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SYNCHRONOUS MOTORS

Pedestal Type - Horizontal - Brushless

Installation, Operation and Maintenance Manual

WEG Group

Installation, Operation and Maintenance Manual

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Synchronous Motors

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Dear Customer,

Thank you for purchasing a WEG Electric Machinery Synchronous Motor. Our products are developed with the highest standards of quality and efficiency which ensure outstanding performance and have been installed in thousands of applications around the world.

It is our hope that this manual will assist you unloading, installing, operating, and properly maintaining your motor. Therefore, we recommend that you read this manual carefully in order to ensure safe and reliable operation and the safety of your facility. If you need any further information, please, contact WEG Electric Machinery.

It is critical that all warnings are respected, particularly with regard to storage, installation and operating procedures and all activities are completed by properly trained personnel using the appropriate tools and equipment. Do not use this equipment outside the operating conditions. It may subject the equipment to stresses larger than those for which it was designed. Failure to heed these warnings may result in equipment damage, injury or loss of warranty protection. Always keep this manual available for reference.

ATTENTION

1. It is absolutely necessary to follow the procedures contained in this manual for the warranty to be valid.
2. The equipment installation, operation and maintenance procedures must be executed 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 or another printed copy may be requested.

WEG ELECTRIC MACHINERY COMPANY, INC.

WEG Group

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1 INTRODUCTION

This manual contains a description of the installation, operation, and general maintenance of a brushless - pedestal type synchronous motor manufactured by WEG Electric Machinery. The complete information package includes: This manual, the outline drawing for the specific motor, the connection diagrams, and any other information supplied by WEG Electric Machinery. All standards and procedures included in this manual must be followed to ensure proper operation of the equipment and to ensure the safety of the personnel involved in the motor installation, operation, and maintenance. Following these instructions is also required to comply with the terms of the warranty as explained at the end of this manual. We strongly recommend reading this manual carefully prior to motor installation and operation.

ATTENTION

In case of any doubt regarding installation, operation, or maintenance, please contact WEG Electric Machinery.

Industry practices are also captured in the following reference documents, and these must be available for reference by both the erector and end user.

API 546	Brushless Synchronous Machines 500kVA and Larger
API 686	Recommended Practices for Machinery Installation and Installation Design
API 670	Machinery Protection Systems
IEEE 43	Recommended Practice for Testing Insulation Resistance of Rotating Machinery
IEEE 141	Recommended Practice for Electrical Power Distribution for Industrial Plants
IEEE 142	Recommended Practice for Grounding of Industrial and Commercial Power Systems
IEEE 242	Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
NEMA MG1	Motors and Generators
NFPA 70	National Electrical Code Handbook

1.1 SAFETY WARNINGS IN THIS MANUAL

In this manual, the following safety warnings are used:

DANGER

Failure to observe the procedures recommended in this warning may result in death, serious injuries and extensive equipment damage.

ATTENTION

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

NOTE

The purpose of these notes is to supply important information for the optimal performance of this product.

2 TECHNICAL ASSISTANCE

Upon request, WEG Electric Machinery will provide qualified technical assistance at the job site to support installation, commissioning, and maintenance of all our products. Considerable time and expense is often saved by taking advantage of factory-trained assistance and supervision, and compliance with warranty terms is guaranteed when installation is supervised and approved by WEG Electric Machinery field engineers.

3 APPROVED COMPOUNDS

The following compounds are approved for use in their specified locations. Similar compounds may be substituted. In the case of any doubt, contact WEG Electric Machinery.

Table 3-1: WEG Electric Machinery Approved Chemicals

Description	Product and Alternatives
Bearing Sealant	Loctite RTV587 Permatex Ultra Blue Curil T
Bearing Oil (Any high-grade mineral oil with the rated viscosity is acceptable)	Shell Morlina® Mobile SHC® 600 Chevron Rando® Petro Canada Enduratex®
Anti-Rust Spray	LEAR Chemical ACF 50 Cosmoline Rust Veto® 342 TECTIL 511 Dasco Guard 400TXAZ
Bolt Lubrication	Loctite C5A Permatex Anti Seize Copper Jet Lube KOPR-KOTE Markal E-Z Grade Copper
Electrical Contact Cleaner	LPS NoFlash® CRC Contact Cleaner Permatex 82588 Contact Cleaner Loctite 1174633 Contact Cleaner

4 GENERAL INSTRUCTIONS

All procedures contained in this manual must be followed to ensure the proper operation of the equipment and safety of personnel. Compliance with these procedures is also required to ensure the application of the warranty terms.
We strongly recommend a detailed reading of this manual before the motor installation and operation. However, in case of any doubt, please contact your nearest WEG Electric Machinery representative. It is also strongly recommended to have a WEG Electric Machinery field service engineer present for the installation and commissioning of a new product to ensure correct installation.

4.1 QUALIFIED PERSONNEL

All personnel involved with equipment installation, handling, operation and maintenance should be well-trained regarding safety standards and industry or trade practices that govern the work. Before commencing the installation, it is the responsibility of the person in charge to ascertain that all personnel are qualified.

All qualified personnel must also observe:

- All technical data regarding the applications (operating conditions, connections and installation environment), provided in the purchase order documents, operating instructions, manuals, and other documentation.
- The specific determinations and conditions for local installation.
- The use of appropriate tools and equipment for handling and transportation.

4.2 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, poor handling, or failure to comply with the local, state, or industry operation standards, may cause severe personal injury and equipment damage.

The end user or contractor responsible for installation of the motor must ensure that:

- Only qualified personnel will perform the installation and operation of the equipment.
- Such personnel will have access to this manual and other documents supplied with the motor.
- Installing personnel will perform the work, strictly complying with the local, state and federal regulations, as well as industry standards and any product-specific documentation.
- Failure to comply with the installation and safety rules may void the product warranty.

ATTENTION

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

4.3 ENCLOSURE DESIGN (DEGREE OF COOLING & INGRESS PROTECTION)

The enclosure design of a motor shall facilitate two important functions—an effective degree of:

- Ingress Protection (IP)
- Cooling

In general, all the motors designed and manufactured at WEG Electric Machinery are furnished with a NEMA approved enclosure which inherently provides a degree of ingress protection and cooling. Table 4-1 indicates the standards associated with the most-commonly installed enclosure types.

Table 4-1: Enclosure Standards

NEMA	ENCLOSURE DESIGNATION	IC Code Complete	IP Code
OPEN	Open Guard	IC 0A1	IP 00
DP	Drip-proof	IC 0A1	IP 12
DPG	Drip-proof, Guarded	IC 0A1	IP 22
WPI	Weather Protected, Type I	IC 0A1	IPW 23
WPII	Weather Protected, Type II	IC 0A1	IPW 24
TEFV	Totally Enclosed Forced Ventilated	IC 3A7	IP 44
TEWAC	Totally Enclosed Water-to-Air Cooled	IC 8A1W7	IP 54
TEAAC	Totally Enclosed Air-to-Air Cooled	IC 6A1A6	IP 54

4.3.1 Motors Used in Hazardous Locations

Motors intended for hazardous areas are designed with additional safety features, and specific standards apply to each, based on the classification of the unit. In order to operate rotating electric machinery in a hazardous environment, standards have been established by organizations and countries throughout the world. The standards commonly recognized are those established by the *International Electrotechnical Commission* (IEC). The IEC was founded in 1906 to help coordinate and unify national electrotechnical standards. In the United States, the *National Electric Code* (NEC) and *National Fire Protection Association* (NFPA) have developed guidelines for protection.

International standards classify hazardous gas areas into zones. In the United States, the NEC classifies hazardous locations into classes, where hazardous gas/vapor areas are defined as a Class I area. To describe the frequency of a particular hazardous area, each class is subdivided into divisions. For a gas and vapor classification (i.e. Class I), a comparison between the applicable international and national standards is shown in Table 4-2.

Table 4-2: Gas and Vapor Classification

IEC/CENELEC or IEC/EN		NEC/NFPA	
Zone 0	May exist continuously under normal operating conditions	Class I Div. 1	May exist continuously or periodically under normal operating conditions
Zone 1	May exist periodically under normal operating conditions		
Zone 2	May exist under abnormal or accidental conditions	Class I Div. 2	May exist under abnormal or accidental conditions

4.3.1.1 General Precautions in Hazardous Locations

Before installing, operating or carrying out maintenance on products used in hazardous locations, the following precautions must be observed:

- The standards listed above, applied to each case, must be studied and understood.
- All requirements included in the applicable standards must be followed accordingly.
- Before carrying out maintenance activities, inspection or repairs on the motor, ensure all power sources are de-energized and properly locked out.
- All motor protection must be correctly installed and adjusted before operation.
- Ensure all grounding connections are sized correctly and securely installed.
- All electrical connection terminals must be tight to avoid poor contacts which may result in sparking.

4.3.2 General Care

Before installing, operating or servicing electric motors for areas of risk, the following safety procedures must be taken:

- Study and understand the standard according to the degree of protection of the motor mentioned in Section 4.3.
- All the requirements established by the applicable standards must be met.

4.3.3 Additional Care

- Shut down the motor and wait until it is completely stopped before performing any maintenance, inspection or repair. All the existing protections must be installed and properly adjusted before putting the motor into operation.
- Make sure the motors are properly grounded.
- The terminals must be properly connected so as to prevent any kind of poor contact that may cause heating or spark.

NOTE

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

5 OPERATING CONDITIONS AND STANDARDS

5.1 OPERATING CONDITIONS

In order for the product warranty to remain valid, the motor must be operated in compliance with the rated data indicated on the nameplate, observing all applicable standards and codes, as well as the information provided in this manual.

5.2 STANDARDS

The motors are normally specified, designed, manufactured and tested according to the standards described in Table 5-1. The applicable standards are specified in the commercial contract that, in turn, depending on the application or installation local, may indicate other national or international standards.

Table 5-1: Examples of Applicable Standards

	STANDARDS
Specification	API-546 NEMA MG1
Tests	API-546 NEMA MG1
Degrees of Protection	API-546 NEMA MG1
Cooling	API-546
Mountings	API-546
Noise	API-546
Mechanical Vibration	API-546
Mechanical Tolerances	API-546
Balancing	API-546

5.3 ENVIRONMENTAL CONDITIONS

WEG Electric Machinery motors are designed to be operated in following ambient conditions unless specifically mentioned on the motor nameplate or outline drawing:

- Ambient temperature: -15 ºC to + 40 ºC (5 ºF to 104 ºF).
- Altitude: up to 1000 m (3280 ft.) unless specifically designed and included in outline drawing.
- Environment according to the degree of protection of the motor.
- Area: Non-hazardous area.

5.4 VOLTAGE AND FREQUENCY

The motor must be able to perform its main function continuously in Zone A, but it does not have to fully meet its performance characteristics at rated voltage and frequency (see rated characteristics point in Figure 5-1, and it may present deviations). The temperature rises may be above those at rated voltage and frequency.
The motor must be able to perform its main function in Zone B, but it may present larger deviations of its performance at rated voltage and frequency than in Zone A. The temperature rises may be higher than those observed at rated voltage and frequency and might be higher than those in Zone A.
Prolonged operation close to Zone B is not recommended.

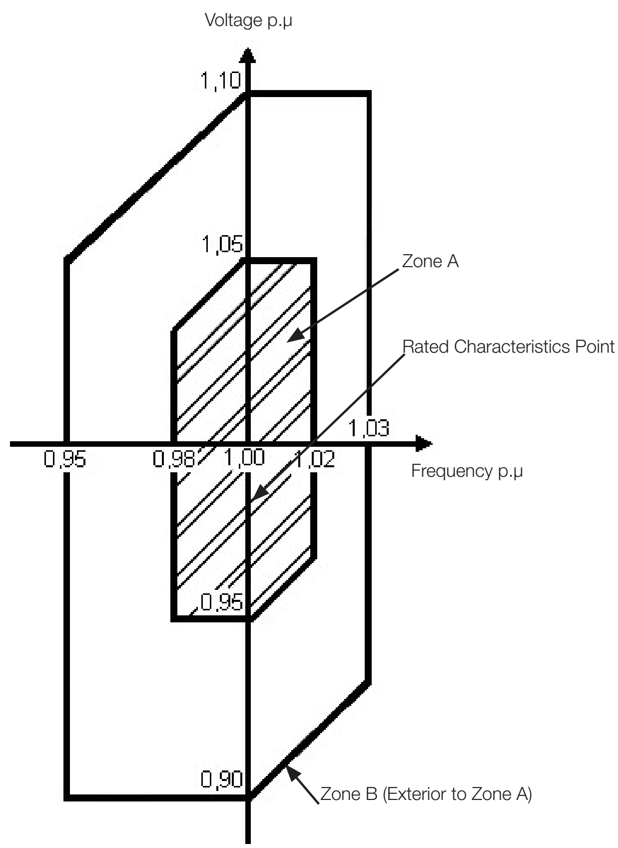


Figure 5-1: Voltage and Frequency Variation Limits (IEC60034-1)

6 RECEIVING, HANDLING AND STORAGE

6.1 RECEIVING

All motors are factory tested, packaged according to the transportation method, and shipped in a manner designed to protect the integrity of the unit. The shipping container and all other transportation boxes must be inspected during acceptance and checked for any damage that may have been caused during transport.

ATTENTION

Any potential shipping damage must be reported immediately to WEG Electric Machinery. Unreported damaged caused by shipping will not be covered by the warranty. If any damage is detected during unpacking or installation, it must be photographed, documented and reported immediately to WEG Electric Machinery.

The following procedure must be followed for the unpacking of all units.

- Visually inspect all components and assemblies for damage or signs of contamination.
- Identify all loose parts and verify all components against packing lists to ensure completeness.
- Verify that all plugs, protective caps, and other shipping devices are installed correctly.
- Once the unit is open, do not clean the coating from machined surfaces such as the shaft journal or soleplate surfaces until the unit is ready to be installed.
- Do not remove the grease-based corrosion protection from the shaft end, nor the closing plugs or rubber parts in terminal box holes. These protections must remain in place until the final assembly. A complete visual inspection of the motor must be performed after removing the package.
- If the unit is received during cold weather, allow the unit to stabilize to room temperature before removing the protective packing material. This precaution will minimize the condensation of moisture on the cold surfaces and eliminate the possibility of early malfunctions caused by wet windings and insulating materials.

ATTENTION

Parts supplied in additional packages must be checked upon receipt.

6.2 HANDLING

6.2.1 Lifting Procedure

The following procedure must be followed for the lifting of all units.

- Use only the existing lifting lugs to lift the motor.
- Prior to hoisting or moving the shipping container or covered base, the following items must be noted to ensure safety.
  - Hoist locations and components must be inspected and the lifting diagram followed.
  - The weight indicated on the packaging or on the unit nameplate must be noted.
  - Crane or hoist capacity and travel limits must be known and sufficient for the lift.
- Motors packed in wooden shipping containers must be lifted at the points shown or by suitable forklift.
- Never lift the unit by its wooden packing box.
- Never allow the motor or its shipping container to drop or expose it to any impact.
- The lifting lugs of the bearing housing, heat exchanger, end shield, connection boxes etc., must be used for handling only these components.
- Never lift the motor by the shaft or other auxiliary lifting features.
- Lifting and lowering must be done gently in order to avoid damage to the bearings, stator and other components.

For units without a base:

- Lift the stator using all 4 lifting holes provided and shown in Figure 6-1.
- Use appropriate shackles and slings for weight of assembly.
- Ensure sufficient length of slings to prevent high loads in rigging.
- Prior to lifting rotor and installing in stator, place gasket or other durable protective material between rotor and stator to prevent damage to laminations.

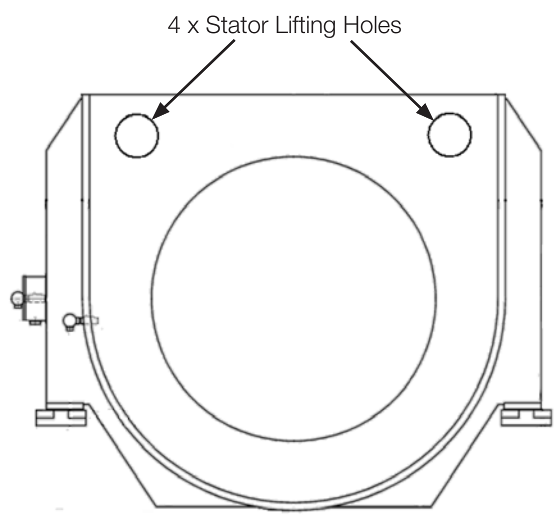


Figure 6-1: Typical Handling of Motor without a Base

For units with a base:
- Lift the complete assembly using the 4 lifting plates provided in the base.
- Use appropriate shackles and slings for weight of assembly.
- Ensure sufficient length of slings to prevent high loads in rigging.
- Ensure base is level prior to lifting to prevent shifting during crane operations.
- Ensure bearing protective paper is in place prior to lifting (if applicable).
- If the unit is provided with a shaft locking cradle, ensure it is properly-positioned and tightly-installed prior to lifting the base.
- Lift complete rotor & stator minus top enclosure with four lifting plates on base using vertical sling angle chains.
- Lift parts/sub-assemblies using only labeled threaded holes & labeled hooks.
- The lifting lugs of the bearing housing, heat exchanger, end shield, connection boxes etc, must be used for handling only these components.
- Never lift the motor by the shaft or other auxiliary lifting features.
- Lifting and lowering must be done gently in order to avoid damage to the bearings, stator, and other components.

Figure 6-2: Typical Handling of Motor with a Base

6.2.2 Transport Procedure

If the entire unit is to be transported, the following procedure must be followed.

For units without a base:
- Remove rotor from stator.
- Install each component in the WEG EM-supplied shipping container, or a container sufficient to support the weight and protect the component.
- For motors intended for 6+ weeks of storage, install protective bearing paper to prevent bearing damage during shipping.
- Protect all machined surfaces with anti-rust coating.
- Protect each component with a minimum two layers of plastic and sufficient drainage to prevent water pooling within the component.
- Install desiccant packets or other moisture-absorbing product.

For units with a base:
- If supplied, install the shaft locking cradle and secure tightly.
- Protect all machined surfaces with anti-rust coating.
- For motors intended for 6+ weeks of storage, install protective bearing paper to prevent bearing damage during shipping.
- Protect the complete assembly with a minimum two layers of plastic and sufficient drainage to prevent water pooling within the component.
- Install silica gel packets or other moisture-absorbing product.

6.3 SHORT-TERM STORAGE

Any damage to the painting or corrosion protection of the machined parts must be corrected.

ATTENTION

The space heaters must be ENERGIZED when the motor is not operating or is in long-term storage.

6.3.1 Short-Term Indoor Storage

If the entire unit is to be temporarily stored indoors, the following procedure must be followed.
- Ensure all components are covered and protected from dust.
- Protect all machined surfaces with anti-rust coating.
- Ensure ambient conditions are controlled and prevent extreme changes in temperature which will cause condensation to form on critical electrical components.
- Ensure space heaters are energized.

6.3.2 Short-Term Outdoor Storage

If the entire unit is to be temporarily stored outdoors, the following procedure must be followed.
- Place components on wooden or other appropriate surface.
- Choose a location away from sources of dust, debris or construction activities which may cause impact or damage to the assembly or its components.
- Ensure all components are covered with at least two layers of plastic:
  - Secure plastic in case of strong winds.
  - Ensure drainage exists within the plastic envelope.
- Form a sloped surface to prevent the pooling of water, snow, or debris.
- Protect all machined surfaces with anti-rust coating.
- Ensure space heaters are energized.
- Repair all damages occasionally occurred during transportation before storing the motor, which is necessary to ensure proper storage conditions.

