



# **Instructions For Three Phase Induction Motors**

## **Large Cast Iron Frame Type**

**IEC Frame 280 (NEMA Frame 444) and above**

## **Large Steel Fabricated Frame Type**

**IEC Frame 315 (NEMA Frame 5000) and above**

## **Vertical High Thrust Type**

**IEC Frame 112 (NEMA Frame 182) and above**



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## 1. INTRODUCTION

### 1.1 General

This and the following instructions address the more common situations encountered in motor installation, operation and maintenance. For the TECO motor warranty to be and to remain in effect, the motor must be installed and operated in strict accordance with the outline drawing, motor nameplates and these instructions, and must not be altered or modified in any unauthorized manner.

During the installation and operation of motors in heavy industrial applications there is a danger of contact with live electrical and rotating parts. Therefore to prevent injury and/or damage the basic planning work for installation, transport, assembly, operation, etc.... needs to be done and checked by authorized and competent personnel only.

Since these instructions cannot cover every eventuality of installation, operation and maintenance, the following points should however be considered and checked.

- (a) Technical data and information on permissible use such as assembly, connection, ambient and operating conditions given in the related catalogue, operating instructions, nameplates and other production documentation.
- (b) General erection and safety regulations.
- (c) Local (job site) and plant-specific specifications and requirements.
- (d) Proper use of transport, lifting devices and tools.
- (e) Use of personal protective equipment.

**The following safety indications should be observed when reading these instructions:**



**Electric Hazard.**



**Danger.**

#### **ATTENTION !**

**Warning of possible damage to the motor or installation.**

This instruction manual is for **TECHNICAL USE ONLY, NOT FOR COMMERCIAL PURPOSE**. The warranty is limited to coverage expressed in your sales contract. Documentation of storage, transportation, installation and examination, if required, shall be obtained from TECO service centers before start and maintenance.

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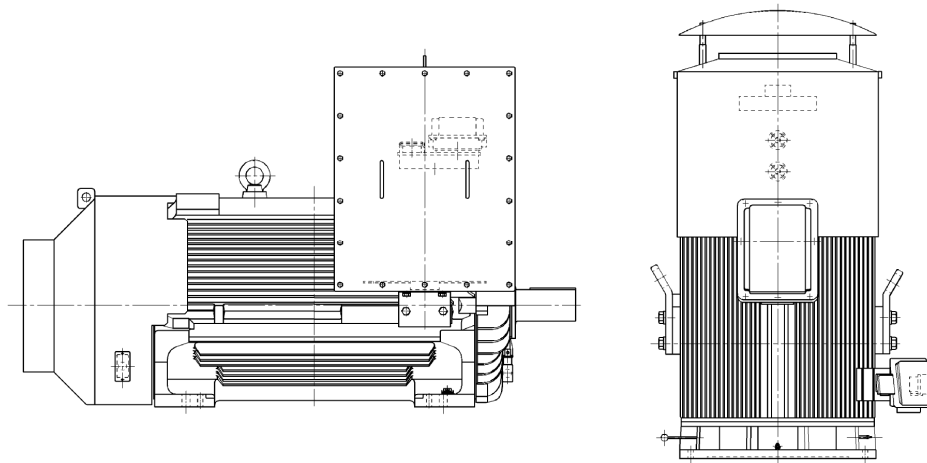
## 1.2 Serial number of the machine

Each electric motor is identified with a serial number. It has been stamped on a main name plate which is attached on the frame by rivets. This serial number is very important as an index for tracking this motor's history.

## 1.3 Mounting

In this instruction manual, the arrangements for most of the electric motor are as follows:

Cast Iron Frame:



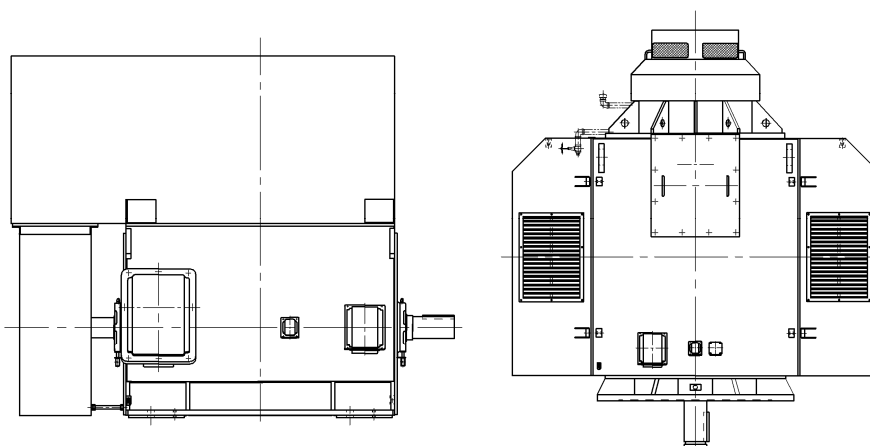
IM 1001

Horizontal foot mounting (HFM)

IM 3011

Vertical flange mounting (VFM)

Steel Fabricated Frame:



IM 1001

Horizontal foot mounting (HFM)

IM3011

Vertical flange mounting (VFM)

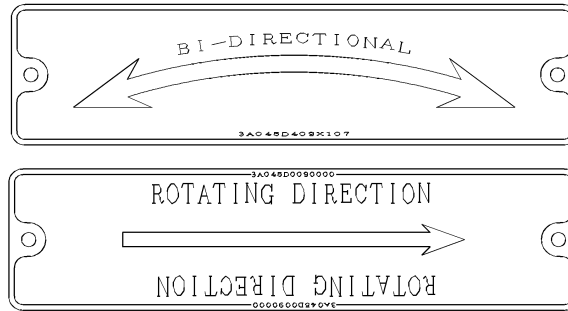
**Fig. 1-1 Mounting arrangement**

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## 1.4 Direction of rotation

The arrow on the direction nameplate indicates the direction of the rotation of the Rotor, looking in front of the DE-Shaft-end.

The motor must be operated just on the plate shown direction.



**Fig. 1-2 Direction nameplate**

### **ATTENTION !**

**Operating the motor in the incorrect direction may cause serious damage to both the motor and driven equipment.**

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## 2. ACCEPTING, INSPECTION, STORAGE, TRANSPORTATION

### 2.1 Inspection upon receipt

Check the following points upon receipt :

- (a) Is there any visible damage to the motor or case? Any damage should be photographed, documented and reported to the carrier and TECO immediately.
- (b) Are the nameplate ratings identical with your confirmed order ?
- (c) Are dimensions and color in compliance with your specifications ?
- (d) Are the nameplate ratings for heater, thermal protector, temperature detector, etc. identical with your confirmed order ?
- (e) Are all accessories and accompanying instruction manuals in good order ?
- (f) Does the arrow head indicate the correct direction of rotation?
- (g) If there are any specific requirements, please ensure they are in conformity with your specification.

### 2.2 Storage

#### 2.2.1 General

When motors are not in operation, the following precautionary measures must be taken to ensure the motors do not suffer deterioration or damage from moisture, dust and dirt, or careless handling. The climate, length of time the equipment is to be stored, and the adequacy of the storage facilities will determine the storage precautions required.

Any deterioration or damage of the motors due to customer's incorrect storage of the motors is not covered by the warranty. This includes all periods of time when the motor is installed on site but has not been placed into operation.

The following procedures must be followed and a maintenance log must be kept to keep from voiding factory warranty. The records are also useful to decide if a motor is suitable or not to be put into service.

#### 2.2.2 Location

The ideal storage area is a clean, heated, and well-ventilated building.

- (a) High and dry, well-ventilated indoor, without exposure to direct sun light, free from dust, corrosive gas (such as chlorine, sulfur, dioxide, and nitrous oxides) and fumes, and infestation by vermin or insects.
  - (b) The ideal storage temperature range is from 10°C to 50°C (50°F to 125°F) , and relative humidity is  $\leq 60\%$ .
  - (c) Not close to a boiler or freezer.
  - (d) Precautions should be taken to prevent rodents, snakes, birds or other small animals from nesting inside the motors. In area where they are prevalent, precautions must be taken to prevent insects, such as dauber wasps, from gaining access to the interior of motors.
  - (e) Entirely free from vibration. Vibration levels above 2.5 mm/s (0.1 in/sec) velocity could damage the bearings and cause “brinelling” of the bearing races.
-

- (f) Motors should be put on pallets to prevent moisture from accumulating underneath.
- (g) Motors should be stored in a heated building, outdoor storage is not suitable for motors. If motors have to be stored outdoors for some reasons, they should be well covered with a tarpaulin and protected from contamination and the elements. Motors should be well shielded from dust, but under well-ventilated circumstances. This should be for a very short period of time (say less than one month) only and the risk of deterioration is the responsibility of the users.
- (h) Water-cooled motors or motors using bearings with water-cooling coils, please make sure the water is dried off to prevent tube corrosion or frost damage.

### **2.2.3 Motor Position (Vertical motor only)**

Motors must be stored in vertical position. Where motors are mounted to machinery, the mounting must be such that drains and breathers are fully operable and are at the lowest point of the motor.

### **2.2.4 Moisture prevention**

Since moisture can be very detrimental to electrical components, the motor temperature should be maintained about 3°C above the dew point temperature by providing either external or internal heat. 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. Check weekly that the space heaters are operating.

Incandescent light bulbs can be placed within the motor to provide heat, if the anti-condensation space heaters are not fitted. However, if used, incandescent bulbs must not be allowed to come in contact with any parts of the motor because of the concentrated hot spot that could result.

### **2.2.5 Prevent Corrosion**

When motors are shipped from the factory, the shaft extension and bearing journals on sleeve bearing motors, are covered with a protective coating. This coating should be examined to see that it has not been accidentally removed. The coating should be renewed if there are any signs of corrosion or if the coating has been removed. Care should be taken to keep parts such as fitted surface, key, shaft extension, mounting feet or face, and axial central hole from any collision with foreign matters, and to have rust preventative in place. It is a good practice to seal any shaft openings with silicone, rubber caulking, or tape. If any rust is observed, measures should be taken to remove the rust and protect against it. Grease or anti-corrosion agent should also be generously applied to prevent rusting.

TECO reserves the right to void warranties based upon evidence of rust or other indications of moisture inside the motor that indicate that the motor was improperly stored.

### **2.2.6 Insulation resistance test**

Even during storage, the insulation resistance should be kept above the specified values.

- (a) For measurement of insulation resistance and acceptable standard values, please refer to measures stated in 4.1.2 "Measurement of insulation resistance".
  - (b) Insulation resistance test should be performed once every three months.
  - (c) Resistance measurement of each temperature detector (ex. PT 100 Ω/°C) is necessary once every three months.
-

### 2.2.7 Long period of idle (storage)

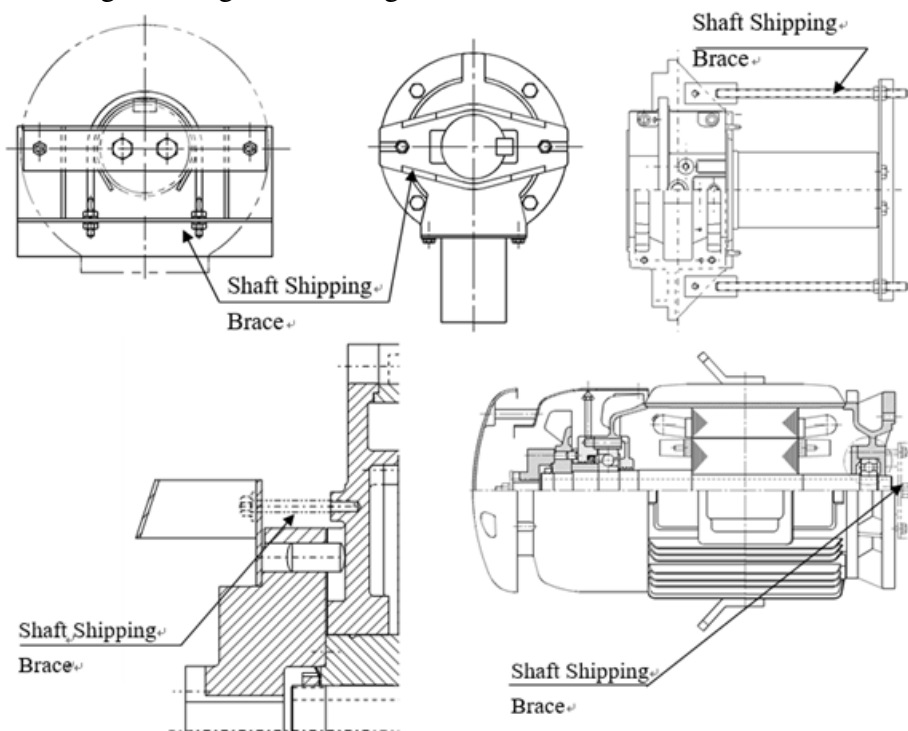
If the motor is not in operation for a long period of time (one week and above) after installation or has been in operation but stopped for a period of time, the following precautions must be taken.

- (a) Protect the motor as measures stated in 2.2.4 and 2.2.5.
- (b) Insulation resistance test should be performed as stated in 2.2.6.
- (c) Bearing Protection per 2.2.8.
- (d) Operation test should be performed once every three (3) months.
- (e) If external vibration is present, the shaft coupling should be opened.
- (f) If motors are mounted shaft up, a solid protective plate or shield shall be mounted above the installation if needed.
- (g) If motors are mounted shaft down, drip covers are to be mounted to give satisfactory protection if needed.
- (h) If motors are equipped with drain plugs, they should be removed.
- (i) When motors equipped with brushes, the brushes should be lifted in the brush holder, if there is no protective strip (such as MYLAR) between the brushes and collector rings.
- (j) Water-cooled motors or motors using bearings with water-cooled coils, ensure the water is dried off to prevent tube corrosion or frost damage.
- (k) Storage maintenance must be documented for warranty and reference purposes.

### 2.2.8 Bearing protection

- (a) If the motor has been provided with a shaft shipping brace to prevent shaft movement during transit, it must be removed before operating the motor.

It is very important that this brace be reinstalled exactly as it was originally, before the motor is moved from storage or any time when the motor is being transported. This prevents axial rotor movement that might damage the bearings.

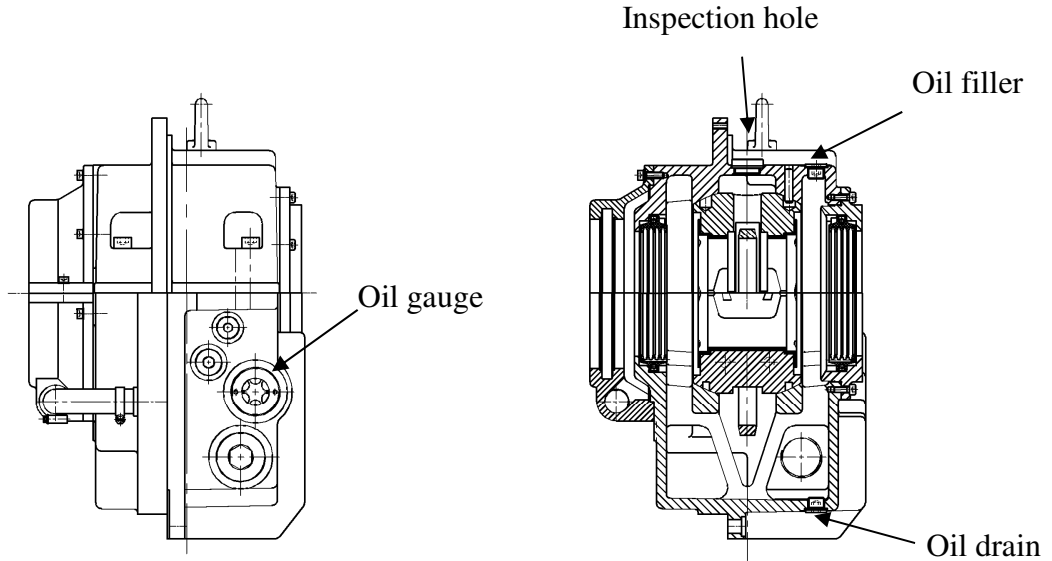


**Fig. 2-1 Shaft shipping brace**

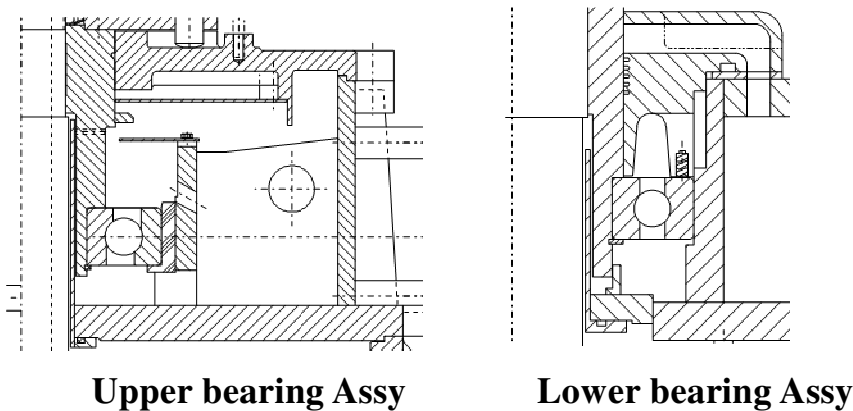
- (b) Motors equipped with oil lubricated bearings are shipped from the factory with the bearing oil reservoirs drained. In storage, the oil reservoirs should be properly filled to the center of the oil level gauge with a good grade of rust inhibiting oil.

To keep the bearing well oiled and prevent rusting, the motor shaft should be rotated several revolutions every month ensuring the shaft does not come to rest in its original position. Motors equipped with sleeve bearings, While the shaft is rotating, it should be pushed to both extremes of the endplay.

If the motor is not in operation for over six months, dismantle the upper cover of the bearing housing and check the anti-corrosion protection.



**Fig. 2-2(A) Sleeve bearing( Horizontal motor only)**

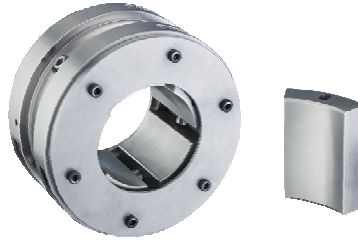


**Fig. 2-2(B) oil lubricated bearings (Vertical motor only)**



**Motor must not be moved with oil in reservoir. Drain oil before moving to prevent sloshing and possible damage. Refill oil when motor has been moved to the new location.**

- (c) Motors with anti-friction bearings are properly lubricated with the correct grade of grease at the factory and no further greasing is required in storage. If the motor is not in operation for over three months, add grease to each bearing per lubrication nameplate. The shaft should be rotated at least 15-20 revolutions every month to maintain proper distribution of the grease within the bearings.
- (d) Tilt-pad bearings are a type of sleeve bearing (Fig 2-3) used in special design applications. Due to the nature of this bearing, a loose oil ring for delivering lubricant cannot be provided. Therefore, during the storage interval, oil must be manually introduced periodically into the pads and housing to prevent the occurrence of oxidation of the precision machined components.



**Fig. 2-3 Tilt-pad bearings**

- (1) Before oiling, Remove the pipe plug from the bearing cap located above the tilt-bearing shell.
- (2) Pour in approximately one cup of oil (about 240 ml) every month and rotate the shaft a few revolutions every two (2) weeks. Please note that the oil level does not exceed the upper limit of the oil gauge. For more information, please refer to this manual 5.5.5.

For long periods of storage, the oil that accumulates in the housing should be removed.

- (e) The bearing assembly parts of motors with oil mist lubrication are put on with anti-rust oil, so they can be preserved for several months in good condition. The motor should be stored indoor and well-ventilated environment and prevent contact with contaminated or corrosive air. The following points should be noted :
- (1) During preservation, the Inpro seal can not prevent moisture from going through into the bearings. Please use the oil mist to lubricate the bearings every two (2) weeks.
  - (2) If the color of flow out oil is changed, the bearing should be rusted or have contamination in it. Please contact TECO.
  - (3) Avoid using grease as it will plug the vent/drain.
  - (4) All assembly surfaces are painted with seal bonds, do not disassemble them at anytime.
  - (5) Do not remove the plugs in vent/drain to prevent the moisture.
  - (6) Do not apply any force on the Inpro seal to prevent damage.
  - (7) The Inpro seal is a labyrinth type seal. Therefore it can not contain a pressure differential. Please ensure that the oil chamber does not have negative pressure during transportation or storage.
- (f) If the storage is over two (2) years, it is recommended that the bearing assembly is dismantled and the bearing parts are inspected before commissioning. Any corrosion has to be removed with fine emery clothes.
- (g) Motors with anti-friction bearings with provisions for oil mist are shipped from factory with the correct grade of grease in the bearings and therefore it is not necessary to hook up the motors to the oil mist system. The shaft should be rotated several revolutions every month to maintain proper distribution of the grease within the bearings. If customers choose to hook up to the oil mist system, all grease must be removed from the bearings.

