marathon™ WEG Group

Driving efficiency and sustainability

THREE PHASE SQUIRREL CAGE & SLIPRING INDUCTION MOTOR

INSTALLATION, OPERATION &

MAINTENANCE MANUAL

(READ THIS MANUAL CAREFULLY)

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1. SAFETY INSTRUCTIONS

⚠ CAUTION

These instructions must be followed to ensure safe and proper installation, operation and maintenance of the motor. They should be brought to the attention of anyone who installs, operates or maintains this equipment. Ignoring these instructions may invalidate the warranty.

1.1 Confirm that the parameters on the nameplate meet your requirements.
1.2 Confirm that the motor is not damaged.
1.3 Remove transport shaft locking device if fitted. Keep this device in stock to be used on all further transportation.
1.4 Lift the motor using the eyebolts or the lifting lugs integrated with the motor frame only. Alternatively, follow any otherwise stated separate lifting instructions.
Check that the eyebolts or the lifting lugs integrated with the motor frame are undamaged before lifting. Lifting eyebolts must be tightened before lifting. If needed the position of the eyebolt must be adjusted with suitable washers. If there is more than one lifting lug, they must be used together to share the weight.
The centre of gravity of motors with the same frame may vary due to different outputs, mounting arrangements and auxiliary equipment. To move a packed motor, a sling must be used to carry the motor over the base, or eyebolts or lifting lugs integrated with the motor frame.
1.5 Before installation, confirm that the mounting (IM) is in line with the identification on the nameplate. Check that the drain holes are at the lowest position.
1.6 For motors fitted with antifriction bearings, rotate the rotor manually to confirm that it runs freely. If any damage or abnormal sound, please contact manufacturer.

2. SAFETY CONSIDERATIONS

⚠ CAUTION

2.1 The motor is intended for installation and use by qualified personnel, familiar with relevant safety requirements. If the motor is not installed, operated and maintained correctly, it may cause harm to personnel and equipment. Safety equipment necessary for the prevention of accidents at the installation and operating site must be provided in accordance with the local regulations.
2.2 Before maintenance is carried out, all electrical supplies connected with the motor and its auxiliary parts must be turned off. Confirm that the motor is already at a standstill.
2.3 Earth connections must be carried out according to local regulations before the motor is connected to the mains supply. Any protection devices must also be earthed to prevent accidents during service.
2.4 Any fitted thermal protection devices should not be left open circuit and always be used. The protection devices will ensure high uptime of motor.
2.5 Depending on the operating conditions and environment, the most suitable degree of protection must be chosen to prevent any damage and accidental contact with internal rotating parts or with live parts
2.6 Under the occasions of auto-starting, auto-shutting and remote-starting, a warning plate must be displayed.
2.7 Before starting, confirm that all shaft keys are fitted firmly.
2.8 In order to prevent overload, it is recommended to hook the RTDs to the control panel and set temp. rise limits with alarm and trip.
2.9 It is recommended to install a phase failure protection device.
2.10 Coupling halves and pulleys must be fitted using suitable equipment and tools that do not damage the bearings. Never fit a coupling half or pulley by hammering into place, or remove it using a lever pressed against the body of the machine.
2.11 In case of any abnormal sound, Stop the motor immediately and contact manufacturer.
2.12 Protect motor against the ingress of water.
2.13 When motor is used with valid speed drive, confirm that it does not exceed the maximum safety speed of motor and operate without over load.
(At lower speed, the ventilation of the motor will reduce; motor should be operated in accordance with designs specification.)
2.14 Confirm safety measures to avoid accidents in brake failures.

2.15 Motors are provided with re-greasing nipples which can be used during operations. These machines are intended for lubrication during operation by qualified personnel familiar with relevant safety requirements. Any rotating parts or live parts should be suitably protected.

These safety considerations must be followed to avoid injury from electrical and mechanical sources.

3. ENVIRONMENTAL REQUIREMENTS AND OPERATING CONDITIONS

3.1 ENVIRONMENTAL REQUIREMENTS

3.1.1 To achieve desired performance normal ambient temperatures limits are -20°C to nameplate specified temperature.
3.1.2 Standard design altitude (if not specified otherwise) is 1000 meters above sea level.
3.1.3 The relative humidity should be less than 95% at operating conditions.

If there is any deviation from these maximum environment conditions, such as normal ambient temperatures lower than -20°C or nameplate specified temperature or the relative humidity is more than 95%, or the altitude above sea level is more than 1000 meters, or high vibration situations, the suitability of motors for operation must be checked. Any questions, please contact manufacturer.

3.2 OPERATING CONDITIONS

3.2.1 The frequency and voltage of power supply must be as indicated on the name plate and its tolerance should be according to IEC60034-1/IS-325:1996 (except the special design according to the agreement).

The open-drip-proof motors (IP23) are suitable for operating indoor in clean, dry, ventilated and non-corrosive air. More details see IEC60034-1/IS-325:1996. If open-drip-proof motors (IP23) operate outdoors, adverse weather conditions will affect the standard performance of the motors.

3.2.2 The totally-enclosed fan-cooled motors, air to air cooling and air to water cooling motor (IP55) is suitable for operating in relatively dirty, humid, and dusty environments. For more details see IEC60034-1/IS-325:1996 .
3.2.3 For the water-cooled motors and the ambient temperatures should be no less than 0°C, to avoid the cooling water getting frozen.
3.2.4 Foundations must be even, and sufficiently rigid to withstand possible short circuit forces. They shall be designed to avoid transmission of detrimental vibratory forces that may damage the motor. Ref. ISO10816 for details.
3.2.5 The ambient space should be large enough to facilitate heat dissipation and maintenance. Ensure that the motor surrounding area has adequate air change to effectively dissipate heat generated within the motor.

4. TRANSPORTATION AND STORAGE

4.1 TRANSPORTATION

4.1.1 All medium and big motors are fitted with shaft locking devices to prevent damage during handling & transportation.
4.1.2 Immediately, upon receipt of the motor, check for external damage and if found, take photographs. It is important to inform the transportation company and the supplier/manufacturer with evidence of damage to take corrective action and or initiate insurance claim.
4.1.3 Packed motor shall be lifted using sling under the base of pallet or using the lifting lugs/eye bolt fitted to the motor frame, or with a forklift.

4.2 SHORT PERIOD STORAGE (NOT EXCEEDING 6 MONTHS)

4.2.1 ⚠ The motors should always be stored in clean, dry, vibration free, dust free and corrosion free environment.
4.2.2 The motors should always be stored on a smooth surface free from vibration. If it is not possible, motor shall be placed on thick wooden planks or flexible rubber support to isolate the motor from transmitted vibration.

4.2.3 The storage place should not be near to boiler or a freezer and any extreme temperature environment.
4.2.4 Preferable storage temperature is 25°C with < 65% RH. If the motors are equipped with space heaters, the space heaters should be energized at the space heater voltage shown in the name plate.
4.2.5 The best relative humidity of the storage place shall be less than 65%. Keep the temperature of motors above dew by energizing the anti-condensation heaters.
4.2.6 If motors are stored outdoors, the plastic packing must be removed, canopy must be provided to protect against the ingress of water and exposure to direct sunlight.
4.2.7 Protect against the ingress of insects.
4.2.8 For water cooled motors a mixture of water and glycol (more than 50%) should be filled in the heat ex changer and the end flanges sealed off to prevent the loss of mixture.