- Place the motor on platforms or foundations which ensure protection against land humidity and keep the motor from sinking into the soil. Free air circulation underneath the motor must be assured.

ATTENTION

Never place the motor or any subassemblies directly on the ground. Always use wooden or other appropriate blocking.

6.4 LONG-TERM STORAGE

If the unit is to be stored for more than thirty (30) days prior to installation, the instructions below must be followed. In addition, if a unit is to be decommissioned or removed from service for maintenance, overhaul, or repair, the instructions below should also be followed.

6.4.1 General Guidelines

It is critical during long-term storage to protect the critical features of the unit (windings, bearing surfaces, and electrical connections) to prevent the need for costly repairs not covered by warranty. It is the responsibility of the end user to ensure that the motor is stored in a location which will not subject it to any contamination, vibration, extreme temperatures, or other conditions which may have a negative impact on the lift of the unit.

In general, a well-covered unit with energized space heaters stored in a dry area, free from strong winds or other environmental factors will not suffer significant deterioration during long-term storage. It is impossible to predict all possible sources of contamination at a particular site, and it is strongly-recommended to have WEG Electric Machinery Field Engineering support when organizing and implementing a long-term storage plan.

ATTENTION

To ensure compliance with warranty, all long-term storage procedures must be followed and documented by the end user.

6.4.2 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 following criteria described.

6.4.2.1 Long-Term Indoor Storage

- The storage location must include a fully-intact roof.
- The storage location must be protected against high humidity, harmful vapors, rapid changes in temperature, rodents and insects.
- Corrosive gases such as Chlorine, Sulfur Dioxide or acid must not present.
- The storage location must be free from any vibration.
- The storage location must include filtered incoming air.
- The storage location ambient temperature must be between 0°C and 40°C (32°F and 100°F).
- The storage location relative air humidity must be below 50%. If this is not possible, the unit must be completely covered and the space heaters fully-energized to prevent moisture ingress.
- The storage location must be clean.
- The storage location must have a fire detection system.
- The storage location must include a reliable electrical supply for space heaters and monitoring using a light or other easily visible means.
- If one or more of the requirements above cannot be met, it is required that additional protection, such as wooden crating, external heat sources, or third-party storage be used to protect the integrity of the unit. Contact WEG Electric Machinery to review the long-term storage plan.

6.4.2.2 Long-Term Outdoor Storage

ATTENTION

Long-term outdoor storage of motors is not recommended.

If outdoor storage cannot be avoided, the motor should be well-protected for the local conditions as described below.

- The unit must be placed well off the ground on heavy wood or other blocking.
- The unit must be placed on stable ground, where flooding, sinking, blowing snow or dust will not contaminate or damage the unit.
- An adequate shelter of wood and multiple layers of plastic must be constructed to protect the exterior of the unit during storage and this structure should be designed to shed rain and snow as well as protect the unit from contamination and excessive changes in temperature.
- Insulating tarpaulins used for concrete insulation may be required to thermally insulate the unit.
- The space heaters must be energized and a visible means of inspection the condition of the circuit such as a light bulb must be used.
- Ensure bearing protective paper is in place prior to lifting (if applicable).

ATTENTION

When storing a unit outdoors, it is critical to understand the local conditions and protect the unit accordingly.

ATTENTION

In case the motor remains stored for long periods of time, it is recommended to inspect it regularly as specified in Maintenance Plan During Storage section of this manual.

6.4.3 Spare Parts

- Components and sub-assemblies shipped separately from the main unit must be treated using the requirements above. All sub-assemblies and components should be identified and stored indoors until they are required for installation onto the main assembly.
- Air relative humidity inside package must not exceed 50%.

6.4.4 Space Heater

The space heater installed in the motor must be energized during storage and whenever the unit is not operating to avoid moisture ingress into the windings. It is strongly recommended to include an easily visible means of inspecting the condition of the space heater circuit.

ATTENTION

The space heater must be energized any time the unit is not operating.

6.4.5 Insulation Resistance

During the storage period, insulation resistance testing of the motor should be completed and recorded according to Table 6-1.

Any significant change or decrease in the insulation resistance level must be investigated.

6.4.6 Exposed Machined Surfaces

All exposed machined surfaces (e.g. shaft end and flanges) must be protected following the next procedures.

- Prior to shipping from WEG Electric Machinery, all machined surfaces such as the shaft journal, coupling flange, and soleplate upper surfaces are protected with a rust inhibitor.
- This protective coating should be reapplied every 6 months.
- If the coating is removed and/or damaged, it must be re-coated immediately.
- Approved rust inhibiting compounds are provided in Table 3-1.

6.4.7 Bearing

- The bearing is factory-protected for long-term storage.
  - The rust inhibiting coating must be inspected and re-applied as needed every 6 months.
- The bearing must be kept enclosed and protected from dust, humidity and other contamination.
- Prior to installing, the bearing must be fully cleaned with solvent to remove the rust inhibiting coating.
- For motors intended for 6+ weeks of storage, install protective bearing paper to prevent bearing damage during shipping.
  - The bearing protective paper must be installed prior to transport, and removed prior to operation.

6.4.8 Electrical Connection Boxes

When the insulation resistance testing of the motor is completed, the main terminal box and accessory boxes must also be inspected according to the following procedure.

- The interior of all connection boxes should be dry, clean of any dust or contamination.
- All electrical contacts should be free of corrosion.
- Grommets or seals should be installed and in good condition without tears or cracks.
- If any item is found damaged or dirty, it must be cleaned or replaced as required.

ATTENTION

The main terminal box is typically shipped separately from the motor. Ensure that the main motor leads are supported and protected from contamination or damage during handling, storage and installation.

6.4.9 Coolers

When the radiator remains for a long period out of operation, it must be drained and dried. The drying may be done with preheated compressed air. During the winter, in case of freezing risk, all the water must be drained, even if the motor remains out of operation just for a short period so as to prevent deformation of pipes or damages to the seals.

NOTE

During short stoppages, it is recommended to keep the water circulation at flow instead of interrupting its circulation through the heat exchanger.

6.4.10 Preparation for Service After Long-Term Storage

6.4.10.1 Cleaning

- The interior and exterior surfaces of all components must be free of oil, water, dust and other contaminants.
  - Painted surfaces may be wiped with clean rags and mild detergents if needed.
  - Electrical conductors must only be cleaned with electrical contact cleaner.
  - Dust or other loose particles may be vacuumed or cleaned with dry, compressed air.
- The corrosion inhibitor on exposed surfaces may be cleaned with solvents and clean rags.
- Ensure that all bearing and shaft components are thoroughly cleaned and free of rust inhibitor, dust, or contamination prior to assembly.

ATTENTION

While cleaning the bearing journal and sleeve, do not wear rings or other jewelry, and ensure that no tools or hard objects scratch or damage the surface.

6.4.10.2 Bearing Lubrication

- After installation of the bearing pedestal, fill the bearing reservoir with a high-grade mineral oil to the halfway point on the sight glass.
- Do not use hydraulic, synthetic, or oils with high detergent content.
- See outline drawing or motor nameplate for required oil viscosity.

6.4.10.3 Checking the Insulation Resistance

Prior to commissioning the motor, a complete set of electrical tests must be completed according to the Section 7 Insulation Resistance.

6.4.11 Maintenance Plan During Storage

During the storage period, the motor maintenance must be performed and recorded in accordance with the plan described in Table 6-1.

Table 6-1: Maintenance Plan for Long-Term Storage

	Monthly	Every 2 Months	Every 6 Months	Every 2 Years	Before Starting Operation	Note
Site Storage Inspection						
Inspect the Area for Cleanliness		X			X	
Verify Humidity and Temperature		X				
Inspect for Insects or Rodents		X				
Package Inspection						
Visual Inspection for Damage			X			
Record Relative Humidity		X				
Change Desiccant			X			As necessary
Space Heater						
Confirm Operation	X					
Complete Motor						
Clean External Surfaces			X		X	
Inspect Painted Surfaces			X			
Inspect Rust inhibiting Coating			X			
Re-Apply Rust inhibiting Coating			X			
Windings						
Measure Insulation Resistance		X			X	
Measure Polarization Index		X			X	
Junction Box and Grounding Terminals						
Clean Junction Boxes			X		X	
Inspect all Seals and Grommets			X			
Inspect Lugs and Terminals			X		X	
Grease or Rolling Bearing						
Spin the Shaft		X				
Relubricate the Bearing			X		X	
Disassemble and Clean the Bearing				X		
Sleeve Bearings						
Spin the Shaft			X			
Apply Anti-corrosive and Dehumidifier					X	
Apply Rust inhibiting Coating			X			
Clean and Install Lubrication					X	

7 INSULATION RESISTANCE

7.1 SAFETY CONSIDERATIONS

DANGER

Insulation resistance testing includes high voltages. Follow the safety procedures provided in IEEE43 Section 4 as well as specific local regulations. Failure to comply with these procedures may result in personal injury.

7.2 GENERAL REMARKS

- The unit should have been stored with activated space heaters and protected from moisture.
- Insulation resistance must be measured prior to motor operation.
- If the windings have absorbed significant moisture, drying may be required prior to operation.
- Insulation resistance and polarity index values must be interpreted by qualified engineers and should be compared against factory data.
  - Contact WEG Electric Machinery or consult the motor test data for factory results.

NOTE

The insulation resistance must be measured using a megohmmeter of sufficient size to provide the required voltage and of sufficient sensitivity to measure the expected leakage current. Ensure that the unit is calibrated and functioning correctly.

7.3 STATOR WINDING MEASUREMENT

DANGER

Insulation resistance testing includes high voltages (see Table 7-1). Failure to comply with these procedures may result in personal injury.

The stator winding test voltage must comply with IEEE43 according to Table 7-1.

Table 7-1: Insulation Resistance Test Voltage

Winding Rated Line-Line Voltage (V-AC)	Insulation Resistance Test Direct Voltage (V-DC)
< 1000	500
1000 - 2500	500 -1000
2501 - 5000	1000 - 2500
5001 - 12000	2500 - 5000
> 12000	5000 - 10000

Prior to the insulation resistance and polarity index tests, the following checks must be completed.

- Ensure that CT secondary connections are shorted.
- Ensure that all power cables are disconnected and secured.
- Ensure that motor frame and windings not being tested are properly grounded.
- Ensure winding temperature is recorded.
- Ensure stator winding temperature sensors are grounded.
- Ensure lightning arrestors and surge capacitors (if installed) are disconnected.
- Ensure bus coupler or other sensing equipment is disconnected.
- Ensure each phase is tested with the neutral bus open and isolated.

It is possible to determine the insulations resistance of the motor stator by connecting a megger between any one of the stator terminals and the frame machine.

The frame must be grounded and the three phases of the stator winding must remain connected to the neutral point, as shown in Figure 7-1.

a) b)

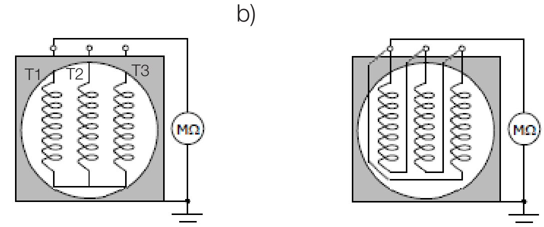


Figure 7-1: Connection of the Megohmmeter to the Stator Winding

When possible, each phase must be insulated and tested separately. The separate test allows comparing the phases. When a phase is tested, the other two phases must be grounded to the same ground of the frame, as shown in Figure 7-2.

c)

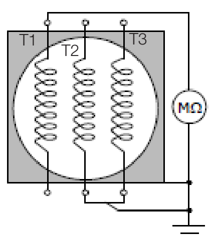


Figure 7-2: Connection of the Megohmmeter to Separate Phases

a) Insulation resistance measurement for star connected winding
b) Insulation resistance measurement for delta connected winding
c) Insulation resistance measurement for one phase of winding.

If the total winding measurement presents a value below recommended, the neutral connections must be opened and the insulation resistance of each phase must be separately measured.
The one-minute reading stator insulation resistance at windings temperature of 40ºC (140 ºF) must be at least:

$$\left(\frac{\text{Rated Voltage of Machine}}{1000}\right) + 1 = \text{Minimum resistance value in megaohms}$$

Minimum resistance value provided in Table 7-2 may be used as a general guide; however, rapid changes in measured insulation resistance values are the most significant indications of a potential problem. If the stator insulation resistance measures less than specified for the voltage rating of the motor, the machine must be dried out until at least the minimum recommended resistance value is obtained. Temperature corrections should be made according to Figure 7-3.

ATTENTION

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

7.4 MEASUREMENT ON ROTOR, EXCITER AND ACCESSORIES

NOTE

The test voltage for the main rotor, exciter rotor, and exciter stator is 500 Volts DC.

7.4.1 Measurement of Main Rotor Insulation Resistance

- Disconnect the main rotor leads (Identified MF1-MF2) from the diode wheel.
- Connect the megohmmeter between the rotor lead (MF1) and the motor shaft.
- Typically, the diode wheel bolts are bare metal, and may be used to electrically connect to the shaft.

7.4.2 Measurement of Exciter Stator Insulation Resistance

- Disconnect the exciter power supply cables (Identified EF1-EF2) within the exciter junction box.
- Connect the megohmmeter between the exciter lead (EF1) and the motor frame.
- Typically, there is a ground lead in the exciter junction box which is connected to ground.

7.4.3 Measurement of Exciter Rotor Insulation Resistance

- Disconnect the three exciter rotor leads (Identified T1, T2, T3) from the diode wheel.
- Connect the megohmmeter between the exciter rotor lead (T1) and the motor shaft.
- Typically, the diode wheel bolts are bare metal, and may be used to electrically connect to the shaft.

DANGER

After each insulation resistance test has been completed, ground the tested lead to completely discharge it.

7.5 CONVERSION OF MEASURED VALUES

If the insulation resistance testing is conducted at a temperature other than 40ºC (104ºF), the resistance values must be corrected to 40ºC using the temperature correction coefficient provided in IEEE43. The measured insulation resistance may be multiplied by the coefficient read in the plot below for the winding temperature, and this corrected value recorded for comparison to other, corrected data.

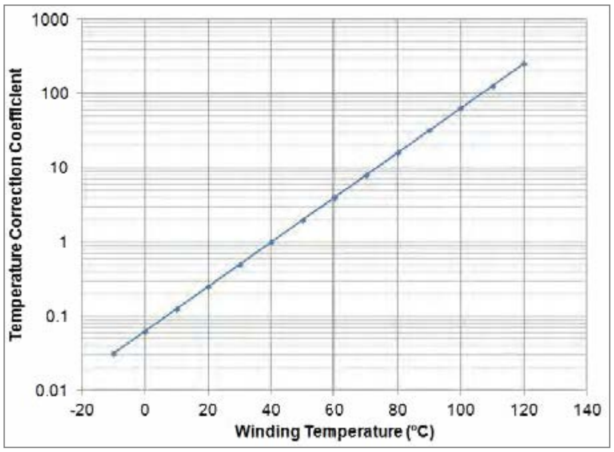


Figure 7-3: Plot of Temperature Correction Coefficient vs. Winding Temperature

The age of the unit, contamination on the windings, humidity, time out of service, and other factors will affect the insulation resistance measurement. The limits provided in Table 7-2 may be used as a general guide; however, rapid changes in measured insulation resistance values are the most significant indications of a potential problem.

7.6 MINIMUM INSULATION RESISTANCE

If the measured insulation resistance of the main stator or rotor windings falls below those values given in Table 7-2, or if the values have decreased significantly during the storage interval, the windings must be dried according to the procedure below prior to operation.

Table 7-2: Minimum Insulation Resistance

Component	Insulation Resistance (New Units)	Insulation Resistance (Existing Units)	Insulation Evaluation
Stator Windings	-	Line Voltage (kV) + 1	Acceptable if Greater than (Eg, 13.8kV unit should be >15MΩ)
Salient Pole Rotor	2MΩ	1MΩ	Acceptable if Greater
Exciter Stator	100MΩ	1MΩ	Acceptable if Greater
Exciter Rotor	100MΩ	1MΩ	Acceptable if Greater

NOTE

It is recommended to maintain a record of insulating resistance measurements for each motor. These measurements, taken at regular six month, will provide a means of detecting a gradual deterioration of the winding insulation.

7.6.1 Drying the Windings Using External Heat

The easiest and most convenient method of drying out motor consists of placing the complete, or partially disassembled, machine in an oven. The motor can also be moved to an enclosure heated by steam pipe or electric heaters. Openings at both top and bottom of enclosure will allow moisture to be carried off. A maximum temperature in the enclosure of 85˚ C (185˚ F) is recommended. External heat also can be applied by placing space heaters beneath the motor to obtain an even distribution of heat along the length of the unit. Care must be taken to provide adequate air circulation to ensure a complete and thorough drying process. Degree of "wetness" or moisture in winding must be considered in rate of rise. The wetter the winding, the slower the rise. If the temperature is increased too rapidly, high local pressure may build up as moisture in the insulation vaporizes.

ATTENTION

- The temperature of the motor should be raised slowly to avoid building up excessive vapor or gas pressure which could prove harmful to the insulation.
- Do not exceed a temperature rise of 10°C (18°F) per hour.
- Do not allow any part of the windings or unit to exceed 85°C (185°F).

7.6.2 Drying the Windings Using Short Circuit

The stator can be dried out by driving the motor at normal speed with a driving motor and with the terminals shorted circuited. Field excitation should be just enough to cause rated full-load stator current flow in the stator windings. This may require extra resistance in series with the exciter field winding to limit stator current.

ATTENTION

Do not hurry the drying-out process. Never permit the temperature of the motor to exceed the maximum allowable temperature rise marked on the data plate.

7.6.3 Drying the Windings Using Direct Heat

- Apply heat to the unit using external heaters, blowers, lamps, or other external sources.
- Allow humid air to escape from the unit by removing all protective plastic, or removing covers in the case of TEWAC or TEAAC units.
- Do not allow any part of the windings or unit to exceed 85ºC (185ºF).
- The temperature and current must be monitored at all times during this test to prevent any damage to the windings or other components.
- Measure the insulation resistance at least every two hours to determine the status of the drying process.

7.6.4 Drying the Windings Using Direct Current

- Apply direct current to the stator windings using a welding machine or other suitable device.
- Ensure that the external source has adjustable voltage and is rated for the necessary current.
- The applied current must not exceed 50% of the rated nameplate stator current.
- Do not allow any part of the windings or unit to exceed 65ºC (150ºF).
- The temperature and current must be monitored at all times during this test to prevent any damage to the windings or other components.
- Measure the insulation resistance at least every two hours to determine the status of the drying process.

NOTE

For the application of direct current, apply the voltage to all three phases in series or all three phases in parallel to ensure uniform heating.

ATTENTION

Do not exceed 50% of the rated nameplate current at any time. Do not permit the temperature to exceed the values listed to avoid damage to the windings or insulation.

Continue the drying process until the insulation resistance reaches an acceptable value as per Table 7-2. Typically, a humid winding will show a significant increase in resistance after 24 - 48 hours.

