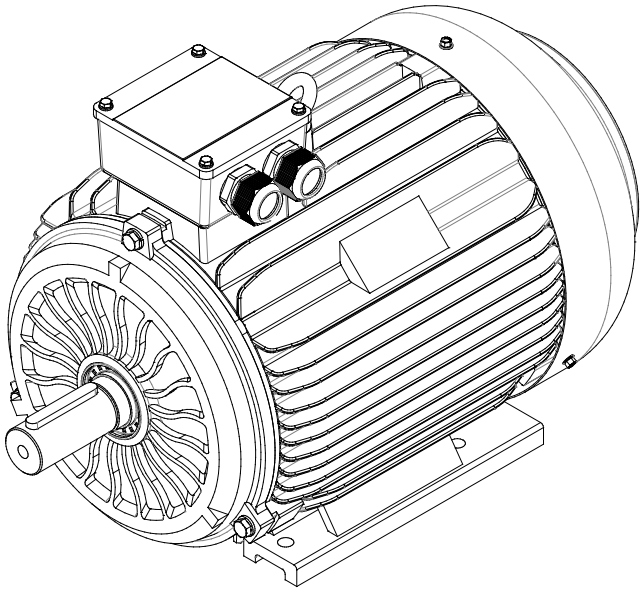
FOCQUET
1st in Electrical Power Machines

3-PHASE INDUCTION MOTORS
INSTALLATION OPERATION
&
MAINTENANCE MANUAL



Contents

1. Safety specification

NOTE!

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 the instruction may invalidate the warranty.

1.1 Confirm that the parameters in the nameplate meet your requirement.

1.2 Confirm that the motor is not damaged.

1.3 Remove transport locking if employed. Reinstall it before transportation once more.

1.4 Lift the motor using the eyebolts or the lifting lugs integrated with the motor frame only, if not, otherwise stated in the separate lifting instruction.

Check that 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 are more than one lifting lug, they must be used together to bear the weight.

The center of gravity of motors with the same frame may vary due to different outputs, mounting arrangements and auxiliary equipment.

To convey the motor with packet, the sling must be used to carry the motor over the base, or eyebolts or the lifting lugs integrated with the motor frame are used.

1.5 After 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. Any question, please contact Focquet sa/nv.

2. Safety considerations

NOTE!

Obey the safety precaution measures as following.

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 maintain correctly, it will harm the health and life of human being.

NOTE!

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 maintaining, must turn off all supply connected with motor and its auxiliary parts. Confirm that the motor is already standstill.

2.3 Earthing must be carried out according to local regulations before the motor is connected to the supply.

The protection devices also must be earthing to prevent accidents in service.

2.4 The protection devices should not be open circuit and should be used. The protection devices can ensure the life 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 No contact with live parts. Under the occasions of auto-starting, auto-shutting and remote starting, must set a sign plate to note that the motor is starting before turn off.

2.7 Before starting, confirm that all shaft and keys are fitted firmly.

2.8 In order to prevent overload, you'd better to install the monitor of winding temperature. Focquet sa/nv. can install the monitor of winding temperature, its lead connect directly with controller to provide loss of supply protection.

2.9 No phase failure in service. It is recommended to install the 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 When access to the noise source, must wear the earhood.

For more information about noise limits, please contact Focquet sa/nv. or reference the relevant product standard of Focquet sa/nv.

2.12 Protection against the ingress of water.

2.13 When motor used in varied speed mechanism, confirm that it do not exceed the maximum safety speed of motor and operate without overload.

(At lower speed, the ventilation of the totally-enclosed fan-cooled motor will decrease. The separate fan should be added to avoid the overheat.) Any question, please contact Focquet sa/nv.

2.14 Confirm safety measure to avoid accidents in brake failure.

2.15 Some motors of Focquet provide continuous operation regreasing nipples. The machine is intended for lubrication during operation by qualified personnel, familiar with relevant safety requirements. Internal rotating parts or live parts should be integral protected.

NOTE!

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

3. Environmental requirements and operating conditions

3.1 Environmental requirements

3.1.1 Normal ambient temperatures limits are -15℃to 40℃if standard

performance is to be achieved.

3.1.2 Maximum altitude 1000 m above sea level.

3.1.3 The relative humidity is less than 95%.

NOTE!

If there is deviation between upper environment conditions and practice, such as normal ambient temperatures are lower than -20℃ or higher than 45℃, or the relative humidity is more than 95%, or altitude above sea level is more than 1000 m, or high vibration occasion, Suitability of motor for operation must be checked. Any question, please contact Focquet sa/nv.

3.2 Operating conditions

3.2.1 The deviation between supply frequency and rated frequency is no more than 1%, the deviation between supply voltage and rated voltage is no more than 5% (except the special design according to the agreement).

3.2.2 The open-drip-proof motor (IP23, IP21) is suitable for operating in clean, dry, ventilation and no-corrosive air indoor. More detail, see GB 755.

NOTE!

If the open-drip-proof motor (IP23, IP21) operate outdoor, weather will affect the standard performance of motor.

3.2.3 The totally-enclosed fan-cooled motor (IP44, IP54,IP55) is suitable for operating in relative dirty, humidity, dust environment. More detail, see GB 755.

3.2.4 The outdoor anticorrosive motor is suitable for operating outdoor or in corrosive air, high humidity environment.

3.2.5 For the watercooled motor and the motor with watercooled bearing, the ambient temperatures is no less than 0, to avoid water freeze.

3.2.6 Foundations must be even, and sufficiently rigid to withstand possible short circuit forces. They shall be dimensioned as to avoid the occurrence of vibration due to resonance.

3.2.7 The installation space should be large enough to facilitate heat dissipation and maintenance.

NOTE!

Check that the motor has sufficient airflow. Ensure that no nearby equipment, surfaces or direct sunshine, radiate additional heat to the motor.

If there are other ventilators, they do not affect the ventilation of motor. If it is affected, must adjust the wind power of ventilator or change the ventilating path of motor to ensure the ventilation effectively.