4.3 LONG PERIOD STORAGE (EXCEEDING 6 MONTHS)

CAUTION

Check the following points in addition to the requirement of short period storage:

4.3.1 Insulation resistance should be measured once every two months and the value should be recorded.
4.3.2 The humidity should be measured once every two months and recorded. If the humidity is more than recommended, change the storage place.
4.3.3 The paint of motor surfaces should be checked once every three months. If there is rust, it must be cleaned and repainting must be done.
4.3.4 The shaft extensions and flanges should be checked for rust once every three months. If there is rust, it must be cleaned off and antirust treatment done.
4.3.5 Motors with rolling bearings will have correct lubrication before leaving the factory. Turn shaft once a month by hand.
4.3.6 Motors with sleeve bearings are drained off oil before leaving the factory, but they shall be refilled during storage to avoid rusting.
4.3.7 If the storage of motors with sleeve bearings exceeds one year, the sleeve bearings must be dismantled and antirust measures must be taken.
4.3.8 After prolonged period of storage (>1 year), the entire bearing grease must be renewed before putting the motor into the operation.
4.3.9 Measure insulation resistance before starting and when winding dampness is suspected. Resistance should exceed 10M ohm. If the 10M ohm resistance value is not achieved, the winding is too damp and must be dried. The 10M ohm resistance value is still not achieved, the motor must be repaired.

Reference limits for insulation resistance of electric motors:

Insulation resistance value	Remarks
<10MΩ	Unacceptable (contact manufacturer for further instructions)
10 MΩ to 50 MΩ	Handle with caution
50 MΩ to 100 MΩ	Normal
100 MΩ to 500 MΩ	Good
500 MΩ to 1000 MΩ	Very Good
>1000 MΩ	Excellent

4.3.10 The maximum vibration velocity measured in the horizontal and vertical direction at the machine feet shall not exceed 25% of the RMS value of vibration velocity measured at the adjacent bearing in either the horizontal or Vertical direction.

4.4 STORAGE AFTER INSTALLATION

After installation or after operating for a period, if the motor will be not in operation for a long period, protect the motor as measures stated under “long period storage”. Otherwise the motor should be in operation once every two months.

5. INSTALLATION

5.1 PRE INSTALLATION CHECK

5.1.1 Check all rating data on the nameplate, especially voltage and winding connection (star or delta).
5.1.2 Measure insulation resistance before commissioning and when winding dampness is suspected. Resistance should exceed 10M ohm (measured with a Megger). If this reference resistance value is not achieved contact manufacturer.
5.1.3 Check the motor for damaged, distorted and/or loose components. Turn the shaft by hand to check free rotation for motors with antifriction bearings.
5.1.4 Check the mounting arrangement. Apart from the basic type of construction IM B3, the motors can also be supplied in various other types of construction. Like IMB 35, IMV1 etc.
5.1.5 Clean dust and other debris from the motor.
5.1.6 After a long period of storage, check the lubrication and replace it if necessary.

5.2 FOUNDATION

A good foundation design can ensure safe operation and convenient maintenance. Space around the motor foundation should be large enough to facilitate heat dissipation and necessary maintenance.
Ensure cool air flow through/over the surface and parts of the motor without any blockage. Ensure the devices or heating elements do not to affect the cooling of the motor. Foundations should be strong and well designed to avoid any transmitted vibration and resonance.

5.2.1 Foundations must be even, and sufficiently rigid to withstand possible short circuit forces. If motors are connected with other equipment, both should be installed on foundations made in concrete. A suitable type of construction should be chosen for frequent shock loading.
5.2.2 Foundations should be 2mm smaller than the base of the driven equipment for installation adjustment to attain the correct alignment.
5.2.3 The foundation must be suitable for each footplate area. The foundation surface must be bigger than the footplate area.
5.2.4 Any height differences between the motor and the driven machine should be adjusted with shims. The sur face for the shims must be a larger area than that of the feet. The number of the shims shall preferably be limited to 3.
5.2.5 Select an appropriate foundation surface for the soleplate or common bedplate which will be considered more reliable for motor operation.

Foundations must be even, and sufficiently rigid to withstand possible short circuit forces. Incorrect alignment can lead to bearing failure, vibration and even shaft fracture, as well as accidents.

5.3 INSTALLATION

5.3.1 PREPARATION FOR INSTALLATION

5.3.1.1 A number of steel shims may be required of 0.1mm, 0.2mm, 0.5mm, 1.0mm thickness.
5.3.1.2 Simple tools, such as lever, jack and bolts.
5.3.1.3 Measurement instruments, such as micrometer for adjusting installation of shaft coupling.
5.3.1.4 Before mounting the motor, the foundation surface must be clean.
5.3.1.5 Check the position and height of the mounting holes.
5.3.1.6 Remove transport locking device if fitted. Re-install the transport locking device before transportation. If same device cannot be re installed, a special device has to be installed to arrest movement of shaft during transportation.

5.3.2 CONSIDERATION BEFORE INSTALLATION

5.3.2.1 The drill holes for mounting must be rough to be grouted with concrete firmly.
5.3.2.2 To grout the studs with concrete firmly, studs must be clean from thick paint, paint drops and dirt.
5.3.2.3 The concrete surface must be clean from lubrication and dirt.
5.3.2.4 The anti-rust protection applied to the shaft extension and the feet must be cleaned with suitable cleaning agent.
5.3.2.5 Fasten the steel studs to the holes.

5.3.2.6 Ensure that the drain holes are at the lowest position after installation. When the drain holes are open, measures must be taken to protect against the ingress of any foreign material.
5.3.2.7 For long periods of storage or the motor is repaired, the insulation resistance must be checked before starting. This includes stator windings, rotor windings of slip-ring motors, and other auxiliary devices.
5.3.2.8 Lift the motor using only the eyebolts or lifting lugs integrated with the motor frame only. The smaller lifting lugs for auxiliary devices are not suitable for lifting the motor.
5.3.2.9 If there is more than one lifting lug, they must be used together to share the weight.
5.3.2.10 If slings are used on the lifting lugs, keep the slings the same length and not twisted before lifting.

Do not lift the motor with two ends of the same sling. If there are two eyebolts or lifting lugs, lift the motor with two separate slings.

5.3.3 INSTALLATION

5.3.3.1 Installation of shaft coupling

(1) The shaft coupling of the motor must be dynamically balanced to grade G 2.5 or better for 4 pole and above. For 2 pole motors the balancing of coupling has to be done to grade G1.0 or better at rated speed. As stan dard, balancing of the motor has been carried out using half key.
(2) Before installing the coupling, the shaft and the coupling bore must be greased.
(3) Basically, the coupling should be heated and pushed onto the shaft extension with only light axial force. To avoid bearing damage, do not hammer the coupling.
(4) It is recommended to use a flexible coupling to join the motor to the driven equipment.
(5) For motors with the sleeve bearings, the couplings must be of limited end float type to prevent axial force being transmitted to the motor shaft.
(6) Before installing the coupling, it should be balanced using half shaft key to achieve an overall balance condition.
(7) After the couplings of the motor and the driven machines are coupled together, the protective shield must be installed outside the couplings.
(8) For motors with sleeve bearings, the location of the magnetic centre is indicated on the motor. The motor must be coupled at its magnetic centre
(9) There must be enough space left between the couplings of motor and of the driven machine to prevent axial force caused by heat expansion which could lead to bearing failure.