7.6.5 Drying Out Check

After the insulation resistance rapidly drops with increasing winding temperature, it will slowly rise as the moisture is driven off and finally will level off to a steady value as shown in Figure 7-4. Once a steady acceptable value of insulation resistance is read on the megger, the dry-out process can be concluded. Keep a record of insulation resistance checks taken once or twice a year. This will be helpful in detecting deterioration of windings.

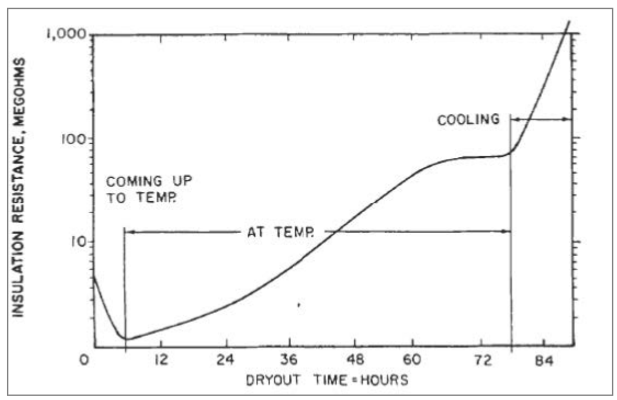


Figure 7-4: Typical Drying Out Curve

7.7 POLARIZATION INDEX

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

$$PI = IR_{10} / IR_1$$

The polarization index allows the evaluation of the motor insulation conditions according to Table 7-3.

Table 7-3: Polarization Index
(Relation Between 10 Minutes and 1 Minute)

Polarization Index	Insulation Evaluation
1 or less	Unacceptable
< 1.5	Dangerous
1.5 to 2.0	Marginal
2.0 to 3.0	Good
3.0 to 4.0	Very Good
> 4.0	Excellent

Class F insulated windings are expected to have polarization index values greater than two.

- The polarization index test is typically conducted on each phase at 1000 Volts DC.
- If values of insulation resistance are greater than 5000mΩ, the test may not be valid.
- See IEEE43 for details of interpreting the polarization index test or contact WEG Electric Machinery.

DANGER

After each insulation resistance test has been completed, ground the tested lead to completely discharge it.

8 COMPONENTS OF A SYNCHRONOUS MOTOR

The main components in a synchronous motor are:

- Stator
- Rotor
- Brushless Exciter
- Bearings
- Heat Exchanger
- Accessories

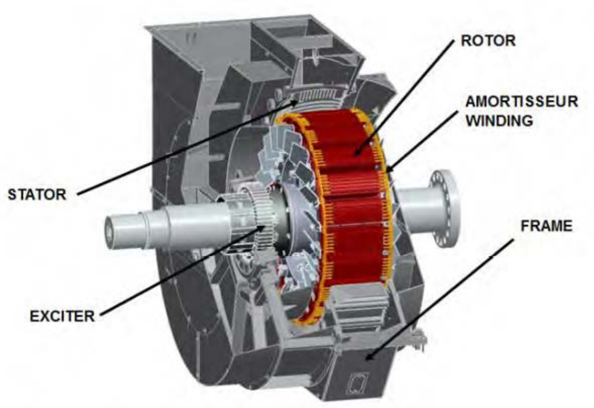


Figure 8-1: Illustration of Typical Synchronous Motor Components

8.1 STATOR FEATURES

- The stator core is a compressed assembly of plated steel laminations.
- The stator windings are secured into the core, treated using vacuum pressure impregnation (VPI), and baked using a proprietary process to provide long-term reliability.
- Windings are typically produced with Class F (NEMA MG1) unless specified by the end user.
- Stator RTDs are installed directly into the stator to measure the hottest operating temperatures.

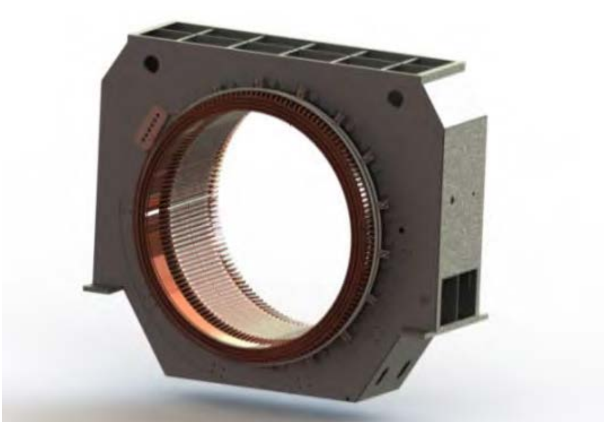


Figure 8-2: Stator

8.2 ROTOR FEATURES

- The synchronous rotor includes both wound poles connected in series and an amortisseur winding or "squirrel" cage designed for starting.
- The salient poles are wound in opposite directions, to produce alternating magnetic fields. These magnetic fields are "synchronized" to the rotating field created by the stator windings.
- The amortisseur winding operates as an induction motor during starting, accelerating the rotor up to near synchronous speed.
- The amortisseur winding also protects the main rotor from electrical resonance and other harmful instabilities.

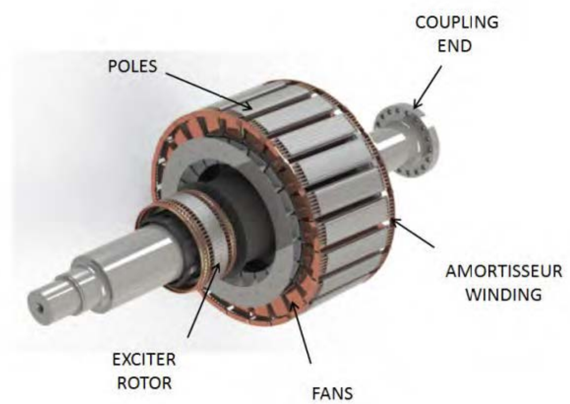


Figure 8-3: Rotor

8.3 BRUSHLESS EXCITER FEATURES

- The brushless exciter assembly consists of a direct current (DC) powered generator stator which induces an alternating current (AC) in the exciter rotor during rotation.
- This three-phase AC current is delivered to a rotating rectifier wheel (diode wheel). The diode wheel converts the AC current to DC, and supplies this rectified current to the main rotor field.

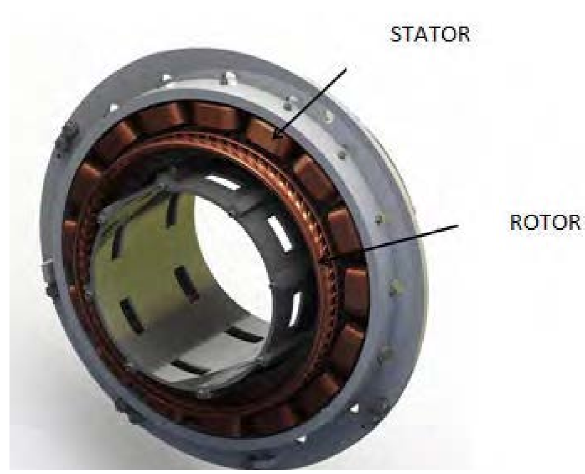


Figure 8-4:Exciter Rotor and Stator

8.4 ROTATING RECTIFIER (DIODE WHEEL) FEATURES

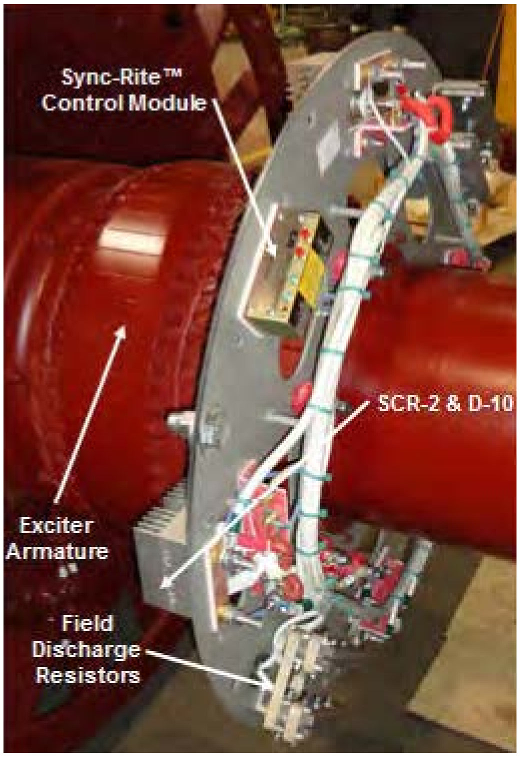


Figure 8-5: Diode Wheel Components

8.4.1 Startup

- During startup, the amortisseur (squirrel cage) windings in the main rotor are energized by the rotating magnetic field in the stator.
- The amortisseur windings create a torque in the rotor which causes it to accelerate in the direction of the rotating magnetic field of the stator.
- A large induced current develops in the rotor pole windings, and this is converted to heat in the field discharge resistors (FDRs).
- The FDR circuit is activated by closing SCR2.
- The "RED" LED lights on the Sync-Rite control module indicate the presence of the FDRs in the circuit.

8.4.2 Synchronization

- As the unit accelerates, the Sync-Rite™ control module and Sync-Rite™ Filter monitor the speed of the rotor compared to the rotating field of the main stator.
- As the induced voltage wave from the rotor passes through the FDRs, the Sync-Rite™ controller attempts to gate SCR1 and energize the main field. This is indicated by the "GREEN" LED lights on the Sync-Rite™ control module during startup. The "GREEN" LED lights on the Sync-Rite™ control module indicate when the SCR1 if off.
- When the rotor speed achieves 95% of its synchronous speed, the Sync-Rite™ module applies the current from the brushless exciter to the main rotor, and the rotor "pulls-in" to the rotating magnetic field developed in the stator windings. (Note: Sync-Rite™ values may be set between 92% and 98% depending on the application). The "GREEN" LED lights will turn off when the SCR1 is gated on.
- If the unit successfully synchronizes, the excitation current will stabilize and the main stator current will decrease to the unloaded value.
- On the Sync-Rite Plus™ the "BLUE" LED light will be on when the motor is synchronized. On all other Sync-Rite™ models, the LED lights on the Sync-Rite™ control module will be off.

NOTE

The Sync-Rite Plus™ has a blue indicator light to show when the motor is synchronized.

8.4.3 Normal Operation

- During normal "synchronized" operation, the diode wheel rectifies the AC current from the brushless exciter and provides the current to the main rotor.
- The voltage passed to the main rotor determines the power factor of the motor and is controlled by adjusting the DC excitation voltage provided to the brushless exciter stator.
- The SCR2 is open and the FDRs are not included in the circuit.

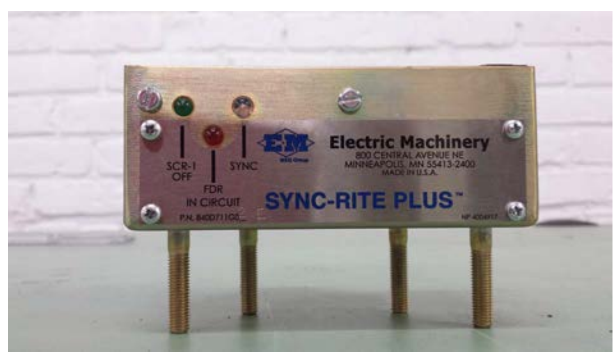


Figure 8-6: Standard Sync-Rite Plus™

In Figure 8-7, the outer dashed line represents components located on the synchronous motor, and the inner dashed line represents rotating components. The Field Application Circuit includes both the Sync-Rite Plus™ and Sync-Rite Plus™ Filter modules.

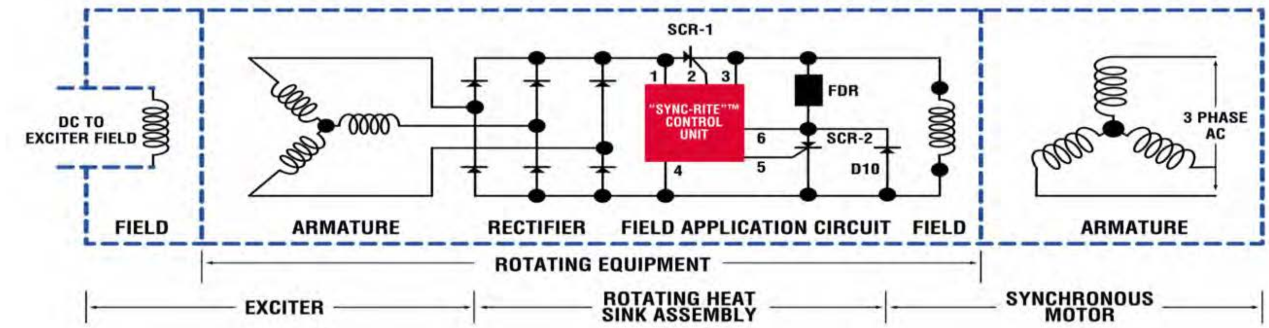


Figure 8-7: Excitation Control Circuit

8.5 BEARING FEATURES

- The typical bearing is located at the non-drive (exciter) end of the motor and is placed on a pedestal.
- The bearing is a sleeve or fluid type design with Babbitt applied to the sleeve surface to protect the shaft.
- The bearing is a split-sleeve design, with oil ring lubrication and radiant cooling.
- The bearing is conservatively-sized to accommodate the weight of the rotor and all dynamic loads applied during operation and transient conditions.

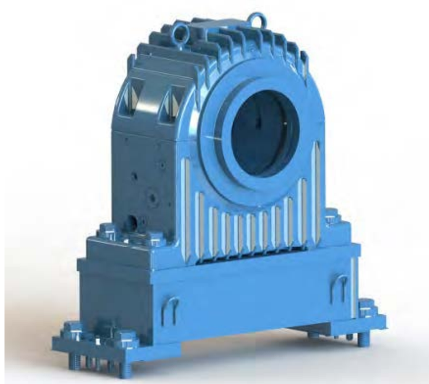


Figure 8-8: Bearing Pedestal

8.6 HEAT EXCHANGER

8.6.1 Heat Exchanger Features – WPI, WPII, TEFV, and Drip-Proof Units

- Heat is transferred directly from the stator windings to air using forced convection.
- The air is moved either by fan blades connected to the rotor, or an external fan arrangement.
- The warm exhaust air is vented out the top enclosure to atmosphere.
- Cool, ambient air passes through a set of filters, and enters the unit through the top enclosure.

8.6.2 Heat Exchanger Features – TEWAC and TEAAC Units

- Heat is transferred directly from the stator windings to air using forced convection.
- The air passes through a water-to-air or air-to-air heat exchanger which reduces the bulk temperature.
- The cooled air cycles back through the unit.
- A small amount of atmospheric air is allowed to enter the unit through a makeup air filter to prevent dangerous pressures building due to changes in temperature.
- Some units include a pressurization module which allows the unit to operate in IEC Zone I or II areas. Special installation and operation instructions are provided with these units.

8.7 ACCESSORIES

Accessories include sensors which monitor the condition of the motor, as well as any special equipment requested by the end user. Examples of common accessories are given below.

- Resistive temperature detectors (RTD) on stator windings
- RTDs on bearing sleeve
- RTDs on heat exchanger (air in, air out, water in, etc.)
- Displacement probes on bearing
- Tachometer to measure rotation of shaft
- Velocity probes on bearing pedestal or frame
- Stator space heater
- Bearing oil reservoir heater
- Current transformers (CTs) in main terminal box
- Surge capacitor, lightning arrestor, bus coupler for partial discharge (PD) monitoring

9 INSTALLATION

The care and workmanship of the motor installation will have a significant impact on the reliability and operational life of the unit. If any doubts exist regarding the sections below, consult WEG Electric Machinery or request field engineering support prior to critical installation steps. At a minimum, API 686 and NEMA MG2 should be consulted as references to determine the requirements for proper installation.

ATTENTION

Installation is a critical step in the commissioning of a motor. Ensure installation is performed by well-trained personnel, familiar with API 686, NEMA MG2 and all of the requirements of this manual.

9.1 LOCATION

The final location of the motor will typically be determined by the location of the machine it is to drive. In general, locate the motor in a clean, well ventilated area, accessible for inspection and maintenance. Unless the motor includes special enclosures, do not install in areas of excessive moisture, dust, pulp or other contamination.

Minimum considerations required when selecting a suitable location are:

- The conditions in the proposed area must match the type of enclosures and heat exchanger unit provided with the motor.
- The environment must be free of harmful or corrosive gases.
- Adjacent equipment, walls, buildings etc. must not interfere with the ventilation of the unit.
- Sufficient overhead space must be available to install and remove the top enclosure.
- Sufficient space must be available around the unit for normal inspection and maintenance.
- Ensure sufficient distance on the non-drive to permit removal of rotor (if desired).

ATTENTION

Ensure the degree of protection matches the actual operating environment of the motor.

9.2 DIRECTION OF ROTATION

The rotation direction is indicated on the motor nameplate as well as in the outline drawing.

ATTENTION

The unit must not be operated in the opposite direction of rotation for extended periods. If reverse direction operation is desired, the rotor fan blades may be reversed.

9.3 COOLING AND VENTILATION

9.3.1 Air Cooled Motors

In air cooled motors, the cooling air passes through the gap between the rotor and stator, and then passes radially through vents located in the stator core. This warm air is then exhausted to atmosphere (WPI, WPII, Drip-Proof, and TEFV) or cooled and recycled (TEWAC and TEAAC). The Figure 9-1 and Figure 9-2 shows the extensive research which determines the optimal airflow in a typical synchronous motor, and this flow must not be altered by modifying components or restricting inlet areas.

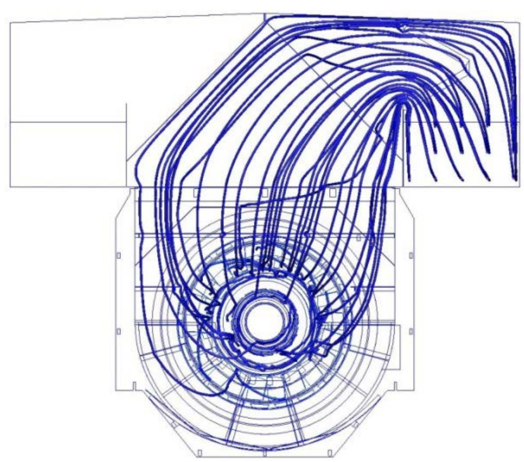


Figure 9-1: Typical Air Cooling System Inflow

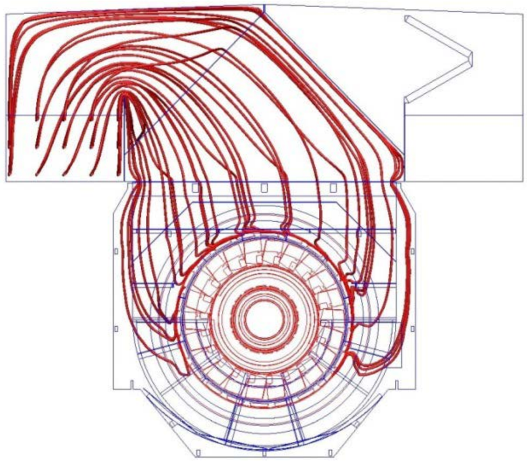


Figure 9-2: Typical Cooling System Exhaust

In all motor types, the cooling air passes through the gap between the rotor and stator, and then passes radially through vents located in the stator core. This warm air is then exhausted to atmosphere (WPI, WPII, Drip-Proof, and TEFV) or cooled and recycled (TEWAC and TEAAC). Figures 9-1 and 9-2 show the extensive research which determines the optimal airflow, and this flow must not be altered by modifying components or restricting inlet areas.

