-1 standard. Above this temperature, the working conditions are considered special and the motor specific documentation must be consulted.

Table 4.3 shows the numerical values and the composition of the acceptable temperature at the hottest spot on the winding.

Table 4.3: Insulation class

Insulation class		B	F	H
Ambient temperature	°C	40	40	40
T = temperature rise (temperature measurement method by resistance variation)	°C	80	105	125
Difference between the hottest spot and the average temperature	°C	10	10	15
Total: temperature of the hottest point	°C	130	155	180

ATTENTION

If the motor operates with winding temperatures above the limits of the insulation thermal class, the lifespan of the insulation, and hence that of the motor, will be significantly reduced, or it may even result in the motor burnout.

4.5.2.3 Alarm and trip temperatures

The motor alarm and trip temperatures must be set at the lowest possible value. These temperatures can be determined based on the factory tests or through the motor operating temperature. The alarm temperature can be set 10 ºC above the machine operating temperature at full load, always considering the highest ambient temperature on site. The adjusted trip temperatures must not exceed the maximum admissible temperatures for the stator winding insulation class and for the bearings (considering the lubrication type and system), according to Table 4.4.

Table 4.4: Maximum temperature settings

	Temperature rise (Δt)	Maximum temperature (ºC)	
		Alarm	Trip
Winding - class F	Class B	120	130
	Class F	130	155
Winding - class H	Class H	155	180
Bearings	-	110	120

ATTENTION

The alarm and trip values may be determined as a result of experience, but they must not exceed the values indicated in Table 4.4.

ATTENTION

The motor protection devices are listed in the WEG drawing – Connection diagram.
Not using these devices is the sole responsibility of the user and, in case of damage to the motor, it will void the warranty.

4.5.2.4 Temperature and ohmic resistance of Pt100 thermoresistors

Table 4.2 shows temperature values in function of the ohmic resistance measured for Pt100 thermoresistors.

Formula: $\frac{\Omega - 100}{0.386} = °C$

Table 4.2: **Temperature X Resistance (Pt100)**

° C	0	1	2	3	4	5	6	7	8	9
0	100.00	100.39	100.78	101.17	101.56	101.95	102.34	102.73	103.12	103.51
10	103.90	104.29	104.68	105.07	105.46	105.95	106.24	106.63	107.02	107.40
20	107.79	108.18	108.57	108.96	109.35	109.73	110.12	110.51	110.90	111.28
30	111.67	112.06	112.45	112.83	113.22	113.61	113.99	114.38	114.77	115.15
40	115.54	115.93	116.31	116.70	117.08	117.47	117.85	118.24	118.62	119.01
50	119.40	119.78	120.16	120.55	120.93	121.32	121.70	122.09	122.47	122.86
60	123.24	123.62	124.01	124.39	124.77	125.16	125.54	125.92	126.31	126.69
70	127.07	127.45	127.84	128.22	128.60	128.98	129.37	129.75	130.13	130.51
80	130.89	131.27	131.66	132.04	132.42	132.80	133.18	133.56	133.94	134.32
90	134.70	135.08	135.46	135.84	136.22	136.60	136.98	137.36	137.74	138.12
100	138.50	138.88	139.26	139.64	140.02	140.39	140.77	141.15	141.53	141.91
110	142.29	142.66	143.04	143.42	143.80	144.17	144.55	144.93	145.31	145.68
120	146.06	146.44	146.81	147.19	147.57	147.94	148.32	148.70	149.07	149.45
130	149.82	150.20	150.57	150.95	151.33	151.70	152.08	152.45	152.83	153.20
140	153.58	153.95	154.32	154.70	155.07	155.45	155.82	156.19	156.57	156.94
150	157.31	157.69	158.06	158.43	158.81	159.18	159.55	159.93	160.30	160.67

4.5.2.5 Space heater

When the motor is equipped with 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 on the specific nameplate fixed to the motor.

4.6 COOLING

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

4.6.1 TGA cooling system

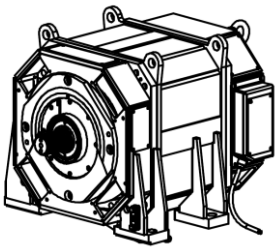


Figure 4.1: **TGA cooling**

The TGA motor is cooled by means of ducts. See the technical documentation to provide the ventilation according to flow and pressure recommended.