5.3.3.2 Installation of pulleys

The standard motors are not suitable for belt-pulley application unless specially designed for such service. Any belt driven motor must be specially designed according to the customer's information on belt-pulley details.

(1) The flat belts do not apply for large motor.
(2) The length of the sheave should not be greater than the shaft extension, otherwise this can lead to shaft fracture.
(3) The fan end of the double shaft extension motor should not be connected to belt pulley for power transmission.
(4) Ensure the parallelism of the motor shaft and the driven shaft. The centre distance between the motor shaft and the driven shaft shall preferably be greater than the larger pulley diameter by at least 1.6 times.
(5) The belt pulley must be dynamically balanced before installation.
(6) The motor shaft must be painted with rust inhibitive mineral based coating before mounting the motor pulley.
(7) Do not exceed the maximum belt forces (i.e. radial bearing loading) stated in the relevant production order.
(8) It is also advisable to limit the belt velocity to under 32 m/min to minimize belt abrasion and vibration.
(9) Place the sheaves and belt as close as possible to the motor body to reduce the bending moment and prevent shaft fractures.
(10) For disassembly of pulleys it is recommended to use the special devices to avoided damaging the key and shaft surface.
(11) Hammers should not be use when lifting or removing motor pulley.
(12) The alignment of both the driving and driven pulley should be perpendicular to the motor shaft so that there is not additional axial force on the motor shaft.

5.3.3.3 Conveyance with Gear

(1) Make sure the loading capacity of shaft and bearings is appropriate for the size and installation position (over hung) of gearing case. Helical gears are to be mounted on motor shaft, the motor bearing system must be suitably designed to take the axial forces.
(2) Pay close attention to ensure the parallelism of shafts.
(3) The teeth of gears should be correctly and precisely matched, the force conveyance centres should lie on the same line.
(4) There should be no slip, jumping, vibration or unusual noises during operation.

5.3.3.4 Thermal effects.

In aligning the motor (and rotor) axially with the driven equipment, consideration should be given not only to the end-play indicator position but also to axial shaft expansion and increase in shaft centreline height due to thermal expansion effects.

(1) Shaft height growth (change in shaft centerline elevation) for TEFC motor can be calculated based on temp difference of 40°C as follows: D=(0.00045)×(motor foot to shaft centerline dimension)mm

Thermal effects of the driven machine must be considered at the same time in order to calculate the total thermal effects.

(2) A space must be left between couplings according to the load. Shaft length growth for motor can be calculated based on temp difference of 55°Cas follows: D=(0.0006)×(motor frame length dimension) mm

Ensure the couplings, except rigid couplings, can move free axially.

5.3.3.5 Coupling arrangement for sleeve bearing motors - Axial clearance

(1) Motor fitted with sleeve bearings should be directly coupled to the driven machine or with a gear box. Belt pulley type coupling cannot be used.

When coupling the motor the following aspects must be considered:
(1) Bearing axial clearance which is shown on the chart below for each bearing size.
(2) Axial displacement of the driven machine. If any.
(3) Motor shaft shall be located at its magnetic centre during coupling.
(4) Allowance to be considered for oil film thickness.
(5) Differential thermal growth of motor and driven shaft to be taken care of.

5.3.3.6 Installation of rigid foundation

(1) Clean the surface of the foundation.
(2) Foundation must be even. Flatness of individual foot support should be within 0.05 mm and co planarity of feet supports shall be within 0.15mm.
(3) Motors connected with other equipment should be installed on the soleplate or common bed which will be considered more reliable for motor operation. It is better to embed the soleplate or common bed in concrete together. This is however not applicable for crusher or mill application where it is preferred to amount the motor on a separate foundation. Foundation must be levelled to be below 0.05 mm flatness.
(4) Put the motor on the foundation carefully to prevent any damage.
(5) Check the mounting surface. Each footplate area of foundation must be uniformly rigid to prevent any incline of motor during operation.
(6) For large motors and high voltage motors, the footplate must be dowelled after installation.
the machine has one dowel hole per foot. Deepen the holes by drilling through to the stool foundation. After that, the holes are smoothed with a reaming tool. Suitable dowel pins should be driven in to the holes to ensure that the alignment is not disturbed during operation and to allow easier re-installation after any possible removal of the motor.

5.3.3.7 Installation on concrete foundation

(1) Clean the surface of foundation.
(2) Foundation must be rigid enough to ensure stability.
(3) Make sure the concrete is completely cured, then tighten the bolts.
(4) Use rigid and solid soleplate or common bed as the surface of the foundation. Flatness of foot support shall be with 0.05 mm and co planarity of all feet plates shall be within 0.15mm.
(5) Check the mounting surface. Each footplate area must be same rigid on the foundation to prevent motor in clined during operation.
(6) For large motors and high voltage motors, the footplate must be dowelled after installation. The machine has one dowel hole per foot. Deepen the holes by drilling through to the stool foundation. After that, the holes are smoothed with a reaming tool. Suitable dowel pins should be driven in to the holes to en sure that the alignment is not disturbed during operation and to allow easier re-installation after any possible removal of the motor.

5.3.3.8 Installation of vertical motors

(1) If motors are to be connected with a pump, and both are installed on the same foundation, the foundation of the motor/pump must be rigid and firm to provide adequate support. There must be no vibration due to inadequate stiffness of the mounting stool and external transmitted vibration.
(2) All mounting surfaces must be clean and level.
(3) The foundation must be levelled to below 0.05mm (2mil) flatness.
(4) Make sure the above requirements are acceptable, before setting the motor on the mounting foundation.

5.3.3.9 Adjustment of installation

The motor shaft and the driven shaft should be aligned within limited tolerances in both radial and parallel alignment. Alignment beyond limited tolerance may lead to bearing failure. Refer to coupling manufacturer instruction for more details.

	Radial limited (mm)	Axial limit (mm)
Flexible	0.05	0.05
Rigid	0.03	0.02

(1) Before adjustment, the couplings of the motor and the driven machine must be coupled together and be convenient for adjustment.
(2) For large motors with foot fixing, adjustment bolts must be installed in the feet of the motor before adjustment.
(3) Adjustment bolts may also be installed in the driven machine for high accuracy installation.
(4) It is necessary to use high accuracy instruments to measure installation for high accuracy alignment.
(5) All measured data must be recorded to be referenced later.

6. CONNECTION

6.1 CONNECTION OF COOLERS

6.1.1 Connection of forced ventilated air coolers.
These coolers are provided with separately excited motors, which are to be connected to LV supply as specified in the GA drawing. Ensure proper connection of terminals so that rotation of the motor is in de sired direction. Adequate space must be provided at the air entry and exit zones so that air flow is not inhibited.