ATTENTION

Do not restrict, cover, block or otherwise impede the air inlet or exhaust of any motor. Restriction may lead to increased temperature with risk of damage to windings.

ATTENTION

The protection devices of the cooling system must be monitored periodically.

9.3.2 Water Radiators

In closed cooling systems air is cooled by radiators after removing heat generated by the equipment.
Clean water, with the characteristics below, must be used as coolant:

- PH: 6 to 9
- Chlorides: maximum 25.0 mg/l
- Sulphates: maximum 3.0 mg/l
- Manganese: maximum 0.5 mg/l
- Suspended solids: maximum 30.0 mg/l
- Ammonia: no traces

ATTENTION

The water inlets and outlets must not be blocked in order to avoid water overheating.

9.3.2.1 Radiators for Application with Seawater

ATTENTION

In case of radiator cooled by sea water all materials in contact with water must be resistant to corrosion. Some radiators may feature sacrificial anodes which are corroded during operation of the heat exchanger, protecting the exchanger heads. In order to keep the integrity of the heads, these anodes must be periodically replaced, according to the corrosion degree presented.

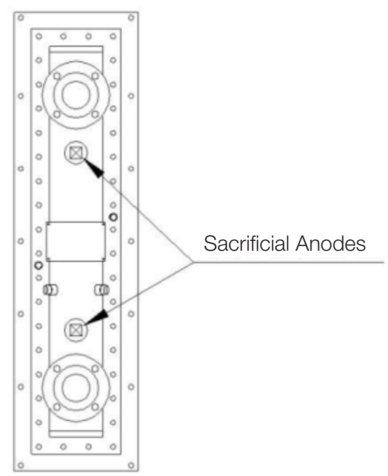


Figure 9-3: Radiator with Sacrificial Anodes

9.4 PRESSURIZATION AND PURGE SYSTEM

Pressurized units are provided for operation in Zone I or II environments and must be installed following the additional requirements provided in the purge assembly manual.

9.5 BRAKE

For further information on installation, operation and maintenance of the brake (if applicable), refer to the dimension drawing of the motor and specific manual of this equipment.

9.6 MOTOR DIMENSIONS

Overall motor dimensions and mechanical details are provided in the outline drawing.

9.7 MOTOR ELECTRICAL CONNECTIONS

All electrical connections which must be made by the erector are featured in the electrical connection drawing. All electrical connections must be made in accordance with this drawing as well as NFPA 70 and any local, state, federal, or other applicable regulations. Ensure that long leads are sized to prevent losses or heating of cables.

9.8 POWER FACTOR REGULATION

Several types of power factor control options are provided by WEG Electric Machinery as well as third-party suppliers. The range of power factor allowed during operation must comply with the nameplate data of the motor. Excessive leading power factor may cause high temperatures in the rotor windings while excessive lagging power factor may cause high temperatures in the stator windings. Either of these conditions will have a detrimental impact on the life of the motor and must be avoided by careful programming of the power factor control module.

9.9 EXCITER POWER SUPPLY AND CONTROL

The exciter power supply typically includes protection against loss-of-field and other abnormal operating conditions. WEG Electric Machinery provides both standard (analog) and advanced (digital) excitation power supply options which are sized for the motor to which they are matched.

ATTENTION

Ensure that the nominal rating of the AC supply to the exciter power supply module is at least 30% greater than the maximum excitation power required on the motor nameplate.

10 MECHANICAL INSTALLATION

10.1 FOUNDATION AND GROUTING

The design and construction of the foundation and grouting is ultimately the responsibility of the erector and end user, however, the following requirements are provided as a guide to quality design and installation practices.

API 686 states: *"The foundation design shall be capable of resisting all applied dynamic and static loads specified by the machinery manufacturer, loads from thermal movement, dead and live loads as applicable or as specified in the local building codes, wind or seismic forces, and any loads that may be associated with installation or maintenance of the equipment."*

ATTENTION

Because of its high compressive strength, chemical resistance, and dimensional stability during drying, all motors must be installed using epoxy-type grout.

NOTE

The design and construction of the foundation and grouting is ultimately the responsibility of the erector and end user. The outline drawing provides the weight (static) loads of all components.

- The operating, short-circuit, and other loads are provided in the outline drawing for the motor.
- The outline drawing also provides the weight (static) loads of all components.
- Stainless steel shims are provided with units to permit adjustment in the vertical direction.
- Jacking bolts and oversized bolt holes are provided to permit adjustment in the horizontal plane.
- It is expected that the anchor bolts will be installed to Figure A-3 or A-4 of API 686 or a similar arrangement which permits extension of the anchor bolts to resist dynamic loads as well as slight adjustments to permit installation of the soleplates onto the foundation bolts.
- Grout should not be poured until the motor has been installed and aligned to the driven equipment according to the following requirements.
  - The stator assembly is adjusted to achieve a main air gap of 5–10% of the nominal value at 8 locations recorded on both ends of the motor and magnetic center is set equally to within 1.5mm (0.060 inches) on both ends of the motor when measured at 8 locations.
- During grout mixing, pouring, and other operations, the motor must be protected to ensure dust, splatter, or other contamination does not contact any surface of the frame or windings.
- Grout should be poured to a height no less than 25mm (1.0 inches) from the bottom edge of the soleplate to ensure sufficient hydraulic pressure is available to force grout under the soleplate.
- Grout height should not exceed the height of the pockets into which the foundation bolts are installed.
- During grout installation, all threaded features and bolts must be protected from contamination.

10.2 BEARING PREPARATION

If the bearing has been properly stored, it will only require disassembly and cleaning prior to installation. The steps below may vary depending on the accessories selected for the bearing.

- Remove any vibration probes, or horizontally-mounted RTD probes from the bearing.
- Remove any seals from the bearing assembly, and the outer cover plate.
- Remove the bolts holding the upper bearing housing and remove the housing.
- Remove the bolts holding the upper bearing sleeve and remove the sleeve.
  - Ensure no metal or other hard objects contact the Babbitt surface of the bearing.
- Remove the oil flinger ring if installed in the bearing.
- Remove any flexible RTD probes from the lower sleeve using their connectors on the lower housing.
- Securely support the weight of the shaft, and lift the shaft approximately 1.0mm (0.040 inches) until the lower bearing sleeve may be easily rotated.
- Remove the lower bearing sleeve.
- Clean all components using clean mineral spirits, and ensure that no residue remains on any surface.
- Clean the bearing cap mating surface of any dry gasket material.
- Reinstall the lower bearing sleeve into the housing in the correct orientation.
- Carefully lower the shaft into position, and remove the support.
- Reinstall any flexible RTD probes into the lower sleeve through their connectors on the lower housing.
- Apply a small amount of oil to coat the bearing surfaces in the lower assembly.
- Reinstall the oil flinger, upper sleeve, and any associated instrumentation.
- Apply gasket material around the bearing cap surfaces and reinstall the bearing cap.
- The lower bearing assembly is now ready to receive the main rotor assembly.

10.3 ALIGNMENT AND LEVELING

10.3.1 Single Bearing Base-mounted Motor

Single-bearing (engine-type) base-mounted motors connected with rigid couplings are typically aligned using the following basic procedure.

- The complete base is mounted on its soleplates and installed on the foundation to closely-align the rotor shaft with the driven equipment. The assembly is positioned vertically using the base jacking bolts.
- The rotor is approximately positioned to align the coupling with the driven equipment.
- The shaft coupling bolts are installed and torque applied to required value.
- The driven equipment is rotated and shaft deflection values recorded.
- The motor bearing pedestal is adjusted to set the required deflection value.
- The stator assembly is adjusted to achieve a main air gap within +/- 5 – 10% of the nominal value at 8 locations recorded on both ends of the motor and magnetic center is set equally to within 1.5mm (0.060 inches) on both ends of the motor when measured at 8 locations.
- All hold-down bolts are tightened to full-load and the shaft deflection checked again.

NOTE

The shaft locking cradle components should be itemized and stored near the unit to be used if the motor must be removed for shipping.

10.3.2 Single Bearing Non-Base-Mounted Motor

Single-bearing (engine-type) non-base motors connected with rigid couplings are typically aligned using the following basic procedure:

- The bearing pedestal is mounted and installed on its soleplate with a nominal shim pack thickness.
- The bearing pedestal assembly is lifted onto the foundation using the soleplate jacking bolts to support and level the bearing assembly.
- The stator is mounted on its soleplates using a nominal shim pack thickness and the complete assembly mounted on the foundation using the soleplate jacking bolts to support and level the stator.
- The rotor is inserted into the stator. This activity may be performed prior to stator installation depending on the site.
- The rotor is approximately positioned to align the coupling with the driven equipment.
- The bearing pedestal assembly may be adjusted to align the shaft with the driven equipment.
- The shaft coupling bolts are installed and torque applied to required value.
- The driven equipment is rotated and shaft deflection values recorded.
- The motor bearing pedestal is adjusted to set the required deflection value.
- The bearing pedestal is adjusted so that shaft is mechanically centered in the bearing.
- The stator assembly is adjusted to achieve a main air gap within +/- 5 – 10% of the nominal value at 8 locations recorded on both ends of the motor and magnetic center is set equally to within 1.5mm (0.060 inches) on both ends of the motor when measured at 8 locations.

10.3.3 Two Bearing Base-Mounted Motor

Two-bearing motors connected with rigid or flexible couplings are typically aligned using the following basic procedure.

- The complete motor assembly is approximately positioned to align the coupling(s) with the driven equipment. Parallel and angular runout is measured and the motor assembly position adjusted to achieve the values required by the coupling manufacturer or driven equipment. See Figure 10-1.
- The shaft coupling bolts are installed and torque applied to required value.
- All hold-down bolts are tightened to full-load and parallel and angular runout is checked again.
- If needed, the stator assembly is adjusted to achieve a main air gap within +/- 5 – 10% of the nominal value at 8 locations recorded on both ends of the motor and magnetic center is set equally to within 1.5mm (0.060 inches) on both ends of the motor when measured at 8 locations.

DANGER

Extreme care must be taken when lifting the stator, rotor, and other assemblies. Serious injury may result from improper lifting methods or falling components.

ATTENTION

The installation and alignment of the motor assembly requires experienced, highly-skilled personnel familiar with the installation of large equipment. The procedures above are not exhaustive and require careful planning to protect surfaces during rotor installation and other critical activities. Contact WEG Electric Machinery in case of any questions regarding the proper installation or alignment.

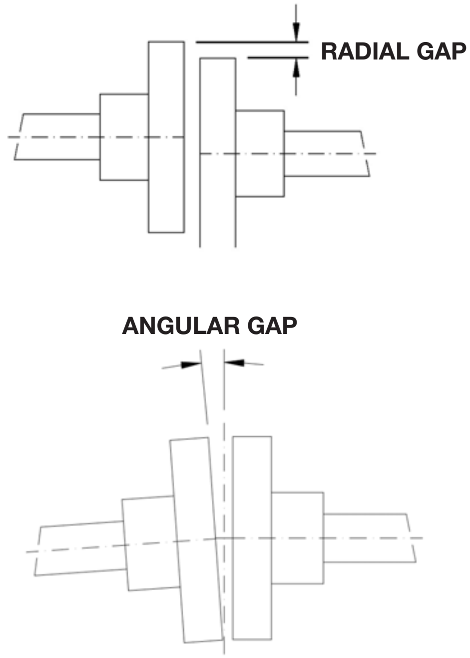


Figure 10-1: Parallel and Angular Misalignment Measurements

10.4 MAGNETIC CENTER (IF APPLICABLE)

Magnetic center (if applicable) is a reference position which is determined as the location of the rotor in the stator where no axial forces are generated by the magnetic fields. The rotor is positioned on magnetic center during installation at WEG Electric Machinery, and no adjustment is required by the customer. Three lines are scribed on the shaft of the motor to indicate the maximum bearing thrust limits (outer lines) and magnetic center (inner line). Unless specified on outline drawing, shaft is scribed to indicate magnetic center and end float limits on either direction. Exciter stator is shimmed to axially align stator and rotor cores. Customer to provide 4.7752mm (0.188 inches) limited end float to hold rotor on magnetic center with ± 3.175mm (0.125 inches) to prevent performance degradation.

Magnetic center is a reference position which is determined as the location of the rotor in the stator where no axial forces are generated by the magnetic fields. The magnetic center may be accurately verified using the following procedure and Figure 10-2.

- Using two, small, parallel rods; touch the outermost stator lamination and simultaneously the outermost rotor lamination, as shown in Figure 10-2.
- Ensure that the rods are touching the actual laminations, and not insulating plates, brackets, or other features.
- Pinch the rods carefully and remove them to preserve the axial distance measurement.
- Record the distance at 8 positions on each side of the unit and ensure that the measurements are consistent on each side (in plane) and the average measurements on each side are equal to within 1.5mm (0.060 inches).

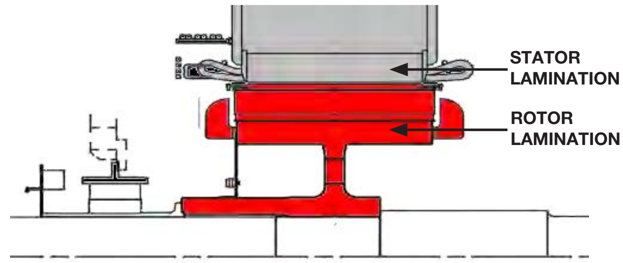


Figure 10-2: Magnetic Center

10.5 BEARING CENTER – MECHANICAL CENTER

Mechanical center is a position determined by the nominal distance from features located on the shaft, to their respective contact surfaces on the bearing sleeve. Mechanical center may be accurately verified using the following procedure and Figure 10-3.

- Using a set of feeler gages or other accurate instrument, measure the axial distance from the outer face of the bearing sleeve to the shoulder machined into the shaft journal.
- For single-bearing units, only one shoulder will be present.
- Ensure that the axial distance matches the dimensional requirements provided in the outline drawing.
- For two-bearing units, unless clearly specified on the outline drawing, ensure the axial distance on each side of the drive end bearing is equal when the unit is coupled and located at its nominal position.
- Unless clearly indicated, the bearings are not designed to withstand axial forces. The drive train must be designed to ensure all thrust or other axial forces are restrained by the driven equipment.

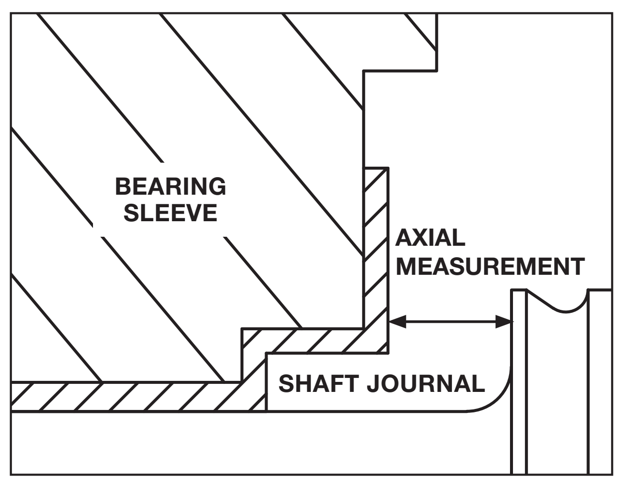


Figure 10-3: Bearing Mechanical Center

10.6 BEARING CLEARANCE

In addition to mechanical center, the bearing clearance must be measured and recorded prior to operating the unit. The following procedure may be used to accurately measure the bearing clearance.

- With the motor coupled, and all hold-down bolts installed, the bearing cap and upper sleeve may be removed.
- Place lead wire or Plastigage® at two positions along the shaft journal (inboard and outboard).
- Install the upper bearing sleeve and tighten its hold-down bolts.
- Remove the upper bearing sleeve and record the thickness of each strip.
- The deviation must be less than 0.025mm (0.001 inches) per foot of axial distance.
- If the deviation is larger than the requirement above, the bearing position must be corrected.

ATTENTION

The bearing is insulated to prevent shaft currents from circulating through the bearing sleeve. It is critical to ensure that the bearing insulation is not shorted when installing or performing inspections on the bearing assembly.

11 POST-GROUTING INSTALLATION

The grout must be poured according to API 686 Chapter 5 once the motor is found to be in acceptable alignment with the driven equipment. Once the grout has been installed and allowed to cure according to the manufacturer's procedure, the alignment steps in Sections 10.3 through 11.7 are repeated and any final adjustments are made. If this final alignment is found to be acceptable, the installation may continue.

11.1 SOFT FOOT INSPECTION

The foundation must be inspected for a soft foot condition prior to applying full torque to all hold-down bolts. The foundation bolts which pass through the motor soleplate must be loosened and a dial-indicator placed on the soleplate to measure the vertical deflection between the soleplate and foundation. When the foundation bolt is tightened to its full-load torque, no more than 0.025mm (0.001 inches) of deflection is allowed. This check must be performed at each foundation bolt during the tightening process.

11.2 HOLD-DOWN BOLT INSTALLATION

The motor and bearing pedestal hold-down bolts were installed and tightened prior to grouting, but must be verified after the grout has cured. Remove each bolt, inspect the threads for any grout residue or other contamination, and lubricate both the threads and underside of the bolt head with lubricant (see Table 3-1). Install the bolts and tighten using a torque wrench and multiplier (if necessary) to the value prescribed on the outline drawing. Hydraulic tools apply large side-loads onto standard-head bolts and must not be used for the hold-down bolts on the motor assembly. Each hold-down bolt must be permanently marked using a paint pen or other marking tool with a straight line starting at the center of the bolt head, and continuing down the side of the washer to the base material. This indicating line permits a simple inspection method and ensures no change in the bolt's position during operation.

11.3 DOWEL PIN INSTALLATION

At least 4 sets of dowel pins were provided with the motor for the bearing pedestal, exciter stator ring, exciter mounting bracket, and main motor foot. Pilot holes are provided in each of the locations where dowel pins are required, and these holes must be drilled and reamed to a close fit with the corresponding dowel pin. Industrial magnetic base drills and sharp tools are required to ensure a good fit between the pins and their respective holes.

ATTENTION

All hold-down bolts must be installed and marked, and all dowel pins installed prior to operation of the unit.

11.4 BEARING REASSEMBLY

Once the bearing clearance has been verified, the bearing may be reassembled. The following procedure may be used as a guide with different steps required for different optional accessories and instrumentation.

- Ensure all traces of lead wire or Plastigage® have been removed and all surfaces are clean.
- Reinstall the upper bearing sleeve and tighten bolts.
- Carefully install the oil slinger ring and tighten all hardware.
- Ensure locating pins are flush with the outer surface of the ring to prevent catching on the bearing sleeve.
- Install the labyrinth oil seal assembly.
- Fill the bearing reservoir with the appropriate oil up to a 50% level in the oil sight glass.
- Rotate the oil slinger ring several times to ensure it rotates freely and delivers oil to the sleeve.
- Apply a thin layer of gasket material to the mating surface between the upper and lower bearing housing.
- Reinstall the upper bearing housing and torque all bolts.
- Install the tachometer adapter (if supplied) and end cover plate.
- Install the outer oil seals and ensure they are concentric with the shaft to within 0.6mm (0.025 inches).