4. Transportation and storage

4.1 Transportation

4.1.1 The motors are with different protection before leaving factory, ensure to keep the same protection from damage and scratching during transportation.

4.1.2 Some medium and big motors fitted with cylindrical-roller, angular contact bearings and/or sliding bearing must be fitted with locking devices during transport.

4.1.3 Upon receipt the motor, must check immediately for external damage and if found, take photograph and inform the forwarding agent without delay. It is important to inform the transportation Co. and supplier with damage evidences in time. And it will meet the customer's requirement for products and service.

4.1.4 When motors are not in operation immediately, the protection measures and manage personnel should be undertaken to assure best performance.

4.1.5 If motor with packet, check the following points upon receipt ： Is there any damage? Are all accessories in good order? If there is any doubt, please take photograph and inform the supplier immediately.

4.1.6 For motors with packet, lift the motor using the lifting lugs only or the forklift must be used to carry the motor over the base of pallet.

4.1.7 The forklift cannot be used to carry the motor from the base or other position.

4.2 Short period storage(not exceed 3 months)

4.2.1 The motor should always be stored in clean, in dry, vibration free and dust free and corrosive free conditions.

4.2.2 The motor should always be stored in the smooth foundation surface and entirely free from vibration and easy for movements.

4.2.3 The storage place should not be located in the uncertainty environment. Not located near to a boiler or freezer.

4.2.4 The better temperature of the storage place is 5℃ to 50℃. If the motor is equipped with space heaters, they should be energized at the voltage shown by the space heater nameplate attached to the motor.

4.2.5 The better relative humidity of the storage place is less than 75%. Keep the temperature of motor above dew point from condensation.

Anti condensation heaters, if fitted, should preferably be energized and checked period.

Since moisture can be very detrimental to electrical components, the motor temperature should be maintained above the dew point temperature by providing either external or internal heat, if not fitted with heater.

Incandescent light bulbs can be placed within the motor to provide heat. However, if used, they must not be allowed to come in contact with any parts of the motor because of the concentrated hot spot that could result in.

4.2.6 Motors are stored outdoor, the plastic packets must be discarded. And the covers must be set to protect against the ingress of water but not to affect the ventilation. Motors should be put on a rigid foundation to prevent moisture and dust.

4.2.7 Protection against the ingress of insects.

4.2.8 Storage in original packet, must open a enough hole to maintain effective ventilation but not to affect the protection against rain.

4.2.9 Ensure to let water out in the cooled pipe of the watercooled motor and the watercooled bearing, to protect against corrosion or possible fractured pipe.

Add the mixture of water and glycol into the pipe to ensure impossible fractured pipe. The proportion of glycol is no less than 50%. After adding the mixture, must jam the entrance of pipe to prevent the mixture from loss.

4.3 Long period storage(exceed 3 months)

Check the following points except the requirement of short period storage ：

4.3.1 Storage period is not too long and storage pile is not too high to damage motors.

4.3.2 Insulation resistance should be measured once every two months and maintain the record.

4.3.3 The humidity should be measured once every two months and maintain the record. If humidity is more than requirement, adjust the storage place.

4.3.4 The paint of motor surface should be checked once every three months. If there is rust, it must be cleaned and repainting must be done

4.3.5 The rust of shaft extension and flange should be checked once every three months. If there is rust, it must be cleaned by metallographer sand paper carefully and antirust measures must be done.

4.3.6 Motors with roller bearings have been filled proper lubrication before leaving factory, they need not refill lubrication during storage. Turn shaft once a month by hand to check free rotation, each are more than ten cycles.

4.3.7 Motors with sliding bearings have let out lubrication before leaving factory, they need refill lubrication during storage to avoid rusting. Turn shaft positively and reversely once a month by hand to check free rotation, each are more than ten cycles.

4.3.8 The storage of motors with sliding bearings exceeds one year, the sliding bearings must be dismantled and antirust measures must be done.

4.3.9 After long period storage, check the bearing. Change the rusting bearing and fill lubrication.

4.3.10 Measure insulation resistance before starting and when winding dampness is suspected. Resistance shall exceed the 1M ohm. If the 1M ohm resistance value is not attained, the winding is too damp and must be oven dried. After oven dried, the 1M ohm resistance value is still not attained, the motor must be repaired.

Oven dried method:

Dismantle motor and put the stator winding into the oven. For the wound-rotor motor, rotor should be put into the oven at the same time. Oven temperature should be less than 100℃. Keep good ventilation inside and outside oven. When insulation resistance exceeds the 1M ohm or insulation resistance value get steady, oven dried is over.

Stall the rotor and apply lower voltage to winding, ensure that the applied current is 1/3 to 1/2 of rated current. Winding temperature should be less than 100℃.

When insulation resistance exceeds the 1M ohm or insulation resistance value get steady, oven dried is over.

4.4 Storage after installation

After installation or after operation for a period, the motor will be not in operation for a long period, protect the motor as measures stated in 4.3. Otherwise the motor should be in operation once every two months.

5. Installation and calibration

5.1 Check before installation

5.1.1 Check all rating data of nameplate, especially voltage and winding connection (star or delta).

5.1.2 Measure insulation resistance before commissioning and when winding dampness is suspected. Resistance shall exceed the 1M ohm (measured with Megger). If the reference resistance value is not attained, the winding is too damp and must be oven dried. Oven temperature should be less than 100℃.

5.1.3 Check the motor for damage, distortion, loose. Turn shaft by hand to check free rotation.

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. The basic type of construction IM B3 can be modified as other type of construction IM V5 by additional support or changing bearing to bear the axial force.

5.1.5 Clean dust and other thing on the motor.

5.1.6 For long period storage motor, check the lubrication and replace it if necessary.

5.2 Foundation

NOTE!

The better foundation design can ensure safe operation and convenient maintenance. So the space around the foundation should be large enough to facilitate heat dissipation and maintenance.

Ensure cooled air flow through the surface and parts of motor without any block.

Ensure other device or heater not to affect the cooled motor.

Foundations should be strong and free of vibration.