### **2.2.9 Removal from storage**

After long period of idle or storage, and, prior to energizing the motor, a thorough inspection and megger test of windings is required. The bearings should be inspected for corrosion, brinelling and deformation.

If any of the following conditions pertain, then re-conditioning may be required before putting a motor into service.

- (a) Winding resistance is less than recommended.
- (b) Evidence of rust or other indications of moisture inside the motor.
- (c) Corrosion or brinelling or deformation occurred in bearings.
- (d) Idle or storage longer than the warranty period.
- (e) Idle or storage in dirty or damp surroundings.
- (f) Storage in unheated area where the temperature and humidity fluctuate.
- (g) Idle or storage where it has been subject to vibration, such as from nearby machinery or passing traffic.
- (h) Outdoor storage.
- (i) No maintenance records showing that the storage procedures have been followed.

Any reconditioning required, as noted by the inspections after removal from storage, should be performed prior to putting the motor into service. Such inspection and testing or re-conditioning are available from local TECO service/facilities. Reconditioning after idle or storage is not covered by factory warranty. Any parts that must be replaced due to damage or deterioration will be at customer's cost.

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## 2.3 Transportation

### ATTENTION !

To keep the rotating parts of motors from moving, thus preventing damage and scratching during transportation, they should be held securely with a locking device. Remove all transit clamps before operating the motor. It is very important that this device be reinstalled, exactly as it was originally, before the motor is moved from storage or any time when the motor is being transported.

If the motor is added and installed with other accessories (for example, coupling...), the shaft shipping brace provided by TECO cannot be used, and the user needs to modify or re-make the shaft shipping brace to protect the bearing.

Vertical mount type motors should be transported in the vertical position.



Do not use the hoisting hook/eyebolts to lift more than the motor itself. They are designed to support the motor only.

Make sure the hoisting hook is correctly attached to the eyebolt(s) or lug(s) of the motor and that the eyebolt(s)/lug(s) are fully threaded in before hoisting. Also note such parts as fan cover, ventilation box, bracket, slip-ring covers, etc. may have their own hoisting lugs which can only carry their own weight. Nothing extra should be attached while hoisting.

Do not twist or cross the steel cables. Make sure the eyebolts have been securely threaded with the shoulder flush and the sling angle is correct.

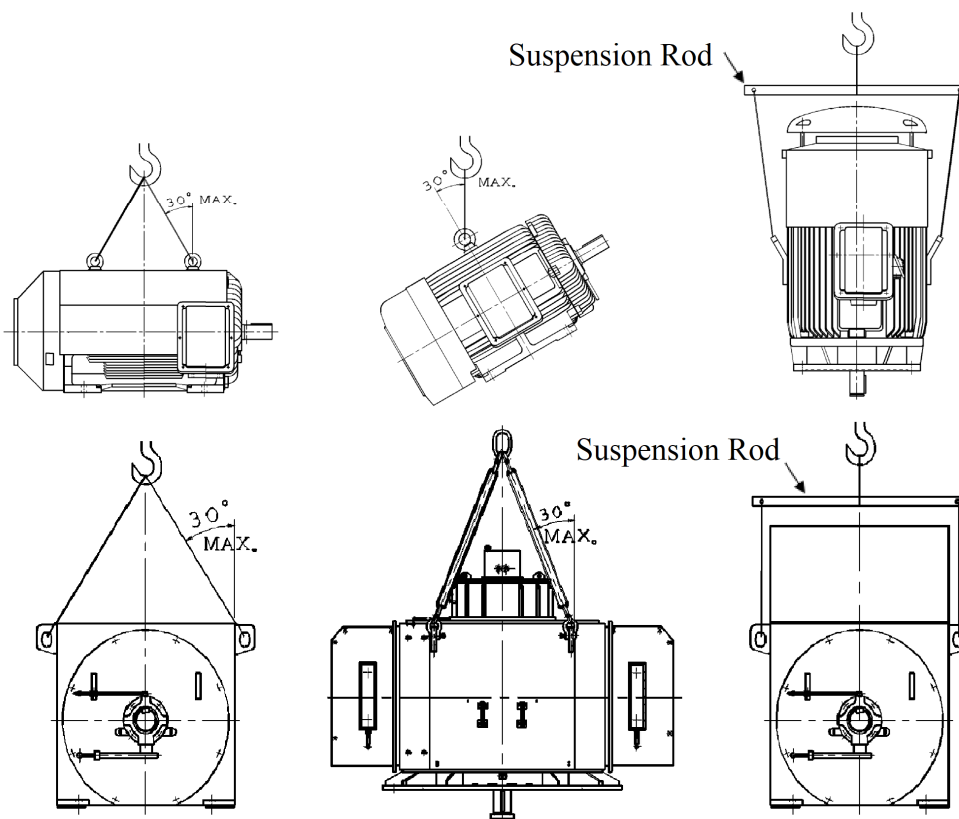


Fig. 2-4

### **3. INSTALLATION**

#### **3.1 Site and environment for motor installation**

##### **3.1.1 General**

Standard environment and site conditions for the installation of motors are usually set as follows :

- (a) Ambient temperature :  $-20 \sim +40$  °C
- (b) Humidity : Relative humidity shall be below 95%RH for totally-enclosed types, and below 80%RH for semi-enclosed types.
- (c) Elevation : Below 1000 meters.
- (d) Harmful gases, liquids, dusts and high moisture levels should be absent.
- (e) Foundations should be strong and free of vibration.

For water-cooled motors or motors using bearings with water-cooling coils, the ambient temperature must not drop below 5°C (41°F) to prevent frost damage. If lifting a motor under -20°C is required, or there are any special environmental conditions, please inform us at time of order.

##### **3.1.2 Ventilation and space**

- (a) Installation area should be well-ventilated.
  - (b) The installation space should be large enough to facilitate heat dissipation and maintenance.
-

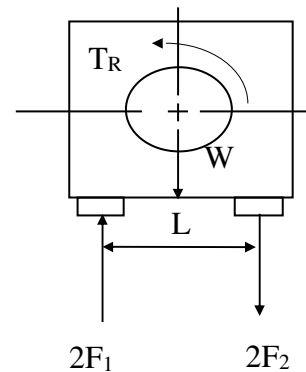
## 3.2 Foundation

Motor manufacturer is not responsible for the foundation design. Motor weight, thrust load, twisting moments, seismic forces and other external applied loads must be considered in foundation design.

### 3.2.1 Reactions of horizontal motor

For a horizontal motor with four hold down bolts, the reactions necessary for foundation design are as follows – kg per bolt at centerline of hold down bolt holes :

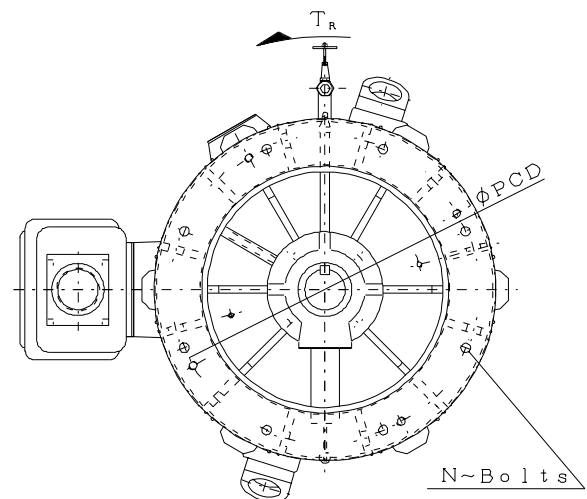
- (a) Static weight = motor weight / bolt number
- (b) Rated motor torque ( $T_R$ ) ,  
Reactions = motor weight/bolt number  $\pm T_R/2L$
- (c) Maximum motor torque ( $T_{max}$ ) ,  
Reactions = motor weight/bolt number  $\pm T_{max}/2L$



**Fig. 3-1 A**

For a vertical motor with N pcs hold down bolts, the reactions necessary for foundation design are as follows – kgs per bolt at centerline of hold down bolt holes :

- (a) Rated motor torque ( $T_R$ ) ,  
Reactions =  $T_R / \text{bolt number} / (\text{PCD}/2)$
- (b) Maximum motor torque ( $T_{max}$ ) ,  
Reactions =  $T_{max} / \text{bolt number} / \text{PCD}/2$



**Fig. 3-1 B**

### 3.2.2 Soleplate & common bed

Use rigid and solid soleplate or common bed as foundation.

#### ATTENTION !

For best motor performance, it is advisable to use a soleplate or common bed, particularly when using a shaft coupling.

The foundation must be strong, rigid, flat and free from external vibration. The possibility of machine resonance with the foundation has to be verified. In order to avoid resonance vibrations with the machine, the natural frequency of the foundation together with machine must not be within a  $\pm 20\%$  range of the running speed frequency.

If the soleplate or common bed doesn't have enough stiffness, the critical speed of motors or equipment will then be changed. This change may cause a large vibration (resonance) and decrease the life of machines.

The calculation and design of the foundation is not included in the TECO scope of supply and the customer or a third party is therefore responsible for it.

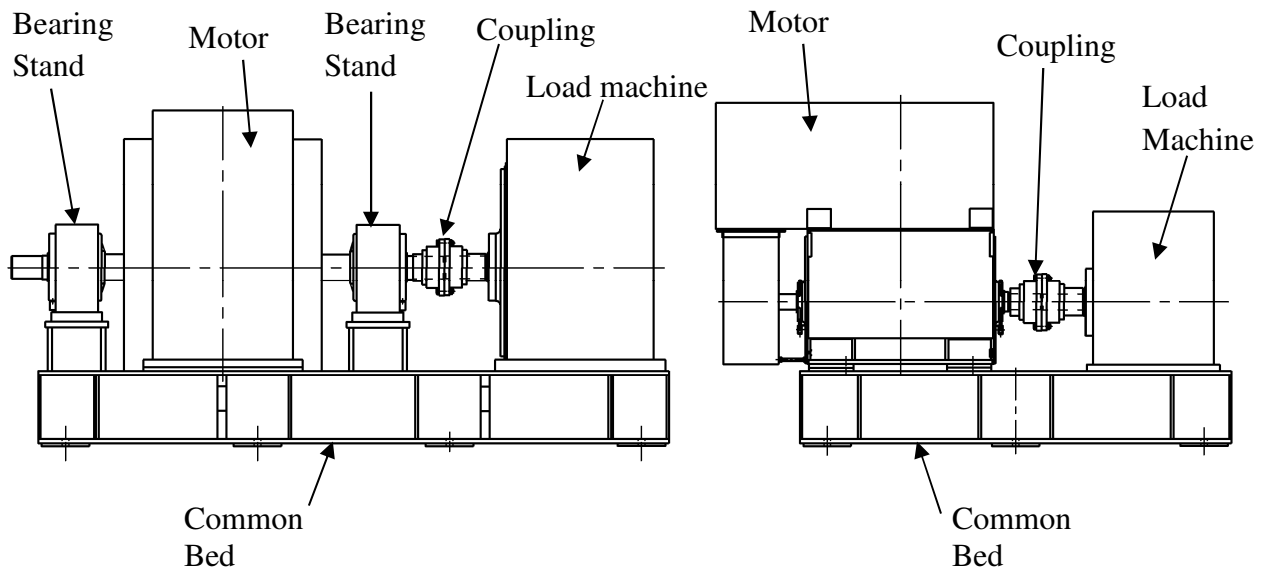
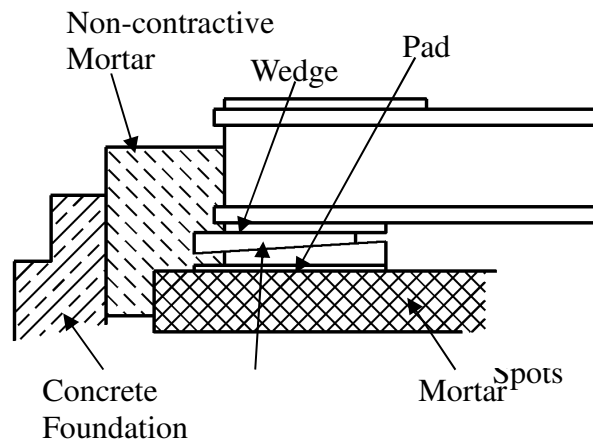


Fig. 3-2

### 3.2.3 Installation

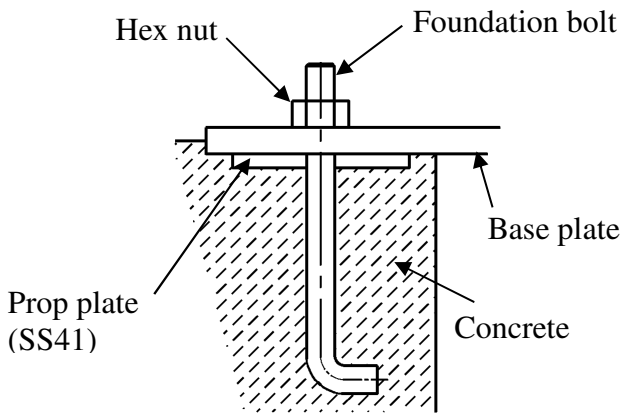
- (a) Select an appropriate foundation surface for the soleplate or common bed which will be considered the ultimate level.
- (b) Align the position of the common bed with reference to that level at a minimum of four points. The accuracy should be within 0.04mm (1.5mil).
- (c) Sole plate or common bed should be embedded in concrete foundation as illustrated in Fig.3-3. Stiff pads should also be installed beneath the wedges which are welded together at various spots about 400-500mm (15-20inches) apart to enable the foundation to evenly carry the weight of the whole motor.
- (d) The base should be sturdy and rigid to keep it flat and level.
- (e) Make sure the mortar and concrete are completely dry and the precision of the level is acceptable, then set the motor on the mounting foundation.
- (f) After accurately install shaft couplings, weld the wedges to prevent soleplate or common bed moving.



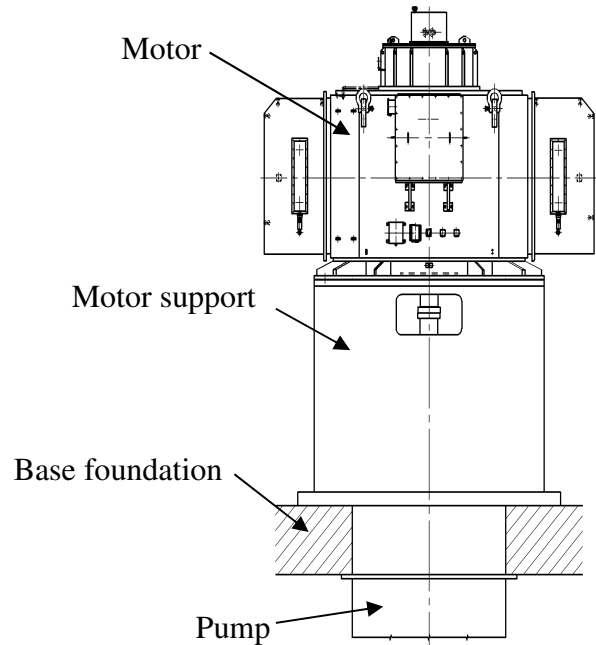
**Fig. 3-3**

### 3.2.4 The foundation of vertical induction motor (Also the foundation of pump)

- (a) Foundation of motor/pump must be rigid and secure to provide adequate support. There must be no vibration, twisting, misalignment etc. due to inadequate foundations.
- (b) A massive concrete foundation is preferred in order to minimize vibration. Rigidity and stability are enhanced by prop plate and foundation bolt. As shown in Fig.3-4 and Fig.3-5.



**Fig. 3-4**



**Fig. 3-5**

### 3.2.5 Installation of vertical motor

- (a) All mounting surfaces must be planished and clean.
- (b) Foundation must be leveled at least at 4 points and guaranteed to be below 0.04mm flat and level.
- (c) Make sure the mortar and concrete are completely dry, and the precision of the level is acceptable, then set the motor on the mounting foundation.
- (d) Accurately install shaft couplings.

### 3.3 Installation of shaft coupling

#### 3.3.1 General

#### ATTENTION !

Motors must always be accurately aligned, and this applies especially where they are directly coupled.

Incorrect alignment can lead to bearing failure, vibration and even shaft fracture. As soon as bearing failure or vibration is detected, the alignment should be checked.

#### 3.3.2 Mounting procedure

Field application of a coupling to the motor shaft should follow the procedures recommended by the coupling manufacturer. The motor shaft extension must not be subjected to either extreme heat or cold during coupling installation.

#### 3.3.3 End-play

Although the sleeve bearings are equipped with thrust faces, these are intended only to provide momentary axial restraint of rotor movement either during start-up or when operating the motor disconnected from the driven equipment. They must not be operated under a constant thrust load unless they were originally designed for this condition.

Motors with either sleeve or anti-friction bearings are suitable for connection to the driven load through a flexible coupling. Coupling solidly to the load is not acceptable. With sleeve bearings, the flexible coupling should be of the limited end float type to prevent the possibility of any end thrust from the load being transmitted to the motor bearings, which could cause bearing damage.

The recommended limits of end float for couplings are as follows :

- When the motor is in operation after installation, be sure that the end-play indicator is within the 6mm of the groove on the shaft or aligned to the shaft shoulder immediately outboard of the drive-end bearing to assure there is low friction between shaft and bearing.
- Unless otherwise specified, the designed end-play value  $X$  of the groove for TECO motors in general is within 7mm (0.276") as illustrated in Fig. 3-6. In essence, the end-play indicator is adjusted to point at the center of the groove or the drive-end shaft shoulder; thus  $X$  equals to  $7 \pm 1$ mm (0.276"  $\pm$  0.039") or so, and the end-play value ( $Y$ ) of the couplings should equal or be smaller than 2.4mm (0.094").
- If the desired value  $Y$  is greater than 3mm (0.118") caused for instance by a thrust load and/or load machine with large end-play, please inform us at time of order.

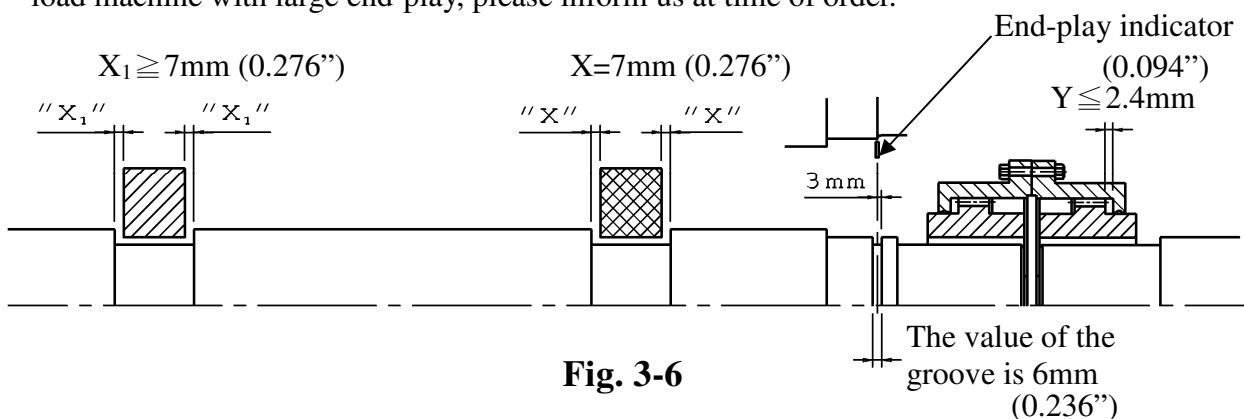


Fig. 3-6

### 3.3.4 Thermal growth

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. In general, the axial shaft growth for motors can be disregarded since neither bearing fixed nor any shaft growth due to temperature increase will produce an elongation away from the coupling.

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

$$\Delta = (0.0005) \times (\text{motor foot to shaft centerline dimension})$$

For non-TEFC machines, divide this number by 2.

### 3.3.5 Alignment

It is desirable, in normal operation, that the motor operate on its magnetic center, so that no axial force is exerted on the coupling.