4.6.2 TGV cooling system

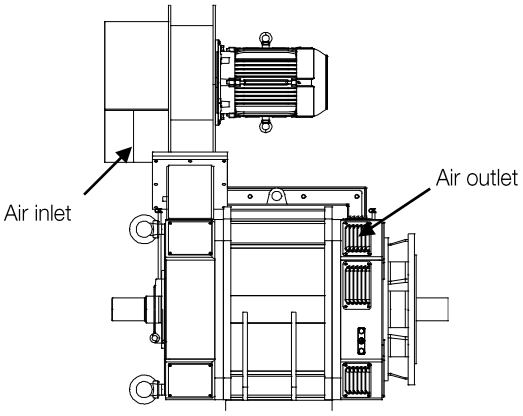


Figure 4.2: **TGV cooling**

The TGV motor cooling system is composed by a blower installed on top of the motor.

NOTE

The air inlets and outlets must never be blocked, since that could cause overheating of the motor or even its burning.

Ensure the correct direction of rotation of the radial fan by observing the indication of the arrow. Operation in the wrong direction of rotation considerably reduces the air flow, resulting in overheating of the motor.
Remove any object that may hinder the free internal or external air circulation through the motor.

4.7 ELECTRICAL CHARACTERISTICS

4.7.1 Electrical connections

4.7.1.1 Main connection

Connections to main terminals must be made according to the connection diagram of the motor. 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 defined by facing the shaft end on motor drive-end side.
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 grid, it is necessary to carefully measure the winding insulation resistance.

4.7.1.2 Grounding

The motor frame and terminal box (if any) 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.

4.7.2 Connection diagram

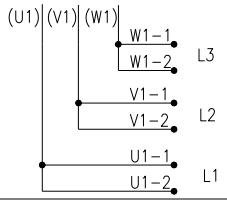
4.7.2.1 IEC60034-8 connection diagram

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.

3 ELECTRICAL TERMINALS	6 ELECTRICAL TERMINALS	6 ELECTRICAL TERMINALS - DAHLANDER				
9100 U V W L1 L2 L3	**9101** Δ: W2 U2 V2 / U1 V1 W1 / L1 L2 L3 Y: W2 U2 V2 / U1 V1 W1 / L1 L2 L3	**9102** **Δ** 1U 1V 1W 2W 2V 2U L1 L2 L3 LOWEST SPEED	**9103** **YY** 1U 1V 1W 2W 2V 2U L1 L2 L3 HIGHEST SPEED	**9104** **Y** 1U 1V 1W 2W 2V 2U L1 L2 L3 LOWEST SPEED	**9105** **YY** 1U 1V 1W 2W 2V 2U L1 L2 L3 LOWEST SPEED	**9106** **Δ** 1U 1V 1W 2W 2V 2U L1 L2 L3 HIGHEST SPEED
3 ELECTRICAL TERMINALS + NEUTRAL						
9121 U V W N L1 L2 L3 N						

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:

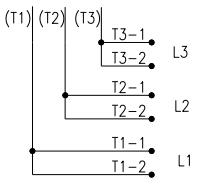


4.7.2.2 NEMA MG1 connection diagram

3 ELECTRICAL TERMINALS	6 ELECTRICAL TERMINALS	6 ELECTRICAL TERMINALS - DAHLANDER				
9200 T1 T2 T3 L1 L2 L3	**9201** Δ: T6 T4 T5 / T1 T2 T3 / L1 L2 L3 Y: T6 T4 T5 / T1 T2 T3 / L1 L2 L3	**9202** **Δ** T1 T2 T3 T6 T5 T4 L1 L2 L3 LOWEST SPEED	**9203** **YY** T1 T2 T3 T6 T5 T4 L1 L2 L3 HIGHEST SPEED	**9204** **Y** T1 T2 T3 T6 T5 T4 L1 L2 L3 LOWEST SPEED	**9205** **YY** T1 T2 T3 T6 T5 T4 L1 L2 L3 LOWEST SPEED	**9206** **Δ** T1 T2 T3 T6 T5 T4 L1 L2 L3 HIGHEST SPEED
3 ELECTRICAL TERMINALS + NEUTRAL						
9221 T1 T2 T3 N L1 L2 L3 N						

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:



4.7.2.2.1 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 4.7.2.1 and 4.7.2.2 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.

4.7.2.3 Accessory connection diagram

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

4.8 MECHANICAL CHARACTERISTICS

4.8.1 Base

- The base or structure where the motor will be installed must be sufficiently rigid, flat, free of external vibration and capable to withstand the mechanical loads to which it will be submitted;
- If the dimensioning of the base is not carefully executed, this may cause vibration in the base, on the motor and the driven machine;
- The base structural design must be done based on the dimensional drawing, on the information about foundation mechanical loads, and on the motor anchoring method.
- The customer is responsible for the design and construction of the foundation according to the requirements described in Natural frequency of the base.

ATTENTION

Place shims of different thicknesses between the motor supporting surfaces and the base in order to allow a precise alignment.

NOTE

The user is responsible for dimensioning and building the foundation where the motor will be installed.