6.1.2 Connection of ventilation ducts.
Motors designed for cooling airflow to and/or from the machine with air ducts have connection flanges as specified in the dimensional drawing. Clean the air ducts thoroughly before connecting them to the motor, and check for possible obstructions in the ducts. Seal the joints with appropriate gaskets. Check for possible leaks in the ducts.

6.1.3 Connection of air-to-water coolers.
Motors equipped with an air-to-water heat exchangers have flanges specified in the dimensional drawing. Connect the flanges and seal the joints with appropriate gaskets. Ensure desired quantity and quality of

water at required minimum pressure to heat exchanger. It is important to use pure and inhibited water, i.e. water for domestic consumption full fill all these requirements. If saline, brackish, high turgidity or dirty water is used, proper inhibiting agent must be added to the cooling water to protect the cooling system against corrosion, fouling and when necessary, against freezing, standard values for the cooling water to be used in the cooling system.

Standard values for the cooling water to be used in the cooling system :

- pH 6.5 - 9.5
- Alkalinity (CaCO3) > 1 mmol/litre
- Chloride (Cl) < 120 mg/litre
- Conductivity < 1500 µs /cm

6.2 CONNECTION OF SLEEVE BEARINGS

6.2.1 Motors with forced lubrication systems are equipped with oil pipe flanges, and possibly with pressure gauges and flow indicators. Install all necessary oil pipes and connect the oil circulating units.

6.2.2 Install the oil supply system near the motor at an equal distance from each bearing as far as possible.

6.2.3 Install the oil outlet pipes downwards from the bearings at a minimum angle of 10°. The oil level inside the bearing will increase if the slope of the pipes is too small, the oil will flow too slowly from the bearing to the oil container, and this can result in oil leaks or disturbances in the oil flow.

6.2.4 Fill the oil supply system with appropriate oil with the correct viscosity. The correct type of oil and viscosity is indicated on the dimensional drawing. After connecting the forced oil system to the bearing flanges, the entire oil system must be flushed. The residual oil in bearing oil sump must be drained out. Clean oil must be filled in the system before putting the system in operation.

6.2.5 Turn the oil supply on, and check the oil circuit for possible leaks prior to starting the machine. The normal oil level is obtained when half of the oil sight glass is covered.

The sleeve bearings are delivered without lubricant. Running the motor without lubricant will result in immediate bearing failure.

6.3 MAIN SUPPLY WIRING

⚠ WARNING

6.3.1 Safety regulations of supply wiring

(1) All interconnecting wiring for controls and grounding should be in strict accordance with national standard and local regulations.
(2) All interconnecting wiring should be finished by qualified personnel, familiar with relevant safety requirements.
(3) De-energize all equipment, including auxiliary equipment. Verify that all parts are isolated from their respective supply. Install an obvious notice board on the switch to provide a safeguard against accidental re-energizing of the equipment.
(4) Connect all parts to protective earth.
(5) Cover or provide barriers against live parts in the surrounding area.

6.3.2 Power

The rated conditions of operation for the motor are as shown on the nameplate. Within the limits, given below, of voltage and frequency variation from the nameplate values, the motor will continue to operate but with performance characteristics that may differ from those at the rated conditions:

(1) +/- 10% of rated voltage.
(2) +/- 5% of rated frequency.
(3) +/- 10% combined voltage and frequency variation so long as frequency variation is no more than +/- 5% of rated frequency.

Operating the motor at voltages and frequencies outside of the above limits can result in both unsatisfactory motor performance and damage, and even failure of the motor.

6.3.3 Main supply wiring

(1) Motors are available with terminal boxes rotatable through 2 x 180° as a standard. The terminal box can be adjusted according to the requirement of the user but must be sealed.
(2) Note nameplate markings and connection diagram in the terminal box. The 6 terminals are marked with leters U1, V1, W1 and U2, V2, W2 or the 3 terminals are marked with letters U, V, W. The 6 terminals may be connected delta or star according to the connection diagram, or a star/delta type starter.

Check the phase sequence from the connection diagram, the standard phase sequence is for clockwise rotation looking from the drive end of the motor.
For counter-clockwise rotation, the phase sequence is in accordance with the order instructions.

(3) It is important to verify that the supply voltage and the frequency are the same as the values indicated on the nameplate of the motor before starting.
(4) For multi-speed motor, the connection diagrams received with the motor have to be studied before starting the installation work to determine the rotation direction at different speeds. Any question, please contact Marathon.
(5) In order to ensure continuous and trouble-free running, it is therefore important that the length of the insulation and creepage distances between input cables and terminal-box are sufficient. Stripping, splicing and insulating of the high-voltage cables must be performed in accordance with instructions by the cable manufacturer.

The stripped, spliced cables must be insulated to avoid any accident.

(6) The space between the cable entries and the cables must have a cable gland installed and be insulated. Unused cable entries must be properly sealed. The plastic plugs provided with the motor are for transport purposes only.
(7) The inside of the main terminal box must be free from dirt, moisture and foreign debris. The box itself, cable glands, and unused cable entrance holes must be closed in a dust-tight and watertight manner according to the manufacturer's instructions.

6.4 AUXILIARY TERMINAL BOXES

6.4.1 Thermal protection connections could be located in an auxiliary terminal box on the motor. Auxiliary terminal boxes are attached to the frame of the motor according to the number of accessories and customer needs, and their positions are shown on the dimensional drawing of the machine.
6.4.2 Various protection device wiring must be according to the wiring regulations and safety standard.
6.4.3 Auxiliary devices such as thermostats, thermocouples, PT 100 resistance temperature detectors, and anti-condensation heating elements will generally terminate on terminal blocks located in the auxiliary terminal box on the motor.
6.4.4 Caution must be exercised anytime contact is made with the incoming space heater circuit as space heater voltage is often automatically applied when the motor is shutdown.
6.4.5 Connect the instruments and auxiliary equipment according to the connection diagram in the auxiliary terminal box.
6.4.6 The inside of the auxiliary terminal box must be free from dirt, moisture and foreign debris. The box itself, cable glands, and unused cable entrance holes must be closed in a dust-tight and watertight manner according to the manufacturer's instructions. There are labels inside the cover.

6.5 CONNECTION OF ROTOR SUPPLY OF SLIP-RING MOTORS

6.5.1 To gain access to the rotor circuit through the sliprings for slip-ring type motors, the cables should be connected with proper terminations. The cables have to be directly connected with the rotor terminal board.
6.5.2 Study the connection diagram provided with the motor carefully before connecting any cables.

6.6 CONNECTION OF EXTERNAL BLOWER MOTORS

6.6.1 AC motors fed with frequency converters are generally equipped with an external blower to ensure their normal operation at different speeds.

6.6.2 The external blower motor is normally a three phase A.C. induction motor. A connection box is usually located on the frame of the blower motor. Ensure proper supply voltage as per name plate on blower motor.
6.6.3 Earth connections must be carried out according to local regulations before the external blower motor is connected to the supply.
6.6.4 The warranty does not cover damaged bearings due to improper cabling or earth connection.

The external blower motor must be connected to a protective earth according to local regulations.