The motor shaft and the driven shaft should be aligned within the following tolerances in both angular and parallel alignment :

Table 3-1

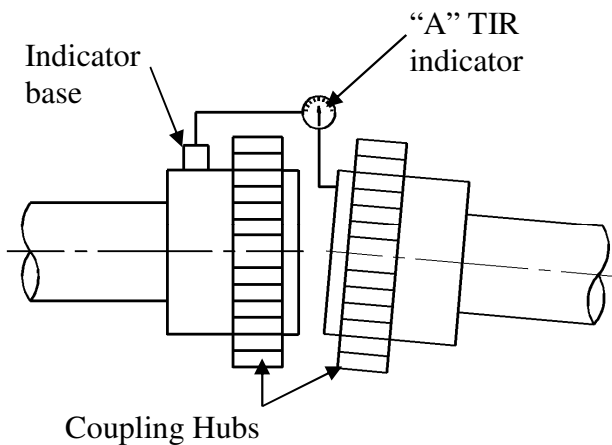
Unit : mm

TIR	Range of rotating speed	Solid coupling	Flexible coupling
C	2500rpm and above	0.03	0.03
	Below 2500rpm	0.04	0.05
A	2500rpm and above	0.03	0.03
	Below 2500rpm	0.03	0.04

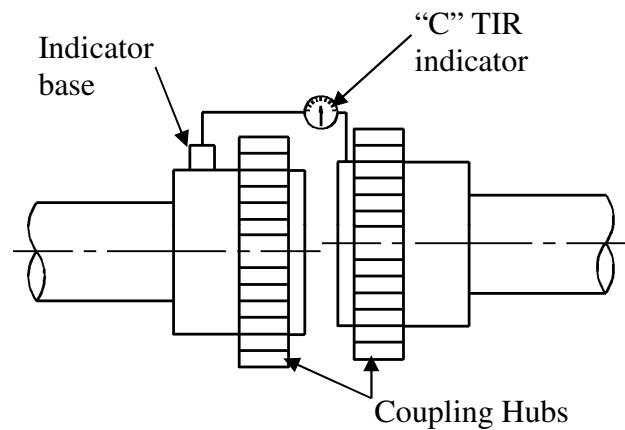
**Angular misalignment** is the amount by which the centerlines of driver and driven shaft are skewed. It can be measured using a dial indicator set up as shown in Fig.3-7. The couplings are rotated together through 360 degrees so that the indicator does not measure run out of the coupling hub face. The shafts should be forced against either the in or out extreme of their end float while being rotated.

**Parallel misalignment** is the amount by which the centerlines of the driver and driven shafts are out of parallel. It can be measured using a dial indicator set up as shown in Fig.3-8. Again, the couplings are rotated together through 360 degrees so that the indicator does not measure runout of the coupling hub outside diameter.

**TIR** = Total indicator reading (by dial indicator)



**Fig. 3-7**



**Fig. 3-8**

### **ATTENTION !**

**Measurements should be made only after shimming and with hold-down bolts properly tightened.**

#### **3.3.6 Shims for horizontal motor**

During alignment, the motor is adjusted vertically by shimming between the mounting surface and the motor feet. The shims (furnished only if part of the motor order) should be as large as the projected area of the motor foot pad and should either partially or completely encircle the hold-down bolts. Shimming must be done carefully to prevent any uneven support of the frame feet that could result in frame distortion due to hold-down bolt tension. When properly shimmed, it should be possible to insert 0.05mm thick feeler gauge between the top shim and the bottom of any frame foot.

#### **3.3.7 Dowel for motor**

After the motor has been properly aligned with the driven equipment and the hold-down bolts have been installed and tightened, for motors with fabricated frame, at least two dowel pins should be installed in two diagonally opposite motor feet.

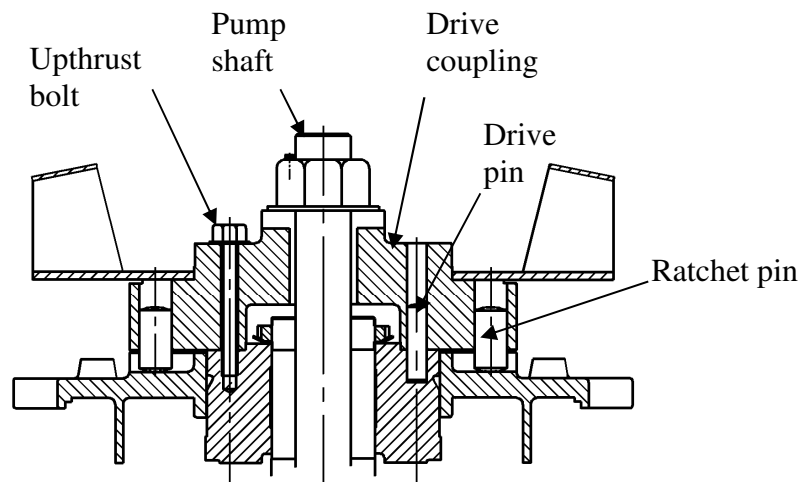
For motors with fabricated frame, pilot holes are provided to facilitate final field drilling and reaming of the required dowel holes. Since the dowel pilot hole in the frame foot is set at a 45° angle from the vertical, it may first be necessary to spot face the motor mounting surface. This can be accomplished with a flat bottom drill utilizing the pilot hole as a guide.

### 3.3.8 Installation of shaft coupling (Vertical hollow shaft motor only)

Bolted coupling as Fig.3-9

- (a) Bearings are provided to absorb some upward shaft thrust when the coupling is fitted.
- (b) The coupling is fastened with bolts.
- (c) This coupling type is not auto-release type.

Note : Standard high thrust motors can absorb momentary upthrust load up to 30% of the standard downthrust load. If the upthrust is long duration (over 10 seconds) and/or exceeds 30% of the standard high thrust rating, special design arrangements are required and a standard motor is not suitable.



**Fig. 3-9**

### 3.3.9 Non-reverse ratchet/coupling, as Fig. 3-9 (If fitted)

The non-reverse coupling is also a bolted type and,

- (a) It prevents the pump and motor from rotating in the reverse direction.
- (b) It also prevents damage from over speeding and damage to pump shaft and bearings.
- (c) The ratchet pins are lifted by the ratchet teeth and are held clear by centrifugal force and friction as the motor comes up to speed.
- (d) When power is removed, speed decreases, and the pins fall. At the instant of reversal, a pin will catch in a ratchet tooth and prevent backward rotation.
- (e) When installing the non-reverse coupling, do not use lubricant. Lubrication will interfere with proper operation. The top half of the coupling should seat solidly on the lower half and the pins should touch the bottom of the pockets between the teeth in the plate.
- (f) As with the bolted coupling, the upthrust capabilities are 30% of the standard high thrust rating for downthrust.

#### **ATTENTION !**

**Do not apply non-reverse ratchets on applications in which the pump reversal time from shutdown (the instant the stop button is pressed) to zero speed is less than one second.**

### 3.3.10 Manual rotation of large vertical rotor with sleeve bearing during alignment

- (a) If there is a thread in the non-drive end shaft center, the breakaway torque can be overcome by the use of torque wrench provided there is no ratchet. Remove the top cover, insert a bolt in the threaded shaft center and use a torque wrench to apply the rotating force. The breakaway torque is decided if a torque wrench is feasible.

$$\text{Torque [kg-mm]} = \text{Rotor Wt [kg]} * \text{Thrust Pad Center Radius [mm]} * 0.4$$

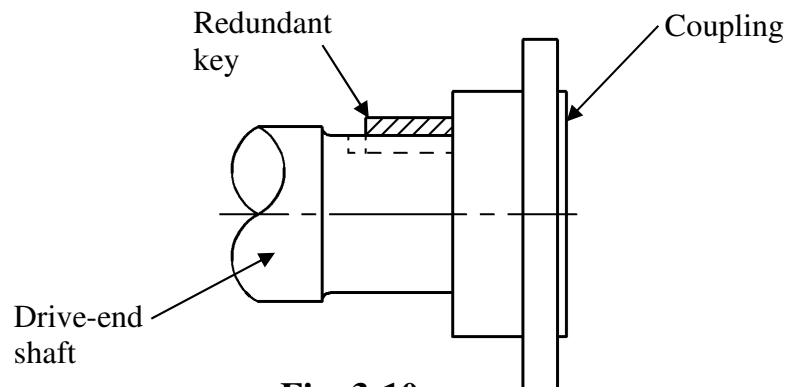
0.4 = coefficient of friction for dry lubrication

- (b) An alternate is to use a long bar bolted to the coupling to apply the torque.
- (c) If the rotor can be lifted either from above using a crane attached to the top of the rotor or from below using a jack, then the rotor weight is reduced and the torque needed to breakaway is much less. This does not always work, as sometimes the pads adhere to the thrust collar face due to cohesion.

There is no danger of Babbitt damage due to breakaway because it only takes a small revolution of the rotor to lubricate all shoe surfaces.

### 3.3.11 Removal of redundant shaft key

When the length of coupling hub is different from the length of shaft key, the motor may have a high vibration level due to this unbalance condition. The removal of redundant shaft key is necessary, shown as Fig.3-10 (hatch area).



**Fig. 3-10**

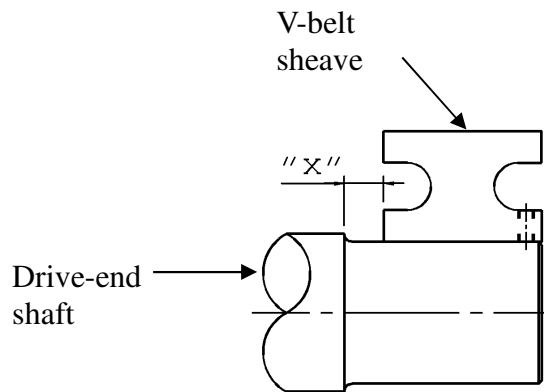
## 3.4 Installation for belt drive

### 3.4.1 General

In general, power transmission through direct flexible coupling is appropriate for large motors. Such motors are not suitable for belt, chain or gear connection unless specially designed for such service. However, for small and medium motors of which outputs within the ranges shown on table below, it is acceptable to use belt transmission as indicated. Beyond these ranges, do not apply belt sheaves unless specially designed.

### 3.4.2 Diameter of sheaves

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 35 m/sec to limit belt abrasion and vibration. The smaller the outer diameter of the V-belt sheave, the greater the shaft bending stress will be. If the bending stress is in excess of the shaft fatigue stress, the shaft may break. Therefore, please inform us when you have decided the size of the sheaves and the length of the belts upon ordering.



**Fig. 3-11**

### **ATTENTION !**

**Place the sheave and belt as close as possible to the motor body (it is advisable to make x as shown in Fig.13 equal to 0) to reduce the bending moment and improve shaft life.**

### 3.4.3 Table of belt-sheave application for general electric motors

Output (kW)			V-Belt Sheave							
			Conventional V-Belt				Narrow V-Belt			
4P	6P	8P	V-Belt Type	Number of Belts	Min. PCD (mm)	Max. Width (mm)	V-Belt Type	Number of Belts	Min. PCD (mm)	Max. Width (mm)
11	--	--	B	4	160	82	3V	4	125	48
--	11	--	B	5	170	101	3V	5	140	59
--	--	11	B	5	190	101	3V	6	160	69
15	--	--	B	5	170	101	3V	6	125	69
--	15	--	B	5	224	101	3V	6	160	69
--	--	15	C	4	224	111	5V	3	180	60
18.5	--	--	B	5	200	101	3V	6	140	69
--	18.5	--	C	4	224	111	5V	3	180	60
--	--	18.5	C	5	224	136	5V	4	180	78
22	--	--	B	5	224	101	3V	6	160	69
--	22	--	C	5	224	136	5V	4	180	78
--	--	22	C	5	250	136	5V	4	200	78
30	--	--	C	5	224	136	5V	4	180	78
--	30	--	C	5	265	136	5V	4	224	78
--	--	30	C	6	265	162	5V	5	224	95
37	--	--	C	6	224	162	5V	4	200	78
--	37	--	C	6	265	162	5V	4	224	78
--	--	37	C	7	280	187	5V	5	250	95
45	--	--	C	6	265	162	5V	4	224	78
--	45	--	C	7	280	187	5V	5	224	95
--	--	45	C	7	315	187	5V	6	250	113
55	--	--	C	7	265	187	5V	5	224	95
--	55	--	C	8	300	213	5V	6	250	113
--	--	55	D	5	355	196	5V	6	280	113
75	--	--	C	8	315	213	5V	6	250	113
--	75	--	D	6	355	233	5V	6	315	113
--	--	75	D	6	400	233	5V	6	355	113
--	90	--	D	6	400	233	5V	6	355	113
--	--	90	D	6	425	233	8V	4	355	124
--	110	--	D	7	400	270	8V	4	355	124
--	132	110	D	7	450	270	8V	4	400	124
--	160	132	D	9	450	344	8V	4	450	124

### 3.5 Mechanical connections

Mechanical connection includes the connection of oil supply, water supply, ventilation and other systems. To ensure correct operation, please read the external dimension drawing, nameplate and specification table attached to the motor.

#### ATTENTION !

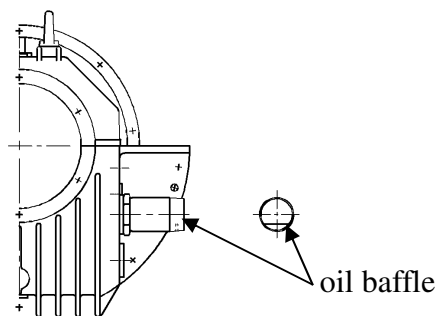
**Do not drill holes through the frame during the installation of the pipes or any other equipment, as this can damage the machine seriously.**

#### 3.5.1 Circulating oil supply system for bearing lubrication

Piping design and piping engineering are related to the normal operation of the oil supply system. The connected components (pressure gauges, flow meters, etc.), pipe joints, flanges (or threads) shall be considered by experienced personnel. To ensure the best circulation of lubricating oil

- The oil outlet pipe must be open to the atmosphere, and the oil drain pipe must be installed as close to the bearing as possible with an exhaust valve.
- Whether it is the air pressure applied to the bearing from the oil inlet pipe or the oil outlet pipe, it will cause the bearing to leak oil. It is necessary to ensure that the pressure in the oil storage reservoir of the oil supply system will not be reversed back to the bearing by the oil discharge pipe.
- The slope of the drain pipe should be at least 45 mm/m. If the slope is too small, it may cause problems such as poor oil return, elevated oil level in the bearing oil reservoir, and oil leakage.

The motor installed with the circulating oil supply system comes standard with an oil inlet orifice plate to adjust the oil inlet condition. Please refer to the outline dimension drawing for the various data. If the oil inlet pressure cannot reach the required value, please replace the orifice plate and change the hole diameter to achieve the specified flow rate. There is an oil baffle inside the attached oil outlet pipe joint (Fig. 3-11). Its function is to keep the bearing at a proper oil level. When assembling, the oil baffle must be located at the bottom and parallel to the motor foot seat surface.



**Fig. 3-11**

- Before connecting the oil supply system to the bearing, check the cleanliness of the oil pipes and various parts in the oil tank, and clean the filter.
- After the oil supply system is turned on, before the motor starts, check the oil circuit for leaks.
- The filter in the oil circuit needs to be cleaned or replaced regularly. The mesh of the filter is recommended to be 15~20 $\mu$ m.

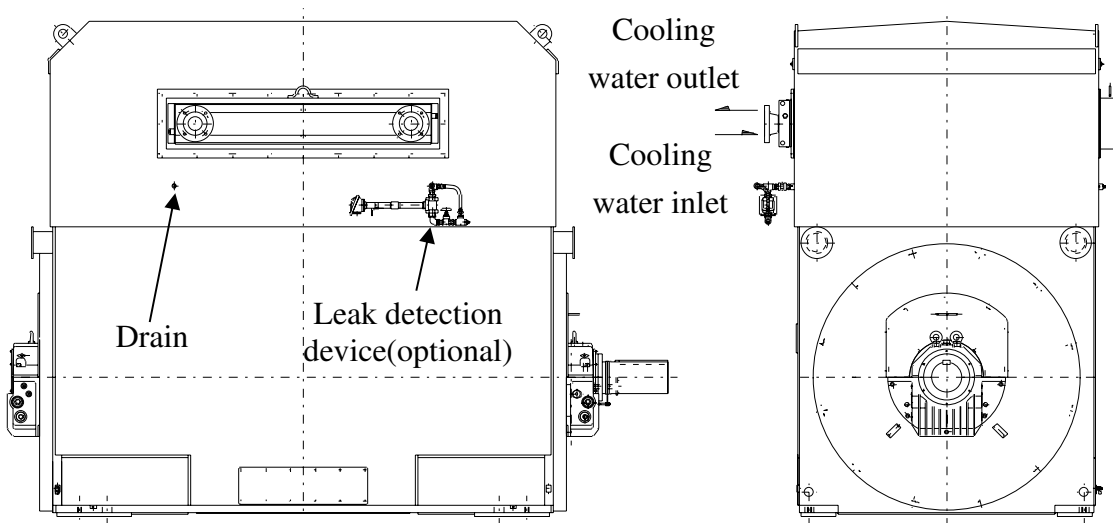
#### ATTENTION !

**When the motor leaves the factory, there is no lubricating oil inside the bearing. If it is started directly, the bearing will be damaged.**

### 3.5.2 Cooling water supply system

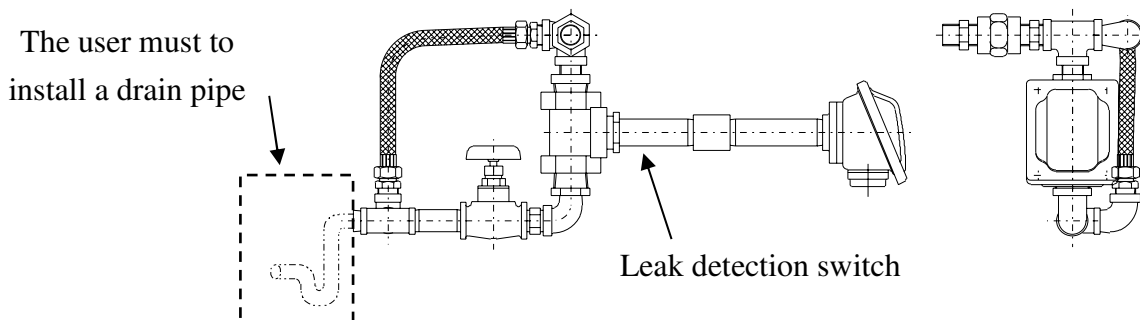
Water-cooled motors need piping to supply cooling water. Please read the external dimension drawing attached to the motor and refer to Fig. 3-12 for connection.

- To connect the flange of the water pipe box, a suitable gasket sealing joint should be selected to avoid leakage.
- All piping connected to the water pipe box must be well supported to ensure that no additional weight or thermal expansion stress is applied to the water pipe box. If there is a valve installed at the water inlet of the water pipe box, it must be operated slowly and carefully to ensure that excessive external force is not applied to the water pipe box.
- In the process of water supply, if there is gas blockage, the exhaust bolt on the top of the water pipe box can be used for exhaust action. After exhaust, the bolts must be maintained tightly.
- Before starting, make sure that the cooling water and air circulation are unobstructed.
- Please be sure to prevent damage to the water pipe box due to freezing of moisture at any time and anywhere.