4.8.2 Base loads

Based on Figure 4.3, base loads may be calculated by the following equations:

$$F_1 = +0.5.m.g. + \frac{(4C\max)}{(A)}$$

$$F_2 = +0.5.m.g. - \frac{(4C\max)}{(A)}$$

Where: F1 and F2 - Feet reaction on base (N)
g - gravity acceleration (9.81m/s^2)
m - Motor mass (kg)
Cmax - Maximum torque (Nm)
A - Obtained in the motor dimension drawing (m)

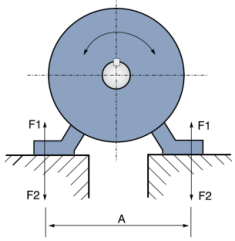


Figure 4.3: **Base loads**

4.8.3 Types of bases

4.8.3.1 Sliding base

In case of belt-driven 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 bolt lies between the motor and the driven machine The other rail must be assembled with the bolt placed in the opposite position, as shown in Figure 4.4.
The motor is bolted 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.

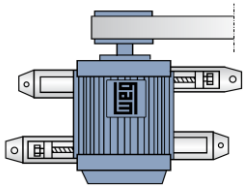


Figure 4.4: Sliding base

4.8.3.2 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.

4.8.3.3 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.

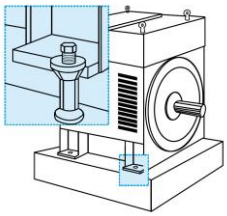


Figure 4.5: **Anchors**

4.8.4 Natural frequency of the base

In order to ensure a safe operation, in addition to a stable base, 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 ≥ +25% or ≤ -20% related to the frequencies provided above.
- The foundation higher order natural frequencies ≥ +10% or ≤ -10% related to the frequencies provided above.

4.8.5 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 4.6 and Figure 4.7.

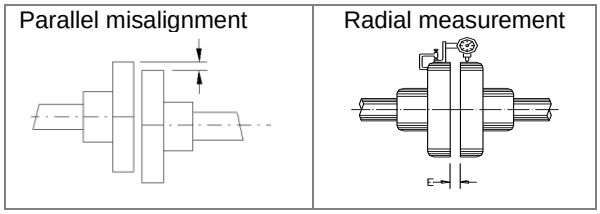


Figure 4.6: **Parallel alignment**

Figure 4.6 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 coaxial failure. In case of deviation, the appropriate correction must be implemented by adding or removing assembly shims . Half of the dial indicator measurement difference in the 90º and 270 º points represents a horizontal coaxial failure.
This measurement indicates when it is necessary to lift or lower the motor, or move it to the right or to the left on the driven side in order to eliminate the coaxial failure.
Half of the dial indicator maximum measurement difference in a complete rotation represents the maximum run out found.
The misalignment in the shaft complete spin 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.

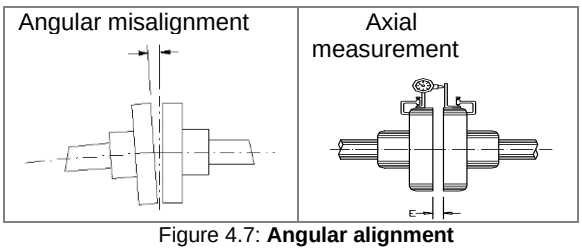


Figure 4.7: **Angular alignment**

Figure 4.7 illustrates the angular misalignment and the practical form to carry out this measurement procedure.
The 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 measurement difference in the 90° and 270° points represents a horizontal misalignment which must be adequately corrected by displacing the motor laterally/angularly.
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.

4.8.6 Doweling

After aligning the set and having assured a perfect alignment (both, hot and cold), the motor must be doweled to the anchor plate or to the base, as shown in Figure 4.4.

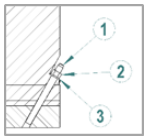


Figure 4.4: Dowel pin set

Figure 4.4 legend:
1. Dowel pin (optional supply)
2. Nut (optional supply)
3. Washer (optional supply)

NOTE

For the doweling, the motor has a pre-hole with Ø9 mm, which must be first expanded to Ø11.5 mm, and then reamed to Ø12 mm with a taper of 1:50.

4.8.7 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.
Follow the manufacture's instructions when mounting or removing couplings or other drive elements and cover them with a touch guard. For trial run in uncoupled state, lock or remove the shaft end key. Avoid excessive radial and axial bearing loads (note manufacture's documentation). The balance of the machine is indicated as H= half and F= full key. In half key cases coupling must be half key balanced without a key. In case of protruding, visible part of the shaft end key, establish mechanical balance.

ATTENTION

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

NOTES

The user is responsible for the motor installation.
WEG is not liable for damages to the motor, associated equipment and installation, occurred due to:

- Excessive vibration transmission;
- Incorrect installations;
- Incorrect alignments;
- Improper storage conditions;
- Noncompliance with instructions before start-up;
- Incorrect electrical connections.