11.5 EXCITER AIR GAP

The exciter air gap may be adjusted by measuring the gap at 8 locations from the outboard end of the exciter, and jacking the stator frame using the supplied jacking bolts. The final exciter air gap must be uniform to within 5-10% of the nominal value when measured at 8 locations around the exciter. The axial exciter position must also be verified using the same technique used for the main air gap in Section 10. Exciter stator shims are provided if axial adjustment is required.

11.6 DIODE WHEEL

Once the exciter air gap has been verified, the diode wheel may be installed. A series of bolts secures the wheel to the exciter rotor, and the wheel must be oriented to allow the 5 electrical connections to be made. There are two connections to the main rotor field (clearly marked MF1 and MF2) as well as three connections to the exciter rotor (clearly marked L1, L2 and L3). Secure all connections and check the tightness of all hardware on the diode wheel to ensure no components have become loose during transport or storage.

11.7 ENCLOSURES

Once all air gap and alignment steps have been completed, the enclosures may be installed. The enclosures are typically installed using the procedure provided below, but the procedure may require modification to suit a particular end user site.

- Ensure all interior surfaces are clean and no materials, tools, or debris are left in the unit.
- The lower enclosures may be installed on both ends of the unit – install all bolts but do not tighten.
- The upper enclosures may be installed on both ends of the unit – install all bolts but do not tighten.
- The top enclosure (WPI, WPII, TEWAC, or TEAAC) may be installed into position – do not tighten nuts.
- Install the large diode wheel inspection covers – install all bolts but do not tighten.
- Install the shaft seals on bolt sides of the unit – install all bolts but do not tighten.
- Lifting the lower enclosures, make adjustments until the lower shaft seals fit snugly around the shaft.
- Tighten the lower enclosure bolts.
- Make adjustments in the upper enclosure position until the upper shaft seals fit snugly around the shaft.
- Tighten the upper enclosure bolts.
- Tighten the top enclosure nuts.
- Tighten all shaft seal bolts, diode wheel inspection cover bolts, and any ducting provided with the unit.
- Install and tighten all ground wires, external instrumentation, conduit, plugs, or other hardware provided with the motor according to the outline drawing.

12 ELECTRICAL SYSTEM INSTALLATION

12.1 ELECTRICAL CONNECTIONS

To ensure all connections are carried out correctly, refer to the electrical connection diagram provided with the motors well as NFPA 70 and any local, state, federal, or other applicable regulations.

12.2 PRIMARY POWER SUPPLY

The quality of the primary power supply will have a strong impact on the reliability and operational life of the motor. The variation in voltage and frequency of the primary power supply must conform to NEMA MG1 Part 21.

12.3 TYPICAL HIGH VOLTAGE CONNECTIONS

- The main stator leads are routed to the main terminal box.
- The leads are identified as T1, T2, and T3 (which is equivalent to L1, L2, and L3 or U1, V1, and W1).
- The neutral leads are identified as T4, T5, and T6.

ATTENTION

The motor has a Rotation Direction Arrow on the non-drive end side. Ensure proper rotation during commission or reverse two leads to correct rotation.

12.4 PRIMARY ELECTRICAL PROTECTION

The motor must be protected against excessive voltage, current, phase imbalance and other dangerous conditions using a motor protective relay. The programming of this protective relay must be completed prior to putting the motor into operation, and must respect the specifications of the motor nameplate as well as IEEE 242 or another approved protection specification.

12.5 MOTOR INSULATION RESISTANCE

- Prior to completing the electrical connections between the motor and end user power supply, the insulation resistance of all components must be tested according to Section 7.
- If drying is required, it may be completed according to Section 7.6.
- The high voltage leads supplied to the motor should also be tested using an appropriate method.

12.6 ACCESSORY CONNECTIONS

The exciter stator, space heater, and all instrument connections are made in their respective terminal boxes.

- Verify all connections in the electrical connection drawing.
- Ensure that all connections are made with appropriately sized lugs.
- Ensure that unused CT connections are shorted to prevent high voltages.
- Ensure that incoming cables are sized appropriately for the current and cable length according to NFPA70.

ATTENTION

Failure to adequately monitor the provided instrumentation with alarm and trip limits provided may void the terms of the warranty.

12.7 EXCITER FIELD SUPPLY AND CONTROL

The exciter field supply should be set to match the current requirements of the outline drawing and operationally verified once the unit is energized.

12.8 GROUNDING

- Stainless steel ground pads are located on the motor frame.
- Grounding pads are also located on the main terminal box.
- Verify all ground locations on the outline and electrical connection drawing.
- Ensure that all connections are made with appropriately sized lugs.

ATTENTION

Proper grounding of the unit and all terminal boxes is critical to safe operation. Ensure that all ground connections are sized according to IEEE142 or local regulations.

12.9 TERMINAL BOX AND LEAD THROAT

The main terminal box and lead throat are typically installed after grouting of the motor and final adjustments are made. The following procedure may be used as a guide to installation.

- Lift the lead throat into position and route the motor leads through.
- Install the lead throat on the motor and install bolts – do not tighten.
- Lift the main terminal box into position and route the leads into the box through the hole provided.
- Set the main terminal box down on the base constructed by the end user and use temporary blocking or other spacers to set the approximate height and position.
- Install the bolts connecting the lead throat to the main terminal box – do not tighten.
- Check the level of the main terminal box, operation of the door, and access to all accessory boxes.
- Tighten all bolts on the lead throat.
- Complete all electrical connections according to the outline drawing and sections above.
- Install permanent shims or other features and tighten the main terminal box to its base.

13 THERMAL PROTECTION COMMISSIONING

The motors include temperature sensors, which are protection devices to prevent excessive temperature rise (in case of overloads, motor stuck, low voltage, and lack of ventilation of the motor).

13.1 TEMPERATURE SENSORS

13.1.1 Thermocouple

A thermocouple is a sensor for measuring temperature. It consists of two dissimilar metals, joined together at one end. When the junction of the two metals is heated or cooled a voltage is produced that can be correlated back to the temperature. The thermocouple alloys are commonly available as wire.

13.1.2 Thermistors

A thermistor is a temperature-sensing element composed of sintered semiconductor material which exhibits a large change in resistance proportional to a small change in temperature. Thermistors usually have negative temperature coefficients which mean the resistance of the thermistor decreases as the temperature increases.

13.1.3 Resistance Thermometers (RTDs)

Resistance thermometers, also called resistance temperature detectors (RTDs), are sensors used to measure temperature by correlating the resistance of the RTD element with temperature. Most RTD elements consist of a length of fine coiled wire wrapped around a ceramic or glass core. The RTD element is made from a pure material, typically platinum, nickel or copper. The material has a predictable change in resistance as the temperature changes and it is this predictable change that is used to determine temperature. The detector terminals must be connected to a control panel with a temperature meter.

Figure 13-1: Typical RTD

13.2 THERMAL PROTECTIONS

The temperature sensors are installed on the main stator, bearings and other component parts that require temperature monitoring and thermal protection. The terminals of the temperature sensors are available in the accessory box. The sensors must be connected to an external temperature monitoring and protection system.

13.2.1 Stator Winding Temperature Detectors

- The stator RTD measurements protect the windings from thermal damage and excessive temperatures.
- The alarm and trip values are located on the outline drawing and must be programmed into the relay which monitors the stator winding temperatures.
- Once the motor has been commissioned and the nominal operating temperature at full-load is established, it is strongly-recommended to reduce the alarm value to a level approximately 20ºC (36ºF) higher than the maximum, normal operating temperature. This will provide maximum protection while minimizing erroneous alarm signals.
- It is strongly recommended to monitor all RTDs, however, at least three instruments arranged on the three phases of the stator winding must be monitored.
- Grounding pads are also located on the main terminal box.

13.2.2 Bearing Temperature Detectors

- Bearing RTD probes are typically installed in two methods:

1. Stiff probes which are threaded into the bearing housing and pass into the bearing sleeve to a point close to the surface of the bearing sleeve.
2. Probes with a flexible lead which are inserted into the bearing sleeve using a “star” washer or other device which forces the tip of the probe into a hole close to the surface of the bearing sleeve.

- The two types or probes provide a similar measurement of the bearing sleeve temperature and must be monitored by a protective relay.
- The alarm and trip values for the bearing sleeve temperature are provided in the outline drawing.

- Once the motor has been commissioned and the bearing operating temperature at full-load is established, it is strongly-recommended to reduce the alarm value to a level approximately 10ºC (18ºF) higher than the maximum, normal operating temperature. This will provide maximum protection while minimizing erroneous alarm signals.

ATTENTION

Ensure that the bearing insulation is not shorted when installing, commissioning, or inspecting the bearing instrumentation.

13.3 SPACE HEATERS

Figure 13-2: Typical Space Heater

- The space heaters must be energized when the unit is not operating to prevent the ingress of humidity into the windings.
- The space heater circuit may be connected via a relay to the main motor circuit breaker so that the space heaters will energize the moment the main circuit breaker is opened.
- Verify the space heater voltage and current requirements on the outline and electrical connection drawings.

13.4 WATER LEAK SENSOR

Motors with air-water heat exchanger feature a water leak sensor intended to detect water leaks from the radiator into the motor. This sensor must be connected to the control panel, according to the wiring diagram of the motor. The signal of this sensor must be used for alarm.

14 VIBRATION PROTECTION COMMISSIONING (IF APPLICABLE)

14.1 GENERAL NOTES

Synchronous motors operating below 600RPM are factory-balanced statically to comply with API 546. Vibration protection on motors may be located on the motor frame, bearing housing, or directly on the shaft journal in the case of a displacement probe arrangement.

14.2 BEARING HOUSING VIBRATION PROBES

Vibration probes installed on the bearing housing are typically velocity probes and measure the external vibration of the bearing housing structure. The probes are often arranged in the vertical, horizontal, and axial directions, and Table 14-1 provides typical bearing housing probe alarm and trip levels. Once the motor has been commissioned and the nominal full-load vibration is established, it is strongly-recommended to reduce the alarm values to a level 25% higher than the nominal operating value. This will provide maximum protection while minimizing erroneous alarm signals.

Table 14-1: Acceptable Vibration Levels for Bearing Housings

Bearing Housing Velocity Probe Vibration Limits		
	Inches per second (1X)	mm per second (1X)
Maximum Normal Operation	0.0001 X RPM	0.0025 X RPM
Alarm	0.0002 X RPM	0.0050 X RPM
Shutdown	0.0003 X RPM	0.0075 X RPM

Where: RPM is the operating speed of the motor.

14.3 FRAME VELOCITY PROBES

Frame vibration probes installed on the stator frame are typically velocity probes and measure the external vibration of the stator frame. The probes are typically arranged in horizontal directions and Table 14-2 provides typical frame housing probe alarm and trip levels. Once the motor has been commissioned and the nominal full-load vibration is established, it is strongly-recommended to reduce the alarm values to a level 25% higher than the nominal operating value. This will provide maximum protection while minimizing erroneous alarm signals.

Table 14-2: Acceptable Vibration Levels for Frame Velocity Probes

Frame Velocity Probe Vibration Limits		
	Inches per second (1X)	mm per second (1X)
Maximum Normal Operation	0.0002 X RPM	0.0050 X RPM
Alarm	0.0004 X RPM	0.0100 X RPM
Shutdown	0.0006 X RPM	0.0150 X RPM

Where: RPM is the operating speed of the motor.

14.4 SHAFT DISPLACEMENT PROBES

The shaft displacement probes typically installed on a bearing include a pair of probes arranged radially, with 90 degrees between them. The probes must be installed so that the distance between the probe and shaft surface is accurately set to meet the probe manufacturer's requirements. For typical applications, Table 14-3 provides shaft displacement probe alarm and trip levels. Once the motor has been commissioned and the nominal full-load vibration is established, it is strongly-recommended to reduce the alarm values to a level 1.0 mil pk-pk [25 μm pk-pk] higher than the nominal operating value. This will provide maximum protection while minimizing erroneous alarm signals.

Table 14-3: Acceptable Vibration Limits for Shaft Displacement Probes

Shaft Displacement Probe Vibration Limits		
	mils pk-pk (1X)	μm pk-pk (1X)
Maximum Normal Operation	2.0	50
Alarm	4.0	100
Shutdown	5.0	125

14.5 KEY PHASOR PROBES

If the end user has specified a key phasor or tachometer probe to measure the speed of the drive train, this will typically be installed in the bearing housing. The probe is most-commonly a displacement probe which is aligned to reads a notch cut into the rotor shaft. The displacement probe must be installed per Section 14.

15 COMMISSIONING AND STARTUP

15.1 COMMISSIONING

15.1.1 Pre-Commissioning Inspection

The complete motor assembly and all electrical systems must be thoroughly-tested before startup and after any period of extended storage or disuse. A complete report of all observations and testing should be kept on file with this manual.

The following procedure may be used as a checklist.

1. Check bearing oil level, rotation of oil ring, and installation of seals.
2. It is strongly recommended to rotate the motor using a barring device or other slow turn and check the following:
   a. Check oil slinger ring for rotation.
   b. Listen for any sounds of contact in the motor or exciter area.
   c. Check the shaft seals and oil seals for any evidence of binding or rough contact.
3. Verify alignment of the drive train using crank deflection or other suitable means.
4. Verify that the cooling system is functional (depending on type) and no inlets or exhaust ducts are blocked or restricted.
5. Ensure all temperature instrumentation is installed, functional, and displaying logical data (Section 13).
6. Ensure all ground connections are in place and correctly-sized (Section 12).
7. Ensure that all sources of electrical energy are closed and locked.
8. Ensure all protective relays are energized and properly programmed (Section 12).
9. Ensure winding insulation resistance is within the required values (Section 7).
10. Ensure all hold-down bolts are tight, and all dowel pins are installed (Section 11).
11. Ensure all electrical connections are identical to those on the outline drawing (Section 12).
12. Ensure the excitation power supply is energized and set to the correct output current (Section 12).
13. Verify all accessories and optional instrumentation is energized and functioning.
14. Check if the motor is clean and if all the objects that will no longer be used have been removed from the operation area, such as: packages, tools, measuring instruments and alignment devices.
15. Check if coupling connecting components are in perfect operating conditions, duly tightened and greased, where necessary.
16. Inspect the cooling system. In motors with water cooling, inspect the operation of the radiator water supply system. In motors with forced ventilation, check the direction of rotation of the fans.
17. The motor air inlets and outlets must be clear.
18. Verify pre-startup checklist in API 686, Chapter 9, Section 6 for complete drive train.

ATTENTION

- Avoid any contact with electric circuits.
- Even low-voltage circuits may put life at risk.
- In any electromagnetic circuit, over-voltage may occur under certain operating conditions.
- Do not open the electromagnetic circuit suddenly, because the presence of an inductive discharge voltage may break the insulation or injure the operator.
- In order to open those circuits, driving switches or circuit breakers must be used.

15.1.2 First Startup Procedure

The initial startup of a motor should be completed manually, and should only be for a period of time to verify the following:

1. Rotation of the unit is correct.
2. Inrush current measured is similar to that expected.
3. Unit synchronizes in a reasonable period of time.
4. Main current and excitation current are similar to that expected in the outline drawing.

DANGER

Only authorized and essential personnel should be near the motor or driven equipment during an initial startup. The circuit breaker area should also be free of non-essential personnel during closing and opening of the circuit breaker.

15.1.3 Motor Starting

Following a successful startup, the unit should be allowed to completely coast-down, with the duration of the coast-down typically recorded. If all settings were acceptable during the first start and no abnormal sounds, vibrations or other issues were detected, additional starts may be completed using the following as a basic procedure. The driven equipment representative may have a specific commissioning plan, and this procedure may be modified to accommodate it as long as the time between starts and other operational limits are respected:

1. During all starts, record the inrush current as well as the time required for the unit to synchronize.

2. Verify the main stator current, exciter current and voltage, and power factor settings.
3. Verify and record the winding and bearing temperature probes as well as any other instrumentation installed on the motor.
4. Verify the rotation of the oil slinger ring by looking down through the top of the bearing housing.
5. Listen carefully to the motor during operation for any sounds of grinding, bumping or other contact.

15.1.4 Loaded Operational Data

If it is possible to bring the drive train to full load, the following data should be collected and recorded at least every 10 minutes until the stator winding temperatures achieve a stable value. This typically requires several hours depending on the size of the motor and cooling method:

1. Bearing temperature
2. Stator winding temperatures
3. Air Inlet and outlet temperatures and cooling water temperatures (if applicable)
4. Any measured vibration levels
5. Stator voltage and current
6. Net power and power factor
7. Exciter voltage and current

15.1.5 Starting Frequency

The high current delivered to the stator and rotor during a full-voltage startup (also known as “on the line startup”) limits the number of starts that may be completed in a given period. The motor nameplate provides the number of starts per hour which may be completed with the unit at ambient or operating condition, and these limits must be programmed into the motor protective relay to protect the windings of both the stator and rotor. It is also necessary to be absolutely certain that the motor is fully-stopped prior to attempting any starts, and the motor protective relay should be programmed with an appropriate delay to prevent a rotating start.

ATTENTION

Exceeding the rated number of starts per hour or starting a motor while rotating will cause damage to the windings and may void the terms of the warranty.

16 RELEASE FOR COMMERCIAL OPERATION

Once all commissioning steps have been completed and all protective devices have been found functional and correctly programmed, the motor may be released for commercial operation. Typically, an extended commissioning program will be defined by the driven equipment supplier, and operational checks of the motor should continue during this period.

16.1 REGULAR INSPECTION

During normal operation, the end user should periodically inspect the condition of the motor, and this inspection should be recorded to permit the investigation into any rapid change in condition. The following list represents a minimum inspection checklist which should be performed at least weekly. A more frequent interval may be required depending on the criticality of the equipment, amount of recording instrumentation, and remoteness of the site or plant.

1. Ambient temperature, date, and time
2. Loading on drive train
3. Bearing oil level as measured in the sight glass
4. Rotation of oil slinger ring
5. Bearing temperature
6. Stator winding temperatures
7. Air Inlet and outlet temperatures and cooling water temperatures (if applicable)
8. Any measured vibration levels
9. Stator voltage and current
10. Net power and power factor
11. Exciter voltage and current
12. Pressure drop across filters (if measured)
13. Overall sounds or other qualitative observations

16.1.1 Coolers

For motors with air-water heat exchanger, it is important:

- To control the temperature at the radiator inlet and outlet and, if necessary correct the water flow.
- Set the water pressure just the necessary to overcome the resistance imposed by the pipes and radiator.
- In order to control the motor operation, it is recommended to install thermometers at the radiator air and water inlet and outlet and record those temperatures at certain time intervals.
- When installing the thermometers, you may also install recording or signaling instruments (siren, light bulbs) in certain places.

16.1.1.1 Inspection of the Performance of the Coolers

- In order to control the operation, it is recommended to measure the temperatures at the radiator water and air inlet and outlet and record them periodically.
- The radiator performance is expressed by the temperature difference between the cold water and cold air during normal operation. This difference must be periodically controlled. If an increase in this difference is observed after a long period of normal operation, probably the radiator must be cleaned.
- A reduction of performance or damage to the radiator may also occur by air accumulation inside it. In this case, removing the air from the radiator and pipes may correct the problem.
- The pressure difference on the water side may be considered an indicator of the need of cleaning the radiator.
- We also recommend measuring and recording the pressure difference of the water before and after the radiator. Periodically, the new values measured are compared to the original value, and an increase of the pressure difference indicates the need of cleaning the radiator.