**Fig. 3-12**

The water pipe box air hood is preset to install a water guide groove to prevent condensate (or overflow water) from polluting the coil. The drain is on the cooling water inlet/outlet side and one on the opposite side. Both are sealed with plugs when leaving the factory. The user must at least Choose 1 place to install the drain pipe. If the customer chooses a leak detection device, a drain pipe must be installed at the end of the leak detection device assembly. Please refer to Fig. 3-12 and Fig. 3-13 for connection. The drain pipe needs to be kept open and blocked during operation, and the design of the water bend can prevent foreign matter from entering



**Fig. 3-13**

### 3.5.3 Purge and prepressurization system

The system includes an air control unit and a relief valve, which works with uncontaminated pressurized air as the protective gas. (For more information, see 6.4 of this manual and system supplier's instruction manual)

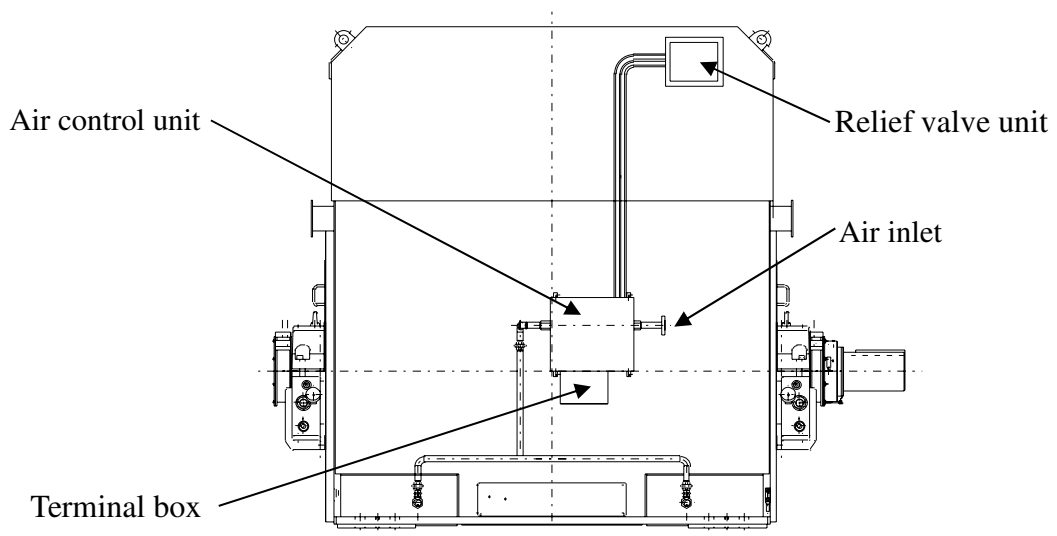
- Purge system only performs the "Pre-Start Purge", which remove potentially explosive gases inside the motor.
- Pressurization system automatically switches to leakage compensation mode for operation after "Pre-Start Purge". The system can operate continuously under a set over-pressure to keep potentially explosive gases from entering the motor.

Read the nameplate and certificate of explosion proof motor to determine whether Purge system or pressurization system is necessary. Before connecting the air supply to the system:

- the supply pipe work should be flushed through with instrument quality air to remove any debris that may remain in the pipes.
- Strongly recommends a local isolation valve installed between the air supply and the purge system.

Before connecting the air supply to the Purge and prepressurization system. The Terminal Box is incorporates the terminal connection points for the alarm and interlock switches. The user must make use of this alarm facility in accordance with the local code of practice for Action on Pressure or Flow Failure. Most codes include the following recommendations:

- Zone 1 Installations: Alarm and Automatic Trip of Power.
- Zone 2 Installations: Alarm Only on pressure or flow failure with power being removed manually.

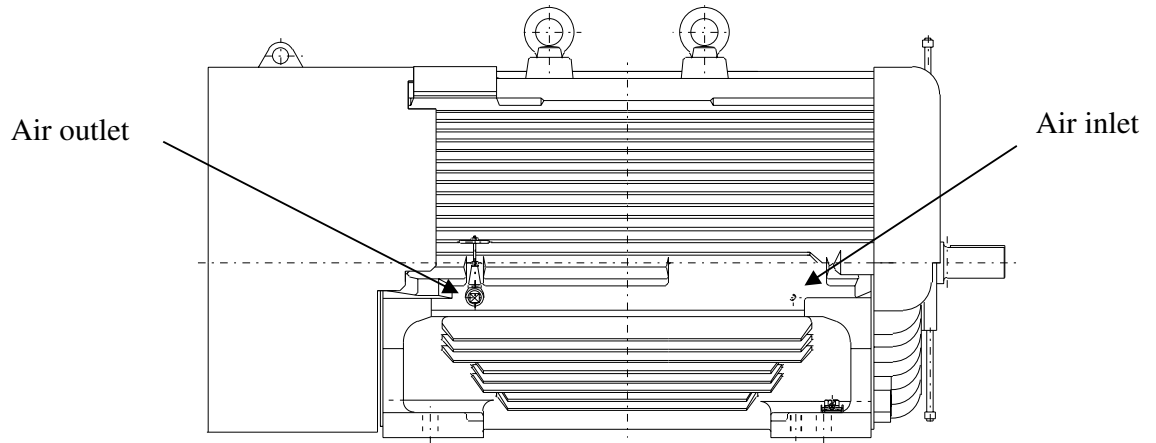


**Fig. 3-14**

An explosion-proof motor that needs "pre-start purge" but uninstalled an air control unit. Before connecting the air supply to the motor without air control unit. Read the outling drawing attached to the motor, and refer to Fig. 3-15.

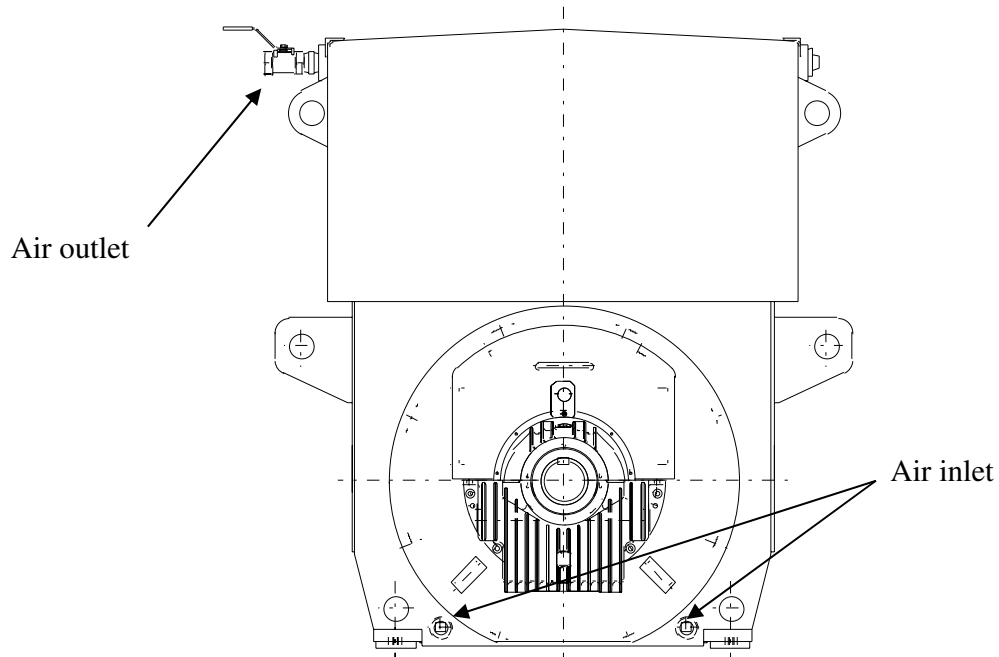
**Cast Iron Frame:**

air inlet and outlet are located on the opposite side and opposite end of the motor



**Steel Fabricated Frame:**

air inlets are located at the bottom of the frame,  
air outlet is located at the top of the cooler.



**Fig. 3-15**

### 3.6 Electrical connections

All interconnecting wiring for controls and grounding should be in strict accordance with local requirements such as the USA National Electrical Code and UK IEE wiring regulations.

Wiring of motor and control, overload protection and grounding should follow the instructions of connection diagrams where provided.

#### **ATTENTION !**

- **All electrical connections must strictly abide by the national electrical standards and local regional regulations.**
- **Before starting the installation work, make sure that the cables are separated from the power supply network and connected to the protective ground.**

#### 3.6.1 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 :

+/- 10% of rated voltage

+/- 5% of rated frequency

+/- 10% combined voltage and frequency variation so long as frequency variation is no more than +/- 5% of rated

#### **ATTENTION !**

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

#### 3.6.2 Main lead box

The main lead box furnished with the motor has been sized to provide adequate space for the make-up of the connections between the motor lead cables and the incoming power cables.

#### **ATTENTION !**

**For explosion-proof equipment, cable entry methods (for example conduit or cable glands) must be certified to IECEx, ATEX standards. The main requirement is that IP66 (or better) ingress protection must be provided by use of seals or washers. cable entry methods are not included in the manufacturer's scope of supply .**



**The bolted joints between the motor lead and the power cables must be made and insulated in a workman-like manner following the best trade practices.**

### 3.6.3 Grounding

Either fabricated motors or fan cooled cast frame motors are all provided with grounding pads or bolts.



**Before the motor is connected to the power supply ,the motor must be grounded by a proper connection to the electrical system ground.**

### 3.6.4 Rotation direction

The rotation direction of the motor will be as shown by either a nameplate on the motor or the outline drawing. The required phase rotation of the incoming power for this motor rotation may also be stated. If either is unknown, the correct sequence can be determined in the following manner : While the motor is uncoupled from the load, start the motor and observe the direction of rotation. Allow the motor to achieve full speed before disconnecting it from the power source. Refer to the operation section of these instructions for information concerning initial start-up. If resulting rotation is incorrect, it can be reversed by interchanging any two (2) incoming cables.

#### **ATTENTION !**

**If the motor is completed with a non-reverse ratchet (NRR) assembly, take extra cause to make sure the power sequence is correctly identified and connection is made to the connection diagram for the motor. If the power sequence is unclear, NRR mechanism has to be disabled by removing all ratchet balls (or pins) before doing bump test. Failure to do so could cause damage of the motor and NRR mechanism, and the damage is not covered by factory warranty.**

### 3.6.5 Auxiliary devices

Auxiliary devices such as resistance temperature detectors, thermocouples, thermoguards, etc., will generally terminate on terminal blocks located in the auxiliary terminal box on the motor. Other devices may terminate in their own enclosures elsewhere on the motor. Such information can be obtained by referring to the outline drawing. Information regarding terminal designation and the connection of auxiliary devices can be obtained from auxiliary drawings or attached nameplates.

The independent forced blower hidden inside the cold box will connect the motor outlet wire to the outside of the cold box according to the standard, and use the external blower junction box of the cold box for power connection.

If the motor is provided with internal space heaters, the incoming voltage supplied to them must be exactly as shown by either a nameplate on the motor or the outline drawing for proper heater operation.



**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.**

## 4. OPERATION

### 4.1 Examination before start

#### 4.1.1 Wiring check

When motors are installed in good manner, ensure the wiring is according to the diagram. Also, the following points should be noted :

- (a) Make sure all wiring is correct.
- (b) Ensure the sizes of cable wires are appropriate and all connections are well made for the currents they will carry.
- (c) Ensure all connections are properly insulated for the voltage and temperature they will experience.
- (d) Ensure the capacity of fuse, switches, magnetic switches and thermo relays etc. are appropriate and the contactors are in good condition.
- (e) Make sure that frame and terminal box are grounded.
- (f) Make sure that the starting method is correct.
- (g) Make sure switches and starters are set at their right positions.
- (h) Motor heaters must be switched off when the motor is running.

#### 4.1.2 Measurement of insulation resistance



**During and immediately after measuring, the terminals must not be touched as they may carry dangerous residual voltages. Furthermore, if power cables are connected, make sure that the power supplies are clearly disconnected and there are no moving parts.**

- (a) For rated voltage below 1000V, measured with a 500VDC megger.  
For rated voltage between 1000V to 5000V, be measured with a 1000VDC megger.  
For rated voltage above 5000V, be measured with a 5000VDC megger.
- (b) In accordance with IEEE 43-2000, there are three recommendation minimum insulation resistance values. These values corrected to 40°C are :
  - (1) kV+1 in Megohms for most windings made before 1970, all field windings and windings not otherwise described.
  - (2) 100 Megohms for most DC armatures and AC windings built after about 1970 with form wound coils.
  - (3) 5 Megohms for machines with random wound stator coils and for form wound coils rated below 1kV.

### **ATTENTION !**

**After measurement the winding must be grounded or shunted to discharge residual voltages.**

- (c) On a new winding, where the contaminant causing low insulation resistance is generally moisture, drying the winding through the proper application of heat will normally increase the insulation resistance to an acceptable level. The following are several accepted methods for applying heat to a winding :
- (1) If the motor is equipped with space heaters, they can be energized to heat the winding.
  - (2) Direct current (as from a welding equipment) can be passed through the winding. The total current should not exceed approximately 20% of rated full load current. If the motor has only three leads, two must be connected together to form one circuit through the winding. In this case, one phase will carry the full applied current and each of the others, one-half each. If the motor has six leads (3 mains and 3 neutrals), the three phases should be connected into one series circuit.



**Ensure there is adequate guarding so live parts cannot be touched.**

- (3) Heated air can be either blown directly into the motor or into a temporary enclosure surrounding the motor. The source of heated air should preferably be electrical as opposed to fueled (such as kerosene) where a malfunction of the fuel burner could result in carbon entering the motor.

### **ATTENTION !**

**Caution must be exercised, when heating the motor with any source of heat other than self contained space heaters, to raise the winding temperature at a gradual rate to allow any entrapped moisture to vaporize and escape without rupturing the insulation. The entire heating cycle should extend over 15-20 hours.**

Insulation resistance measurements can be made while the winding is being heated. However, they must be corrected to 40°C for evaluation since the actual insulation resistance will decrease with increasing temperature. As an approximation for a new winding, the insulation resistance will be approximately halved for each 10°C increase in insulation temperature above the dew point temperature.

- (d) Should the resistance fail to attain the specified value even after drying, careful examination should be undertaken to eliminate all other possible causes, if any.

#### **4.1.3 Power source**

- (a) Ensure the capacity of the power source is sufficient.
- (b) Ensure the supply voltage and frequency ratings are identical to those on the nameplate.
- (c) Voltage variation should be confined to  $\pm 10\%$  of the rated value and the phase to phase voltages should be balanced.

#### 4.1.4 Bearing lubrication

For oil (grease) use, please read the motor's attached drawing and nameplate. (For more information, please refer to this manual 5.5 and 5.6)

(a) Oil lubrication type:

- (1) For sleeve bearing motors, the oil reservoir must be filled with oil to the correct level. On self-lubricated bearings, the standstill oil level will be at the center of the oil gauge. The proper oil is a rust and oxidation inhibiting, turbine grade oil. Refer to the lubrication nameplate for the recommended viscosity.
- (2) Correct lubricating oil temperature is a necessary condition for the bearing to operate at an appropriate temperature. Please refer to the inlet oil temperature of the circulating oil supply system as follows :(temperature setting in special cases is indicated in the outline drawing)

Oil inlet temperature :

Normal	20°C ( 70°F) ~ 50°C (120°F)
Alarm setting	60°C (140°F)
Trip setting	65°C (150°F)

- (3) If the motor is in storage for over three (3) months, refilling of some new oil should be undertaken before operation to prevent bearing damage due to dry friction. The oil level should be kept at the center of the oil gauge. If necessary, drain some oil after refilling.

(b) Grease lubricant type:

Please pay special attention to ensure that the initial bearing is oiled

- (1) The bearings have been well greased at factory before delivery. However, regreasing is required if a significant period has elapsed between manufacture and use or in storage. Fill new grease until it overflows and the old grease is entirely replaced.
- (2) Unless otherwise specified and shown on nameplate, ExxonMobil Polyrex EM is the standard applied to TECO motors.
- (3) If roller bearing is used, add a small amount of grease if abnormal sound occurs in the bearings. If this sound, disappears temporarily after regreasing, it is a normal condition and can operate as it is, as long as the temperature rise of the bearing is normal.

#### 4.1.5 Oil-mist lubrication motors

Unless otherwise specified, Inpro seals are used as TECO standard.

(a) Before operation :

Please check the rotor & stator parts of the Inpro seal, and make sure that they don't contact each other. A 0.03mm feeler gauge is suggested to inspect the gap between rotor and stator as shown in Fig.4-1 If they are touching on one side, it means that this seal is in the wrong position. You can use a wooden or rubber hammer to adjust this seal gently. If this can't be done, this seal may be damaged and have to be checked. Please contact with our service department.

(b) Lubricant :

Please use ISO VG68 or equal viscosity oil..

## (c) About the oil mist lubrication generation system :

The users have to prepare an oil mist lubrication system and apply suitable inlet oil quantity and pressure. Please follow the instruction for the oil mist lubrication system that you used. Avoid high oil pressure to prevent oil from going into the inside of the motor damaging the insulation or causing oil leakage.

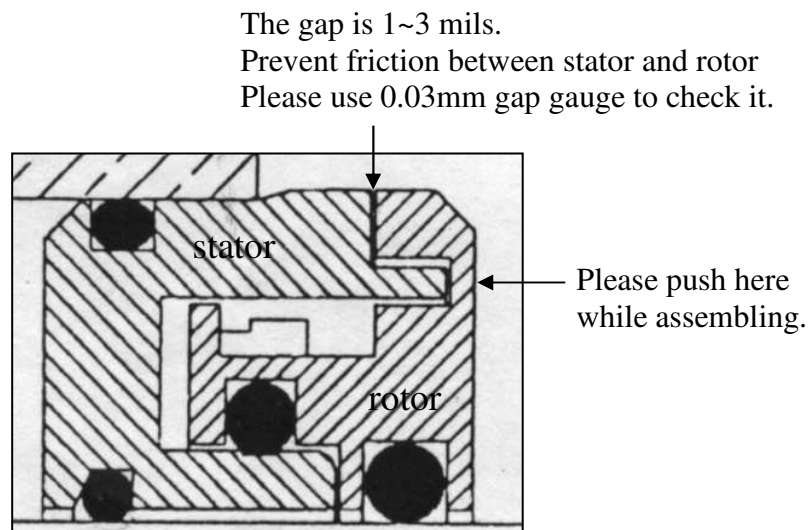
## (d) Operation :

Before first operation or after a long time without running, please turn on the oil mist lubrication system for at least 5 hours to lubricate the bearings. If you use the central control system, the mist system shall operate continuously for a minimum of 48 hours. After making sure the pressure is stable and flow out oil is in good condition, you can operate this motor.

## (e) Appendix :

Fitting or reclassifier of oil-mist lubrication system :

Reclassifiers or fittings are devices which convert small particle-size dry mist to larger particle sizes which can lubricate bearings. Please use correct fittings or reclassifiers.



**Fig. 4-1**

#### 4.1.6 Cooling water for the cooler on water-cooled motors

Make sure the quality, volume and inlet temperature of cooling water for the motors are normal before the machine is in operation.

Water :	General tower water or industrial water, the suspended solid shall be below 20 $\mu$ m/l
Volume :	Please see outline drawing
Inlet temperature :	Normal                    5°C( 41°F) ~ 30°C(86°F)
	Alarm setting            35°C( 95°F)
	Trip setting                40°C(104°F)

Special temperature settings will be noted in outline drawings.

#### 4.1.7 For motors equipped with independent force-ventilating blower unit

- (a) Ensure the voltage and frequency of the power source are identical to the ratings shown on blower motor name plate.
- (b) Ensure the wiring to blower motor is according to the connection diagram.
- (c) Test run the blower motor to ensure the phase currents are within the tolerance limits.
- (d) Ensure the cooling air flow direction is correct. Refer to motor outline for cooling air flow direction.
- (e) Blower motor should be started prior to operating the main motor.
- (f) Do not switch off the blower motor immediately after the main motor is shut off. It must be left running for 15 minutes after the main motor is shut down.
- (g) For small blower motor, double shield and pre-lubricated ball bearings are used and re-lubrication is not necessary.

#### 4.1.8 Remove all locks

##### **ATTENTION !**

**Make sure all locks which fasten the movable parts of the motor during transportation are dismantled and the shaft can rotate freely.**

#### 4.1.9 Clean before starting

##### **ATTENTION !**

**Ensure there are no foreign matters or tools inside the motor before starting.**

#### 4.1.10 Transmission system check

Make sure the transmission system, including belts, screws, bolts, nuts and set pins are in good condition.



**The keys fitted to the shaft extensions are held by plastic tape only to prevent them from falling out during transportation or handling. The shaft key shall be removed to prevent it from flying out, when the motor is operated prior to the couplings etc. being fitted to the shaft extension.**

#### 4.1.11 Test run

Make sure the items above are examined. Test the motor running with or without load. Record and check according to the statement of 5.11 "Records of operation and maintenance" at 15 minute intervals during the first three hours of operation. Then regular examinations should take place at longer intervals. If everything goes well, the motor can be classified as "in good order".

##### **ATTENTION !**

**To avoid the abnormal bearing temperature and vibration level increase, we suggest do not run a vertical high thrust motor continuously without load.**

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## 4.2 Starting operation

### 4.2.1 Starting load

Initially run the motor unloaded prior to coupling to other machines. Unless otherwise specified, a motor usually starts with light load which is then gradually increased proportional to the square of speed and at last reach 100% load at full load speed.