6.7 EARTH CONNECTIONS.

⚠ CAUTION

6.7.1 Earth connections must be carried out according to local regulations before the motors are connected to the mains supply.
6.7.2 The motors usually have a protective earth terminal in the terminal box. However, larger motors also have an external earth terminal on the frame, foot or flange. These terminals must be connected to a protective earth at the same time.
6.7.3 The motor must be grounded by a proper cable connection to the electrical system ground point.

6.8 REQUIREMENTS FOR MOTORS WITH FREQUENCY CONVERTERS

6.8.1 In frequency converter applications the motor frame external earth must be used for equalizing the potential between the motor frame and the driven machine, unless the two machines are mounted on the same metallic base.

7. COMMISSIONING

7.1 CHECK BEFORE STARTING

When the motors are installed, ensure the wiring is according to the diagram. Also, the following points should be noted to achieve the normal operation of the motor.

7.1.1 Check that the motor is properly anchored to the foundation. Check for cracks in the foundation and the general condition of the foundation.
7.1.2 Check the tightness of the fixing bolts.
7.1.3 Make sure all wiring, including wiring for auxiliary equipment, are correct.
7.1.4 Ensure the sizes of cable wires are appropriate and all connections are well joined for the currents they will carry.
7.1.5 Ensure all connections are properly insulated for the voltage and temperature they will experience.
7.1.6 Make sure that all cable joints outside the terminal box are insulated.
7.1.7 Make sure that frame and terminal box are grounded.
7.1.8 Ensure the ratings of fuses, switches, magnetic switches and thermo-relays etc. are appropriately and the contactors are in good condition.
7.1.9 Make sure that the starting method is correct.
7.1.10 Check the assembly of the main terminal box and the cooling system.
7.1.11 For forced lubricated motors, check that the lubrication system is commissioned and running before the motor is switched on.
7.1.12 Check the connection of oil and cooling water pipes and check for leaks when running.
7.1.13 Check pressure and flow for oil and cooling water.
7.1.14 Check routing of main cable to avoid any stress.
7.1.15 Ensure that heater voltage is not applied when the motor is in operation, especially when the heater voltage is often automatically applied when the motor is shutdown.

7.2 MEASUREMENT OF INSULATION RESISTANCE

Before a motor is started up for the first time, after a long period of standstill or within the scope of general maintenance work, the insulation resistance of the machine must be measured. The insulation resistance of both stator and rotor windings must be measured.

For new motors with dry windings, the insulation resistance should be very high. The resistance can, however, be extremely low if the motor has been subjected to incorrect transportation and storage conditions and humidity, or if the motor is operated incorrectly.
The insulation resistance measurement provides information about the humidity and dirtiness of the insulation. Based upon this information, correct cleaning and drying actions can be determined.

(1) If the measured value is considered too low the winding must be cleaned and/or dried. If these measures are not sufficient, please contact MARATHON.
(2) Motors which are suspected to have moisture problems should be dried carefully independent of the measured insulation resistance value.
(3) The insulation resistance indicated in the test report is normally considerably higher than the values measured on site, because the insulation resistance is very high for new machines with dry windings when leaving the factory.

7.2.1 Minimum values for insulation resistance

Generally, the insulation resistance values for dry windings should exceed the minimum values significantly. Definite values are impossible to give, because resistance varies depend on the motor type and local conditions. In addition, the insulation resistance is affected by the age and usage of the motor.

7.2.1.1 The control value of insulation resistance

Ref clause 4.3.9

7.2.1.2 Stator winding insulation resistance measurement

The insulation resistance is measured using an insulation resistance meter (megger). Different meters are used according to various voltages.
(1) Up-to 1000 V, megger voltage 500V
(2) 1001 V - 3300V, megger voltage 1000V
(3) 3301 V - 6600V, megger voltage 2500V
(4) 6601V - 11000V, megger voltage 5000V

During or after measuring, the terminals must not be touched together immediately as they may carry residual dangerous charges. Furthermore, if the supply cables are connected, make sure that the power supplies are clearly disconnected and that the rotor is not turning before insulation resistance measurement is taken.

No matter what meters are used, the test time must last 1 minute, after which the insulation resistance value is recorded. Before the insulation resistance test is conducted, the following actions must be taken:
(1) Verify that all power supply cables are disconnected.
(2) Verify that the frame of the motor with the stator windings being tested is earthed.
(3) Make sure that auxiliary devices are earthed.
(4) The insulation resistance measurement should be carried out in the terminal box. The test is usually per formed to the whole winding as a group, in which case the meter is connected between the frame of the motor and the winding.
(5) After the insulation resistance measurement the winding phases must be earthed briefly in order to discharge them.

7.2.2 Insulation resistance measurement for a motor with slip rings.

Insulation resistance measurements for a motor with slip rings should be carried out same as squirrel cage motors.
(1) Verify that all supply cables are disconnected from the main supply.
(2) Verify the slip ring unit connection cables are disconnected from their supply.
(3) Verify that the shaft, the frame of the motor and the rotor windings are earthed.
(4) The carbon brush connections should be checked to be in good order.

The insulation resistance of the rotor winding should be measured. Take note and measure as follows:
(1) Verify that the frame of the motor and the stator windings are earthed.
(2) Verify that the shaft is earthed.
(3) The rotor winding can generally be connected in a star connection. If each phase must be measured separately, the rotor winding phases not been tested should be earthed.

(4) After the insulation resistance measurement the winding phases must be earthed briefly in order to discharge them.

7.2.3 Insulation resistance measurement for auxiliaries

(1) The test voltage for the space heater should be 500 VDC.
(2) The insulation resistance measurement for PT-100 detectors is not recommended.

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7.3 COMMISSIONING AND START-UP

7.3.1 First test start

7.3.1.1 The first start should last only about one (1) second. The objective of the first start is to check the direction of rotation of the motor. The motor should turn in the same direction as is shown with an arrow located on the frame or the fan cover.
7.3.1.2 The direction of rotation of an external blower motor is indicated by an arrow near the blower motor.
7.3.1.3 It should also be verified that the rotating parts do not touch any stationary parts.
7.3.1.4 If the desired direction of rotation for some reason is different from the one specified on the motor, contact manufacturer for further advice.
7.3.1.5 To alter the direction of rotation, interchange the connection of any two line cables.
7.3.1.6 Motors with slip rings cannot be operated without a starter.
7.3.1.7 The first start is made with an uncoupled coupling between the motor and driven machine.
7.3.1.8 Without a coupling between the motor and driven machine, it is normal that there is shaft over-run during shutting down for machines equipped with sleeve bearing.

7.3.2 Running Unloaded

7.3.2.1 During the first one or two hours of running, it is important to keep a close surveillance of the motor in case of any changes in vibration or temperature levels. If any abnormal sounds occur, shut down the motor, and find the reason for the changes. If necessary, consult the manufacturer of the motor.
7.3.2.2 The motor may be direct-on-line starting, star delta starting or auto-transformer starting.
7.3.2.3 If the motor rotor fails to rotate within one or two seconds, shut off the power supply immediately. Investigate thoroughly and take corrective action before attempting a restart.