17 MAINTENANCE

The reliability and operational life of a synchronous motor may be significantly increased by implementing a simple and cost-effective maintenance procedure. A checklist for a minimum annual maintenance is provided below as well as a more comprehensive 5-year maintenance inspection. The intervals for these inspections must take into account the duty cycle of the motor, cleanliness of the operating environment, any changes to the measured data such as winding temperature, and availability of an outage to perform the work. WEG Electric Machinery is pleased to provide service engineers if requested to help plan and execute a maintenance program and significant downtime can often be avoided by coordinating a maintenance plan which monitors and assessed the condition of the equipment. A periodic inspection program should be established. The time between inspections will be based on hours of operation, operating conditions, number of short circuits, etc. More frequent inspections should be made during the first year of operation. Thereafter, experience of the user will dictate the most economical methods and periods of inspections.

17.1 GENERAL

A proper motor maintenance plan, when properly executed, includes the following recommendations:

- Keep the motor and all related equipment clean.
- Periodically measure the insulation resistance.
- Routinely measure the temperature of windings, bearings and ventilation system.
- Inspect wear, operation of the lubrication system and useful life of the bearings.
- Check the ventilation system to ensure air is flowing correctly.
- Inspect the heat exchanger.
- Measure the machine vibration levels.
- Inspect related equipment.
- Check all of the motor accessories, protections and connections, ensuring that they are operating properly.
- The frame must be kept clean, without oil or dust built up on its external part in order to make the heat exchange with the ambient easier.

ATTENTION

Noncompliance with the recommendations may cause undesired stops of the equipment. The frequency with which such inspections are performed depends on local application conditions. Whenever 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, please contact WEG EM.

17.2 GENERAL CLEANING

The frame must be kept clean, without oil or dust built up on its external part in order to make the heat exchange with the ambient easier.

- The interior of the motor must also be kept clean, and free from dust, debris and oils.
- For cleaning, use brushes or clean cotton clothes. If the dust is not abrasive, an industrial vacuum cleaner must be used to remove the dirt from the fan cover and the excess of dust on fan blades and on the frame.
- The grounding brush compartment must be kept clean and without dust accumulation (if applicable).
- Debris impregnated with oil or moisture may be removed with a cloth soaked in 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.

17.3 ANNUAL MAINTENANCE INSPECTION

1. Check bearing oil level, cleanliness of oil, and function of oil slinger ring.
2. Inspect shaft seals on both sides of the motor and adjust or replace as needed.
3. Inspect the bearing oil seals and adjust or replace as needed.
4. Check all space heaters for operation. Measure resistance and compare to commissioning data.
5. Change oil in bearing if contaminated, or any presence of water is detected.
6. Check all hold-down bolts and apply full torque according to Section 11.
7. Complete full electrical tests according to Section 7.
8. Remove and clean air filters if installed. This may be required on a much more frequent interval depending on contamination in the area such as dust, pulp, or etc.
9. Remove diode wheel cover and visually inspect diode wheel and other components for contamination, evidence of overheating, loose connections, or other potential damage.
10. Record all measurements and observations along with the detailed information about the motor including:
    a. Serial number
    b. Number of operating hours
    c. Number of starts
    d. Typical loading (50%, 100%, etc)

17.4 FIVE YEAR MAJOR MAINTENANCE INSPECTION

1. Complete all of the activities in the Annual Maintenance Inspection.
2. Disassemble bearing and inspect lower sleeve, shaft journal, and check bearing alignment.
3. Change oil in bearing.
4. Reinstall bearing to Section 11.
5. Check each component on the diode wheel including diodes, SCRs and FDR assembly.
   a. Contact WEG Electric Machinery for support or to purchase a Universal Tester.
6. Perform a drop test of the rotor poles.
7. Remove all enclosures and perform a visual inspection of all windings and connections.
8. Inspect amortisseur bar connections, stator blocking and coil connections.
9. The main stator and rotor may be cleaned using dry, compressed air or a vacuum.
10. Replace any damaged or missing gasket material and install all enclosures to Section 11.

ATTENTION

After completing a maintenance interval, perform the commissioning steps in Section 15 to ensure all wiring and other components have been properly installed.

17.5 BEARING MAINTENANCE

17.5.1 Bearing Lubrication

Lubrication is one of the most important check points of proper maintenance and must be carried out in accordance with the instructions supplied with the machine. Lubricants are used for bearings to reduce friction and wear between rubbing surfaces and to carry off heat. The need for cleanliness in working with bearings and lubricants is extremely important. Dirt and other foreign materials can severely shorten the service life of the bearing.

Periodically, the bearing lubricant should be checked to ensure proper operation. If inspection indicates that the lubricant is dirty, it should be changed immediately. Always maintain the level shown on the gauge. It is especially important to check lubrication levels during the first few operating hours, since a dropping level may indicate leakage. It should be noted that machines may have a different lubricant level while running than stationary.

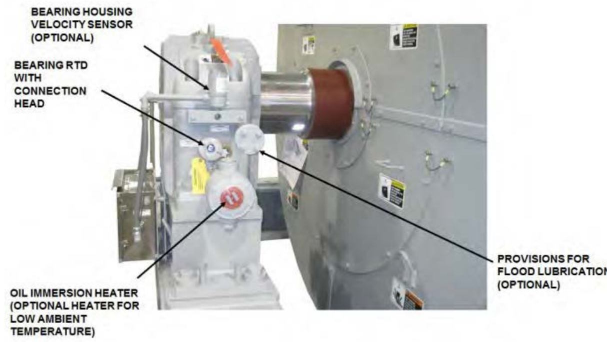


Figure 17-1: Typical Bearing Pedestal

17.5.1.1 Sleeve Bearing Maintenance

- Sleeve bearings may be lubricated by oil ring or by a flood lubrication unit with oil ring assist.
- Drain and refill bearing housings periodically – See maintenance plain for more information.
- The oil level sight gauge is located to indicate the standing oil level. Do not overfill or oil may be thrown out along the shaft into the windings.
- After installation of the bearing pedestal, fill the bearing reservoir with a high-grade mineral oil to the halfway point on the sight glass.
- Do not use hydraulic, synthetic, or oils with high detergent content.
- See outline drawing or motor nameplate for required oil viscosity.

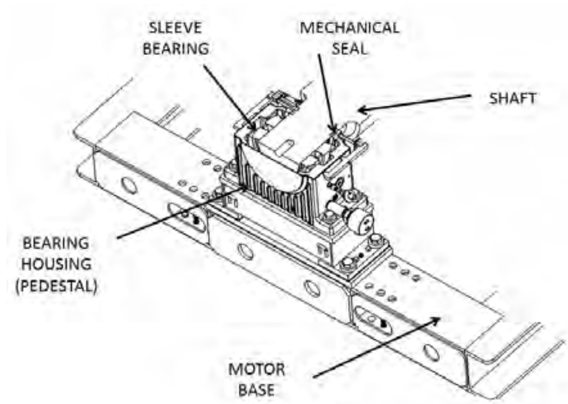


Figure 17-2: Bearing Pedestal Cross Section

17.6 WINDING MAINTENANCE

The motor winding insulation resistance must be measured at regular intervals, especially during damp weather or after long periods out of operation. The windings must undergo a careful visual inspection at frequent intervals, recording and fixing any damages. Low values or sudden variations in the insulation resistance must be carefully investigated. At points where the 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.

17.6.1 Winding Inspection

The following inspections must be performed after the winding is carefully cleaned:

- Check the connections and winding insulation.
- Check if spacers, bindings, groove wedges, bandages and supports are fixed correctly.
- Check if there were no breaks, if there are no faulty welds, short circuit between turns and against the mass in the coils and connections. In case any fault is detected, contact WEG Electric Machinery.
- Ensure that all cables are properly connected and that terminal fixation components are duly tightened. If necessary, retighten them.

17.6.2 Winding Cleaning

For satisfactory operation and longer useful life of insulated winding, it is recommended to keep them free of dirt, oil, metallic dust, contaminants, etc. In order to do so, it is necessary that the winding be periodically inspected and cleaned and that it operates in clean air. If re-impregnation is necessary, contact WEG Electric Machinery. The winding may be cleaned with industrial vacuum cleaner with a non-metallic thin tip or just a dry cloth. For extremely dirty conditions, there might be the need of cleaning with a proper liquid solvent. This procedure must be quick to prevent prolonged exposure of the windings to solvent effects. After being cleaned with solvents, the winding must be completely dried. Measure the insulation resistance and the polarization index to ensure the winding is completely dry. Winding drying time after cleaning varies depending on weather conditions, such as temperature, humidity, etc.

DANGER

Most solvents currently used are highly toxic and/or flammable. The solvents must not be used in the straight parts of the coils of high voltage motors, because the protection against corona effect may be affected.

17.6.3 Winding Damage

If any layer of resin on the windings is damaged during cleaning or inspection, such parts must be corrected with adequate material (in this case, please contact WEG Electric Machinery).

17.6.4 Insulation Resistance

Insulation resistance must be measured after all maintenance procedures have been performed.

ATTENTION

Before putting the motor into operation, in case it remained out of operation for some time, it is essential to measure the insulation resistance of the windings and ensure that the values meet the specifications.

17.7 MAINTENANCE OF THE COOLING SYSTEM

- The air-air heat exchangers must be kept clean and unblocked in order to ensure a perfect heat exchange. In order to clean the pipes, a round brush may be used to remove the dirt.
- The pipes and radiator of air-water heat exchangers must be periodically cleaned in order to prevent the built up of incrustations.

NOTE

- If the motor features filters in the air inlets and/or outlets, they must be cleaned by using compressed air.
- If the dust is difficult to remove, wash them in cold water with mild detergent and dry them in the horizontal position.
- In case the filter is impregnated with dust containing grease, it is necessary to wash it with gasoline, kerosene or another petroleum solvent or hot water with P3 additive.
- All the filters must be dried after the cleaning. Do not twist them.
- Change the filter if necessary.

17.8 EXCITER MAINTENANCE

17.8.1 Exciter

In order to have a good performance of its components, the motor exciter compartment must be kept clean. Clean it regularly, following the procedures described in this manual. Check the main exciter and auxiliary exciter winding insulation resistance regularly so as to determine their insulation conditions, following the procedures described in this manual.

17.8.2 Diode Testing

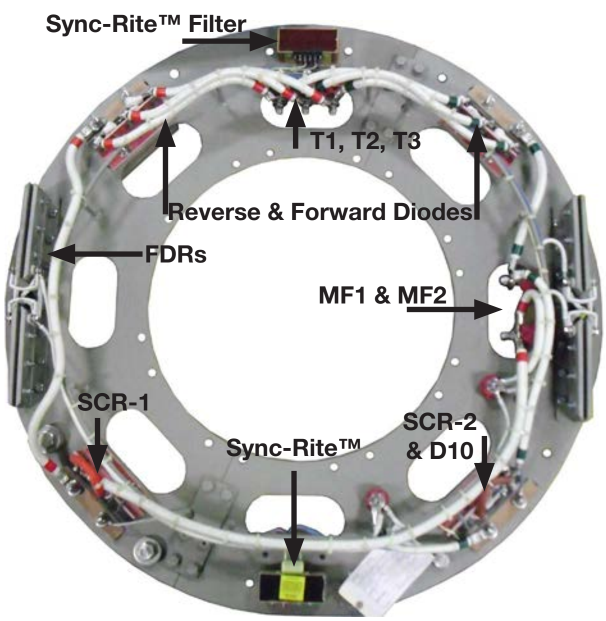


Figure 17-3 Typical Diode Wheel

The diodes installed in the rotating rectifier (diode) wheel are conservatively designed to withstand voltages much higher than expected in normal service. If at any time faulty diodes are suspected, typically indicated by a step-change in power factor for the same loading, they can be tested in the following manner.

NOTE

When checking diodes, the diode must be isolated from the circuit and the polarity confirmed to ensure the voltages are passed or blocked correctly.

- Disconnect the diodes from the rectifier circuit by removing the flexible lead connection.
- Using a standard multimeter set to the "Diode" function, verify that the diode is blocking voltage in the reverse bias direction, and has a low "cut-in" voltage in the forward bias direction.
- The diodes may also be tested in blocking using a 500 Volt DC megohmmeter.
- If one or more diodes are open or shorted, or if values are recorded which are significantly different from other components, or from previously-recorded values, those diodes should be replaced.

17.8.2.1 Diode Replacement

In order to replace any of the diodes, WEG Electric Machinery recommends that the following recommendations be followed:

1. Replace the damaged diodes by new diodes identical to the original ones.
2. The diodes are already supplied with insulated flexible connection braid and connection terminal.
3. Clean the heat sink disk completely around the diode mounting hole.
4. Check if the diode thread is clean and free of burs.
5. After fixing the diodes, connect the diode flexible braids.

17.8.3 SCR Testing

The SCRs installed in the rotating rectifier (diode) wheel are also conservatively designed to withstand voltages much higher than expected in normal service. If at any time faulty SCRs are suspected, typically indicated by a failure to synchronize, or loss of field, they can be tested in the following manner.

ATTENTION

The application of more than 10V in the thyristors trigger may damage the triggering circuit. The noncompliance with this instruction may damage the equipment.

NOTE

When checking SCRs, the SCRs must be isolated from the circuit and the polarity confirmed to ensure the voltages are passed or blocked correctly.

The SCR connections are as indicated in Figure 17-4. Gate and Cathode leads must be disconnected before testing if the SCR is in a circuit.

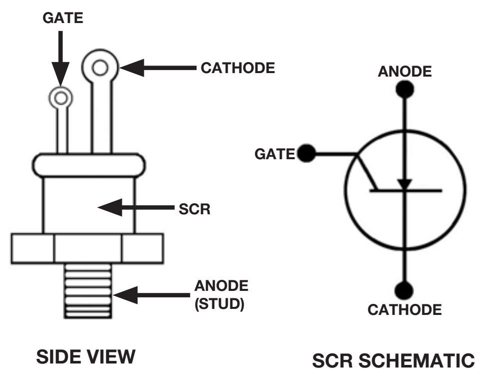


Figure 17-4 SCR Connections

The following checks will give a reasonable good indication of the condition of the of the condition of the SCR. It will detect marginal or voltage-sensitive units.

1. Connect the negative lead of an ohmmeter to anode and the positive lead to cathode. The resistance should exceed 1 megohm.
2. Reverse the ohmmeter leads from step 1. The resistance should again exceed 1 megohm.
3. As shown in Figure 17-5, connect X to Y. DC voltage should read 6 volts. Touch wire Z momentarily to gate. DC voltage reading should drop to less than one volt. Open X-Y connection and reconnect. DC voltage reading should return to 6 volts.

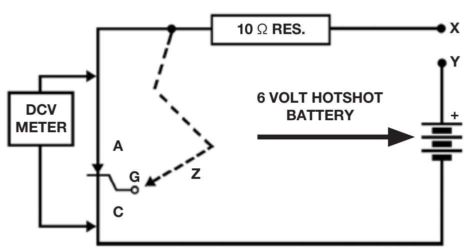


Figure 17-5 SCR Test Schematic

NOTE

The diode polarity is indicated by an arrow on its frame. When replacing the thyristors, make sure they are installed in each part of the heatsink disk with the correct polarity.

The current conduction must occur only in the anode-cathode direction, that is, in the direct polarization condition.

17.8.4 Universal Tester (Optional)

The Universal Tester is intended to test all electrical components on the rectifier wheel, which consist of diodes, SCRs, FDRs, Sync-Rite™ Filter and the Sync-Rite™ control. The benefit of the Universal Tester is that it allows testing of all electrical components without removal from the rectifier wheel.
The tester will perform 3 modes of operation. Each operation will have its own unique individual test cable for the following components:

- Sync-Rite™ Control
- Sync-Rite™ Filter
- Rectifier Diode Wheel (forward and reverse diodes, SCRs and FDRs)

For more information about the Universal Tester see WEG EM manual 6200-INS-401 or contact WEG Electric Machinery.

Figure 17-6: WEG EM Universal Tester

17.9 VIBRATION

Any sign of increase in unbalance or vibration of the machine must be immediately investigated.

17.10 TIGHTENING TORQUES FOR MOTOR BOLTS

The Table 17-1: Tightening Torque Tolerance presents torque required for the bolts commonly-used on the motor. These values apply to both carbon and stainless steel fasteners regardless of the fastener grade. This table does not provide the torque required for bolts on the diode wheel, main terminal box, or other electrical connections and the torque values for these components should be verified with their respective electrical connection drawings.

17.10.1 Base Types and Grout

17.10.1.1 Concrete Base

The concrete bases are the most widely used for the installation of these motors. The type and size of the foundation, bolts and anchoring plates depend on the motor size and type.

17.10.1.2 Metal Base

The motor feet must be settled on the metal base so as to prevent deformations of the frame. Do not remove the original base of the machines to align them. The base and foundation must be leveled using leveling devices. When a metal base is used to adjust the height of the motor shaft end to the driving machine shaft end, it must be leveled on the concrete base. After the base is leveled, the anchors tightened and the couplings checked, the metal base and the anchors are cemented.

17.10.2 Motor Mounting

ATTENTION

Mount and align the motor properly. The inadequate mounting can generate excessive vibration that could lead to shaft damage.

17.10.3 Anchoring Plate Set

The anchoring plate set is composed of the anchoring plate, leveling bolts, leveling shims, alignment bolts and anchors.

NOTE

The end user is responsible for the mount, level and grout procedure.

The anchors must be fastened according to Table 17-1.
After positioning of the motor, perform the final leveling by using the vertical leveling bolts and the leveling shims.

17.10.4 Natural Frequency of the Base

In order to ensure a safe operation, the motor must be precisely aligned with the coupled equipment and both must be properly balanced. As a requirement, the motor installation base must be flat and meet the requirements of DIN standard 4024-1. In order to check if the criteria of the standard are being met, the following potential frequencies of vibration excitation generated by the motor and coupled machine must be checked:

- The motor rotation frequency.
- The double of the rotation frequency.
- The double of the electric frequency of the motor supply.

According to DIN standard 4024-1, the natural frequencies of the base or foundation must keep a distance from these potential frequencies of excitation, as specified below:

- The first natural frequency of the base or foundation (natural frequency of first order of the base) must be out of the range from 0.8 to 1.25 times any of the potential frequencies of excitation above.
- The other natural frequencies of the base or foundation must be out of the range from 0.9 to 1.1 times any of the potential frequencies of excitation above.