### 4.2.2 Starting

Too frequent starts can harm the motors. The following restrictions should be observed :

- (a) Motor can be restarted should the initial start fail. Two starts are generally permissible when the motor is cold.
- (b) Motor can be started only once when it is at normal running temperature.
- (c) Should additional starts be necessary beyond the conditions stated above, the following restrictions should be noted :
  - (1) Let the motor cool down for 60 minutes before restarting, fully loaded.
  - (2) Let the motor cool down for 45 minutes before restarting, unloaded.
  - (3) Two inching starts can be regarded as one normal start.

#### **ATTENTION !**

**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.**

Possible reasons for not starting are :

- (1) Voltage drop at the motor terminals is more than allowed (look to confirmed data sheet).
- (2) The counter torque is too large to accelerate the rotor.
- (3) The driven machine is stuck, jammed or blocked.
- (4) The electrical connections have not been made correct to drawings and standards.
- (5) One phase is missing or single phase power has been applied.
- (6) Any combination of the above.

### 4.2.3 Rotating direction

- (a) Most TECO motors can be operated in bi-directional rotation. However, when some special types, such as high speed 2P, certain large capacity motors, those with a non-reverse ratchet etc. should rotate in one direction, please ensure the rotation is in conformity with the directional arrow-mark shown on the attached nameplate.
- (b) To reverse a bi-directional motor, cut the power and wait until the motor stops. Then interchange any two of the three phases.

### 4.2.4 Power source, voltage, current

- (a) Ensure the voltage and frequency of the power source are identical to the ratings shown on the nameplate.
-

- (b) Voltage variation should be confined to  $\pm 10\%$  of the rating and the three phase voltages should be in full balance.
- (c) Ensure the motor phase currents in no-load condition could be variably, within  $\pm 5\%$  of the average values.

#### **4.2.5 Power source, frequency**

The variation of the frequency should be confined to  $\pm 5\%$  of the rating. The aggregate variation of voltage and frequency should be confined to  $\pm 10\%$  of the absolute value of the ratings.

#### **4.2.6 Starting time and unusual noises**

##### **ATTENTION !**

**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 refer to TECO.**

#### **4.2.7 Sleeve bearing oil rings (sleeve bearing types only)**

As the oil ring is used to carry lubricant to sleeve bearings, frequently check from the inspection hole on the upper part of the bearing. to ensure the oil ring is in motion. For self-lubricating bearings, if the oil ring does not rotate, the equipment must be shut down immediately, because the oil ring stalls will cause the bearing to burn.

#### **4.2.8 Bearing lubricating oil**

- (a) Oil quality inspection should be carried out several days after the first trial operation of the equipment. (Please refer to 5.6.2 (b) Lubricant Quality Inspection Items)
  - (b) After the trial operation, if the lubricating oil is to continue to be used, it is recommended to filter and remove the wear particles before using it.
-

#### 4.2.9 Bearing temperature rise

Following the initial start-up, the bearing temperatures should be closely monitored. The rise rate of bearing temperature is more indicative of impending trouble than is the actual temperature.

#### **ATTENTION !**

**If the rise rate of the temperature is excessive, the motor exhibits excessive vibration or unusual noise, shut down the motor immediately. Before start up the motor again, a thorough investigation has been made to figure out the cause.**

If the bearing temperature rise and motor operation appear to be normal, operation should continue until the bearing temperature is stabilized.

Recommended limits on bearing permanently installed detector are as follows :

	Alarm setting	Trip setting
Sleeve Bearings	95°C (203°F)	100°C (212°F)
Anti-friction Bearings	95°C (203°F)	100°C (212°F)

Special temperature settings will be noted in outline drawings.

#### **ATTENTION ! (For sleeve bearing)**

- (1) Self-lube bearing, the rate of temperature rise should be from 11K to 14K for the first ten (10) minutes after starting up and approximately 22K at thirty (30) minutes. The rate of bearing temperature rise is a function of the natural ventilation and operating conditions.
- (2) When the rate of bearing temperature rise is less than  $\pm 1K$  per (30) minutes, the bearing temperature is considered to steady conditions.
- (3) If the total bearing temperature exceeds 100°C, the motor should be shut down immediately and a thorough investigation has been made to figure out the cause.

#### **ATTENTION !**

**If the rise rate of the temperature is excessive, the motor exhibits excessive vibration or unusual noise, shut down the motor immediately. Before start up the motor again, a thorough investigation has been made to figure out the cause.**

4.2.10 Noise and Vibration

**ATTENTION !**

**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.**

(a) NEMA MG1, vibration limits at no load

Table 4-1 Unfiltered Vibration Limits

Speed, rpm	Rotational Frequency, Hz	Velocity, in./s peak (mm/s)
3600	60	0.15 (3.8)
1800	30	0.15 (3.8)
1200	20	0.15 (3.8)
900	15	0.12 (3.0)
720	12	0.09 (2.3)
600	10	0.08 (2.0)

(b) ISO 10816, overall vibration severity chart for customer’s reference

Table 4-2 Motor vibration regulations

Machine	Class I Small machine		Class II Medium machine		Class III Large rigid foundation		Class IV Large soft foundation		
	in/s	mm/s							
Vibration Velocity (r.m.s.)	0.01	0.28	Good						
	0.02	0.45							
	0.03	0.71							
	0.04	1.12							
	0.07	1.80	Satisfactory						
	0.11	2.80							
	0.18	4.50	Unsatisfactory						
	0.28	7.10							
	0.44	11.2	Unacceptable						
	0.70	18.0							
	0.71	28.0							
1.10	45.0								

4.2.11 Recommended winding temperature settings

An electric motor normally has built in “over temperature protection devices” such as thermistors and RTD’s. They are set to trip at levels dependent upon the Class of Insulation of the motor windings. Motors designated Class F insulation have an allowable total temperature of 155°C in total.

Recommended limits on bearing permanently installed detector are as follows :

Alarm setting	145°C (293°F)
Trip setting	155°C (311°F)

Special temperature settings will be noted in outline drawings.

---

#### 4.2.12 Additional points to note

- (a) The motor characteristic data includes values for the acceleration and safe stall times, when specified by the customer. If the motor fails to reach full speed, shut off the power immediately. Investigate thoroughly and take corrective action before attempting to restart.
- (b) Each start of an induction motor subjects the motor to full inrush current with resulting heating of the stator and rotor windings. Each acceleration and repeated start can produce more heat than that produced and dissipated by the motor under full load.

The starting duty for which the motor is designed is shown by a nameplate mounted on the motor and must not be exceeded, if long motor life is expected. Abnormally terminal voltage drop and/or excessive load torque during motor start-up can cause extended acceleration time during which rotor speed is reduced and ventilation is minimized. This can cause rotor destroying or can lead to extreme shorten of rotor life.

- (c) The temperature rating of the motor is shown on the main nameplate as a temperature rise above an ambient temperature. If there is a service factor, it is also shown.

If the motor does not have stator winding temperature detectors and abnormal winding temperatures (as might be indicated by high discharge air temperature, odor, etc.) are suspected, the motor should be shut down immediately and an investigation made before further operation is attempted.

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## 5. MAINTENANCE

### 5.1 Major points in regular inspection and maintenance



**Maintenance and repairs must only be carried out by properly trained personnel.**



**Some testing, such as insulation resistance, usually requires the motor to be stopped and isolated from power supply(ies).**

Routine inspection and maintenance are usually performed visually, audibly, by odor, and by means of simple meters.



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

**Keep away from moving and live parts.**

**Unless deemed necessary, do not remove guards while assessing the motor.**

Timely replacement of worn parts can assure longevity and prevent breakdown.

Routine and regular inspection and maintenance are important in preventing breakdown and lengthening service life.

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 according to factory maintenance program. Generally, the inspection scope is determined by the following factors :

- (a) Ambient temperature and ambient conditions (dust, humidity, other contamination).
- (b) Starting and stop frequency.
- (c) Troublesome parts usually affect motor dysfunctions.
- (d) Easily abraded parts (slip ring, brushes, earthing brushes).
- (e) The important position of motor in the operational system should be duly recognized. Therefore, its life time should be intact and fully protected, especially when it is operating in severe conditions.

### 5.2 Motor windings

- (a) Measurement of insulation resistance and standards to determine quality of insulation resistance, please refer to measures stated in 4.1.2 "Measurement of insulation resistance".
  - (b) Inspection of coil-ends :
    - (1) Grease and dust accumulated on coils may cause insulation deterioration and poor cooling effect.
    - (2) Moisture must not accumulate. Keep coils warm when motor is not in use (use space heater, if it's installed).
    - (3) Discoloring. This is mainly caused by overheating.
  - (c) Ensure no untoward change of wedges from original position occurs.
  - (d) Ensure the binding at the coil end is in its normal position.
-

---

### 5.3 Clean the interior of the motor

(a) After a motor has been in operation for some time, accumulation of dust, carbon powder and grease etc., on the inside is unavoidable, and may cause damage. Regular cleaning and examination is necessary to assure top performance.

(b) Points to note during cleaning :

(1) If using compressed air or a blower :

- Compressed air should be free of moisture. Be sure, that the dust and other materials can come out of motor housing, iron core and windings.
- Maintain air pressure below 4 kg/cm<sup>2</sup>, since high pressure can cause damage to coils.

(2) Vacuum

Vacuum cleaning can be used 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 tools should be non-metallic to avoid any damage to the winding insulation.

(3) Wiping

Surface contamination on the winding can be removed by wiping using a soft, lint-free wiping material. If the contamination is oily, the wiping material can be moistened (not dripping wet) with a safety type petroleum solvent.

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.

#### **ATTENTION !**

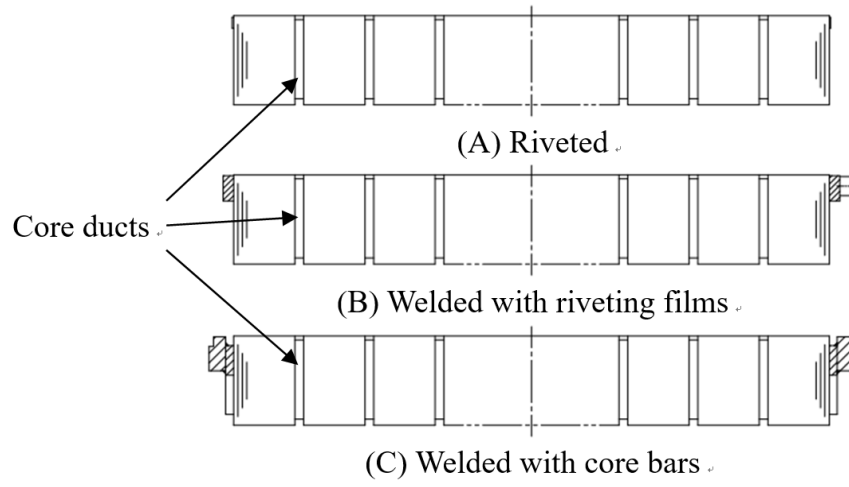
**Solvents of any type should never be used on windings provided with abrasion protection. Abrasion protection is a gray, rubber-like coating applied to the winding end-turns.**



**Adequate ventilation must always be provided in any area where solvents are being used to avoid the danger of fire, explosion or health hazards. In confined areas (such as pits) each operator should be provided with an air line respirator, a hose mask or a self-contained breathing apparatus. Operators should wear goggles, aprons and suitable gloves. Solvents and their vapors should never be exposed to open flames or sparks and should always be stored in approved safety containers.**

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- (4) Keep core ducts completely clean. The difference in temperature rise could be around 10°C before and after cleaning.



**Fig. 5-1**

## 5.4 Clean the exterior of the motor

- (a) On open ventilated motors, 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 movement.

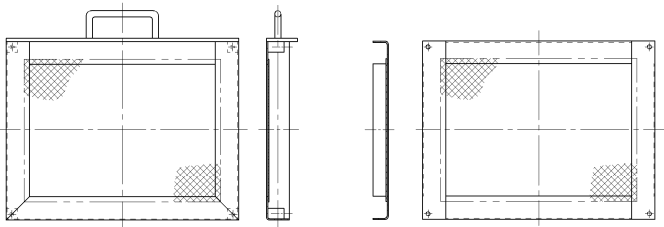
### ATTENTION !

**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.**

- (b) If the motor is equipped with a filter, it must be replaced regularly (changeable type) or cleaned (re-usable type) regularly depending on the site conditions. Filter cleaning is primarily based on environmental conditions (the more dirty, the shorter the cycle). At the beginning of the motor operation, it is recommended that filters should be replaced/cleaned once every seven (7) days and the replacing/cleaning cycle should be adjusted in accordance with the actual operating conditions. Replace or clean immediately the filter when the following conditions occur:

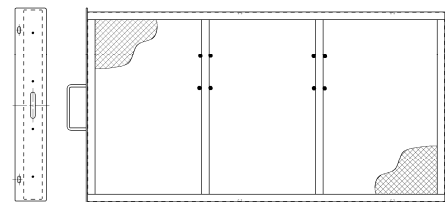
- (1) The temperature detector in the winding shows abnormal temperature or near the alarm limit.
- (2) In the event of pressure alarm signal from the filter differential pressure monitoring system (The pressure alarm setting is based on 50% of the air filter surface has been blocked)

Air filter (permanent type) for cleaning, first in the air side with a vacuum cleaner to clean, and then clean the side of the wind. It is advisable to rinse regularly with clean water to remove unclean dirt from the vacuum cleaner. If a large amount of grease is present, use a detergent solution to clean the filter. These solutions should be washed before reusing the filter.



Disposable type filter fitted into two filter supports.

**Fig. 5-2**



Permanent type filter.

**Fig. 5-3**

- (c) Totally enclosed air-to-air cooled and totally enclosed fan cooled motors 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).
- (d) It is important to keep the external surfaces of any motor clean and free from buildup of dirt and debris as this can function as an insulating blanket causing the motor to overheat drastically and could reducing the life of the motor. Methods of cleaning external surfaces are: Scraping, brushing, dry ice blasting etc.

## 5.5 Maintenance of anti-friction bearing

### 5.5.1 Frequency of relubrication

Bearings should be replenished with grease frequently to prevent the deterioration of grease from adversely affecting bearing life. The life of grease varies greatly as a result of types of model, revolution speed, temperature, operational conditions etc.

The grease recharge interval of the lubricant nameplate attached to the motor, which is the estimated number of operating hours that a good quality lithium soap grease with a mineral base oil can perform adequately when the operating temperature is 70 °C (160°F) the periods shown as Table 5-1 may be used as a guide.

#### **ATTENTION !**

- **Please refer to the lubrication nameplate, if attached to the motor.**
- **If the periods referred to Table 5-1 for drive-end bearing and opposite drive-end bearing are different, for the convenience of maintenance operation, please take the shorter one the required grease replenishment period of these bearings.**
- **For bearing numbers outside the range of Table 5-1, please contact TECO.**

The actual the recharge interval must be adjusted according to different operating conditions, including the following:

- (a) The periods shown in Table 5-1 should be halved for every 15°C (30°F) increase in temperature when the bearing operating temperature is higher than 70°C (160°F).
  - (b) When the bearing operating temperature is lower than 70°C (160°F), the temperature is reduced by 15 °C (30 °F), and the recharge interval can be doubled, but only once. (Thrust bearing, e.g. 72XX, 73XX, please do not extend the interval).
  - (c) If the bearing is installed on the vertical shaft, the recharge interval should be reduced by half. The lubrication nameplate attached to the vertical motor has reduced the interval of grease supply by half. However, for the horizontal motor which can be mounted vertically, the attached lubrication nameplate only considers the horizontal mounting conditions.
  - (d) If the environment is seriously dirty or high humidity, pollutants (dust, moisture, etc.) may enter the bearing. The grease recharge interval should be reduced by half at the beginning of operation. If the lubricating grease samples taken prior to grease recharge are satisfactory, the interval can be gradually increased.
  - (e) No matter how long the interval between grease replenishment is, the bearing should be lubricated at least once a year.
-

TABLE 5-1 Frequency of relubrication (Unit: Motor running time(hour))

Bearing number		600 RPM	720 RPM	750 RPM	900 RPM	1000 RPM	1200 RPM	1500 RPM	1800 RPM	3000 RPM	3600 RPM
60XX	6210	19,000	18,000	18,000	17,000	16,000	15,000	13,000	12,000	7,000	7,000
62XX	12	18,000	17,000	17,000	16,000	15,000	14,000	12,000	10,000	5,000	5,000
72XX	13	18,000	17,000	16,000	15,000	14,000	13,000	11,000	9,000	5,000	5,000
	14	18,000	16,000	16,000	15,000	14,000	12,000	10,000	9,000	4,500	4,500
	15	17,000	16,000	16,000	14,000	14,000	12,000	10,000	8,000	4,000	4,000
	16	17,000	16,000	15,000	14,000	13,000	11,000	9,000	8,000	3,500	3,500
	17	16,000	15,000	15,000	13,000	12,000	11,000	9,000	7,000	3,000	3,000
	18	16,000	15,000	14,000	13,000	12,000	10,000	8,000	6,000	2,500	
	20	15,000	14,000	13,000	12,000	11,000	9,000	7,000	5,000	2,000	
	22	14,000	13,000	12,000	11,000	10,000	8,000	6,000	5,000		
	24	14,000	12,000	12,000	10,000	9,000	7,000	5,000	4,000		
	26	13,000	11,000	11,000	9,000	8,000	7,000	5,000	3,500		
	28	12,000	11,000	10,000	9,000	8,000	6,000	4,500	3,000		
	30	12,000	10,000	10,000	8,000	7,000	5,000	4,000	2,500		
	32	11,000	9,000	9,000	7,000	6,000	5,000	3,500	2,000		
	34	11,000	9,000	8,000	7,000	6,000	4,500	3,000	2,000		
	36	10,000	8,000	8,000	6,000	5,000	4,000	2,500	1,500		
	38	10,000	8,000	8,000	6,000	5,000	4,000	2,500	1,500		
	40	9,000	7,000	7,000	5,000	5,000	3,500	2,000			
	44	8,000	7,000	6,000	5,000	4,000	2,500	1,500			
48	7,000	6,000	5,000	4,000	3,500	2,000					
52	7,000	5,000	5,000	3,500	3,000	1,500					
56	6,000	5,000	4,500	3,000	2,500	1,500					
60	5,000	4,000	4,000	2,500	2,000						

Bearing number		600 RPM	720 RPM	750 RPM	900 RPM	1000 RPM	1200 RPM	1500 RPM	1800 RPM	3000 RPM	3600 RPM
63XX	6310	19,000	18,000	17,000	17,000	15,000	14,000	12,000	11,000	6,000	4,500
73XX	12	18,000	17,000	16,000	16,000	14,000	13,000	11,000	9,000	4,500	3,500
	13	17,000	16,000	16,000	15,000	14,000	12,000	10,000	8,000	4,000	3,000
	14	17,000	16,000	15,000	15,000	13,000	11,000	9,000	8,000	3,500	2,500
	15	16,000	15,000	15,000	14,000	12,000	11,000	9,000	7,000	3,000	2,000
	16	16,000	15,000	14,000	14,000	12,000	10,000	8,000	6,000	2,500	1,500
	17	16,000	14,000	14,000	13,000	11,000	10,000	8,000	6,000	2,500	1,500
	18	15,000	14,000	13,000	13,000	11,000	9,000	7,000	5,000	2,000	
	20	14,000	13,000	12,000	12,000	10,000	8,000	6,000	4,500	1,500	
	22	13,000	12,000	11,000	11,000	9,000	7,000	5,000	4,000		
	24	13,000	11,000	11,000	10,000	8,000	6,000	4,500	3,500		
	26	12,000	10,000	10,000	9,000	7,000	6,000	4,000	3,000		
	28	11,000	10,000	9,000	9,000	7,000	5,000	3,500	2,500		
	30	11,000	9,000	9,000	8,000	6,000	4,500	3,000	2,000		
	32	10,000	8,000	8,000	7,000	5,000	4,000	2,500	1,500		
	34	10,000	8,000	8,000	7,000	5,000	4,000	2,500	1,500		
	36	9,000	7,000	7,000	6,000	5,000	3,500	2,000			
38	9,000	7,000	7,000	6,000	4,500	3,000	1,500				
44	7,000	6,000	5,000	4,000	3,500	2,000					
48	7,000	5,000	5,000	3,500	3,000	1,500					