5.2.1 Foundations must be even, and sufficiently rigid to withstand possible short circuit forces. If motor is not connected with other equipment, both are installed on foundation made in concrete. The suitable type of construction should be chosen for frequent remotion.

5.2.2 Foundations should be lower 2mm than the base of the driven equipment for installation adjustment to attain the alignment.

5.2.3 The foundation must be suitable for each footplate area. The foundation surface must be bigger than footplate areas.

5.2.4 Any height differences between the motor and the driven machine should be adjusted. The surface for the shims must be bigger than that for the feet. The amount of the shims is less than 3.

5.2.5 Select an appropriate foundation surface for the soleplate or common bed which will be considered more reliable for motor operation.

NOTE!

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, further to accident.

5.3 Installation

5.3.1 Preparation for installation

(1) A number of steel shims, 0.1mm, 0.2mm, 0.5mm, 1.0mm thickness respectively.

(2) Simple tools, such as lever, jack and bolts.
(3) Measure instrument, such as micrometer for adjusting installation of shaft coupling.
(4) Before mounting the motor, the foundation surface must be clean.
(5) Check the position and height of the mounting hole.
(6) Remove transport locking if employed. Reinstall it before transportation once more.

5.3.2 Consideration before installation

(1) The drill holes for mounting must be rough to be grouted with concrete firmly.
(2) In order to grout the studs with concrete firmly, the studs must be clean from thick paint, paint drops and dirt.
(3) The concrete surface must be clean from lubrication and dirt by beating away a layer.
(4) The antirust surface of the shaft extension and feet must be clean by gasoline.
(5) Fasten the steel studs and screw cap to the holes. The stainless steel studs should be applied to the rust occasion. The shockproof shims should be added to the vibration occasion.
(6) Ensure that the drain holes are at the lowest position after installation. When the drain holes are open, measure must be done to protect against the ingress of any object.
(7) For long period storage or the repaired motor, the insulation resistance must be checked before starting. It includes stator winding, rotor winding of the slip-ring motor, and other auxiliary devices.
(8) Lift the motor using the lifting lugs integrated with the motor frame only. The smaller lifting lugs for auxiliary devices are not suitable for lifting the motor.
(9) If there are more than one lifting lug, they must be used together to bear the weight.
(10) If the slings are used to carry the lifting lug, keep the slings the same long and not twisted before lifting.

NOTE!

No lifting the motor with two ends of the same sling. If there are two 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. As standard, balancing has been carried out using half key. In the event of balancing with full key, please contact with Focquet sa/nv.
(2) Before installing the coupling, the shaft and the coupling hole must be greased. Don't paint the surface with molybdenum bisulfide.
(3) Basically, the coupling should be heated and pushed onto the shaft extension with slight axial force. Do not hammer coupling to prevent bearing damage.
(4) When the coupling and the driven machine are coupled together, it is recommended that the flexible coupling be applied, no matter the roller bearing or the sliding bearing.
(5) There must be left enough space between couplings of motor with roller bearing and of driven machine.
(6) For the motor with the sliding bearing, the coupling must be limited the removal distance to prevent that axial force of the driven machine is exerted on the coupling and the serious stresses are exerted in the bearing.
(7) Before installing the coupling, calculate the different length between coupling hub and shaft key, then cut the half of this different value (hatch area) to achieve approximate-balance condition.
(8) After the couplings of the motor and the driven machine are coupled together, the shield must be set outside the couplings.

(9) For the motor with the sliding bearing, when installation, keep the windage indicator to locate in groove of shaft and to ensure the magnetic centre of stator and rotor be in line.

NOTE!

There must be left enough space between couplings of motor and of driven machine to prevent axial force caused by heat expanding and further to lead to bearing failure.

5.3.3.2 Installation of pulleys

The most motors are not suitable for belt sheave connection unless specially designed for such service. Any belt sheave must be specially designed according to the supplier's instructions to be used in motor.

(1) The flat belts do not apply to 2P motor above 4kW and 4P motor above 30Kw for power transmission.
(2) The length of the sheave should not be greater than the shaft extension, otherwise can lead to shaft fracture.
(3) The fan end of the double shaft extension motor should be connected with the coupling only.
(4) Ensure the parallelism of the motor shaft and the driven shaft. And keep the vertical of the motor shaft and the belts.
(5) The belt sheave must be dynamically balanced before installation.
(6) The motor shaft must be painted with cosmoline before installation the belt sheave.
(7) The short cylindrical bearings are applied to the motor with belt connection. Do not exceed the maximum belt forces (i.e. radial bearing loading) stated in the relevant product order. It is important to make sure that the chosen motor will meet your requirement.
(8) The diameter ratio between conveyance sheaves should not be greater than 5 to 1 for flat belts, and 8 to 1 for V-belt. It is also advisable to limit the belt velocity to under 32 m/min to limit belt abrasion and vibration.
(9) Place the sheave and belt as close as possible to the motor body to reduce the bending moment and prevent from shaft fracture.

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 (overhung) of gear. If necessary, please contact us to ensure the shaft and bearings will meet your requirements.
(2) Pay close attention to ensure the parallelism of shafts.
(3) The teeth of gears should be correctly and precisely matched, the force conveyance centers should lie on the same line.
(4) There should be no skip, jumping, vibration or unusual noises during operation.

5.3.3.4 Thermal effect.

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 centerline height due to thermal effects.

(1) Shaft height growth (change in shaft centerline elevation) for TEFC motor can be calculated as follows：

Δ =(0.00045)×(motor foot to shaft centerline dimension) mm

NOTE!

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

(2) The space must be left between couplings according to the load. Shaft length growth for motor can be calculated as follows:

Δ =(0.0005)×(motor frame length dimension) mm

NOTE!