4.8.7.1 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.

ATTENTION

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

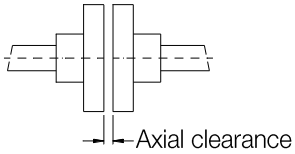


Figure 4.8: Axial clearance

4.8.7.2 Gear coupling

Misaligned gear couplings generate vibrations in the motor transmission itself. Therefore 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.

4.8.7.3 Coupling by pulleys and belts

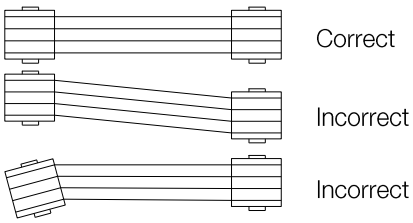


Figure 4.9: Coupling by pulleys and belts

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. Skewed 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. Belt tension must be only enough to avoid sliding during operation.

NOTE

Belts with excessive tension increase the stress applied to the shaft end, causing vibrations and fatigue, which may cause shaft rupture.

Avoid using excessively small pulleys, as they cause bends on the motor shaft due to the belt traction force, which increases as pulley diameter decreases.

ATTENTION

In a specific pulley dimensioning case, WEG must be contacted in order to ensure a correct application.

NOTE

Always use properly balanced pulleys. Avoid key excess, as it represents an increase in the unbalancing mass. Non-compliance with this instruction will cause an increase in vibration levels.

5 STARTING

5.1 DIRECT ON-LINE STARTING

It is the simplest and most economically feasible method; however, it must only be used when the starting current does not affect the power grid.
Bear in mind that the starting current of motors may reach 6 to 7 times the rated current value. Therefore, it must be ensured that this current (Ip) will not affect the supply of other consumers because of the high voltage drop in the power grid.
The machine must be started/can be started when the temperature recorded at PT-100's of the three phases is equal to or greater than -20°C
When turning off the machine the heating resistors of the temperature rise circuit must be turned off.
There is an interlocking system so that the main machine's drive circuit breaker is only activated when the temperature recorded on the winding is greater than or equal to -20°C.
This requirement is met in one of the three situations:

a) When the power grid is "strong" enough and the motor current is negligible in relation to the grid capacity.
b) The motor is always started without load, which reduces the starting time and, in turn, the duration of the starting current and the momentary voltage drop, which is acceptable for the other consumers of the grid;
c) When DOL starting is duly authorized by the local electric utility company.

When the motor starting current is high, the following detrimental consequences may occur:

a) The high voltage drop in the power supply system may cause interference in equipment installed in this system;
b) The protection system (cables, contactors) must be oversized, increasing the installation costs.

NOTE

In some cases, there is an imposition of the electric utility companies that limits the voltage drop of the grid.

5.2 DIRECT ONLINE STARTING FREQUENCY

Since induction motors have a high starting current, the time spent to accelerate loads with high inertia results in a quick rise of the motor temperature. If the intervals between successive starts are too short, the temperature of the windings will rise quickly, reducing their useful life or even burning them. The NBR 17094 and IEC60034-1 standards establishes a minimum starting duty to which the motors must be able to comply:

a) Two successive starts: the first one with the motor cold, i.e., with its windings at ambient temperature, and the second one right afterwards, but only after the motor has decelerated to a full stop;
b) One start with the motor hot, i.e., with the windings at continuous duty temperature.

The first condition simulates the case in which the first motor start is aborted, for instance, by the trip of the motor protection, when a second motor start is permitted right afterwards.
The second condition simulates the case of an accidental motor shutdown under normal operation, for instance, by power outage, when the motor restart is allowed right after the power is reestablished.

5.3 LOCKED ROTOR CURRENT

The motor nameplate indicates the value of I_P/I_n, which is the relation between the starting current and the rated current of the motor.

5.4 STARTING WITH REDUCED CURRENT

If direct online starting is not possible, the following starting systems can be used in order to reduce the motor starting current.

- Star-delta starter;
- Series-parallel starter;
- Autotransformer starter;
- Static starter or soft-starter;
- 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 bearing 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. Check the fans direction of rotation in blower-ventilated motors;
11. The motor air 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 the space heaters;
2. Adjust all protections in the control panel;
3. Turn on the fans (motors with forced ventilation);
4. Slowly rotate the motor shaft to check if there are any parts being dragged and to identify unusual noises;
5. After the previous steps have been concluded, the motor start-up sequence may be initiated;
6. Check the direction of rotation with uncoupled motor;
7. In order to reverse the direction of rotation, the connection of any of the two phases must be inverted;
8. 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
9. Monitor the temperatures and vibration. 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;
10. 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

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 lubricant used complies with all specifications;
- Lubricant characteristics;
- 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 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 for drilling application is **4G**.