Bearing number		600 RPM	720 RPM	750 RPM	900 RPM	1000 RPM	1200 RPM	1500 RPM	1800 RPM
NU2XX	NU214	15,000	13,000	13,000	11,000	10,000	9,000	7,000	5,000
	15	14,000	13,000	13,000	11,000	10,000	8,000	6,000	5,000
	16	14,000	12,000	12,000	10,000	9,000	8,000	6,000	4,500
	17	13,000	12,000	11,000	10,000	9,000	7,000	5,000	4,000
	18	13,000	11,000	11,000	9,000	8,000	6,000	5,000	3,500
	20	12,000	10,000	10,000	8,000	7,000	5,000	4,000	2,500
	22	11,000	9,000	9,000	7,000	6,000	5,000	3,000	2,000
	24	10,000	8,000	8,000	6,000	5,000	4,000	2,500	1,500
	26	9,000	8,000	7,000	6,000	5,000	3,500	2,000	1,500
	28	9,000	7,000	7,000	5,000	4,500	3,000	2,000	1,000
	30	8,000	6,000	6,000	4,500	4,000	2,500	1,500	500
	32	7,000	6,000	5,000	4,000	3,500	2,000	1,000	500
	34	7,000	5,000	5,000	3,500	3,000	2,000	1,000	500
	36	6,000	5,000	5,000	3,500	2,500	1,500		
	38	6,000	4,500	4,500	3,000	2,500	1,500		
	40	5,000	4,000	4,000	2,500	2,000	1,000		
44	5,000	3,500	3,000	2,000	1,500	1,000			
48	4,000	3,000	2,500	1,500	1,000	500			

Bearing number		600 RPM	720 RPM	750 RPM	900 RPM	1000 RPM	1200 RPM	1500 RPM	1800 RPM
NU3XX	NU314	14,000	12,000	12,000	10,000	9,000	8,000	6,000	4,500
	15	13,000	12,000	11,000	10,000	9,000	7,000	5,000	4,000
	16	13,000	11,000	11,000	9,000	8,000	6,000	5,000	3,500
	17	12,000	11,000	10,000	9,000	8,000	6,000	4,500	3,000
	18	12,000	10,000	10,000	8,000	7,000	5,000	4,000	2,500
	20	11,000	9,000	9,000	7,000	7,000	4,500	3,000	2,000
	22	10,000	8,000	8,000	6,000	5,000	4,000	2,500	1,500
	24	9,000	7,000	7,000	5,000	4,500	3,500	2,000	1,000
	26	8,000	7,000	6,000	5,000	4,000	3,000	1,500	1,000
	28	8,000	6,000	6,000	4,500	3,500	2,500	1,000	500
	30	7,000	5,000	5,000	4,000	3,000	2,000	1,000	500
	32	6,000	5,000	5,000	3,500	2,500	1,500		
	34	6,000	4,500	4,500	3,000	2,500	1,500		
	36	5,000	4,000	4,000	2,500	2,000	1,000		
	38	5,000	4,000	3,500	2,500	1,500	1,000		
	40	5,000	3,500	3,000	2,000	1,500	1,000		
44	4,000	3,000	2,500	1,500	1,000	500			
48	3,500	2,500	2,000	1,000	1,000	500			

Bearing number		600 RPM	720 RPM	750 RPM	900 RPM	1000 RPM	1200 RPM	1500 RPM	1800 RPM
222XX	22220	9,000	7,000	7,000	5,000	5,000	3,500	2,000	1,000
	22	8,000	7,000	6,000	5,000	4,000	2,500	1,500	1,000
	24	7,000	6,000	5,000	4,000	3,500	2,500	1,000	500
	26	7,000	5,000	5,000	3,500	3,000	2,000	1,000	500
	28	6,000	5,000	4,500	3,000	2,500	1,500	500	
	30	5,000	4,000	4,000	2,500	2,000	1,000	500	
	32	5,000	3,500	3,500	2,000	1,500	1,000	500	
	34	4,500	3,000	3,000	2,000	1,500	500		
	36	4,000	3,000	2,500	1,500	1,000	500		
	38	4,000	2,500	2,500	1,500	1,000	500		
	40	3,500	2,000	2,000	1,000	1,000	500		
	44	3,000	2,000	1,500	1,000	500			
48	2,500	1,500	1,500	1,000	500				

Bearing number		600 RPM	720 RPM	750 RPM	900 RPM	1000 RPM	1200 RPM	1500 RPM	1800 RPM
223XX	22320	8,000	6,000	6,000	4,500	4,000	2,500	1,500	
	22	7,000	5,000	5,000	4,000	3,000	2,000		
	24	6,000	5,000	4,500	3,500	2,500	1,500		
	26	6,000	4,500	4,000	3,000	2,000	1,000		
	28	5,000	4,000	3,500	2,500	2,000			
	30	4,500	3,500	3,000	2,000	1,500			
	32	4,000	3,000	2,500	1,500	1,000			
	34	4,000	2,500	2,500	1,500				
	36	3,500	2,000	2,000					
	38	3,000	2,000	1,500					
	40	2,500	1,500	1,500					
	44	2,000	1,500						
48	1,500								

### 5.5.2 Kinds of grease

ExxonMobil Polyrex EM grease is standard for TECO motors except some special models for which special grease will be shown on the lubrication nameplate. Please use identical grease or its equivalents when maintaining.

#### **ATTENTION !**

**Do not mix different kinds of grease.**

**Mixing grease with different types of thickeners may destroy its composition and physical properties. Even if the thickeners are of the same type, possible differences in the additive may cause detrimental effects.**

### 5.5.3 Grease quantity

The amount of grease per replenishment depends on the type, size of the bearings and the structure of the bearing housing. The maximum amount of one replenishment for each bearing is shown in Table 5-2.

Table 5-2 Replenishment amount of grease (unit: gram)

Bearing No.		Amount of replenishment	Bearing No.		Amount of replenishment
62XX	6210	50	63XX	6310	80
72XX	6212	40	73XX	6312	60
NU2XX	6213	50	NU3XX	6313	80
222XX	6214	50	223XX	6314	80
	6215	60		6315	100
	6216	60		6316	100
	6217	80		6317	120
	6218	80		6318	120
	6220	100		6320	160
	6222	120		6322	220
	6224	120		6324	270
	6226	140		6326	300
	6228	160		6328	400
	6230	180		6330	450
	6232	200		6332	500
	6234	250		6334	600
	6236	300		6336	700
	6238	350		6338	800
	6240	400		6340	900
6244	450	6344	900		
6248	500	6348	900		

#### ATTENTION !

- **Fill desirable however to regrease until it replaces and the old grease is entirely replaced. The temperature of the bearing will initially increase because of the excess grease. After a few hours, the excess grease will be expelled through the exit tube and the bearing temperature will return to normal.**
- **When using the automatic lubrication system, the amount of lubricating grease should be doubled according to the above table**

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#### 5.5.4 Re-greasing



**If relubrication is to be performed when the motor is running, stay clear of rotating parts.**

It is advisable to re-grease while the motor is running to allow the new grease to be evenly distributed inside the bearing.

- (a) 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.
- (b) The outlet of grease drainage should be opened to allow the proper venting of old grease. If there is a waste grease collection handle, empty the remaining waste grease and open the handle.

Use a grease gun to pump grease through grease nipple into bearings. After re-greasing, operate the motor for 1 to 2 hours to allow any excess grease to vent out. During this process, the bearing temperature may temporarily increase.

#### **ATTENTION !**

**If this is not possible, or considered dangerous, the re-greasing has to be carried out while the machine is at a standstill. In order to avoid oil leakage due to excessive refueling pressure caused by grease accumulation, please add grease in several times. Let the equipment run for a few minutes after each refueling, so that the grease can be evenly distributed and the pressure inside the oil chamber can be reduced.**

---

### 5.5.5 Oil relubrication (For oil lubrication types only)

Use only good quality, oxidation-corrosion-inhibiting turbine oils produced by reputable oil companies. The oils listed below include the following additives:

- Oxidation and rust inhibitor
- Anti-foaming agent
- Anti-wear additive.

Verify the correct oil quality from the lubrication nameplate and the outline drawing .

#### (a) Oil level

For self-cooling (non-forced oil circulation) bearings, the oil level needs to be checked regularly. The standard oil level should be in the middle of the oil gauge surface, but in fact, as long as the oil level is within the observation glass of the oil gauge surface, the oil level can be accepted.

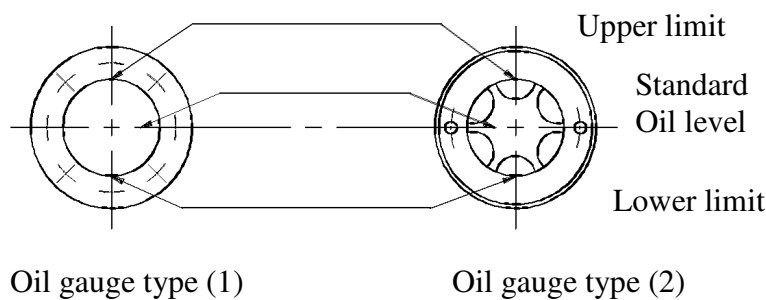


Fig. 5-4 Checking the oil level - type of oil gauge

Maintain proper lubrication by checking the oil level periodically and adding oil when necessary. Because of the initial clearing action of the bearing and the expansion of the oil as it comes up operating temperature, the oil level will be higher after the motor has been in operation for a while than it is with the motor at standstill.

Overfilling should be avoided not only because of the possibility that expansion may force the oil over the oil sleeve and on to the rotor, but also because too high an operating oil level prevents the bearing from clearing itself of excess oil. The resultant churning can cause extra loss, high temperatures, and oxidized oil. If, during operation, the oil level goes above the maximum shown on the sight gauge, drain enough oil to bring the level back within the recommended operating range.

#### **ATTENTION !**

- **When the motor is running, it is not to permit the operating level to fall below the minimum shown on the gauge.**
- **Should it ever become necessary to add excessive amount of make-up oil, investigate immediately for oil leaks.**

## (b) Oil change interval

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 changes a year is typical, but special conditions, such as high ambient temperature, may require more frequent changes. Avoid operating the motor with oxidized oil.

It is recommended to shorten the oil change interval by half at the beginning of operation. If it is confirmed that the lubricating oil sample collected before the oil change is satisfactory, gradually increase the oil change interval. But change the oil at least once a year

## (c) Oil viscosity

- (1) The viscosity of the oil to be used depends upon the type and size of the bearing, its load and speed, the ambient temperature, and the amount and temperature of the cooling water (if used). The lubrication nameplate or instructions with each motor specifies the viscosity range of oil suitable for average conditions. The usual oil viscosity recommendations are summarized in Table 5-3 and Table 5-4.
- (2) Operation in ambient temperatures that are near or below freezing may require preheating the oil or the use of special oil.

Whenever the motor is disassembled for general cleaning and reconditioning, the bearing housing may be washed out with a suitable cleaning solvent. Be sure that the oil metering hole is clear, and then dry the housing thoroughly before reassembly, and ensure all traces of cleaning solvent have been removed.

Table 5-3 oil viscosity for vertical rolling bearing

Bearing Type	Oil viscosity	Range of pole
Angular contact ball (72XX , 73XX)	ISO VG32 (150 SSU/100°F)	2 pole
	ISO VG68 (300 SSU/100°F)	4 pole and above
Spherical roller (293XX , 294XX)	ISO VG68 (300 SSU/100°F)	4 pole & 6 pole
	ISO VG150 (700 SSU/100°F)	8 pole and above

\*\*Remark: When a lubrication nameplate attached to the motor, use lubrication oil it stipulates.

### 5.5.6 Cleaning and installation of bearings

- (a) Apply the proper amount of grease to disassembled parts of the bearing after they have been thoroughly cleaned with high quality cleaning oil. Then protect them from contamination before and during assembly.
- (b) Bearing installation

**ATTENTION !**

**Before installing the bearings, make sure that the shaft mounted parts behind the bearings are in place before installation.**

- Since the bearing is a high precision component, it is important to avoid ingress of dust and foreign matter and hammering during cleaning and installation. Be extremely careful and ensure clean conditions exist during installation and assembly.
- Whenever the motor is disassembled for general cleaning and repair, check whether the oil gauge is clear and dry it completely before assembly.
- If the old oil is found to be polluted and precipitated when changing the oil, it is recommended to wash with kerosene. Before refueling, it is necessary to confirm that the flushing kerosene has been completely discharged before adding new oil.

**ATTENTION !**

**The best way for bearing installation is heat shrinking. Knocking and hammering during installation should be absolutely avoided.**

The bearing should be heated in a bath of clean oil to a temperature of approx. 80°C or using an induction bearing heater with a temperature probe. After warming, slide the bearings in place quickly and nimbly so that it does not shrink onto the shaft before being fully in position. Take care to keep the bearing straight during installation and ensure it is properly seated against the shoulder. Maintain pressure against the shoulder for several seconds to ensure it does not slide back from the shoulder, or become “cocked” on the journal.

Grease the bearing after the temperature returns to normal, and then reassemble the motor.

---

## 5.6 Maintenance of sleeve bearing

### 5.6.1 Daily inspections

#### (a) Oil level

Ensure the volume and quality of lubricating oil are in compliance with specifications. For self-cooling (non-forced oil circulation) bearings, the oil level needs to be checked regularly. The standard oil level should be in the middle of the oil gauge surface, but in fact, as long as the oil level is within the sight glass on the oil gauge surface, the oil level is acceptable. (For more information, please refer to 5.5.5(a) of this manual)

#### (b) Oil ring

Ensure there is motion of the oil ring and it is not clamped, but free to rotate. (for more information, please refer to this manual 4.2.7)

#### (c) Indicator

The indicator of the shaft endplay should be restricted within the specified range of the groove of the shaft or the  $\pm 3\text{mm}$  range of the drive-end shaft shoulder. Otherwise the bearing will be destroyed. (please follow the outline drawing for special cases.)

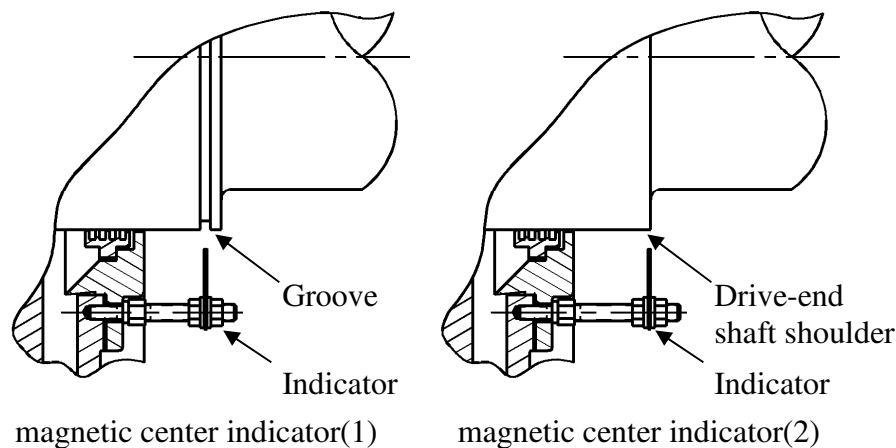


Fig. 5-5 Daily inspection-type of magnetic center indicator

### **ATTENTION !**

**The indicator (including bolts) is fixed and cannot be moved. If you find any looseness or deformation, please make sure that the indicator is in the correct position again. If you have any doubts, please contact. TECO.**

#### (d) Bearing temperature rise

Temperature rise of bearings exceeding the warning limit usually indicates a failure of the motor or lubrication system, so the temperature rise should be closely monitored (refer to 4.2.8 and Table 7-1 of this manual for more information). If the temperature rise beyond the limit is accompanied by increased vibration, the fault may also be related to the installation and centering of the equipment (for more information, please refer to this manual 4.2.9), or is related to the damage in the bearing housing, in which case the bearing needs to be disassembled and inspected

### 5.6.2 Lubrication of bearings

Use only good quality, oxidation-corrosion-inhibiting turbine oils produced by reputable oil companies. The oils listed below include the following additives:

- Oxidation and rust inhibitor
- Anti-foaming agent
- Anti-wear additive.

Verify the correct oil quality from the lubrication nameplate and the outline drawing .

#### (a) Oil viscosity

Table 5-4 oil viscosity for horizontal sleeve bearings

Oil viscosity	Same grade		Range of pole
	ESSO	MOBIL	
ISO VG32 (150 SSU/100°F)	ESSO TERESSO 32	MOBIL DTE OIL LIGHT	2 pole
ISO VG46 (200 SSU/100°F)	ESSO TERESSO 46	MOBIL DTE OIL MEDIUM	4 pole
ISO VG68 (300 SSU/100°F)	ESSO TERESSO 68	MOBIL OIL HEAVY MEDIUM	6 pol & above

Table 5-5 oil viscosity for vertical sleeve bearings

Bearing Type	Oil viscosity	Range of pole
RENK Vertical Bearing Inserts Type EV or Kingsbury Type	ISO VG68 (300 SSU/100°F)	4 pole and above

Verify the correct oil viscosity from the lubrication nameplate and the outline drawing .

#### (b) Recommended control values for the lubricating oil

Lubricating oil should be sampled regularly and verified from the following aspects :

- (1) Smell the oil. Strong acid or burnt smell is not acceptable.
- (2) The oil should be free from debris, and its cleanliness according to ISO 4406 class 18/15.
- (3) The water content must not exceed 0.2%.
- (4) The original viscosity must be maintained within a tolerance of  $\pm 15\%$ .
- (5) The total acid number (TAN) should not exceed 1 mg KOH per gram of oil.
- (6) The quantity of metal impurities should be less than 100 PPM. An increasing trend of the value means that the bearing is wearing.

After the first oil change, the oil can be analyzed approximately in the middle and end of the oil change interval.

## (c) Periodical change of oil

Recommended interval of oil change are as follows : (Unit : Hours)

	Continuous operation	Discontinuous operation
Self-lubricating bearing	8,000	5,000
Bearing with oil circulation systems	20,000	5,000

The recommended interval of oil change can be found on the lubrication nameplate. More frequent changes may be needed on high-speed (3600-rpm), discontinuous operation (frequent starting, frequent forward and reverse rotation...), high oil temperature or excessive pollution due to external influences.

During the first year of operation, it is advisable to take samples of the lubricating oil after about 1000, 2000 and 4000 operating hours. It is possible to determine a suitable oil change interval. (It is not recommended to exceed the continuous operation replacement cycle in the above table)

In conditions where contamination does occur, it may be advisable to flush the reservoir with kerosene to remove any sediment before new oil is added. Proper care must be taken to thoroughly drain the reservoir of the flushing material before refilling with the new oil.

### 5.6.3 Disassembly



**Prior to disassembling, ensure the power supplies are disconnected and there are no moving parts.**

The bearing sleeve is of the spherically seated, self-aligning type. The opposite drive end bearing is normally insulated on larger motors (or when specified). On some motors, the insulation is bonded to the spherical seat of the bearing housing.

#### **ATTENTION !**

**Extreme care must be exercised in removing the bearing sleeve from the insulated support to avoid damaging this insulation.**

The following is the recommended procedure for removing the bearing sleeve :  
(Typical construction are shown as Fig.5-6 below and Appendix 14.)