Ensure the couplings, except rigid coupling, to free move axially. Due to thermal effects only lead to the axial shaft expansion

5.3.3.5 Installation of rigid foundation

(1) Clean the surface of foundation.
(2) Foundation must be even. The tolerance is no more than 0.1mm.
(3) Motor connected with other equipment is 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.
(4) Put motor on the foundation carefully to prevent hit.
(5) Check the mounting surface. Each footplate area must be the same rigid to prevent motor incline during operation.
(6) For the large motor and high voltage motor, the footplate must be with localizer after installation. The machine has one dowel hole per foot at the D-end. Deepen the holes by drilling through to the steel foundation. After that, the holes are tapered with a reaming tool. Suitable tapered pins are fitted to the holes to ensure the exact alignment, and to allow easier reinstallation after any possible removal of the motor.
(7) All shims and footplates must be welded after installation to prevent from untoward change in position during motor operation.

5.3.3.6 Installation of concrete foundation

(1) Clean the surface of foundation.
(2) Foundation must be enough weight to ensure stabilization.
(3) Make sure the concrete are completely dry, then to tighten bolts.
(4) Use rigid and solid soleplate or common bed as the surface of the foundation. The tolerance of the surface is less than 0.1mm.
(5) Check the mounting surface. Each footplate area must be the same rigid to prevent motor incline during operation.
(6) For the large motor and high voltage motor, the footplate must be with localizer after installation. There is left hole in the footplate for locating.
(7) All shims and footplates must be welded after installation to prevent from untoward change in position during motor operation.

5.3.3.7 Installation of vertical motor

(1) If motor connected with pump, both are installed on the same foundation ,foundation of motor/pump must be rigid and weight to provide adequate support. There must be no vibration due to inadequate foundations. (2) All mounting surfaces must be clean and level.
(2) Foundation must be leveled at least at 4 points (for up to H180), 8 points (for above H180) and guaranteed to be below 0.04mm (1.5mil) flat and level.

(3) Make sure the above requirements are acceptable, then set the motor on the mounting foundation.

5.3.3.8 Adjustment of installation

The motor shaft and the driven shaft should be aligned within the limited tolerances in both angular and parallel alignment. Out of the limited tolerances will lead to bearing failure.

(1) Before adjustment, the couplings of the motor and the driven machine must be coupled together and be convenient for adjustment.
(2) For the large motor with the holes of bolts, the adjustment bolts must be installed in the footplates of the motor before adjustment.
(3) The adjustment bolts may be installed in the driven machine for high accuracy installation.
(4) It is necessary to use high accuracy instrument to measure installation for high accuracy adjustment.
(5) All measured data must be recorded to be reference later.

6. Connection

6.1 Connection of Cooler

6.1.1 Connection of air-to-air coolers

Generally, the air-to-air cooler is equipped with the motor. It is not installed by user, but the user is required to keep it ventilation. If the air-to-air cooler is sent to the user separately, install it according to the manufacturer's instruction.

6.1.2 Connection of ventilated 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 air ducts after they have been connected.

6.1.3 Connection of air-to-water coolers

Motors equipped with an air-to-water heat exchanger have flanges specified in the dimensional drawing. Connect the flanges and seal the joints with appropriate gaskets. Prior to starting the motor, the water has to be turned on.

6.1.4 Connection of direct water-cooled motor

Steel frame water-cooled construction is only to be used with a closed fresh water circulation. The water cooling circuit flanges are made according to the

customer's specifications, and are defined on the dimensional drawing.

The cooling water circulates in ducts integrated in the motor frame. The material of the frame and ducts is carbon steel. This material is prone to corrosion in saline and foul water. The corrosion products and fouling deposits might block the water flow in the ducts.

This is why it is important to use pure and inhibited water in the cooling system. In most of the cases, normal tap water, i.e. water for domestic consumption, fulfils all these requirements. If normal tape water not fulfilling these requirements, the cooling water must also be inhibited with an agent protecting the cooling system against corrosion, fouling and when necessary, against freezing. Standard values for the cooling water to be used in the cooling system:

- pH 7.0 - 9.0
- Alkalinity ($CaCO_3$) > 1 mmol/kg
- Chloride (Cl) < 20 mg/kg
- Sulphate < 100 mg/kg
- $KMnO_4$-concentration < 20 mg/kg
- Al-concentration < 0.25mg/kg
- Mn-concentration < 0.05 mg/kg

6.2 Connection of sliding bearings

6.2.1 Motors with flood lubrication system 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 in equal distance from each bearing.

6.2.3 Install and connect the oil inlet pipes to the bearings.

6.2.4 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.

6.2.5 Fill the oil supply system with appropriate oil with correct viscosity. The correct type of oil and viscosity is indicated on the dimensional drawing. If in any doubt of the cleanness of the oil, use a mesh to filter unwanted debris from the oil.

6.2.6 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.

NOTE!

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

6.3 Main supply wiring

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. Make an obvious mark on the switch and provide safeguard against re-energizing 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 4 x 90°. The terminal box can be adjusted according to the requirement of user but must be sealed.
(2) Note nameplate markings and connection diagram in the terminal box. The 6 terminals are marked with letters U1, V1 , W1 and U2, V2, W2 or the 3 terminals are marked with letters U, V , W. The 6 terminals may be connected △ or Y according to the connection diagram. The 3 terminal are connected according to A-U, B-V, C-W.

NOTE!

Check the phase sequence from the connection diagram, the phase sequence for clockwise rotation looking from the D-end of the motor.

For counter-clockwise rotation, the phase sequence is in accordance with ordering.

(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 Focquet sa/nv..

(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.

NOTE!

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

(6) The space between the cables entries and cables must be tightened by bolt and insulated. Unused cable entries must be closed.

(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 instruction.

6.4 Auxiliary terminal boxes

6.4.1 Protection connection will located in the auxiliary terminal box on the motor. Auxiliary terminal boxes are attached to the frame of the motor according to accessories and customer needs, and their positions are shown on the dimensional drawing of the machine.

6.4.2 Various protection wiring must be according to wiring standard and safety standard.

6.4.3 Auxiliary devices such as thermistors, thermocouples, PT 100 resistance elements, standstill heating elements will generally terminate on terminal blocks located in the auxiliary terminal box on the motor. The maximum voltage is 750V.

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 instruction.

6.5 Connection of rotor supply of slip-ring motor

6.5.1 To gain access to the rotor circuit through the sliprings for the slip-ring motor. The cable can be connected with a proper end. The cable can be directly connected with brush holder rocker or rotor terminal board.