Table 17-1: Tightening Torque Tolerance

Bolt Nominal Diameter	Lubricated	Dry	Typically Used
Nominal Diameter	Tightening Torque (Nm) Tolerance ±10%		
3/8 - 16 UNC 2	10 (12)	15 (25)	Enclosures with Gasket
1/2 - 13 UNC 2	20 (30)	45 (60)	Enclosures with Gasket
5/8 - 11 UNC 2	40 (55)	85 (115)	Exciter Frame and Mounting Bracket
3/4 - 10 UNC 2	75 (100)	150 (205)	Exciter Frame and Mounting Bracket
7/8 - 9 UNC 2	120 (165)	245 (330)	Exciter Frame and Mounting Bracket
1 - 8 UNC 2	180 (170)	365 (240)	Exciter Frame and Mounting Bracket
1¼ - 7 UNC 2	360 (240)	N/A	Motor and Bearing Hold-Down
1¼ - 12 UNF 2	400 (545)	N/A	Motor and Bearing Hold-Down
1½ - 6 UNC 2	630 (860)	N/A	Motor and Bearing Hold-Down
1½ - 12 UNF 2	700 (950)	N/A	Motor and Bearing Hold-Down
1¾ - 5 UNC 2	1000 (1350)	N/A	Motor and Bearing Hold-Down
2 - 4 ½ UNC 2	1500 (2030)	N/A	Motor and Bearing Hold-Down

NOTE

Bearing and motor hold-down bolts must be lubricated, both on the threads and underside of the head using lubrication per Table 3-1.

Table 17-2: Bolt Tightening Torque

Strength Class	4.6	5.8	8.8	12.9
Diameter	Tightening Torque (Nm) - Tolerance ±10%			
M6	1.9	3.2	5.1	8.7
M8	4.6	7.7	12.5	21
M10	9.1	15	25	41
M12	16	27	42	70
M16	40	65	100	175
M20	75	125	200	340
M24	130	220	350	590

NOTE

- The strength class is usually indicated on the head of the hexagonal bolt.
- When there is no marking on the bolt, it indicates that the strength class of the bolt is 4.6 (see Table 17-2).
- Allen-type hexagon socket cap bolts have strength class 12.9 (see Table 17-2).

ATTENTION

Tables 17-1 and 17-2 do not provide the torque required for bolts on the diode wheel, main terminal box, or other electrical connections and the torque values for these components should be verified with their respective electrical connection drawings.

17.11 BEARING MAINTENANCE (IF APPLICABLE)

17.11.1 Sleeve Bearings

17.11.1.1 Bearing Data

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

17.11.1.2 Bearing Installation and Operation

In order to obtain the part list, assembling and disassembling instructions and maintenance details, refer to the specific installation and operation manual of the bearings.

17.11.1.3 Protection Adjustments

Each bearing is equipped with temperature detectors. Those devices must be connected to a control panel in order to indicate overheating and protect the bearings from damages due to operation with high temperatures.

ATTENTION

The following temperatures must be adjusted on the bearing protection system:

ALARM 110ºC – SHUTTING DOWN 120ºC

The alarm temperature must be adjusted 10ºC above the working duty temperature, not exceeding the limit of 110ºC.

17.11.1.4 Cooling by Water Circulation

The sleeve bearings with cooling by water circulation feature a serpentine inside the oil tank where the water circulates. The water must present, at the bearing inlet, a temperature below or equal to the ambient temperature in order to perform the cooling. The water pressure must be 0.1 bar and the flow equal to 0.7 l/s. The pH must be neutral.

NOTE

Under no circumstances can water leak into the oil tank, which would cause the contamination of the lubricant.

17.11.1.5 Oil Change

Self-Lubricated Bearings

The oil change of the bearings must be carried out observing the intervals indicated below, according to the bearing operating temperature:

- Below 75ºC = 20,000 hours
- Between 75 and 80ºC = 16,000 hours
- Between 80 and 85ºC = 12,000 hours
- Between 85 and 90ºC = 8,000 hours
- Between 90 and 95ºC = 6,000 hours
- Between 95 and 100ºC = 4,000 hours

Bearings with (External) Oil Circulation

The oil of the bearings must be changed every 20,000 hours of operation or whenever the lubricant presents modifications in its characteristics. The oil viscosity and pH must be checked regularly.

NOTE

The oil level must be monitored daily and kept approximately in the middle of the sight glass.

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

ATTENTION

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

- The selected oil must be the one with proper viscosity for the working temperature of the bearings; That must be observed in an occasional oil change or in periodical maintenances.
- Never use or mix hydraulic oil with the lubricant oil of the bearings.
- Lack of lubricant, due to incomplete filling or the not monitoring of the level, can damage the bearing shells.
- The minimum oil level is reached when the lubricant can be seen touching the lower part of the sight glass with the motor out of operation.

17.11.1.6 Seals

In case of maintenance of the bearings, when adjusting them again, the two halves of the taconite seal must be joined by a garter spring. This spring must be inserted in the ring seat in such way that the locking pin fits into its fillister in the upper half of the frame. Improper installation destroys the seal. Before assembling the seals, clean the surfaces that touch the ring and its seat carefully, and cover them with a non- hardening sealing component. The drain holes located in the lower half of the ring must be cleaned and cleared. When installing this half of the sealing ring, press it slightly against the shaft lower part.

17.11.2 Oil-Filled Rolling Element Bearing

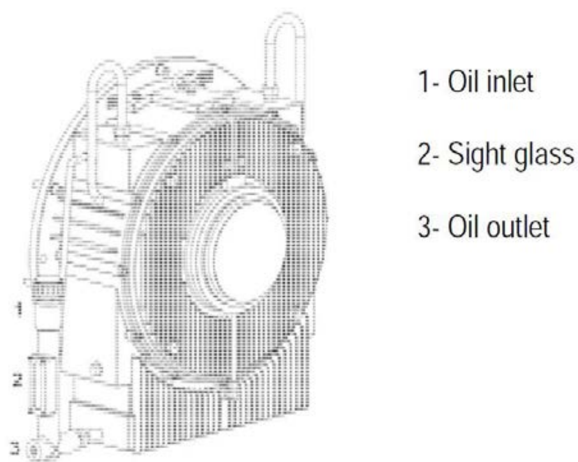


Figure 17-7: Oil-Filled Rolling Element Bearing

17.11.2.1 Lubrication Instruction

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

To put oil in the bearing:

- Close the oil outlet with the plug (3).
- Remove the oil inlet cap (1).
- Fill with the specified oil up to the level indicated in the oil sight glass.

NOTE

1. All threaded holes that are not used must be closed with plugs and no connections can present leak.
2. The oil level is reached when the lubricant can be seen approximately in the middle of the sight glass.
3. The use of a larger amount of oil will not damage the bearing, still it can cause leaks through the shaft seals.
4. Do not use or mix hydraulic oil with the lubricant oil of the bearings.

17.11.2.2 Oil Type

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

17.11.2.3 Oil Change

The oil change of the bearings must be carried out observing the intervals indicated below, according to the bearing operating temperature:

- Below 75ºC = 20,000 hours
- Between 75 and 80ºC = 16,000 hours
- Between 80 and 85ºC = 12,000 hours
- Between 85 and 90ºC = 8,000 hours
- Between 90 and 95ºC = 6,000 hours
- Between 95 and 100ºC = 4,000 hours

The lifespan of the bearings depends on their operating conditions, on the motor operating conditions and on the procedures observed by the maintenance personnel.
The following recommendation must be observed.

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

ATTENTION

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

17.11.2.4 Protection Adjustments

The temperature sensors installed on the bearings must be connected to a control panel in order to indicate overheating and protect the bearings from damages due to operation with high temperatures.

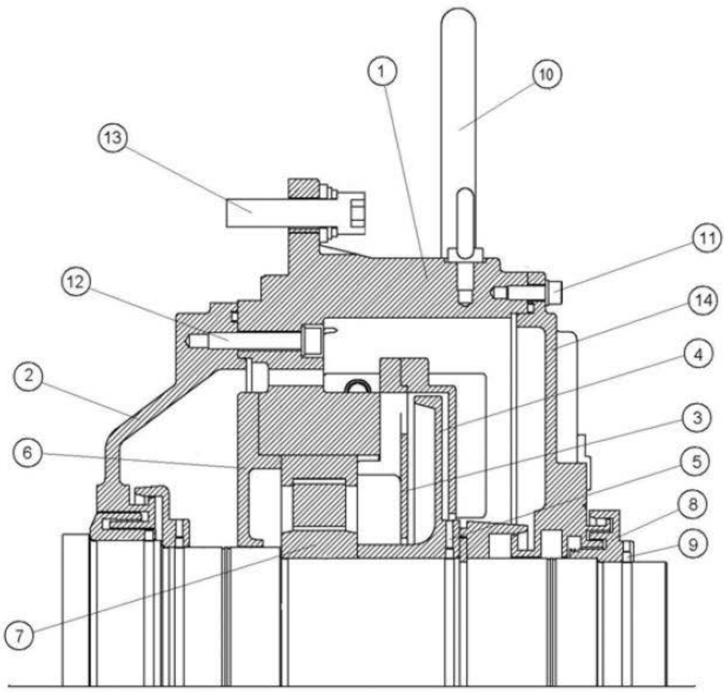
ATTENTION

The following temperatures must be adjusted on the bearing protection system:

ALARM 110ºC – SHUTTING DOWN 120ºC

The alarm temperature must be adjusted 10ºC above the working duty temperature, not exceeding the limit of 110ºC.

17.11.2.5 Oil-Filled Rolling Element Bearing Assembly and Disassembly



1. External oil tank
2. Internal oil tank
3. External bearing cap
4. Oil centrifuge
5. Bolt
6. Internal bearing cap
7. Rolling bearing
8. Taconite seal
9. Bolt
10. Vent
11. External tank fastening bolt
12. Internal tank fastening bolt
13. Cover fastening bolt
14. Bearing protection cover

Figure 17-8: Parts of the Oil-Filled Rolling Element Bearing

In order to disassemble the bearing, follow the instructions below.

Before disassembling

- Clean all the external part of the bearing.
- Drain all the oil from the bearing.
- Remove the temperature sensor from the bearing.
- Provide a support for the shaft in order to hold the rotor during the disassembly.

Disassembly:

Take special care to prevent damages to the balls, rollers and surface of the shaft. Keep the disassembled parts in a safe and clean place.

In order to disassemble the bearing, follow the instructions below.

1. Remove the bolt (9) that fixes the taconite seal (8).
2. Remove the taconite seal (8).
3. Remove the bolts (11) that fix the bearing protection cover (14).
4. Remove the protection cover (14).
5. Remove the bolts (5) that fix the oil centrifuge (4) and remove it.
6. Remove the bolts that fix the external bearing cap (3) and remove it.
7. Loosen the bolts (12 and 13).
8. Remove the external oil tank (1).
9. Remove the bearing (7).
10. If complete disassembly of the bearing is necessary, remove the internal bearing cap (6) and the internal oil tank (2).

Assembly:

Clean the rolling bearing and the oil tanks thoroughly, and inspect all the parts before the bearing assembly.

- Make sure the rolling bearing contact surfaces are smooth and free of signs of scratches or corrosion.
- Before inserting the rolling bearing on the shaft, heat it to a temperature from 50 to 100ºC.
- For the full assembly of the bearing, follow the instructions for disassembly in the reverse order.

ATTENTION

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

17.11.2.6 Grease-Filled Rolling Element Bearing Assembly and Disassembly

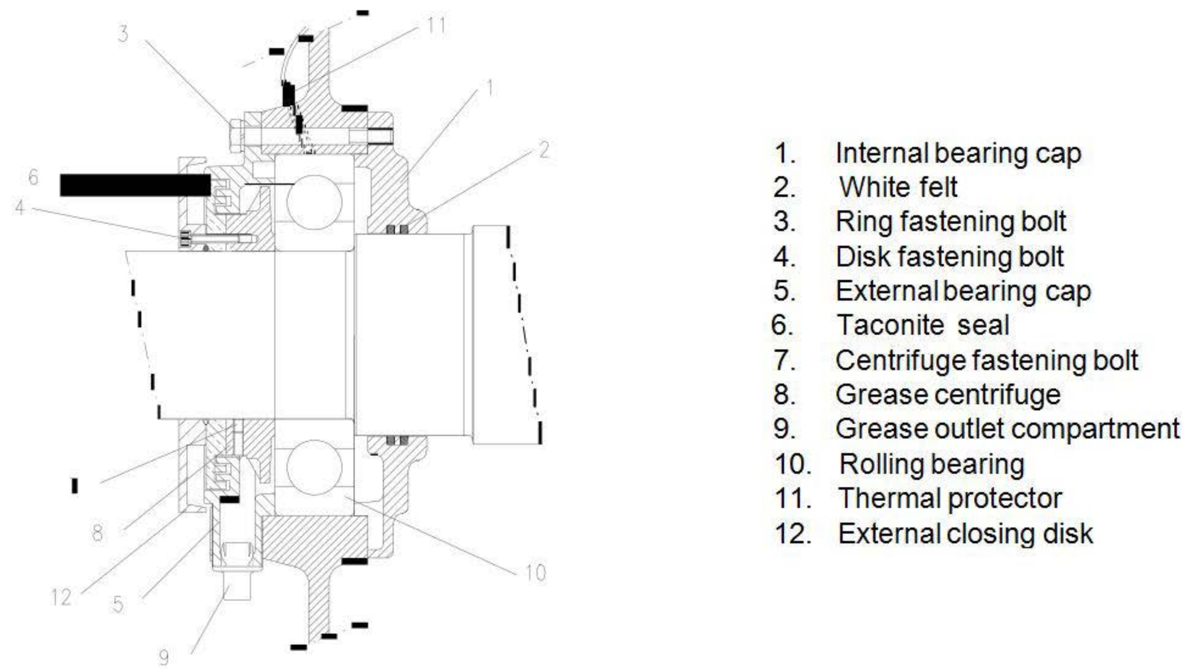


Figure 17-9: Parts of the Grease-Filled Rolling Element Bearing

Before disassembling:

- Remove the extension tubes form the grease inlet and outlet.
- Clean carefully the external part of the bearing.
- Remove the bearing temperature sensors and provide a support for the shaft to prevent damages to the rolling bearing.

Disassembly

Take special care to prevent damages to the balls, rollers and surface of the shaft.

Keep the disassembled parts in a safe and clean place. In order to disassemble the bearing, follow the instructions below.

1. Remove the bolts (4) that fix the closing cap (13).
2. Remove the taconite seal (6).
3. Remove the bolts (3) that fix the fixation caps (1 and 5).
4. Remove external bearing cap (5).
5. Remove the bolt (7) that fixes the grease centrifuge (8).
6. Remove the grease centrifuge (8).
7. Remove the drive end shield.
8. Remove the bearing (10).
9. Remove the internal bearing cap (1) if necessary.

Assembly

- Clean the bearings completely and inspect the disassembled parts and the inside of the bearing caps.
- Make sure the bearing, shaft and bearing cap surfaces are perfectly smooth.
- Fill with the recommended grease up to ¾ of the internal and external fixation cap deposit (Figure 7-10) and lubricate the rolling bearing with grease enough before assembling it.
- Before assembling the bearing on the shaft, heat it to a temperature between 50ºC and 100ºC.
- For the full assembly of the bearing, follow the instructions for disassembly in the reverse order.

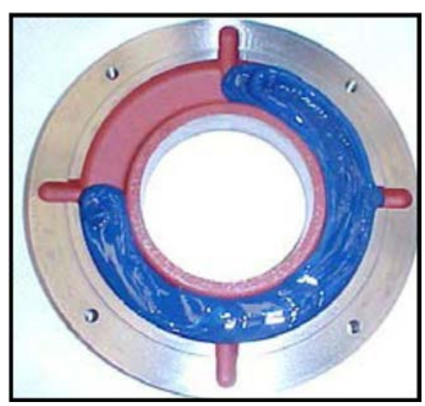


Figure 17-10: External Bearing Cap

GENERAL NOTES:

1. In case the bearing is open, inject new grease through the grease nipple to expel the old grease that is in the grease inlet tube and apply the new grease to the bearing, to the internal ring and external ring, filling 3/4 of the empty spaces. In case of double bearings (ball + roller), also fill 3/4 of the empty spaces between the intermediate rings.
2. Never clean the bearing with cotton cloths, because they may release lint as solid particles.
3. It is important to perform a correct lubrication, that is, apply the correct grease and in the proper quantity, because both an insufficient lubrication and an excessive lubrication damage the bearings.
4. Excessive lubrication makes the temperature rise due to the great resistance against the movement of the revolving parts and especially due to the beating of the grease, which eventually completely loses its lubrication properties.

NOTE

WEG Electric Machinery is not responsible for changing the grease, or even for occasional damages caused by the change.

17.11.2.7 Grease Quality and Quantity

It is important to perform a correct lubrication, that is, apply the correct grease and in the proper quantity, because both an insufficient lubrication and an excessive lubrication damage the bearings. Excessive lubrication makes the temperature rise due to the great resistance against the movement of the revolving parts and especially due to the beating of the grease, which eventually completely loses its lubrication properties.

ATTENTION

Greases with different types of base must never be mixed.
Example: Lithium-based greases must never be mixed with others with sodium or calcium base.

17.11.2.8 Compatibility

The compatibility of different types of grease may cause a problem. You can say the greases are compatible when the properties of the mixture lie within the property ranges of the greases individually.

In general, greases with the same type of soap are compatible with each other, but depending on the proportion of the mixture, there might be incompatibility. Therefore, it is not recommended the mixture of different types of grease without consulting the grease supplier or WEG Electric Machinery. Some thickeners and basic oils cannot be mixed with each other, because they do not form a homogeneous mixture. In this case, you cannot disregard the possibility of hardening or, on the other hand, softening of the grease or fall of the dropping point of the resulting mixture.

17.11.3 Disassembly and Assembly of the Bearing Pt100

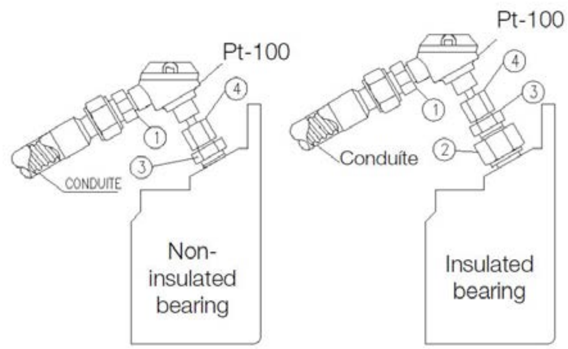


Figure 17-11: Pt100 on the Bearings

Instructions for disassembly:

If necessary to remove the Pt100 for bearing maintenance, the following procedures must be adopted.

- Remove the Pt100 with care, lock the locknut (3) and unscrew just the Pt100 from the bulb adjustment (4).
- The parts (2) and (3) must not be disassembled.

Instructions for assembly:

Before performing the assembly of the Pt100 on the bearing, check if it does not contain dents or any other damage that may compromise its operation.

- Insert the Pt100 on the bearing.
- Lock the locknut (3) with a wrench.
- Screw the bulb (4), adjusting it so that the end of the Pt100 touch the bearing sleeve or the external surface of the rolling bearing.

NOTE

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

17.12 CLEANING AND REGREASING BEARINGS

17.12.1 Sleeve Type Bearings

Remove old oil and replace with new every six months. To remove oil, open oil drain-out plugs. Replace plug and put in new oil through oil filler caps until oil reaches proper level in oil gauge.

18 MOTOR DISASSEMBLY AND ASSEMBLY

All the services referring to repairs, disassembly and assembly must be executed by duly qualified and trained personnel. The disassembly and assembly sequence depends on the mounting characteristics of the motor.