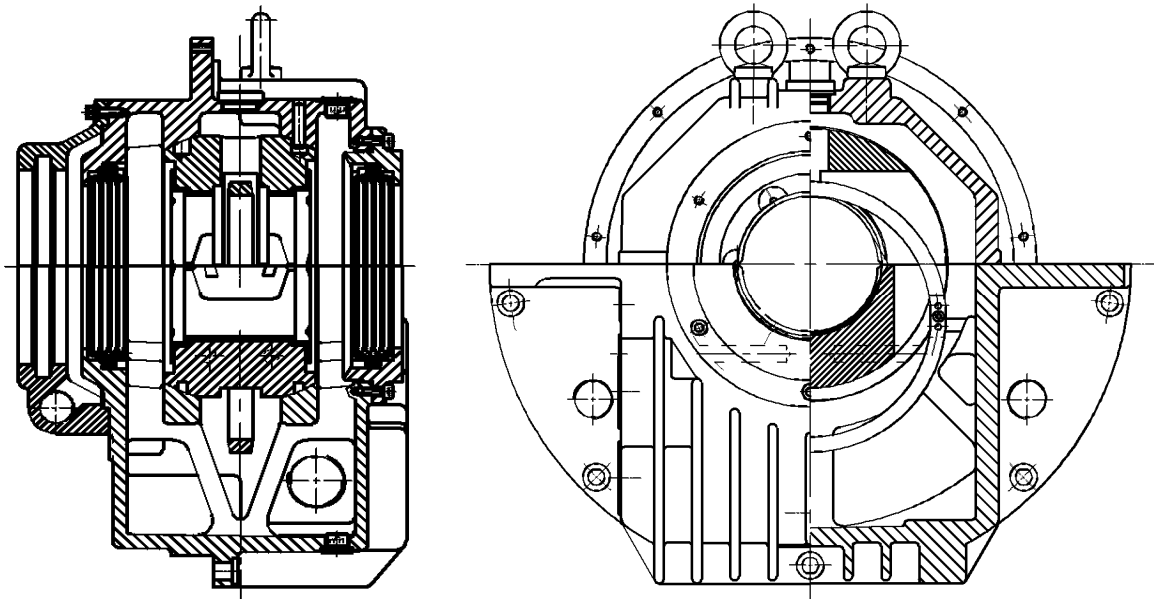
- (a) Remove the oil drain plug in the housing bottom and drain the oil sump.
- (b) Remove all instrumentation sensors that are in contact with the bearing sleeve. These would include resistance temperature detectors, thermocouples, thermometers, etc.
- (c) Remove the socket head bolts holding the bearing cap and the inner air seal. The end cover plate must also be removed if the non-drive end bearing is being disassembled. Remove the bearing cap and top half of the inner air seal. Place them on a clean, dry surface to avoid damage to the parting surfaces.

- (d) Remove the top half of the bearing sleeve using suitable eyebolts in the tapped holes provided. Lift the bearing top straight up and avoid any contact with the shoulders of the shaft journals that might damage the thrust faces of the bearing. Place on a clean, dry surface taking care to prevent damage to either the parting surfaces or the locating pins that are captive in the top bearing half.
- (e) Remove the screws at the partings in the oil ring and dismantle the ring by gently tapping the dowel pin ends with a soft face mallet. Remove the ring halves and immediately reassemble them to avoid any mix up in parts or damage to the surface at the partings.
- (f) Pull up on the garter spring surrounding the floating labyrinth seal and carefully slip out the top half. Rotate the garter spring until the lock is visible. Twist counter-clockwise to disengage the lock, remove the garter spring, and then rotate the lower half of the seal out of the groove in the bearing housing. Note the condition of these floating labyrinth seals. If they are cracked or chipped, they must be replaced. Do not attempt to reuse a damaged seal.
- (g) To remove the bottom bearing half, the shaft must be raised a slight amount to relieve pressure on the bearing. On the drive end, this can be done by jacking or lifting on the shaft extension. Protect the shaft. On the non-drive end, jacking or lifting can be done using eye bolts threaded into the tapped holes provided in the shaft end.
- (h) Roll the bottom bearing half to the top of the shaft journal and then lift it using suitable eye bolts threaded into the holes provided. Again avoid any contact with the shaft shoulders that could damage the bearing thrust faces. Place the lower bearing half on a clean, dry surface to protect the parting surfaces.



**Use extreme care when rolling out the lower bearing half. Keep the hands and fingers well clear of any position where they might be caught by the bearing half if it were accidentally released and suddenly falls back to its bottom position. Serious personal injury could result.**

- (i) Protect the shaft journal by wrapping it with clean, heavy paper or cardboard.



**Fig. 5-6 Sleeve bearing construction**

### 5.6.4 Reassembly

Bearing reassembly is basically a reverse of the disassembly procedures outlined above, with the following suggestion:

- (a) The interior of the bearing housing should be cleaned and then flushed with clean oil or kerosene.
- (b) The bearing halves and the shaft journal should be wiped clean using lint-free cloth soaked with clean oil.
- (c) All parts should be carefully inspected for nicks, scratches, etc., in any contact surfaces. Such imperfections should be removed by an appropriate method such as stoning, scraping, filing, etc., followed by thorough cleaning.
- (d) Before installing the halves of the floating labyrinth seal, observe their condition. Do not attempt to use a cracked or chipped seal. The bottom half seal has a set of drilled holes in its side face. These must be placed at the bottom toward the inside of the bearing. Only in this position the accumulated oil can drain back into the housing.
- (e) Put a bead of Hylomar M around the seal half O.D.'s on both sides adjacent to the angular spring groove. This will prevent oil from by-passing the seal around its outside.
- (f) Place the bottom seal half on top of the shaft and roll it into position. Install the top half and insert the garter spring pulling up on both ends to permit engaging the lock. Run a bead of Hylomar M around the O.D. on both sides adjacent to the garter spring groove on this half also.
- (g) Carefully reassemble the two oil ring halves. Inspect the dowel pins for burrs and straightness and make any corrections required. Do not force the ring halves together. Excessive force may alter the roundness or flatness of the oil ring which can change its oil delivery performance. Once assembled, the oil ring should be measured to ensure it is round, if it is not it should be repaired or replaced.
- (h) Some of the pipe plugs in the housing are metric thread type. These are identified as those which have a copper, lead, or similar material washer. If these plugs are removed, be careful not to lose the washers. Before reassembly, inspect the washers and replace them as required.
- (i) Before installing the bearing cap, observe the position of the floating labyrinth seal. The "tab" must be on top to engage the pocket. Failure to position the seal properly will result in damage when the cap is assembled.

#### **ATTENTION !**

- (1) Hylomar M is the only approved compound for use in the assembly of the bearings on this motor. Other products may harden and impede the operation.**
- (2) During the reassembly of the bearing parts, a thin layer of Hylomar M should be applied to all gaskets and machined interface surface. This suggestion does not apply to the machined surfaces of the bearing liner halves.**
- (3) When seating the bearing shell, apply a thin layer of lube oil at the spherical surface of the liner. Slowly roll the lower bearing liner into the bearing housing making sure the split surfaces of the liner and the housing are flush. Gradually lower the shaft onto the bearing. The weight of the shaft will help rotate the bearing liner so that the babbitt surface of the liner will match the slope of the journal. Sometimes it is required to use a rubber mallet to tap lightly on the bearing housing while slowly rolling the shaft to help this seating operation.**

## 5.7 Maintenance of slip ring (For Wound Rotor only)



Ensure motor is disconnected from power supplies and there are no accessible moving parts before maintenance operation.

### **ATTENTION !**

For more detailed information, see **TECO manual Wound Rotor Induction Motors <3A057H800E>**

### 5.7.1 Constant Pressure Spring

The consistency of the brush pressure is important for normal slip ring operation. At every inspection, spring pressure checks are mandatory.

Constant pressure springs are to be replaced on evidence of heat marks or abnormalities.

On motors held in storage for any length of time, the constant tension brush springs should be removed in order to prevent corrosion between brush face and slip ring surface (and thereafter replaced into position before placing motor into service).

Electro-graphite brush pressure for normal operation :

160 g/cm<sup>2</sup> ±10% (for slip ring with spiral groove)

200 g/cm<sup>2</sup> ±10% (for slip ring without groove)

When frequent vibrations are evident or the brush is small (area below 0.5 cm<sup>2</sup>), the pressure should be greater than as shown.

---

### 5.7.2 Brush replacement

The carbon brush is a part of the equipment which is easily worn away, replace it after it is worn to 1/2~3/5 of original size.

(a) Brush material

The brush material is important to the performance of the motor. Only the most appropriate materials are chosen by TECO, and are listed on the nameplate of motor. It is important to know this when you replace the brush, only the recommended type and grade should be used.

(b) Dimensions

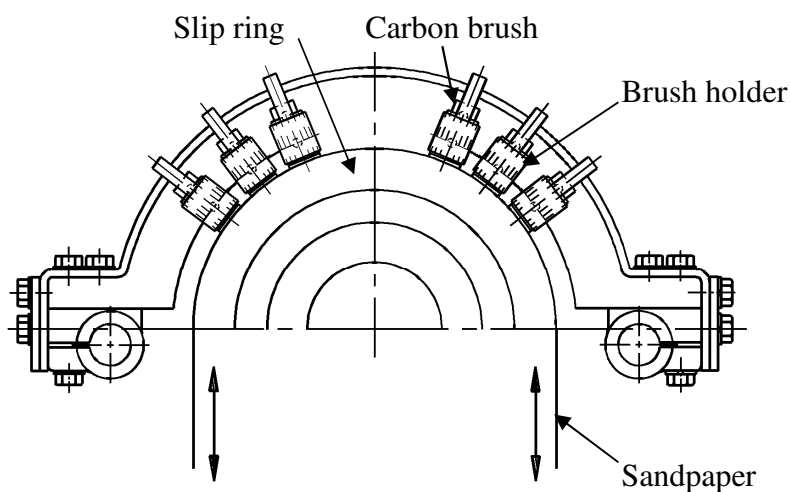
Brush, holder and gap between them, please refer to CNS 2322 C4051 or JIS C2802.

#### **ATTENTION !**

**The gap between a brush and its holder is important for good performance and safety of the motor.**

(c) Adjustment of new brushes (Shown in Fig. 5-7)

- (1) Polish the new brush with sandpaper until it assumes the appropriate contour of the slip ring which it touches.
- (2) Place sandpaper (JIS R6252 NO.40 ... 50) on the slip ring with the abrasive face of the paper against the brush to induce a closer contact by rubbing against each other.
- (3) Repeat item 2 with fine sand-paper (JIS R6252 NO. 100 to 200) until the contact surface between brush and slip ring exceeds 80%.
- (4) Finally, clean the contaminated slip ring and brush with clean cloth or vacuum.



**Fig. 5-7**

### 5.7.3 Slip Ring

It has to be checked at regular intervals, that the contact surfaces of the slip rings are smooth without burning marks, grooves etc. Any dirt has to be removed, and the contact surfaces of the slip rings shall be clean. Formation of patina on the contact surfaces is desirable, but it has to be thin on the slip rings.

**ATTENTION !**

**The TIR of slip ring is very important for good performance. It should be less than 0.05mm after repair and 0.08mm during normal operation.**

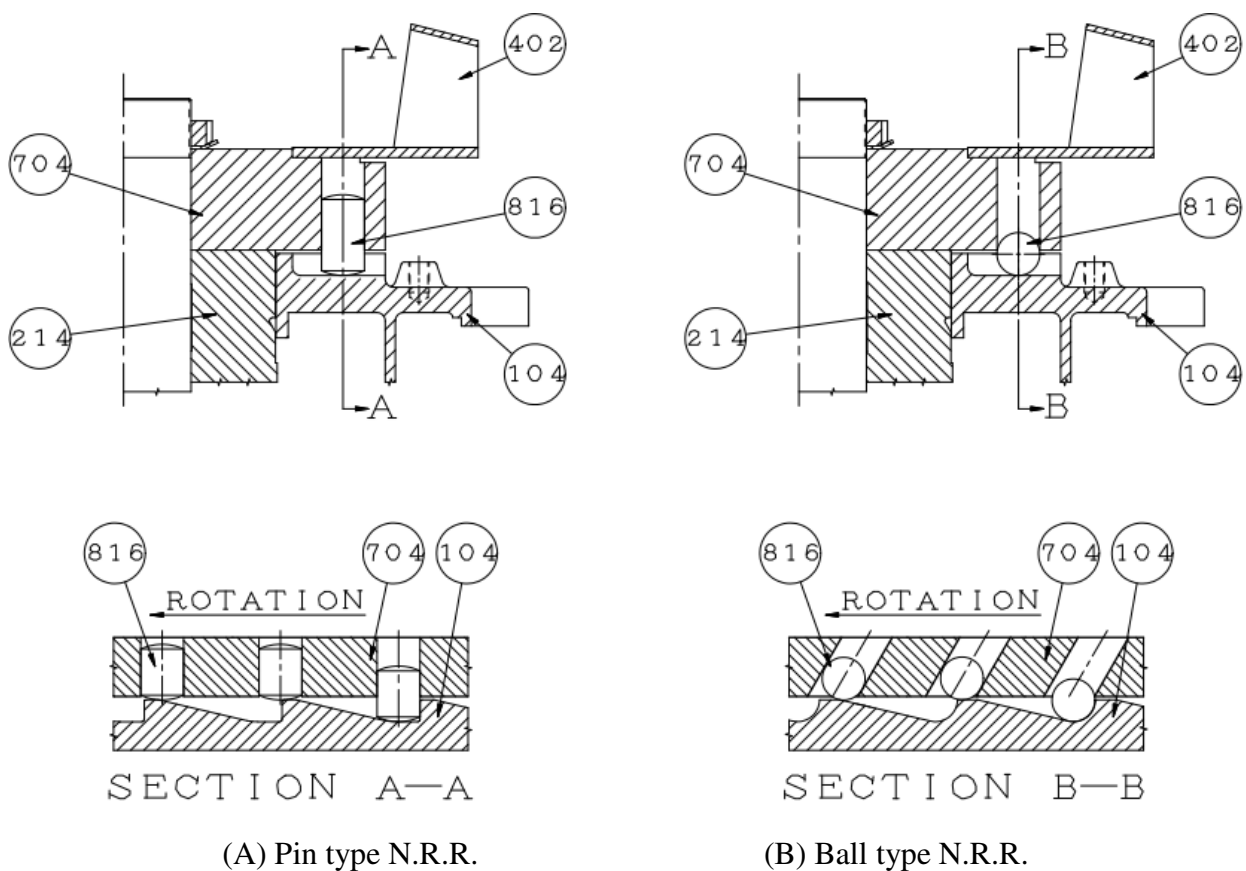
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## 5.8 Maintenance of non-reverse ratchet mechanism (For Vertical Motor only)

### 5.8.1 Non-reverse ratchet mechanism

In the pump piping system, a check valve and a stop valve should be installed in the discharge line. The check valve, placed between the pump and the stop valve, is to protect the pump from reverse flow and excessive back pressure. The stop valve is used in priming, starting and when shutting down the pump. It is advisable to close the stop valve before stopping the pump. This is especially important when the pump is operated against a high static head.

TECO vertical high thrust motors are equipped with non-reverse ratchet (N.R.R.) mechanism only when requested by the pump manufacturer. Typical construction of N.R.R. mechanism is shown as Fig. 5-8 below.



ITEM	NAME	ITEM	NAME
104	RATCHET	704	RATCHET PIN CARRIER
214	BEARING SEAT	816	RATCHET PIN(BALL)
402	EXTERNAL FAN		

**Fig. 5-8**

The N.R.R. mechanism keeps the pump and motor from rotating in the reverse direction. Thus prevents damage from over speeding and damage to water-lubricated pump shaft bearings when, on shutdown, the falling water column tends to drive the pump in the reverse direction.

In normal operation, the ratchet pins are lifted by the ratchet teeth and are held clear by centrifugal force and friction as the motor comes up to speed. When power is removed, the speed decreases and the pins fall. At the instant of reversal, a pin will catch in a ratchet tooth and prevent backward rotation.

### 5.8.2 Service life

The service life of ratchet pins depends not only on the reverse shock load between the pin and ratchet tooth when pump stopped but also the frequency of pump starting and stop in application.

Over time the pins can become deformed due to this reverse shock load, causing the up and down motion of ratchet pins to become sluggish or jammed and unusual noises will arise.

The recommended replacement period for these ratchet pins is every three (3) years. If the reverse shock load is greater than 30% of motor rated torque or the starting frequency is more than twice per day, then the replacement period is to be halved.

#### **ATTENTION !**

**The check valve and stop valve in the discharge line should be regularly inspected and maintained to assure the normal function of these valves. This is important to protect the pump and motor from damage and increase the service life of the N.R.R. mechanism.**

### 5.8.3 Disable the N.R.R. mechanism

Motor with N.R.R. mechanism only can run in uni-direction. The motor can change to suitable for bi-directions by disabling the N.R.R. mechanism. The N.R.R. mechanism can be disabled in the following manner:

- (a) Remove the fan cover or weather cover on the top of motor.
- (b) Remove the external fan or cover on the top of ratchet pin carrier.
- (c) Take out the ratchet pin or ball.
- (d) Replace the external fan or cover.
- (e) Replace the fan cover or weather cover

#### **ATTENTION !**

**The N.R.R. mechanism is refine-balanced by adding weights to the external fan or cover. Before removing the external fan or cover, it should be marked and replaced in the same position to retain proper balance.**

---

## **5.9 Maintenance of water cooler**

### **5.9.1 Installation**

All pipe work attached to the cooler shall be adequately supported to ensure that no pipe work loads due to either static or thermal expansion are applied to the cooler. The cooler element or package must be installed to match the orientation as original arrangement. For three phase induction motor, we use duct type water cooler as standard and install gaskets on all joint faces to avoid water leakage.

### **5.9.2 Operation**

If valves controlling the flow of water into the cooler need to be operated. They should be opened and closed slowly to prevent undue loading on the cooler. During filling, any trapped air should be removed by opening the air vent on the header box (if fitted). If not fitted venting shall be undertaken at some other suitable point in the system. The cooler must be protected at all times against the possibility of freezing of the cooling water.

### **5.9.3 Maintenance**

The pipework supports must be examined regularly to ensure that there are no loads or excessive vibrations being transmitted to the cooler connections. The air filters (option for DC motor only), if fitted, must be cleaned regularly. The fins on the coolers must be examined regularly and, if necessary, cleaned with a detergent cleaner applied with a pressure jet. Mechanical cleaning of the fins is not recommended.

To clean the internals of the tubes, header boxes must be removed and the tubes cleaned with a brass brush. Other more abrasive cleaning methods shall not be used. In the unlikely event of a leak occurring on the pressure retaining gaskets, the header box must be removed and new gaskets fitted.

It is important to ensure that all drain points are examined regularly to confirm that they have not become blocked. If the cooler has been out of commission for an extended period, it will be necessary, before operating the equipment to vent any trapped air until there is a continuous flow of water from the vent.

---

**5.9.4 Header assembly removal**

- (a) Remove all headers to tubeplate fasteners.

Note:

- (1) Where there is a cover box fitted at the return end of the cooler assembly a minimum of two fasteners shall be left in place until the cover box has been supported.
- (2) On all header constructions a minimum of two fasteners shall be left in place until the weight of the header has been supported
- (3) On grid and coverplate headers (recognized by having the header constructed from 2 distinct items) the position of the two remaining fasteners must be chosen to ensure that they support the grid (the non bolted component).

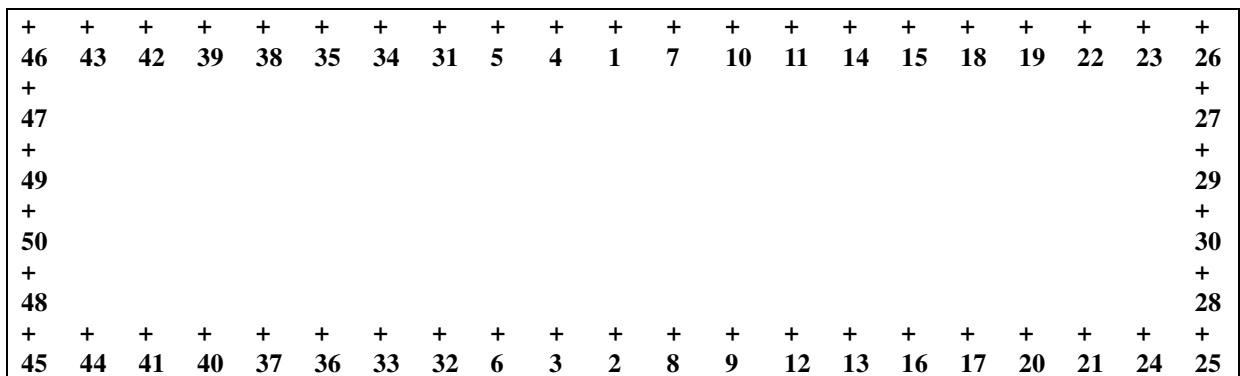
- (b) Remove all traces of gasket from both the tubeplate and header faces with care to prevent damage to the faces. A metal scraper can be used for this purpose if used with care.

Note: On grid and cover plate header constructions the gasket joints between tube plate and grid, as well as between grid and cover plate will require careful removal.

- (c) Inspect the surfaces to be gasketed paying particular attention for surface scratches, dents, and misalignments in machining or local undulations.
- (d) If the gasket sealing surfaces are painted or otherwise coated, it is important that the coating is flat, continuous and without cracks or flakes.
- (e) If the surfaces are damaged, please contact us for a suitable method of repair.

**5.9.5 Reassembly**

- (a) Tighten progressively to 35% final recommended torque information from the dimension drawing in a symmetrical pattern starting at the centre and working toward each end as Fig. 5-9.