Te 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.

6.3.5 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 cooling system (if any).

DANGER

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

7 MAINTENANCE

7.1 GENERAL

A proper maintenance program for electric motors includes the following recommendations:

- Keep the motor and the associated equipment clean;
- Measure the winding insulation resistance periodically;
- Measure the temperature of windings, bearings and cooling system periodically;
- Check the wear, operation of the lubrication system and useful life of the bearings;
- Measure the motor vibration levels;
- Inspect the cooling system;
- Inspect associated equipment;
- Inspect all the motor accessories, protections and connections, ensuring that they are operating properly;

ATTENTION

Noncompliance with the recommendations of section 1.1 may cause undesired stoppages of the equipment.
The frequency of such inspections depends on the local application conditions.
Every time that it becomes necessary to transport the motor, the shaft must be properly locked to prevent damages to the bearings. Use the device supplied with the motor to lock the shaft.
If the motor requires reconditioning or replacement of any damaged part, consult WEG.

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 BEARING MAINTENANCE

NOTE

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

- The informed lubrication intervals, consider a 70 °C working temperature of the rolling bearing;
- Based on the operating temperature ranges listed in Table 7.1, apply the following correction factors for the rolling bearing lubrication intervals:

Table 7.1: Reduction factor for lubrication intervals

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

7.5.1 Instructions for lubrication

The lubrication system was designed in such a way that during the lubrication of the rolling bearings, all the old grease is removed from the rolling bearing races.
It is recommended to make the lubrication with the motor in operation in order to ensure the renewal of the grease in the rolling bearing housing.
If that is not possible due to the presence of rotating parts near the grease nipple (pulleys, etc.) which may put the operator at risk, follow the procedures below:

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

ATTENTION

The injection of all the grease with the motor stopped may lead to the penetration of part of the lubricant into the motor through the internal seal of the rolling bearing cap;

It is important to clean the grease nipples prior to lubrication in order to prevent foreign materials from being dragged into the rolling bearing. For lubrication, use only manual grease gun.

7.5.1.1 Relubrication of rolling bearing with grease outlet drain

The relubrication of rolling bearings with grease outlet drain, as shown in Figure 7.1 and Figure 7.2 must be done as follow:

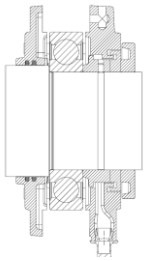


Figure 7.1: Bearing with grease fitting and outlet drain

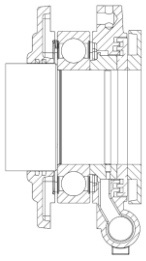


Figure 7.2: Bearing with grease fitting and spring rod

1. Clean with a cotton cloth around the hole of the grease nipple;
2. Remove the drain plug (bearing with outlet drain, as Figure 7.1) or remove the spring rod, clean and put it back in place (bearing with spring rod, as Figure 7.2);
3. With the rotor operating, inject the grease with a manual grease gun the proper amount of grease, informed in the bearing nameplate, has been injected.
4. Keep the motor running long enough so that the grease excess passes through the drain;
5. The excess of grease comes out through the bearing lower drain;
6. Keep the motor running long enough for the grease excess to drain;
7. On bearing with spring rod, remove the excess of grease, by pulling the spring rod and cleaning the spring. This procedure must be repeated as many times as necessary until the spring no longer retains grease;
8. Inspect the bearing temperature to make sure there was no significant variation;
9. Put the drain plug or spring rod back in place.

7.5.1.2 Relubrication of rolling bearing with grease reservoir

The relubrication of rolling bearing, as shown in Figure 7.3, commum for vertical motors, must be done as follow:

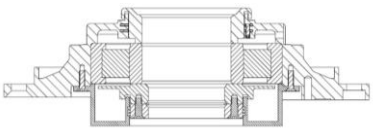


Figure 7.3: Bearing with grease fitting and grease reservoir

1. Clean with a cotton cloth around the hole of the grease nipple;
2. With the rotor operating, inject the grease with a manual grease gun the proper amount of grease, informed in the bearing nameplate, has been injected.
3. The excess of grease comes out from the bearing to the grease reservoir, as Figure 7.3;
4. Keep the motor running long enough for the grease excess to come out of the bearing;
5. Inspect the bearing temperature to make sure there was no significant variation.

NOTE

The grease reservoir volume has sufficient capacity for the relubrication until the end of the bearing lifespan.

Relubricate the bearing at the recommended intervals as many times as necessary until the bearing lifespan is reached, when the bearing must be replaced.