6.5.2 Study the connection diagram delivered with the motor carefully before connecting any cables.

6.6 Connection of external blower motor

6.6.1 The AC motor fed with frequency converter is generally equipped with an external blower to ensure its normal operation at different speeds.

6.6.2 The external blower motor is normally a three phase induction motor. A

connection box is usually located on the frame of the blower motor.

6.6.3 The connection of the external blower motor is the same as the main power cable connections.

6.6.4 The earthing must be carried out according to local regulations before the external blower motor is connected to the supply.

6.6.5 The warranty does not cover destroyed bearings due to improper earthing or cabling.

NOTE!

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

6.7 Earth connections

6.7.1 The earthing must be carried out according to local regulations before the motors connected to the supply.

6.7.2 The motors usually have a protective earth terminal in the terminal box. However, larger motors have an external earthing terminal on the framefoot or flange. These terminals must be connected to protective earth at the same time.

6.7.3 The motor must be grounded by a proper connection to the electrical system ground.

6.8 Requirements for motors with frequency converters

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

For motor frame sizes above H280, it is necessary to use 1 x70 mm flat copper conductor or at least two 50 mm2 round copper conductors. The distance of the round conductors must be at least 150 mm from each other.

7. Commissioning

7.1Check before starting

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

(1) Check that the motor is properly anchored to the foundation. Check for cracks in the foundation and the general condition of the foundation.
(2) Check the tightness of the fixing bolts.
(3) Make sure all wiring, including auxiliary equipment, is correct.
(4) Ensure the sizes of cable wires are appropriate and all connections are well made for the currents they will carry.
(5) Ensure all connections are properly insulated for the voltage and temperature they will experience.
(6) Make sure that the joints outside the terminal box are insulated.
(7) Make sure that frame and terminal box are grounded.
(8) Ensure the capacity of fuse, switches, magnetic switches and thermo-relays etc. are appropriate and the contactors are in good condition.
(9) Make sure that the starting method is correct.
(10) Check the assembly of the main terminal box and cooling system.
(11) Check that the lubrication system is commissioned and is running before the rotor is turned. See 8.2 for more information.
(12) Check the connection of oil and cooling water pipes and check for leaks when running.
(13) Check pressure and flow for oil and cooling water.
(14) Check main cable to avoid the stress effectively.
(15) Ensure that heater voltage is not applied when the motor is operation, but 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 is 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.

7.2.1 Before measurement of insulation resistance

(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 with Focquet.
(2) Motors, that are suspected to have moisture problem, should be dried carefully independent of the measured insulation resistance value.
(3) The insulation resistance value will decrease when the winding temperature rises. The resistance is halved for every 10 K temperature rise above the dew point.
(4) 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 factory.

7.2.2 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 depending on the motor type and local conditions. In addition, the insulation resistance is affected by the age and usage of the motor.

(1) Calculation method of minimum values for insulation resistance

After temperature rise test, the following formula should be applied to minimum values for insulation resistance：

$$R = \frac{U1}{1000 + P/100} \quad (M\Omega)$$

Here

R-insulation resistance (MΩ);

U1-rated voltage (V) P-rated power(kW)

(2) The control value of insulation resistance

When the value of insulation resistance is more than 10MΩ, it is the normal

condition for the low-voltage motor. When the value of insulation resistance is more than 100MΩ, it is also the normal condition for the high-voltage motor. If

the values of insulation resistance are lower than these two values, should check the motors parting from moister and dust.

For the used motor, when the value of insulation resistance is more than 10MΩ,

it is the normal condition for the low-voltage motor; when the value of insulation resistance is more than 100MΩ, it is also the normal condition for the high-voltage motor.

For the slip-ring motor, when the value of insulation resistance is more than 10MΩ, it is the normal condition for the low-voltage motor and the high-voltage motor.

7.2.3 Stator winding insulation resistance measurement

The insulation resistance is measured using an insulation resistance meter(megger). The different meter are used according to the different voltage degrees.

(1) For rated voltage below 1 140V(including 1 140V), measured with a 500VDC megger.
(2) For rated voltage above 1 140V, measured with a 2 500VDC megger.

NOTE!

During or after measuring, the terminals must not be touched immediately as they

may carry residual dangerous voltages. Furthermore, if supply cables are connected, make sure that the power supplies are clearly disconnected and there are no moving parts before insulation resistance measurement.

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 and the stator windings not being tested are earthed.
(3) Make sure that auxiliary device are earthed.
(4) The insulation resistance measuring should be carried out in the terminal box. The test is usually performed to the whole winding as a group, in which case the meter is connected between the frame of the motor and the winding.
(5) If necessary, the tester is connected between the frame of the motor and one of the windings. The frame and the two phases not measured are earthed.
(6) The winding temperatures are measured. After a long time of shut down to test, measure the temperature of enclosure instead of that of winding.
(7) After the insulation resistance measurement the winding phases must be earthed briefly in order to discharge them.

7.2.4 Insulation resistance measurement for a motor with slip rings

Insulation resistance measurement for a motor with slip rings is as well as the general motor.

(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 shaft, the frame of the motor and the rotor windings are earthed. (4) The carbon brush connections are checked to be in good order.
(5) The winding temperatures are measured. After a long time of shut down to test, measure the temperature of enclosure instead of that of winding.

The insulation resistance of the rotor winding is measured. Required notes and measures as following:

(1) Verify that the frame of the motor and the stator windings are earthed.
(2) The shaft is earthed.
(3) The rotor winding can be generally connected in a star connection. If each phase must be measured separately, the rotor winding phases not been tested are earthed.
(4) After the insulation resistance measurement the winding phases must be earthed briefly in order to discharge them.

7.2.5 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.
(3) For the motors are equipped with insulated bearings, if both the shaft ends be insulated from the frame, should disconnect the earthing terminal. If both the shaft ends not be insulated from the frame, should separate the bearing sleeve or end-shield from the bearing.

7.3 Commissioning and Start-up

7.3.1 First test start

NOTE!