7.3.3 Running loaded

7.3.3.1 If the rate of rise in temperature is excessive or if the motor exhibits excessive vibration or noise, it should be shut down immediately and a thorough investigation made as to the cause before it is operated again.
7.3.3.2 Any abnormal noise or vibration should be immediately investigated and corrected.
7.3.3.3 Ensure the voltage and frequency of the power source are identical to the ratings shown on the nameplate. Check current balance of all the 3-phases of the windings.
7.3.3.4 The number of recommended consecutive starts of direct on line supplied motors depends essentially on the load characteristics (torque curve vs. rotational speed, and load inertia), and on the motor type and design. Too many and/or too heavy starts will cause abnormally high temperatures and stresses on the motor, thus accelerating the ageing of the motor insulation and resulting in an abnormally short lifetime, or even a premature motor insulation failure.
7.3.3.5 For the motors with PT-100 resistance temperature detectors, the temperatures of the bearings, stator windings and cooling air should be recorded when the motor is running. After running the motor for some time, the cooling system should be checked. Verify that the cooling fluid, where applicable, and air is circu lating without any obstruction. Record the temperatures of the cooling system, inlet and outlet.
The winding and bearing temperature may not reach a stable temperature until after several (4-8) hours, when running at full load.
The stator winding temperature depends on the load of the motor. If full load cannot be obtained during or soon after commissioning, the present load and temperature should be noted and included in the commis sioning report.
7.3.3.6 If the bearing temperature rise and motor operation appear to be normal, operation should continue until the bearing temperatures stabilize.

(1) The trip limit for anti-fiction bearing is normally set at 95°c for lithium based grease lubricated bearings.
(2) The trip limit for sleeve bearings is normally set at 85°C.
If the rate of rise in temperature is excessive or if the motor exhibits excessive vibration or noise, it should be shut down immediately and a thorough investigation made as to the cause before it is operated again.

7.3.3.7 Any abnormal temperature rise, noise or vibration should be immediately investigated and corrected. Else report to Marathon.
7.3.3.8 Starting time is longer for the motors with large inertia. However, if starting time is longer than usual or if

7.3.3.9 If the capacity of the mains transformer is not big enough to start several motors at the same time, they should start respectively from larger motors to smaller ones.
7.3.3.10 During the running and any investigations, protection devices should not be disconnected.

7.3.3.11 During the first several days of running, it is important to keep a close surveillance of the motor in case of any changes in vibration or temperature levels or abnormal sounds occur.
7.3.3.12 If available, and after the motor has been running for several hours, measure the vibrations or SPM-values from the SPM-nipples, and record the values for future reference use. If not equipped with SPM monitor, check the motor with a vibration measurement instrument. The measurement place should be near the motor bearing. Avoid locating the vibration sensor on sheet metals like fan end shield.
After installation, the vibration value of the motor will be a little higher than it was before leaving the factory.
7.3.3.13 Check that the carbon brushes on the slip rings are not sparking. Ensure that the slip ring surfaces are smooth.
7.3.3.14 During the first period of running, the heat-exchange system should be checked. Verify that the cooling fluid, where applicable, and air is circulating without any obstruction.
7.3.3.15 High temperatures may arise on the motor surfaces under normal operating conditions, so touching should be prevented or avoided.

If the motor exhibits excessive vibration or noise, it should be shut down immediately and a thorough investigation made as to the cause before it is operated again.

7.3.4 Shut down.
7.3.4.1 Reduce the load of the driven equipment, if applicable.
7.3.4.2 Open the main breaker.
7.3.4.3 When the motor is not in operation, anti-condensation heaters have to be switched on when applicable.
7.3.4.4 For motors with water-cooling, the cooling water supply must be switched off in order to avoid condensation inside the motor.

8. LUBRICATION

It is essential to use grease of good quality and with the correct soap base and grade. This will ensure a long and trouble free lifetime of the bearings as a standard lithium based grease is to be used for anti-friction bearings and recommended grade of oil for sleeve bearing.

8.1 RE-GREASING FOR ROLLING BEARINGS

8.1.1 Motors are fitted with re-greasing arrangement. The re-lubrication interval and quantity are mentioned on the motor name plate. It is preferred to provide on line greasing.
8.1.2 Grease must be injected slowly in the bearing for hi-speed motors (1000 < n <2000) it is recommended to pump grease at rate of 12gm per minute. After about 50% of re-lubrication quantity has be injected, a gap of 10 minute must be provided before injecting next 50% at the same rate of 12gm per minute.
8.1.3 For motor speed >2000 rpm greasing rate shall be 2gm per minute and no more then 5 gm of grease shall be injected at time. In case grease is injected too quickly for rotation speed 3000 and above, same may even load to bearing seizure.
8.1.4 The entire grease fill must be renewed after 4-5 relubrication. The grease pot or collector must be cleaned during grease renewal.

The temperature of the bearing will initially increase because of the excess grease and stabilise after some time to a lower temperature.

8.1.5 Re-greasing method

(1) Before re-greasing, the grease nipples should be thoroughly cleaned to prevent any accumulated dirt from being carried into the bearing with the new grease. The spent grease relief valve or plug should be opened to allow the proper venting of the old grease. Use a grease gun to pump grease through the grease nipple into the bearings.
(2) After re-greasing, operate the motor for 10-20 minutes to allow any excess grease to vent out. Close the grease inlet and outlet plug if fitted.

8.1.6 Kind of grease.

Grease with the correct properties is available from all major lubricant manufacturers. If the brand of grease is changed and its compatibility is uncertain, consult the Manufacturer.
Shell Gadus S2 V 100-3 grease is standard for motors except some special models for which special grease will be confirmed according to the specification. Please use identical grease or its equivalents when maintaining and re-lubricating. You can find comprehensive grease information on the name plate of motor.

Re-lubrication is to be performed by authorized personnel only when the motor is running, rotating parts and live parts must be protected. Please refer to the grease types, lubrication intervals and the amounts on the nameplate.

8.2 RE-LUBRICATION FOR THE SLEEVE BEARINGS

8.2.1 For the motors with sleeve bearings, lubricant should be filled before running, as the motor is shipped in dry condition.
8.2.2 In case of forced oil lubricated system, Install the oil supply system near to the motor, which should be turned on first before starting the motor.
8.2.3 Verify through the oil sight glass that the oil level inside the bearing is correct. The correct oil level is in the middle of the oil sight glass, but as long as the oil level is within the oil sight glass, the level is acceptable.
8.2.4 For forced-lubricated motors, the oil supply pressure is adjusted with the pressure valve and orifice. Ensure required flow of oil as per manufacturer recommendation and bearing size.
8.2.5 Check the temperature and the oil level of the bearings continuously in the beginning. This is particularly important for self-lubricating bearings. If the temperature of the bearing suddenly rises, the motor should be stopped immediately, and the reason for the temperature rise must be found before the motor is re-started. If no logical reason is found from the measurement equipment, it is recommended that the bearing is opened, and its condition verified. If the motor is under warranty, the manufacturer must always be contacted before any action is taken.
8.2.6 An oil check should be performed a few days after the first test run of the machine, just before the first oil change, and subsequently as required.
8.2.7 The change of the oil in the bearing should be made after 8000 hr.
8.2.8 Thermal Protecting setting.
As a standard, each bearing of high voltage Marathon Electric is fitted with a PT 100 temperature detector. This device must be connected to a controlling panel with purpose of detecting overheating and protect bearing when operation at high temperature

Insufficient amount of oil can damage the bearings. While excess pressure may cause oil leakage through seals. The minimum recommended oil level reached when the lubricant can be seen touching bottom part of the oil sight glass with the motor in the idle condition.
The oil level must be checked daily being kept approximately in the middle of the oil side glass.