7.5.2 Grease type and quantify

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.

7.5.3 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.

7.5.4 Bearing disassembling and assembling

Before Disassembly:

1. Remove the grease inlet and outlet extension tubes;
2. Thoroughly clean the external part of the bearing;
3. 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, use the appropriate tool and keep all parts in a clean and safe location:

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 7.4) and lubricate the bearing with enough grease before assembling it;
4. Before assembling bearing on the shaft, heat it up to a temperature between 50ºC and 100ºC;
5. For a complete bearing assembly, follow the disassembly instructions in the opposite order.
6. The efficiency of sealing against taconita will be given by the filling of grease between the protrusions of the labyrinth seal and outer ring (if any)

Figure 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.

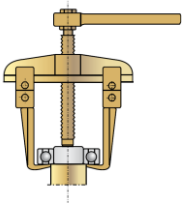


Figure 7.5: Bearing puller device

7.5.5 Bearing protection

7.5.5.1 Protection settings

ATTENTION

The following temperatures must be set in the bearing protection system:
Alarm: 90ºC Shutdown: 110ºC
The alarm temperature must be set to 10ºC above the working temperature, and must never be higher than 110ºC.

7.6 COOLING SYSTEM MAINTENANCE

7.6.1 TGV model

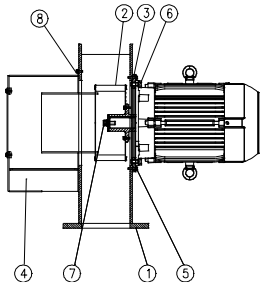


Figure 7.6: TGV Blower

1. Radial fan cover
2. Radial fan
3. Intermediate flange
4. Noise attenuator
5. Bolt for fan cover fixation
6. Bolt for motor fixation
7. Bolt for fan fixation
8. Bolt for attenuator fixation

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.

NOTE

Repair services in motors applied in hazardous atmospheres must only be performed by duly qualified personnel, authorized by WEG to perform such services.

8.1 FULL DISASSEMBLY OF THE MOTOR

Before starting to disassemble the motor, make sure all the electric connections are disconnected.

Cooling system:
Before disassembling the motor, remove blower (TGV model)

Drive end side:
1. Remove temperature detectors, vibration sensors and from the bearing;
2. In order to prevent any damage to the rotor core, provide a support for the shaft/rotor;
3. Disassemble the drive end bearing according to the procedures described in this manual;
4. Remove the D-endshield.

Non-drive end side
1. Remove the device to remove old grease (if applicable) from the bearings;
2. Remove temperature detectors, vibration sensors (if applicable) from the NDE bearing;
3. Disassemble the non-drive end bearing according to the procedures described in this manual;
4. Remove the NDE-endshield.

Removing the rotor
The rotor must be removed by the drive end of the motor. Remove the rotor from the stator by using lifting cables or any other equivalent device. This procedure must be performed carefully in order to prevent the rotor from touching the stator or the stator coil heads.

ATTENTION

Any damaged part (cracks, dents on machined parts, faulty threads) must be preferably replaced, avoiding restorations. All services described herein must be performed by specialized and experienced personnel; otherwise, damages to the equipment may occur. If you have any questions, contact WEG.

8.2 MOTOR ASSEMBLY

In order to assemble the whole motor, follow the disassembly instructions in the reverse order.

8.3 AIR-GAP MEASUREMENT

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

ATTENTION

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

For the single bearing:

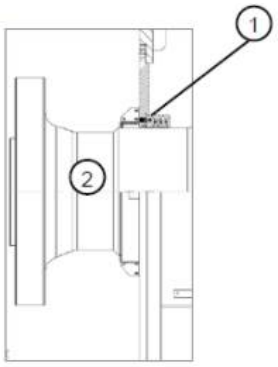


Figure 8.1: DE shaft seal

Legend of Figure 8.1:
1. DE shaft seal
2. Motor shaft

8.4 BLOWER (TGV MODEL)

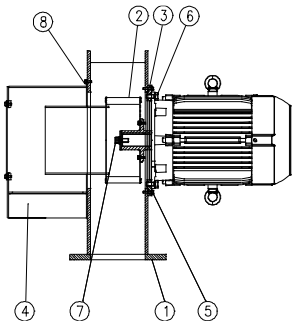


Figure 8.2: **TGV blower**

Disassembly of the blower:

1. Make sure all the electric connections as disconnected;
2. Remove the bolts (6) that fix the motor to the intermediate cover and remove the bolts that fix the motor feet to the motor base;
3. Remove the motor and the axial fan (2);
4. If necessary to remove the fan from the shaft, removing the bolt (7).

Assembly of the radial fan:
In order to assemble the motor and fan, follow the disassembly instructions in the reverse order.
Filter:

The filter must be inspected, cleaned or replaced periodically in order to ensure a continuous supply of fresh and clean air to the motor.