There is 5-8 times starting current when direct-on-line starting, and starting torque is direct proportion with the square of voltage when auto-transformer starting. Adopt auto-transformer starting for under-voltage and adopt direct-on-line starting for heavy load. The load on the motor must in any case be as small as possible.

7.3.1.1 The first start should last only about one (1) second. The objective of the first starting 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. The motor may be operated both in two direction of rotation without indication.

7.3.1.2 The direction of rotation of the external blower motor is indicated by an arrow near the blower motor.

7.3.1.3 It is also 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, the cooling fans, in inner and/or outer cooling circuit, must be changed by the manufacturer, as well as the stamp on the nameplate.

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 If possible, the first start is made with uncoupled coupling between the driving and driven machine.

7.3.1.8 Without coupling between the driving and driven machine, it is normal that there is shaft shift during shutting down.

7.3.2 Running unload

7.3.2.1 During running the motor the first time, if the machine functions as expected, the motor can be left running unload for a longer time.

7.3.2.2 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 or abnormal sounds occur, shut down the motor, and find the reason for the changes. If necessary, consult the manufacturer of the motor.

7.3.2.3 The motor may be direct-on-line starting or auto-transformer starting.

7.3.2.4 If the motor rotor fails to start turning 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 load

7.3.3.1 Initially run the motor unloaded prior to coupling to other machines.

7.3.3.2 If the motor rotor fails to start turning within one or two seconds, shut off the power supply immediately. Investigate thoroughly something wrong in connection or wiring, and take corrective action before attempting a restart.

7.3.3.3 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.

7.3.3.4 Any abnormal noise or vibration should be immediately investigated and corrected. Increased vibration can be indicative of a change in balance due to mechanical failure of a rotor part, a stator winding problem or a change in motor alignment.

7.3.3.5 Ensure the voltage and frequency of the power source are identical to the ratings shown on the nameplate. Keep current balance of 3-phase windings.

7.3.3.6 The number of allowed consecutive starts of direct on line supplied motors depends essentially on the load characteristics (torque curve vs. rotational speed, inertia), and on the motor type and design. Too many and/or too heavy starts 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 motor insulation failure.

(1) Motor can be restarted if the initial start fail. Two starts are generally permissible when the motor is cold.
(2) Let the motor cool down for 60 minutes before restarting, fully loaded. Let the motor cool down for 30 minutes before restarting, unloaded. Two inching starts can be regarded as one normal start.
(3) The load characteristics of the application are needed for determining the starting frequency. As a guideline, the maximum number of starts in a typical application is 800 starts per year.

7.3.3.7 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 circulating 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 commissioning report.

7.3.3.8 If the bearing temperature rise and motor operation appear to be normal, operation should continue until the bearing temperatures stabilize.

(1) The limit on roller bearing is no more than 95℃.
(2) The limit on sleeve bearing is no more than 90℃.

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.

For the motors without Pt-100 resistance temperature detectors, the temperature of the end-shield is measured instead of that of bearing. The temperature of end-shield is usually 10℃lower than that of bearing.

7.3.3.9 Any abnormal temperature rise, noise or vibration should be immediately investigated and corrected. Increased temperature rise can be indicative of a change in balance due to mechanical failure of a rotor part, a stator winding problem or a change in motor alignment.

7.3.3.10 Starting time is longer for the motors with large inertia. However, if starting time is longer than usual or if there is difficulty in starting, or there is abnormal noise, do not run the motor and contact with Focquet.

7.3.3.11 If the capacity of the transformer is not big enough to start several motors at the same time, should start respectively from bigger motor to smaller one.

7.3.3.12 During the running and a thorough investigation, should not disconnect all the protection devices.

7.3.3.13 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.

7.3.3.14 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 the vibration measurement instrument. The measurement place should be near the motor, avoid locating in thinner plate such as fan-shield.

After installation, the vibration value of the motor is little higher than it before leaving factory. Control refer to the followings:

Foundation	Frame size	Vibration velocity(mm/s)
Rigid	Up to H355	3.5
Rigid	Up to 355 for 2P	4.5
Rigid	Above H355	4.5
Rigid	Above H355 for 2P	5.0
Flexible	Up to H355	4.0
Flexible	Up to 355 for 2P	5.0
Flexible	Above H355	5.0
Flexible	Above H355 for 2P	6.0

If the vibration value not in accordance with the values in the table, please check the motor. Any question, contact Focquet.

7.3.3.15 Check that the brushes on the slip rings are not sparking.

Ensure that the slip ring surfaces are smooth. If not, the slip rings must be smoothed on a lathe.

7.3.3.16 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.

7.3.3.17 High temperature may arise on the motor surfaces under operating conditions, so that touching should be prevented or avoided.

NOTE!

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.

Any mechanical failure of a loosing bolt, a rotor part, a stator winding problem or a change in motor alignment can cause abnormal noise or vibration.

7.3.4 Shut down

7.3.4.1 The shutdown of the motor depends on the application, but main guidelines are the same.

7.3.4.2 Reduce the load of the driven equipment, if applicable.

7.3.4.3 Open the main breaker.

7.3.4.4 When the motor is not in operation, anti-condensation heaters have to be switched on where applicable.

7.3.4.5 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 base soap. This will ensure a long and trouble free lifetime of the bearings.

8.1 Re-greasing for the roller bearing

8.1.1 Bearings of ZZ types are usually permanently greased for the smaller machines.

8.1.2 The re-greasing device is designed for the large motors (above H180) and specific motors. It is necessary to change the lubrication at regular intervals.

8.1.3 In case of a newly installed motor or a motor, which has been out of service for more than 2 months, inject new grease into the bearings immediately after start-up. New grease must be injected when the motor is running, and is injected until old grease or excess new grease is discharged through the lubrication valve in the bottom of the bearing housing. See 8.1.5.

The temperature of the bearings will initially increase because of the excess grease. After few hours, the excess grease will be discharged through the lubrication valve and the temperature of the bearing will return to normal running temperature.