9. INSPECTION AND MAINTENANCE

A rotating electrical machine often forms an important part of a larger installation and if it is supervised and maintained properly, it will be reliable in operation and guarantee a normal lifetime.

9.1 THE PURPOSE OF INSPECTION AND MAINTENANCE

9.1.1 Secure that the motor will function reliably without any unforeseen actions or interventions.
9.1.2 To estimate and plan service actions in order to minimize down time.
9.1.3 The purpose of this inspection is to do a quick check whether problems are beginning to develop before they cause failures and unscheduled maintenance breaks.

9.2 NOTICE FOR INSPECTION AND MAINTENANCE

9.2.1 Before working on any electrical equipment, general electrical safety precautions are to be taken into account, and local regulations are to be complied with in order to prevent personnel injury.
9.2.2 Personnel performing maintenance on electrical equipment and installations must be properly qualified. The person must be trained in, and familiar with, the specific maintenance procedures and test requirements for rotating electrical machines.
9.2.3 Motors for hazardous areas are specially designed to comply with statutory regulations concerning the risk of explosion. Safety precautions should be taken into account during inspection and maintenance.
9.2.4 These instructions and recommendations should be read carefully and be used as a basis when planning the maintenance program.
9.2.5 An essential part of preventive or condition based maintenance is to have a selection of suitable spare parts available. The best way to have access to critical spare parts is to keep them on stock.

9.3 THE LEVELS OF INSPECTION AND MAINTENANCE

9.3.1 Routine inspection The purpose of routine inspection is to ensure the normal operation of the motor.
9.3.2 Regular inspection The purpose of regular inspection is to prevent motor failure.
9.3.3 Maintenance intervals- Motor must be maintained periodically to ensure normal operation with minimum down time.

Generally the maintenance scope is determined by the following factors.:

(1) Ambient temperature and operating conditions.
(2) Starting and stopping frequency.
(3) Easily abraded and corrosive parts.
(4) Supply voltage and frequency variation.
(5) The vibration of the driven machine.
(6) The criticality of motor in the plant operation.
(7) The winding and bearing operating temperature

9.4 ROUTINE CHECKS DURING RUNNING OF THE MOTOR

9.4.1 The surfaces of the motor should be kept smooth and clean. The motor exterior should be kept clean and periodically inspected for rust, leaks, oil, water and other derbies.
9.4.2 Check that the connections are tight and there is no leakage in the system. Verify that the cooling fluid, where applicable, and air is circulating without any obstruction. Check the condition of the fan-cover to ensure good air circulation over the motor.
9.4.3 The vibration levels of the driving/driven machine system should be monitored when the motor is running. If any abrupt changes in vibration or temperature levels or abnormal sound occurs, shutdown immediately and check.
9.4.4 Should any of the following abnormal conditions occur, the motor should be shut down immediately to check.

(1) Heavy vibration,
(2) The driven machine damaged,
(3) Bearing worn or overheated,
(4) Bearing misalignment, axial vibration,
(5) Speed reduced suddenly,
(6) Stator and rotor, rub enclosure over heated,
(7) Breathing air fumes,
(8) Personnel accident.

9.5 REGULAR CHECKS

9.5.1 Many processes leading to damage can be prevented or at least slowed down with appropriate maintenance and regular checks.
(1) The tightness of all fastenings should be verified regularly.
(2) Check the condition of connections, mounting bolts and assembly bolts.

(3) Control that the carbon brushes are in good condition and that they can move freely in the brush holders. Follow the wear of the carbon brushes and change them before the wear limit is reached. Verify that the brushes are not sparking.
(4) Check all earth connections.
(5) Check the condition of shaft seals and replace if necessary. If you are not familiar with which type of seals are fitted, please contact manufacturer.
(6) Check the alignment of shaft couplings.
(7) Check the water, grease, oil, or dust has not been permitted to enter the motor housing.
(8) Check the condition of bearings and replace if necessary.
(9) Check the condition of painting and repaint if necessary.

9.6 MAINTENANCE

Maintenance is important to prevent motor failure and lengthen the service life. The periodic maintenance includes:

9.6.1 Periodic maintenance should include:

(1) Clean the motor.
(2) Measure the insulation resistance of the motor.
(3) Torquing the electrical connections, mounting bolts and earth connection bolts.
(4) Remove coal dust from the slip ring unit.
(5) Check the condition of fan-covers and to ensure effective cooling.

9.6.2 The overall maintenance should include:

(1) All the items of light maintenance.
(2) Clean the interior of the motor.
(3) Check the condition of bearings and replace if necessary.
(4) If it is not necessary to replace the bearings, clean the bearings and replace the grease.
(5) Clean and replace other parts of motor as required.

9.7 MAINTENANCE METHOD

9.7.1 Clean the exterior of the motor.

(1) Totally enclosed air-to-air cooled and totally enclosed fan cooled motors (IP 44 and above) require special
cleaning considerations. The external fan must be cleaned thoroughly since any dirt build-up which is not removed can lead to unbalance and vibration. All of the tubes of the air-to-air heat exchanger should be cleaned using a suitable tube brush having synthetic fibre bristles (not wire of any type).
(2) If the motor is equipped with fan-covers, they should be cleaned and reconditioned at a frequency that is dictated by conditions.
(3) On open ventilated motors (ODP motor with IP 23 and below), screens and louvres over the inlet air openings should not be allowed to accumulate any build-up of dirt, lint, etc. that could restrict free air flow.

Screens and louvres should never be cleaned or disturbed while the motor is in operation because any dislodged dirt or debris can be drawn directly into the motor.

9.7.2 Clean the interior of the motor

After a motor is in operation for a long time, accumulation of dust, carbon powder and grease etc., on the inside is unavoidable, and may cause damage to the motor. Regular cleaning and examination is necessary to assure top performance. Points to note during cleaning:
(1) Vacuum cleaning can be used, both before and after other methods of cleaning, to remove loose dirt and debris. It is a very effective way to remove loose surface contamination from the winding without scattering. Vacuum cleaning tubes should be non-metallic to avoid any damage to the winding insulation.
(2) If using compressed air or a blower, it must be noted that compressed air should be free of moisture and oil.

(3) Surface contamination on the winding can be removed by wiping using a soft, lint-free wiping material.
(4) If the contamination is oily, the wiping material can be moistened (not dripping wet) with a safe petroleum solvent.
(5) Proper health and safety precautions should be followed while cleaning the motor.
(6) For radial ventilation motors, the ventilation route should not be allowed to accumulate any build-up of dirt, lint, etc. that could restrict free air circulation and lead to higher temperature rise.