8.5 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;
- Temperature sensors for each bearing;
- Space heater (if any);
- 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**

EQUIPMENT	Weekly	Monthly	Every 3 months	Every 6 months	Yearly	Every 3 years	Note
STATOR							
Stator visual inspection .					x		
Cleaning control.					x		
Groove wedges inspection.						x	
Stator terminals control.					x		
Measure the winding insulation resistance.					x		
ROTOR							
Cleaning control.					x		
Visual inspection.					x		
Shaft (wearing, incrustations) inspection.						x	
BEARINGS							
Control of noise, vibration, leaking, and temperature control.	x						
Lubricant quality control.					x		
Shaft inspection.						x	
Lubricant change.							According to the period indicated on bearing nameplate.
VENTILATION							
Inspect the ventilation			x				
AIR FILTER (TGV model)							
Inspect and replace, if necessary.			x				
PROTECTION AND CONTROL EQUIPMENT							
Operation test.					x		
Value recording.	x						
Disassembly and operation test.						x	
COUPLING							
Inspection of the alignment.					x		Check it after the first week of operation.
Inspection of the coupling fastening.					x		Check it after the first week of operation.
ENTIRE MOTOR							
Cleaning and vibration inspection.	x						
Condensed water draining.			x				
Screw tightening.					x		
terminal box cleaning.					x		
Electrical and grounding connection tightening.					x		

10 ABNORMALITIES, CAUSES AND SOLUTIONS

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 10.1: Basic list of abnormalities, causes and corrective measures

ABNORMALITY	POSSIBLE CAUSES	CORRECTIVE MEASURE
Motor does not start, coupled or uncoupled.	▪ At least two power cables are interrupted, with no voltage.	▪ Check the control panel, power supply cables, terminals and brush seating.
	▪ Locked rotor.	▪ Unlock the rotor;
	▪ Damaged bearing.	▪ Replace the bearing.
The motor starts at no-load, but fails when load is applied. It starts very slowly and does not reach the rated rotation.	▪ Load torque is too high during start-up.	▪ Do not apply load to the driven machine during start-up.
	▪ Power supply voltage is too low.	▪ Measure the power supply voltage and adjust the value correctly.
	▪ Large voltage drop in the power cables.	▪ Check the installation dimensioning (transformer, cable section, check relays, circuit breakers, etc.).
	▪ Rotor with defective or interrupted bars.	▪ Check and fix the rotor winding.
	▪ One power cable was interrupted after the start-up.	▪ Check the power cables.
After applying a load, the stator current varies with twice as much as the build-up frequency. The motor hums during start-up	▪ The rotor winding is interrupted.	▪ Check and fix the rotor winding.
The motor starts at no-load, but fails when load is applied. It starts very slowly and does not reach the rated rotation.	▪ Load torque is too high during start-up.	▪ Do not apply load to the driven machine during start-up.
Very high no-load current.	▪ Power supply voltage is too high.	▪ Measure the power supply and adjust the value correctly.
Localized hot spots on the stator winding.	▪ Short circuit between turns.	▪ Rewind.
	▪ Interruption of stator winding phases or parallel wires.	
	▪ Poor connection.	▪ Remake the connection.
Localized hot spots on the rotor.	▪ Rotor winding interruptions.	▪ Fix or replace the rotor windings.
Unusual noise during operation with load.	▪ Mechanical causes.	▪ The noise normally reduces when the motor speed decreases; see also: "noisy operation when uncoupled".
	▪ Electrical causes.	▪ The noise disappears when the motor is shutdown. Contact WEG.
When coupled, the noise appears. When uncoupled, the noise disappears.	▪ Defective transmission or driven machine components.	▪ Check the power transmission, coupling and alignment.
	▪ Gear transmission defect.	▪ Align the drive.
	▪ Unaligned/unleveled base.	▪ Realign/level the motor and the driven machine.
	▪ Incorrect balancing of the driven machine components.	▪ Perform a new balancing process.
	▪ Defective coupling.	▪ Repair the coupling.
	▪ Wrong motor rotation direction.	▪ Invert the 2-phase connection.