8.1.4 Change the oil at regular intervals. The time between oil changes depends upon the severity of operating conditions and, hence, must be determined by the motor user. Two or three changes a year is typical, but special conditions, such as high ambient temperature, may require more frequent changes. The re-lubrication interval will never be longer than 12 months.

The recommended lubrication intervals are as follow.

Rated power(kW)	Speed (rpm)	The recommended lubrication intervals		
		Normal condition	Severe condition	Bad condition
<18.5	1500	5 years	3 years	1 year
18.5-90	1500	1 year	6 months	3 months
90-200	1500	3 months	3 months	1 month
200-630	1500	3 months	1 month	15 days
<18.5	3000	5 years	3 years	1 year
18.5-90	1500	1 year	6 months	3 months
90-200	1500	3 months	1 month	1 month
200-630	1500	3 months	1 month	15 days

NOTE!

Normal condition refers to the motor operate at rated power or below in clean environment. Duty cycle is no more than 8h per day.

Severity condition refers to the motor operate at rated power or below in dust environment with the lighter shock load and vibration. Duty cycle is 24h per day. Bad condition refers to the motor operate in very dirty environment with heavy shock load and vibration.

8.1.5 Re-greasing method

(1) Before re-greasing, the inlet fitting should be thoroughly cleaned to prevent any accumulated dirt from being carried into the bearing with the new grease. The outlet of grease drainage should be opened to allow the proper venting of old grease. Use a grease gun to pump grease through grease nipple into 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 Kinds of grease

Grease with the correct properties is available from all major lubricant manufacturers. If the make of grease is changed and compatibility is uncertain, consult Focquet.

Chevron SRI-2 grease is standard for Focquet motors except some special models for which special grease will be confirmed according to the agreement. Please use identical grease or its equivalents when maintaining.

NOTE!

If relubrication is to be performed by the authorized personnel 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 lubrication nameplate, if attached to the motor.

8.2 Re-greasing for the sliding bearing

8.2.1 For the motor with the sliding bearing, it should be re-greased before running. Because no lubrication in it leaving factory.

8.2.2 Install the oil supply system near the motor. Should first turn on the oil supply system before starting motor.

8.2.3 The rotation of the oil ring is verified through the inspection window on top of the bearing when motor running. If the oil ring is not rotating, the motor must be stopped immediately, as a stopped oil ring will result in bearing failure.

8.2.4 Verify that no rotating parts rub against any stationary parts.

8.2.5 Verify through the oil sight glass that the oil level inside 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.

8.2.6 For flood-lubricated motors, the oil supply pressure is adjusted with the pressure valve and orifice. The normal supply pressure is 120 kPa $\pm$ 20 kPa. This gives the right flow of oil to the bearing. Using higher supply pressure gives no additional benefit, but can cause bearing oil leakages.

8.2.7 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 manufacturing factory Focquet must always be contacted before any action is taken.

8.2.8 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. If the oil is changed just after the commissioning, it can be used again after removing wear particles by filtering or centrifuging.

8.2.9 The oil reservoirs of self (not flood) lubricated bearings should be drained and refilled about every six (6) months. More frequent changes may be needed on high-speed (3000-rpm) motors or if severe oil discoloration or contamination occurs.

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 Estimate and plan service actions in order to minimize down time.

9.1.3 The purpose of this maintenance 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 respected in order to prevent personnel injury.

9.2.2 Personnel performing maintenance on electrical equipment and installations must be highly qualified. The personnel must be trained in, and familiar with, the specific maintenance procedures and tests required for rotating electrical machines.

9.2.3 Motors for hazardous areas are specially designed to comply with official regulations concerning the risk of explosion. safety precautions are to be taken into account when 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 the preventative 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

After a period of running, the motors must be maintained. Owing to the varied time and circumstances, motors are used, it is difficult to set the items and periods for regular inspection and maintenance. However, as a guide it is recommended to be performed periodically once a year. Motors operate in bad condition should shorten the maintenance interval.

Generally, the inspection scope determined by the following factors：

(1) Ambient temperature and operating conditions.
(2) Starting and stopping frequency.
(3) Easily abraded parts. Troublesome parts usually affecting motor functions. (4) Supply voltage and frequency variation.
(4) The vibration of the driven machine.
(5) The important position of motor in the operational system

9.4 Routine checks during running of the motor

NOTE!

Any changes in vibration or temperature levels or abnormal sounds occur, should shut down immediately to check. During the running, it is important to keep a close surveillance of the temperature of bearing, once a day at least.

9.4.1 The surfaces of the motor should be kept smooth and clean.

The motor exterior should be kept clean and should periodically be inspected for rust, leaks, oil, water and other dirty.

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. To check the condition of fan-cover and to ensure good air circulation inside the motor.

9.4.3 The vibration levels of the driving-driven machine system should be monitored, when the motor is running. Any changes in vibration or temperature levels or abnormal sounds occur, should shut down immediately to check.

9.4.4 If the windage pointer of sleeve bearing beyond the scope, friction between shaft and bearing occurs, should shut down immediately to check.

9.4.5 Any following abnormal conditions occur, should shut down immediately to check.

(1) Heavy vibration,
(2) The driven machine damaged
(3) Bearing wear or overheat
(4) Bearing misalignment, axial vibration
(5) speed descend suddenly
(6) friction between stator and rotor, enclosure overheat
(7) breathing air fumes
(8) personnel accident

9.5 Regular check

9.5.1 Many processes leading to damages can be prevented or at least slowed down with appropriate maintenance and regular check.

(1) The tightness of all fastenings should be verified regularly.
(2) Check the condition of connections and mounting and assembly bolts.
(3) Control that the 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 earthing.
(5) Check the condition of shaft seals and replace if necessary. If not familiar with the seals, please contact Focquet.
(6) Check the alignment of shaft couplings.
(7) Check the motor. Water, grease, oil, or dust should not be permitted to enter the housing.
(8) Check the condition of bearing and replace if necessary. (9) Check the condition of painting and repaint if necessary.

9.6 Maintenance

The maintenance is important in preventing motor failure and lengthening service life. General speaking, there are a smaller maintenance once a month, and an overall maintenance once a year.