9.7.3 Up keep of anti friction bearings

Anti friction bearings will have to be washed periodically after operating for a long time.
(1) The bearings should be washed, dried and pre-greased with a suitable high quality bearing grease before assembly.
(2) No dirt or foreign debris should be allowed to enter the bearings at any time during the maintenance.
(3) The bearings should be heated and assembled under controlled temperature of 80-110°C
(4) The bearings must be removed by using pullers and re-fitted by heating, or using special tools for the purpose. Do not hammer the bearing as this will cause bearing damage.

9.7.4 Upkeep the sleeve bearings

(1) The importance of cleanliness:

- Check the oil visually with respect to colour.
- Check the oil visually with respect to deposits.
- The original viscosity must be maintained within a tolerance of ±15%.
- Smell the oil. Strong acid or burnt smell is not acceptable.

Replace the oil every 8000 hour of operation.

(2) Caution during cleaning.
Be careful during cleaning. Any slight knock and impact will damage the bearing surface.

9.8 DISASSEMBLY AND RE-ASSEMBLY

9.8.1. Safety : Ensure the power and control cabels have been disconnected

a) Squirrel - cage rotor

Drive - end:

1. Remove the heat exchanger (if any)
2. Remove the fan cover/unscrew the protecting screen (if any)
3. Remove the external fan (if any)
4. Remove the temperature detectors from the bearing (if any).
5. Remove inlet and outlet grease pipe.
6. Unscrew the bolts which fasten the bearing assembly.
7. Remove external caps (if any)
8. Removal of end shield. Ensure proper support of rotor during removal of end shield so that it does not fall on stator.
9. Remove the bearing (S).
10. Remove the internal bearing cap / bearing housing.

b) Slip ring motors

Drive- end:
The procedure are the same as for squirrel rotor motors for sliping unit located at non drive end else follow procedure given below:

Non-drive-end:

1. Remove back protecting cover of the brush holders.
2. Disconnect the cable from the slipring. Dismantle the brush holders.
3. Dismantle the slipping cover unit.
4. Remove the collector unit.

9.8.1.1 Rotor removing

Remove the rotor from inside of the stator by means of hoisting ropes with the help of other devices. The device must ensure that the rotor does not rub in the stator. Also these devices should not cause any damage to rotor itself.

Assembling

1. Fit the rotor into the stator using proper device and pay attention to avoid that the rotor does not rub on the stator or on the coil heads.
2. Place the internal bearing caps.
3. Fill out with grease compartment of the internal bearing caps / housing / end shield (30% - 50% for 2 & 4 pole motor, and 60% - 75% for lower speed motor) and bearing (100%) [check type of grease on the bearing identification name plate attached to motor covers].
4. Check carefully shaft cover surface where bearings will be fitted to avoid scratches, also check for correct me chanical dimension.
5. Heat-up and mount the drive end and non-drive end bearings.
6. Lift the rotor, press supports underneath the shaft and mount drive end non-drive covers.
7. Mount the drive end and non-drive end grease pipes and fittings.
8. Mount the external drive end and non-drive end bearing cap (if any), fix them with internal bearing caps / housing.
9. Mount the external non-drive end fan and fix it.
10. Mount the non-drive end fan cover.
11. Connect the temperature sensor cable to the accessory connection box terminal.

10. MOTOR TROUBLESHOOTING CHART

Your motor servicing and any troubleshooting must be handled by qualified persons with proper tools and equipment.

No	Trouble	Cause	What to do
1	Motor fails to start	Power-off	Check wiring. Switch-on. Install fuse. Check leads.
		Stator winding failure	Check windings.
		Motor may be overloaded	Reduce load.
		Wrong wiring	Check wiring connections.
		Brushes problem	The brushes might be worn or set in correctly.
2	Motor does not come up to rotating speed	Voltage too low at motor terminals	Check connections. Check conductors for proper size. Ensure proper supply voltage.
		Poor contact of control switches or short circuit	Check and repair control switches
		Phase failure of power	Check power and connections
		Poor contact of power line	Check power connections
		Windings earthed or short circuited	Contact Manufacturer

3	Failed to loading after start due to trip of switch	Insufficient capacity of switches and fuses	Replace switches and fuses if wiring permits
		Under-voltage	Check power source
		Overload	Reduce load
4	Electrified enclosure	Wrong connection between the wiring of power lines and earth connections	Correct the wiring
		Moist or aged insulation	Dry out or replace winding
		Connection between live leads and enclosure	Check leads and enclosure. insulate them and proper air creepage distance
5	Motor surface overheating	Overload	Reduce load
		Ambient temperature exceeds name plate rating	Reduce load and improve ventilation
		Under-voltage	Check power line, transformer capacity and source voltage
		Over-voltage	Check power source
		Ventilation duct clogged	Remove the foreign matter in the ducts
		Friction between rotor and stator	Contact Manufacturer
		Unbalanced three-phase voltage	Check circuit or consult power company
6	Speed falls sharply	Sudden overload	Check load and mechanical connection
		Single-phase operation	Check switch, fuses and circuits and repair
		Voltage drop	Check control circuit and power source
7	Electromagnetic noise	Occurrence from first operation of motor	May be normal
		Sudden sharp noise	Check short circuit of windings
		Friction between rotor and stator	Contact Manufacturer
8	Mechanical noise	Wind noise	Noise caused by air flowing through ventilation ducts, maybe normal
		Loose belt sheave or loose coupling	Adjust key and the position of belt or couplings and lock the screw
		Loose screw on fan-cover	Lock fan cover screws tightly
		Friction between fan and end-shield, fan-cover	Repair air guide or fan cover to adjust distance
		Rubbing as a result of in-gression of foreign matters	Clean motor interior and ventilation ducts
		Caused by driven machine	Check the driven machine

9	Bearing noise	Lightly coiled sound	Re-grease
		Obviously bearing sound	Clean bearings and re-grease
		Broken ball or rough races	Replace the damaged bearing
		Improper installation	Check alignment and locking arrangement
10	Vibration abnormal	Motor mounting bed is not strong enough	Reinforce mounting bed
		Unsymmetrical centres between belt sheaves	Align central points
		Central points of couplings do not lie on the same level	Adjust the central points of couplings to the same level
		Unbalanced rotor	Balance rotor again
		Unbalance due to corroded fan blade	Replace fan
		Short circuit of windings of stator or rotor	Contact manufacturer
		Mounting bed vibration caused by near machines	Eliminate the vibration source near motor
		Damaged bearing	Replace the damaged bearing
11	Bearing overheating	Insufficient or excess lubrication	Adjust grease quantity
		Misalignment between motor and driven machine shafts	Adjust belt tension or align couplings
		Friction between bearing and bearing housing or shaft	Replace the damaged shaft or end- shield
		Improper assembly.	Re-assembly motor.

11. HANDLING FOR DISCARDED MOTORS

Scrap motors must be recycled according to the local regulations. The material content used in the manufacturing of the motor are as follows: cast iron, steel, copper, aluminium, insulation materials, polymers, rubber etc.. Recycle all the material as far as possible. The non-metals should be either incinerated or disposed off in landfills. Attention should be paid to ensure that such processes do not adversely affect the environment. Motor products, manufacturing processes and even logistics have been designed to take environmental aspects into account.

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