ABNORMALITY	POSSIBLE CAUSES	CORRECTIVE MEASURE
The stator winding heats up when operating under load.	▪ Insufficient cooling due to obstructed air pipes.	▪ Open and clean the air pipes.
	▪ Overloading	▪ Measure the stator current and reduce the load. Analyze the motor application.
	▪ High number of start-ups or very high moment of inertia.	▪ Reduce the number of start-ups.
	▪ Very high voltage with a subsequent increase in iron losses .	▪ Do not exceed the rated voltage by 110%, unless specifically stated on the nameplate.
	▪ Very low voltage and very high current	▪ Check the power supply voltage and the motor voltage drop.
	▪ Interruption on a power cable or winding phase.	▪ Measure the current in all phases and correct it, if necessary.
	▪ Rotor drags against the stator.	▪ Check the air gap, operating conditions (vibrations, etc.) and bearing conditions.
	▪ Operating conditions are not in compliance with the data provided in the nameplate.	▪ Maintain the operating conditions according to the nameplate or reduce the load.
	▪ Unbalance in the power supply voltage (burnt fuse, incorrect command).	▪ Check for voltage unbalancing or operate with only two phases and correct the issue.
	▪ Dirty windings.	▪ Clean.
	▪ Obstructed air ducts.	
	▪ Dirty air filters.	▪ Clean the filtering device.
	▪ Direction of rotation not compatible with the fan being used.	▪ Analyze the fan regarding the motor direction of rotation.
Noisy operation when uncoupled.	▪ Unbalance.	▪ The noise continues during deceleration after voltage is turned off; ▪ Execute a new balancing process.
	▪ Interruption in one phase of the stator winding.	▪ Measure all connection cables' currents.
	▪ Loose fixation screws.	▪ Tighten and lock the screws.
	▪ The balancing conditions of the rotor get worse after the coupling is mounted.	▪ Balance the coupling.
	▪ Foundation resonance.	▪ Adjust the foundation.
	▪ Deformed motor frame	▪ Check the base flatness.
	▪ Bent shaft.	▪ The shaft may have been bent; ▪ Check rotor balancing and run-out.
	▪ Non-uniform air gap.	▪ Check for shaft bending or bearing wearing.

11 ENVIRONMENTAL INFORMATION

11.1 PACKAGE

Electric motors are supplied in cardboard, polymer, wood or metallic material packages. These materials are recyclable or reusable and must be properly disposed according to the current regulations of each country. All the wood used in the packaging of WEG motors comes from reforestation and receives anti-fungal treatment.

11.2 PRODUCT

Electric motors, under the constructive aspect, are manufactured mainly with ferrous metals (steel, cast iron), nonferrous metals (copper, aluminum) and plastic. The electric motor, in general, is a product that has a long useful life; however, when it must be disposed, WEG recommends that the materials of the packaging and of the product be properly separated and sent for recycling.
The non-recyclable materials must be properly disposed according to the environmental regulations, i.e., in industrial landfills, co-processed in cement kilns or incinerated. The service providers for recycling, disposal in industrial landfills, co-processing or incineration of waste must be properly licensed by the environmental agency of each state to carry out these activities.

11.3 HAZARDOUS WASTE

Grease and oil waste used to lubricate the bearings should be disposed, according to the instructions of the relevant environmental agencies, because its improper disposal can cause impacts to the environment.

12 SERVICE NETWORK

To consult the Service Network, access the website www.weg.net.

13 WARRANTY

These products, when operated under the conditions stipulated by WEG in the operating manual for such product, are warranted against defects in workmanship and materials for twelve (12) months from start-up date or eighteen (18) months from manufacturer shipment date, whichever occurs first.
However, this warranty does not apply to any product which has been subject to misuse, misapplication, neglect (including without limitation, inadequate maintenance, accident, improper installation, modification, adjustment, repair or any other cases originated from inadequate applications).
The company will neither be responsible for any expenses incurred in installation, removal from service, consequential expenses such as financial losses nor transportation costs as well as tickets and accommodation expenses of a technician when this is requested by the customer.
The repair and/or replacement of parts or components, when effected by WEG within the Warranty period do not give Warranty extension, unless otherwise expressed in writing by WEG.
This constitutes WEG's only warranty in connection with this sale and is in lieu of all other warranties, expressed or implied, written or oral.
There are no implied warranties of merchantability or fitness for a particular purpose that apply to this sale.
No employee, agent, dealer, repair shop or other person is authorized to give any warranties on behalf of WEG nor to assume for WEG any other liability in connection with any of its products.
In case this happens without WEG's authorization, Warranty is automatically cancelled.

LIABILITY

Except as specified in the foregoing paragraph entitled "Warranty Terms for Engineering Products", the company shall have no obligation or liability whatsoever to the purchaser, including, without limitation, any claims for consequential damages or labor costs, by reason of any breach of the express warranty described therein.
The purchaser further hereby agrees to indemnify and hold the company harmless from any causes of action (other than cost of replacing or repairing the defective product as specified in the foregoing paragraph entitled "Warranty Terms for Engineering Products"), arising directly or indirectly from the acts, omissions or negligence of the purchaser in connection with or arising out of the testing, use, operation, replacement or repair of any product described in this quotation and sold or furnished by the company to the purchaser.

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