9.6.1 The smaller maintenance includes:

(1) clean the motor.
(2) measure the insulation resistance of motor.
(3) tighten the connection, mounting and earthing bolts. (4) clean the starter and insulation terminal.
(4) remove coal dust from the slip ring and brush.
(5) check the condition of fan-covers and to ensure good air circulation inside the motor.
(1) 9.6.2 The overall maintenance includes:
(1) all the items of the smaller maintenance. (2) clean the interior of the motor.
(2) check the condition of bearing and replace if necessary. Suggest that replace the bearing once a year at the normal condition(operating about 8 000h/year).
(3) if not necessary to replace the bearing, clean the bearing and replace the grease.
(4) clean and replace other parts of motor.

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 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 fiber bristles (not wire of any type).
(2) If the motor is equipped with fan-covers, they should be replaced (disposable type) or cleaned and reconditioned (permanent type) at a frequency that is dictated by conditions. (3) On open ventilated motors(ODP motor with IP 23 and below), screens and louvers over the inlet air openings should not be allowed to accumulate any build-up of dirt, lint, etc. that could restrict free air circulation.

NOTE!

Screens and louvers 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 long time, accumulation of dust, carbon powder and grease etc., on the inside is unavoidable, and may cause damage of 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. Maintain air pressure at 4 kg/cm2, since high pressure can cause damage to coils.
(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 safety type petroleum solvent.

(5) In hazardous locations, a solvent such as inhibited methyl chloroform may be used, but must be used sparingly and immediately removed. While this solvent is non-flammable under ordinary conditions, it is toxic and proper health and safety precautions should be followed while using it.
(6) The proper health and safety precautions should be followed while cleaning the motor. When using a solvent such as inhibited methyl chloroform to clean the motor, ensure good air circulation around the motor.
(7) 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 The cleanliness of the roller bearing

The roller bearings will have to be washed periodically after operating a long time.

(1) The bearings are washed, dried and pre-greased with suitable and high quality rolling bearing grease before assembly.
(2) No dirt or foreign debris is allowed to enter the bearings at any time during the maintenance.
(3) Basically, the bearing should be heated and assembled. The temperature is controlled at 90°C.
(4) The disassembly and mounting of the bearings does not damage the bearings. The bearings must be removed by using pullers and fitted by heating, or using special tools for the purpose. Do not hammer the bearing to prevent bearing damage.

9.7.4 The cleanliness of the sleeve bearing

(1) The discriminance of cleanliness
- Check the oil visually with respect to color.
- 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.

(2) The method of cleanliness

When the condition mentioned above (1) occurs, must determine a suitable oil change and clean the bearing.

The coal oil must be used to clean the bearing. New grease must be injected until coal oil is discharged through the lubrication valve in the bottom of the bearing housing.

(3) Caution during cleanliness

Be careful during cleanliness. Any knock and impact will damage the bearing surface.

10 Motor troubleshooting chart

Your motor service and any troubleshooting must be handled by the 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 lead.
		Stator winding failure	Check windings short circuit or broken.
		Motor may be overloaded	Reduce load.
		Wrong wiring	Check wiring
2	Motor does not come up to rotating speed	Voltage too low at motor terminals because of line drop.	Check connections. Check conductors for proper size.
		Poor contact of control switches or short circuit of starting switches.	Check and repair control switches.
		Phase failure of power.	Check power and connection.
		Poor contact of power line.	Check power connection.
		Windings grounded or short circuit.	Factory repair.
3	Fail to loading after start, due to trip-off of switch	Insufficient capacity of switches and fuse.	Replace switches and fuse if wiring permits.
		Under-voltage.	Check power source.
		Overload.	Lighten load.
4	Electricized enclosure	Confusing the wiring of power line and earthing.	Correct the wiring.
		Insulation moistered or aged.	Drying or replace winding.
		Connection between lead and enclosure.	Check lead and enclosure and insulate them.
5	Motor surface overheating	Overload.	Lighten load or replace motor.
		Ambient temperature exceeds 40°C.	replace higher insulation class, or lower ambient temperature.
		Under-voltage.	Check power line, transformer capacity and source voltage.
		Over-voltage.	Check power source.
		Fuse broken (Single-phase operation).	Install the specified fuse
		Ventilation duct clogged.	Remove the foreign matter in the duct.
		Friction between rotor and stator.	Factory repair or replace motor.
		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, fuse and circuit 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.	Should be repaired at factory.
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 screw tightly.
		Friction between fan and end-shield, fan-cover.	Adjust the distances between fan and end-shield, fan-cover.
		Rubbing as a result of ingression of foreign matters.	Clean motor interior and ventilation ducts.
		Caused by driven machine	Check the driven machine.
9	Bearing noise	Even sound.	May be normal.
		lightly collided sound.	Re-greasing.
		Obviously bearing sound.	Cleaning bearing and grease.
		Broken ball or rough races.	Replace the damaged bearing.
10	Abnormal Vibration	Improper installation.	Lock the mounting screws.
		Motor mounting bed is not strong enough.	Reinforce mounting bed.
		Unsymmetrical centers 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.
		Unbalanced fan or broken fan blade.	Replace fan or balance fan again.
		Short circuit of windings of stator or rotor.	Factory repair.
		Mounting bed vibration caused by near machines.	Eliminate the vibration source near motor.
11	Bearing overheating	Damaged bearing.	Replace the damaged bearing.
		Poor lubrication.	Changing grease.
		Misalignment between motor and driven machine shafts.	Adjust belt tension or align couplings.

		Friction between bearing and bearing house or shaft.	Replace the damaged shaft or end-shield.
		Improper assembly	Re-assembly motor

11 Handling for discarded motor

The discarded motor must be recycled according to the local regulations.

The material content used in the manufacturing of the motor is as follows: cast iron, steel, copper, aluminium, insulation materials.

For metals that account for a large part of a product, choice of genetic metals that facilitate material recycling is necessary. The nonmetal should be either incinerated or disposed of in landfills. Attention should be paid to enduring that such processes do not adversely affect environment.

Motor products, manufacturing processes and even logistics have been designed to take environmental aspects into account.