18.1 DISASSEMBLY

Below are some cares to be observed when the motor is disassembled:

1. Always use proper tools and devices to disassemble the motor.
2. Before disassembling the motor, disconnect the lubrication and cooling water pipes (if applicable).
3. Disconnect the electrical and accessory connections.
4. Remove the heat exchanger and noise suppressor (if applicable).
5. Remove the temperature sensors from the bearings.
6. In order to prevent damages to the rotor, provide a support to hold the shaft on the front and back sides.
7. To disassemble the bearings, follow the procedures described in this manual.
8. The removal of the rotor from inside the motor must be done with a proper device and with extreme care for the rotor not to scrape the stator core or the coil heads, preventing damages.

18.2 ASSEMBLY

NOTE

When the motor is supplied disassembled, an assembly manual is provided with it, describing the procedures to assemble the motor at the installation site.

Below are some cares to be observed when the motor is assembled:

1. Always use proper tools and devices to assemble the motor.
2. To assemble the motor, use the disassembly procedure in the reverse order.
3. Any damaged part (cracks, dents on machined parts, faulty threads) must be replaced, always avoiding restorations.

Table 17-2 shows the recommended tightening torques of the bolts for the assembly of the motor or its parts.

18.3 MEASUREMENT OF THE AIR GAP

After disassembling and assembling the motor, it is necessary to measure the air gap in order to check the concentrically between rotor and stator. The difference between the air gap measures in two points diametrically opposed must be less than 10% of the average air gap.

18.4 GENERAL RECOMMENDATIONS

ATTENTION

All services described herein must be performed by specialized and experienced personnel; otherwise, personal injuries or damages to the equipment may occur. If you have any questions, contact WEG Electric Machinery.

19 TROUBLESHOOTING

The most common problems associate with synchronous motors may be avoided by a well-planned and executed installation and maintenance program. The chart below provides guidance to diagnosis of commonly observed situations but is not an exhaustive list. In case of any doubt, please contact WEG Electric Machinery Service Department for support or the dispatch of a Field Engineer.

ATTENTION

Operating a motor with protection disabled or at operating conditions for which it was not designed may cause a hazard and may void the terms of the warranty. If there is any doubt regarding the troubleshooting of a unit, contact WEG Electric Machinery.

Table 19-1: Basic List of Abnormalities, Causes and Corrective Actions

ABNORMAL SITUATION	PROBABLY CAUSE (S)	CORRECTIVE MEASURE (S)
Motor will neither start coupled nor uncoupled.	▪ At least two power cables are interrupted, without voltage.	▪ Check the control panel, the power cables, the terminals.
	▪ Rotor is locked.	▪ Unlock the rotor.
	▪ Damaged bearing.	▪ Repair or replace the bearings.
	▪ Excessive load at start.	▪ Check the load characteristics at start.
	▪ Stator circuit is open.	▪ Measure and compare the stator phase resistance.
	▪ Diode in short circuit or open thyristor.	▪ Replace the defective rectifier.
Motor starts with no load, but fails when load is applied. It starts very slowly and will not reach the rated speed.	▪ Power voltage supply is too low.	▪ Measure the power voltage supply, adjust the correct value.
	▪ Sharp voltage drop in the power cables.	▪ Check the section of the power cables.
	▪ Rotor bars (damper winding) are damaged or interrupted.	▪ Check and repair the rotor bars (cage).
	▪ A power cable was interrupted after the start.	▪ Check the connection of the power cables.
Current without load is too high.	▪ Failure in excitation (power factor too low - out of step).	▪ Check the power factor and correct the failure in the excitation.
Heating spots in the stator winding.	▪ Short circuit among turns.	▪ Rewind the stator winding.
	▪ Interruption of the parallel wires or phases of the stator winding.	
	▪ Defective electrical connections.	▪ Make connections again.

Stator winding overheats under load.	▪ Fans operating in the wrong direction.	▪ Correct the direction of rotation of the fans.
	▪ Faulty cooling due to dirt in the heat exchanger (if applicable).	▪ Clean the pipes of the heat exchanger.
	▪ Overload.	▪ Measure the stator voltage, reduce load, check the motor application.
	▪ Excessive number of starts or load inertia excessively high.	▪ Reduce the number of starts.
	▪ Voltage supply too high, increasing the iron loss.	▪ Do not exceed 110% of the rated voltage, except other wise specified on the nameplate.
	▪ Voltage supply is too low, making the current too high.	▪ Check the voltage supply and the voltage drop in the motor.
	▪ Interruption in a power cable or in a winding phase.	▪ Measure the current in all the phases and correct.
	▪ Rotor scratches against the stator.	▪ Check the air gap, operating conditions (vibration...), bearing conditions.
	▪ The operating condition does not correspond to the data on the name plate.	▪ Keep the operating condition according to the motor nameplate or reduce the load.
	▪ Unbalance in the power supply (fuse burnout, wrong command).	▪ Check if there is voltage unbalance or operation with two phases and correct.
	▪ Blocked or restricted air intake or exhaust.	▪ Unblock the air inlet and outlet.
	▪ Contaminated windings.	▪ Visually inspect windings and clean as needed. Contact WEG Electric Machinery for cleaning options.
Heating spots in the rotor.	▪ Interruptions or failure in the insulation of the rotor windings.	▪ Repair the rotor winding or replace it.
	▪ Motor overexcited.	▪ Check and correct exciting current.
Heating in the damper winding (rotor).	▪ High negative sequence current.	▪ Correct voltage unbalance. ▪ Check the harmonic line (correct).
Abnormal noise during operation with load.	▪ Mechanical causes: The noise normally decreases when the speed reduces; see also: “Noisy operation when uncoupled”.	▪ Check mechanical causes (balancing, alignment, coupling, bearings...).
	▪ Electrical causes: The noise ceases when the motor is shut down. Contact WEG Electric Machinery.	▪ Perform electrical and magnetic analysis.
When coupled, there is noise; uncoupled, the noise disappears.	▪ Failure in the drive or driven machine.	▪ Check the power drive, the coupling and the alignment.
	▪ Failure in the gear drive.	▪ Align the drive, check the position of the gear box.
	▪ Defect in the coupling.	▪ Align the motor and the driven machine.
	▪ Problems in the foundation.	▪ Repair the foundation.
	▪ Faulty balancing of the components or driven machine.	▪ Perform new balancing.
	▪ Power voltage supply is too high.	▪ Check the voltage supply and the current with no load.
	▪ Wrong direction of rotation of the motor.	▪ Invert the connection of two phases.

Noisy operation when uncoupled.	▪ Unbalance noise remains during deceleration after powering down the voltage.	▪ Perform new balancing.
	▪ Interruption in one phase of the stator winding.	▪ Measure the current input of all connecting cables.
	▪ Fastening bolts are loose.	▪ Refasten and lock the bolts.
	▪ The rotor balancing conditions become worse after the assembly of the coupling.	▪ Balance the coupling.
	▪ Resonance in the foundation.	▪ Adjust the foundation.
	▪ Motor frame is deformed.	▪ Check flatness of the base.
	▪ Crooked shaft.	▪ Correct or replace the shaft.
		▪ Check the rotor balancing and eccentricity.
	▪ Air gap is not even.	▪ Check shaft warpage or bearing wear.
Sparking.	▪ Overload.	▪ Adjust the load to the motor characteristics or dimension a new motor for the application.
	▪ Excessive vibration.	▪ Check cause of vibration and correct it.
Bearing overheating.	▪ Oil slinger ring not rotating.	▪ Verify oil slinger rotation.
	▪ Insufficient oil in reservoir.	▪ Verify oil level and grade installed.
	▪ Insufficient radiant cooling.	▪ Verify airflow around bearing and add external cooling if needed.
	▪ Bearing damage or misalignment.	▪ Disassemble and inspect bearing.
High stator current at no load.	▪ Excitation voltage supply set too high.	▪ Reduce excitation voltage supply and consider automatic power factor regulator.
Motor fails to rotate when circuit breaker is closed.	▪ Damaged or open input lead.	▪ Inspect and check continuity of each input phase.
	▪ Excessive load during start.	▪ Check for ease of rotation of drive train.
	▪ Open circuit in stator or rotor winding.	▪ Measure resistance of each stator phase.
Motor fails to synchronize.	▪ Excitation voltage not applied.	▪ Ensure excitation voltage is energized and is reaching the exciter stator.
	▪ Insufficient excitation voltage.	▪ Increase excitation voltage.
	▪ Unit is not achieving 95% speed.	▪ Check the speed of the unit during startup with external tachometer.
	▪ Excessive line drop during startup.	▪ Measure the voltage during startup and compare to rated line drop of motor data sheet.
FDR remains in circuit after synchronization.	▪ Wiring issue in diode wheel.	▪ Inspect all diode wheel wiring and components.
	▪ Unit is not achieving speed necessary to synchronize.	▪ Verify rotating speed with tachometer and verify unit is unloaded
	▪ Rotodynamics are accelerating unit beyond synchronous speed.	▪ Check drive train rotating analysis to ensure proper sizing of FDRs.
High stator current at no load.	▪ Excitation voltage supply set too high.	▪ Reduce excitation voltage supply and consider automatic power factor regulator.
Mechanical noise in motor.	▪ Seal contact.	▪ Verify all oil and shaft seals.
	▪ Foreign material.	▪ Inspect motor for foreign objects.
	▪ Excessive leading power factor.	▪ Excessive leading power factor may cause a mechanical vibration in the exciter area. Change excitation voltage supply and listen for changes.
	▪ Enclosures ringing or vibrating.	▪ Check bolting of all enclosures.

Bearing overheating.	▪ Oil slinger ring not rotating.	▪ Verify oil slinger rotation.
	▪ Insufficient oil in reservoir.	▪ Verify oil level and grade installed.
	▪ Insufficient radiant cooling.	▪ Verify airflow around bearing and add external cooling if needed.
	▪ Bearing damage or misalignment.	▪ Disassemble and inspect bearing.
Stator overheating.	▪ Blocked or restricted air intake or exhaust.	▪ Clean all filters and inspect air handling system.
	▪ Fouled or malfunctioning heat exchanger (TEWAC, TEAAC).	▪ Perform detailed inspection on heat exchanger units and water supply.
	▪ Contaminated windings.	▪ Visually inspect windings and clean as needed. Contact WEG Electric Machinery for cleaning options.

20 SPARE PARTS

When ordering replacement parts, the motor serial number must be supplied, as indicated on the nameplate and outline drawings. Spare parts must be stored according to Section 6. Depending on the location of the end user, cost of downtime and lead time of components, the following spares may be considered:

- Complete set of diode wheel electronics including
  - 3 Forward diodes
  - 3 Reverse + D10 diode
  - SCR1
  - SCR2
  - Set of FDRs
  - Sync-Rite™ Controller
  - Sync-Rite™ Filter
- Bearing RTDs (depending on installation)

The following parts are unlikely to need replacement during the 5 year interval between maintenance; however the lead time required for these parts may justify the small capital investment:

- Bearing Sleeve
- Rotor Pole
- Oil Seals
- FMR or Excitation Control Components (depending on installation)

21 MAINTENANCE PLAN

A synchronous machine usually does an important job in a larger installation. Hence, it must be supervised and maintained properly to keep the whole installation running without any unscheduled interruptions. The reliability and operational life of a synchronous motor may be significantly increased by implementing a simple and cost-effective maintenance procedure. It is important to note that these instructions only represent a minimum level of maintenance, however, if followed correctly provides good results and the long-term availability of the machine will increase. WEG Electric Machinery is pleased to provide service engineers if requested to help plan and execute a maintenance program and significant downtime can often be avoided by coordinating a maintenance plan which monitors and assesses the condition of the equipment.

21.1 RECOMMENDED MAINTENANCE PLAN

This section presents an overview of a maintenance program for WEG Electric Machinery Synchronous Motors. This program provides only a minimum level of maintenance and is divided into five main steps. Therefore, it should be intensified depending on local conditions or when very high reliability is required.

Table 21-1: Main Maintenance Plan

Steps	Maintenance Required
S1	At this step only basic inspections are required. (See Table 21-2: Complementary maintenance plan). This step should be performed weekly.
S2	The purpose of this check is to find out possible problems that are beginning to develop before they cause failures and unexpected interruptions in the installation. Although, the idea of this step is a visual inspection and small repairs, this inspection should be performed more carefully than in step 1. This maintenance should take approximately 5-10 hours. In order to do all necessary repairs quickly, it is recommended that at least the operational spare parts are available (See spare parts list) when performing the maintenance. This Level should be performed around 6 months after commissioning.
S3	Step 3 requires inspections and tests. The purpose of this inspection is to find out any possible problems in the operation of the machine and to do small repairs to prevent interruptions. The estimated time is the double of level 1 depending on the amount of service that needs to be done. It is necessary to have tools as servicing tools, multimeter, insulation resistance tester and torque wrench. All information about insulation can be found in the insulation resistance section 7. This maintenance should be performed every year after commissioning. Examples of tasks performed in this level: 1. Check bearing oil level, cleanliness of oil, and function of oil slinger ring. 2. Inspect shaft seals on both sides of the motor and adjust or replace as needed. 3. Inspect the bearing oil seals and adjust or replace as needed. 4. Check all space heaters for operation. Measure resistance and compare to commissioning data. 5. Change oil in bearing if contaminated, or any presence of water is detected. 6. Check all hold-down bolts and apply full torque. 7. Complete full electrical tests. 8. Remove and clean air filters if installed. This may be required on a much more frequent interval depending on contamination in the area such as dust, pulp, or other particulates. 9. Remove diode wheel cover and visually inspect diode wheel and other components for contamination, evidence of overheating, loose connections, or other potential damage. 10. Record all measurements and observations along with the detailed information about the motor including: ▪ Serial number ▪ Number of operating hours ▪ Number of starts ▪ Typical loading (50%, 100%, etc.)
S4	Step 4 consists of performing further inspections and hard maintenance. The purpose is to replace all necessary parts and do all measurements suggested in the manual maintenance chapter. It is recommended to have all tools and spare parts during the maintenance to avoid delays. If very well organized this maintenance level should take between 20 to 40 hours. The level 4 maintenance should be performed every 3-5 years. Examples of tasks performed in this level: Complete all of the activities in the Annual Maintenance Inspection plus: 1. Disassemble bearing and inspect lower sleeve, shaft journal, and check bearing alignment. 2. Change oil in bearing. 3. Check each component on the diode wheel including diodes, SCRs and FDR assembly. 4. Contact WEG Electric Machinery for support or to purchase a Diode Wheel Tester. 5. Perform a drop test of the rotor pole. 6. Remove all enclosures and perform a visual inspection of all windings and connections. 7. Inspect amortisseur bar connections, stator blocking and coil connections. The main stator and rotor may be cleaned using dry, compressed air or vacuum

S5	Level 5 requires further inspections and maintenance tasks. In this level the machine may not be running in perfect condition and should be restored into reliable operating conditions. It is very recommended to have a professional from WEG Electric Machinery during this step. Many spare parts can be necessary to complete this task and WEG Electric Machinery can provide all of them. The level 5 should be performed after 10 years or earlier if necessary.

The maintenance plan described in Table 21-2 is only referential, considering that the intervals between each maintenance intervention may vary according to the motor location and operating conditions. The Table 21-2 is a complementary maintenance plan. It contains almost all tasks of Table 21-1 plus some additional tasks. The maintenance personnel responsible should complete all tasks presented on both tables.

Table 21-2: Complementary Maintenance Plan

Equipment	Weekly (S1)	Monthly	3 Months	6 Months (S2)	Annually (S3)	3 to 5 Years (S4)	Note
STATOR							
Stator Visual Inspection and Small Repairs				x	x		
Cleaning Control					x		
Groove Wedges Inspection						x	
Stator Terminal Control					x		
Measure the Winding Insulation Resistance					x		
ROTOR							
Rotor Visual Inspection and Small Repairs				x			
Cleaning Control					x		
Shaft Inspection (Wear, Incrustations)						x	
Inspect Shaft Seals on Both Sides of the Motor and Adjust or Replace as Needed.					x		
Exciter							
Exciter Visual Inspection and Small Repairs				x			
Cleaning Control				x			
Test Diodes					x		
Inspect Windings					x		
Inspect Connections and operation of Triggering Circuit					x		
BEARINGS							
Noise, Vibration, Oil Flow, Leak and Temperature Control	x						
Lubricant Quality Control					x		
Inspect the Bearing Shell and Shaft Track (Sleeve Bearing)						x	
Bearing Visual Inspection and Small Repairs				x			
Change Lubricant in Bearing if Contaminated, or Any Presence of Water is Detected				x			
Lubricant Change					x		According to the Period Indicated on the Bearing Nameplate
Check Bearing Oil Level, Cleanliness of Oil and Function of Oil Slinger Ring					x		
Inspect the Bearing Oil Seals and Adjust or Replace as Needed					x		
Disassembly Bearing and Inspect Lower Sleeve, Shaft Journal, and Check Bearing Alignment						x	

AIR-WATER HEAT EXCHANGER							
Inspection of the Radiators					x		
Clean the Radiators					x		
Change the Gaskets of the Radiator Heads					x		
AIR-AIR HEAT EXCHANGER							
Clean the Ventilation Pipes					x		
Inspect the Ventilation					x		
AIR FILTER(S)							
Inspect and Replace if Necessary	x						Perform procedure every two months
TERMINAL BOX AND GROUNDING TERMINALS							
Clean the Inside of the Terminal Boxes					x		
Retighten the Screws					x		
PROTECTION AND CONTROL EQUIPMENT							
Test Operation					x		
Record Values	x						
Disassemble and Test its Operation						x	
COUPLING							
Inspect Alignment					x		Check after first week of operation
Inspect Fixation					x		
WHOLE MOTOR							
Clean and Inspect Noise and Vibration	x						
Drain Condensate			x				
Retighten the Bolts					x		
Clean Terminal Boxes					x		
Refasten Electric and Grounding Connections					x		
SPACE HEATER							
Check All Space Heaters for Operation. Measure Resistance and Compare to Commissioning Data			x				
BRAKE							
Wear of the Pads							According to the equipment manual
Operating Control							

22 WARRANTY TERMS

WEG Electric Machinery motors are thoroughly tested before shipment and are designed to operate trouble-free for many years within specified limits. Installation, operation, or maintenance by unskilled or poorly-trained workers may result in operation outside the machine limits. In addition, errors in interconnection wiring, unwanted transient voltages, and surges may cause serious damage to the unit and would not be covered by the manufacturer warranty.

(a) Equipment. WEG Electric Machinery warrants the Equipment (excluding software) against defects in material and workmanship for a period expiring on the earlier of twelve (12) months after installation or eighteen (18) months from date of shipment, or agreed upon terms.
(b) Services. WEG Electric Machinery warrants Services against defects in workmanship for a period of ninety (90) days from the date of completion of such Services.
(c) Parts. If applicable to the scope of WEG Electric Machinery's work hereunder, WEG Electric Machinery further warrants: (i) spare parts and components sold by WEG Electric Machinery against defects in material and workmanship for a period of twelve (12) months after shipment and (ii) repaired or refurbished parts repaired by WEG Electric Machinery against defects in material and workmanship for a period of ninety (90) days after shipment, unless repaired pursuant to an original equipment warranty, in which case the repair is warranted for the time remaining of the original warranty period.

This warranty does not apply to any product which has been subject to misuse or neglect (including, inadequate maintenance, improper installation, modification, adjustment, or repair).

IMPORTANT:

Motors described in this manual are updated and this manual is subject to change without notice. To request a new manual, please contact WEG Electric Machinery.

NOTES

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