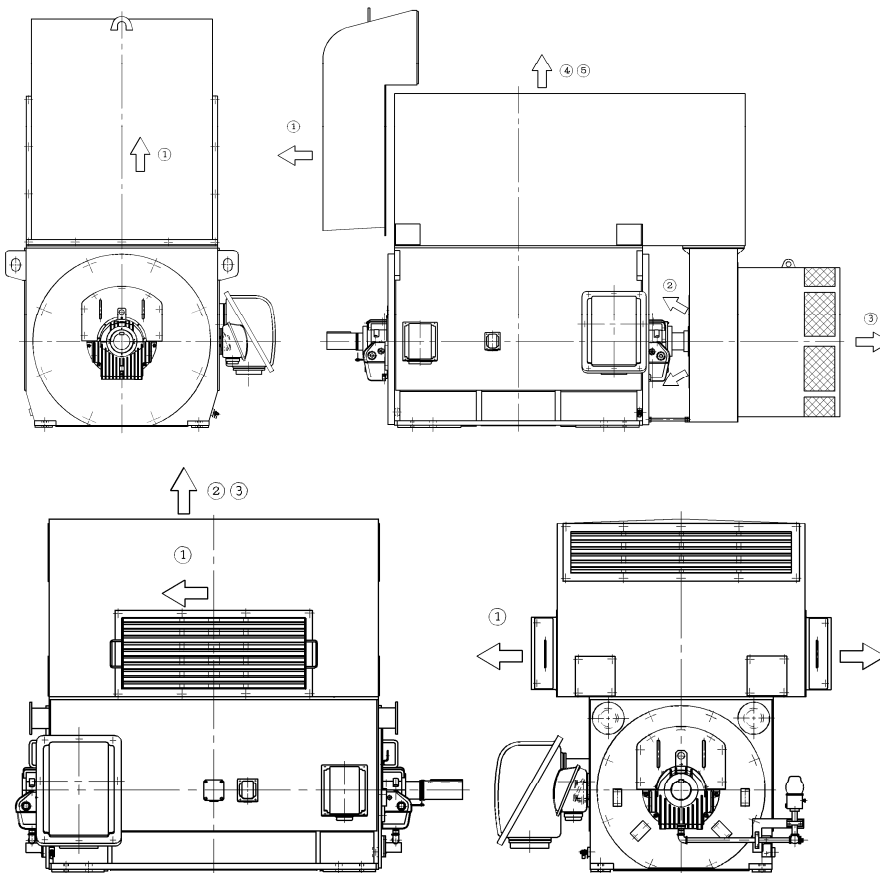
**Fig. 5-9**

- (b) Re tighten to 70% final recommended torque information from the dimension drawing, using the same symmetrical pattern.
- (c) Re tighten to final recommended torque information from the dimension drawing, using the same symmetrical pattern.

## 5.10 Dismantling and Assembly Procedure

### 5.10.1 Enclosure

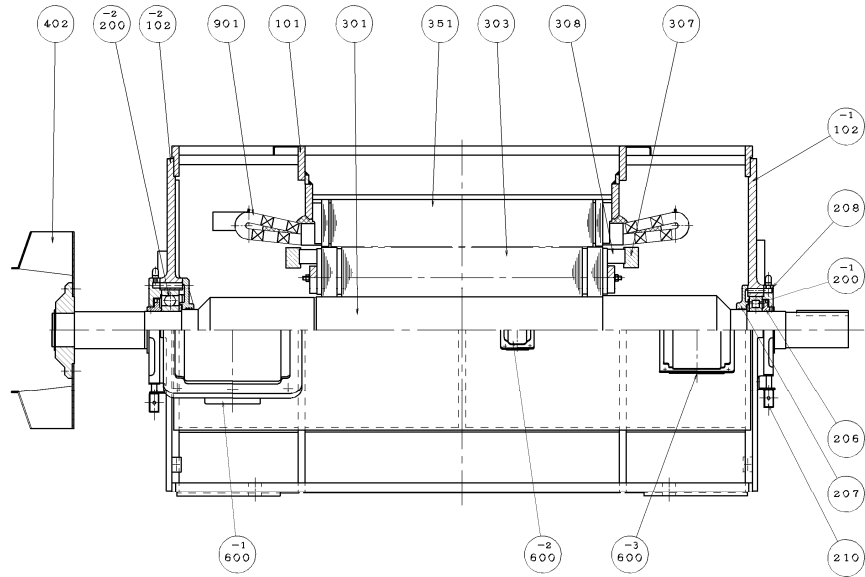
Machine Enclosure	Dismantling the fan cover & cooler	Assembly
TEAAC	<ol style="list-style-type: none"> <li>1. Remove securing bolts between the air outlet box and cooler.</li> <li>2. Remove securing bolts between two half-circle plate covers and the fan cowl at the rear of air inlet.</li> <li>3. Remove securing bolts between the fan cover of air inlet and cooler.</li> <li>4. Remove securing bolts between cooler and frame.</li> <li>5. Lift the cooler by using eye-bolts fastened on the top of the cooler.</li> </ol>	<ol style="list-style-type: none"> <li>1. Seals must seat perfectly on frame.</li> <li>2. Tighten securing bolts by reverse step of dismantling.</li> </ol>
WP11	<ol style="list-style-type: none"> <li>1. Remove securing bolts on the windows.</li> <li>2. Remove securing bolts between silencer and frame.</li> <li>3. Lift the silencer by using eye-bolts fastened on the top of the cooler.</li> </ol>	<ol style="list-style-type: none"> <li>1. Seals must seat perfectly on frame.</li> <li>2. Tighten securing bolts by reverse step of dismantling.</li> </ol>



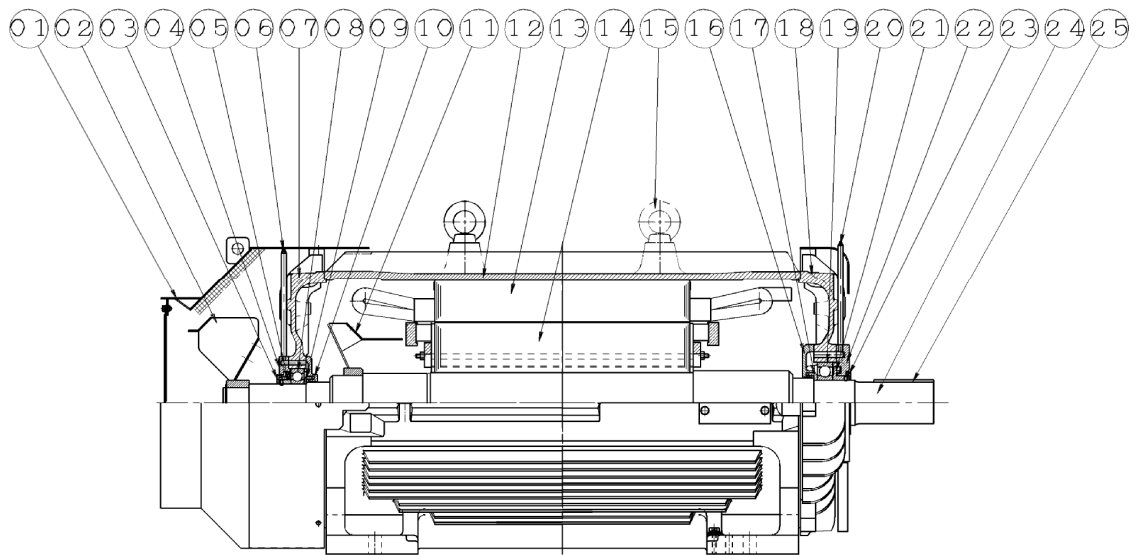
**Fig. 5-10**

### 5.10.2 Bracket with antifriction bearings

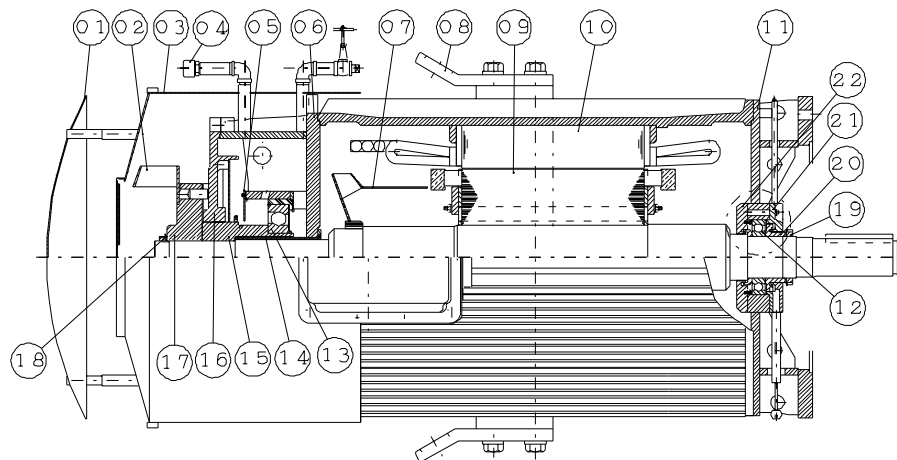
Brackets with anti-friction bearing	Dismantling brackets	Assembly
TEAAC	<p>Please see FIG 5-11 A</p> <ol style="list-style-type: none"> <li>1. Remove the outer fan.</li> <li>2. Remove securing bolts between the bearing cover-outer (208) and the bracket (102).</li> <li>3. It may be necessary to remove any seals / grease flingers / temperature sensors etc attached to the shaft or housings.</li> <li>4. Pull out the bearing cover-outer (208) very carefully.</li> <li>5. Remove securing bolts hold between the bracket (102) and frame (101).</li> <li>6. Pull out the bracket (102) gently.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check the bearing assembly. Keep each part very clean.</li> <li>2. Tighten securing bolts by reverse step of dismantling.</li> </ol>
WPII	Same as above item 2..~5..	Same as above.
TEFC	<p>Horizontal foot mounting, Please see FIG 5-11 B</p> <ol style="list-style-type: none"> <li>1. Remove the fan cover &amp; outer fan.</li> <li>2. Remove securing bolts between the bearing cover-outer (22) and the bracket (18).</li> <li>3. It may be necessary to remove any seals / grease flingers / temperature sensors etc attached to the shaft or housings.</li> <li>4. Pull out the bearing cover-outer (22) very carefully.</li> <li>5. Remove securing bolts hold between the bracket (18) and frame (12).</li> <li>6. Pull out the bracket (18) gently.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check the bearing assembly. Keep each part very clean.</li> <li>2. Tighten securing bolts by reverse step of dismantling.</li> </ol>
	<p>Vertical flange mounting, Please see FIG 5-11 C</p> <p>(一) Upper bearing</p> <ol style="list-style-type: none"> <li>1. Remove the fan cover(01) &amp; external fan(02).</li> <li>2. Remove LK nut(18) and pull out ratchet pin carrier(17) .</li> <li>3. Remove ratchet (16),then you can pull out bearing seat(15).</li> <li>4. Take off bearing(13) from bearing seat byRemove outside retaining ring.</li> </ol> <p>(二) Lower bearing</p> <ol style="list-style-type: none"> <li>1. Remove LK nut(18) and out bearing cover-outer(21) and grease flinger(20),then remove flange bracket(11) bolts and pull out</li> <li>2. Pull out from bearing cover-inner(22),then lower bearing come out from shaft.</li> </ol>	<ol style="list-style-type: none"> <li>1. Check the bearing assembly. Keep each part very clean.</li> <li>2. Tighten securing bolts by reverse step of dismantling.</li> <li>3. Refer to 5.10.3 to adjust the endplay.</li> </ol>



**Fig. 5-11 A**



**Fig. 5-11 B**



**Fig. 5-11 C**

### 5.10.3 Endplay adjustment(For Vertical Motor only)

Endplay is defined as the total axial float of the rotor. When motor is dismantled for any reason, the rotor endplay must be adjusted. During reassemble the bearing, it is necessary to make sure that endplay must be within the proper range.

In order to adjust the endplay setting correctly, a dial indicator should be used to read the axial float of rotor. The upper bearing lock nut should be turned until no further upward movement of the shaft is indicated. Then loosened the lock nut until 0.005” to 0.008” endplay is shown. Finally locked the lock nut with lock washer.

### 5.10.4 Assembly of large main terminal box

When the terminal box contains current transformers, lightning arresters and surge capacitor it is of larger than normal size and weight, and therefore required to be supported separately from the motor. It is therefore necessary for a support structure to be arranged at site to accommodate the terminal box before it can be assembled to the motor and for that reason the box is shipped separately from the motor. After the terminal box has been positioned on its support structure and mated/fastened both to the motor terminal facing and the support structure, internal reconnection of the power leads from the motor within the terminal box is required to be carried out.

It is probable that this work will be required to be carried out under the relevant local electrical legislation/regulations. This may involve control by a senior authorized person, work carried out by a competent person, possibility of inspection by an authorized person, and perhaps a requirement for testing. The principles involved may not be dissimilar to those involved in connecting site external power cables.



**Only use the lifting lugs or eye bolts which are mounted on the top of terminal box to lift or move the main terminal box.**

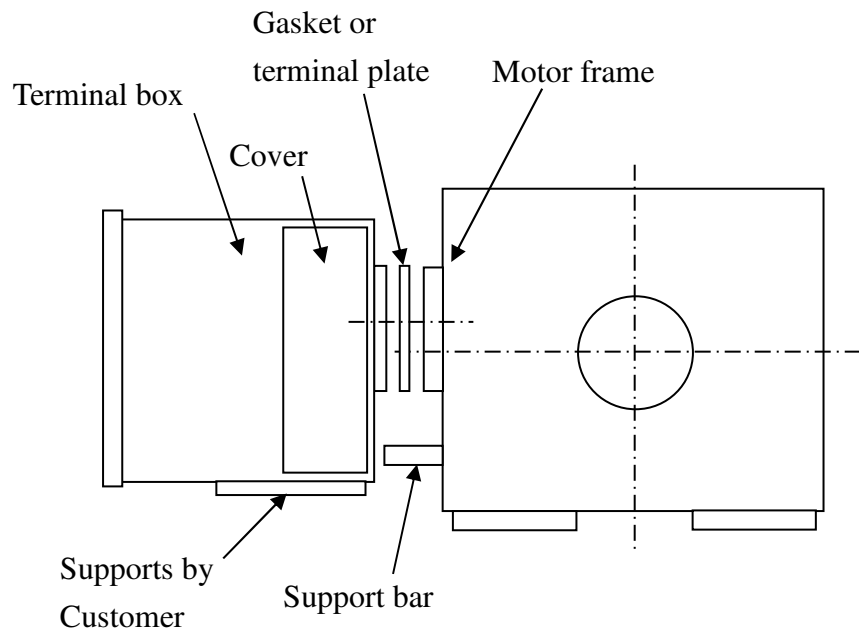
#### **ATTENTION !**

**There is a gasket or terminal plate between the terminal box and motor frame.  
It could prevent water leakage.**

---

**5.10.5 Assembly of large main terminal box with the following suggestion:**

- (a) Remove terminal box lid.
- (b) Lift the main terminal box by crane and move it toward the motor frame.
- (c) Pull the motor leads through the terminal plate, fixed plate and rubber bushes. Take care not to damage cables (insulation can easily be damaged by sharp metallic surfaces).
- (d) Tighten securing bolts between the terminal box and motor frame including the bolts on the support bar. For convenience, take off the cover plates fastened at both sides of the terminal box.
- (e) Thread power leads through the CT's and connect as per schematic connection diagram. Connect U2(T4),V2(T5),W2(T6) to star (neutral) point strap. Connect U1(T1),V1(T2),W1(T3) to rear of terminal posts.
- (f) Shim or adjusting the supports for the terminal box as necessary to ensure good support.
- (g) Carry out any inspection or testing that is deemed necessary. Please check all mounting bolt and lead ensuring there is no damage and everything is secure.
- (h) Refit terminal box lid ensuring gasket is properly seated.

**Fig. 5-12**

## **5.11 Records of operation and maintenance**

### **5.11.1 Objective**

- (a) Fully understand the purpose of the motors in operation and discover any abnormalities in advance.
- (b) Prevent negligence and omissions in maintenance.
- (c) Map pertinent maintenance plans after fully understanding the operation of the motor.
- (d) Assess the life of the depreciating parts to determine the amount of spare parts to be kept.
- (e) Plan the amount of spare motors and replacement parts to repair the motors in operation according to actual situation and schedule.

### **5.11.2 Records of operation**

- (a) It is advisable to use a primed form with yes/no or right/wrong selections for the operator to easily fill out.
- (b) Principle contents :
  - (1) Serial number of machine.
  - (2) Load machine type.
  - (3) Models and specifications of motors.
  - (4) Three-phase voltage.
  - (5) Three-phase current.
  - (6) Temperature of a motor and bearings when in operation.
  - (7) Ambient temperature, humidity, weather, date and time.
  - (8) Time of start and stop.
  - (9) Special remarks.
  - (10) Operator's name.

### **5.11.3 Maintenance records**

- (a) It is advisable to use a primed form with yes/no or right/wrong selections for the operator to easily fill out.
  - (b) Principle contents :
    - (1) Serial number of machine.
    - (2) Load machine type.
    - (3) Models and specifications of motors.
    - (4) Ordinary operating conditions and data.
    - (5) Cause, date and disposition measures at breakdown.
    - (6) Quantity and name of replaced spare parts.
    - (7) Date of maintenance and initial operation.
    - (8) Items and date of maintenance.
    - (9) Special remarks.
    - (10) Name of maintenance personnel.
-

## **6. SPECIAL NOTES FOR EXPLOSION PROOF MOTOR**

### **6.1 Introduction**

Special notes refer to the installation, operation and maintenance of motor protected against the risk of explosion and designed for use in potentially explosive atmospheres.

Explosion proof motors are designed specially to comply with official regulations concerning the risk of explosion in hazardous areas. If improperly used, connected or alter badly, no matter how minor, their reliability would be doubt.

The related standards of connection and use of electrical apparatus in hazardous area should be taken into consideration. Only trained personnel familiar with these standards could handle this type of apparatus.

### **6.2 Special notes for inspection and storage**

- (a) Ensure the nameplate details for explosion proof information are identical with purchase requirements.
- (b) Ensure receipt of completed manual if having related explosion proof equipment.

### **6.3 Special notes for installation**

- (a) Ensure the explosion proof type and installations of all relative electrical equipment, system and facility are appropriately chosen before starting.
  - (b) When installing the motor, always connect the earthing and check before starting that all earthing are effectively connected.
  - (c) Supply connections shall be made with ring type terminal lugs which have insulated shanks. Clearance distances shall not be reduced when tightening connections.
  - (d) On auxiliary terminals the conductor insulation shall extend to within 1 mm of the terminal throat.
  - (e) There shall be no loose conductor strands on any terminal.
  - (f) The drain plugs (when fitted) shall be replaced immediately after use and sealed with an appropriate sealing compound.
  - (g) The brass terminal links shall be connected correctly so as not to reduce the clearance distances.
  - (h) Electric data of the motor, valid for the rated power, can be found on the nameplate. It is the responsibility of the user to ensure that the motor nameplate voltage and frequency are the same as the mains supply.
-

- (i) Connection to the mains supply suggested to be executed by a recognized professional, respecting local demands and regulation. TECO cannot be held responsible for damage due to incorrect connection or use.
- (j) For Ex e (IEC 60079-7) motors, settings of locked rotor time and locked rotor current should meet the requirements specified by type test for explosion proof electrical apparatus certificate/manufacturer . Circuit breakers complying with IEC 60898 and IEC 60898 are chosen to ensure correct tripping actions when a locked rotor fault occurs.
- (k) User should select explosion proof cable gland according to the tapped holes specified on outline drawings. Cable gland is not included in the scope of supply of TECO. The suggested cable diameter is shown as follows Table 6-1. (Please contact TECO if you have special conditions)



Table 6-1 Cable Gland Selection

Tap Size		Cable Diameter (mm)		Tap Size		Cable Diameter (mm)	
Metric	NPT	Min.	Max.	Metric	NPT	Min.	Max.
M20X1.5	1/2" or 0.75"	9.4	14.4	M50X1.5	2"	33.1	44.1
M25X1.5	0.75" or 1"	13.5	20.0	M63X1.5	2.5"	46.7	56.0
M32X1.5	1" or 1.25"	19.5	26.3	M75X1.5	3"	58.0	68.0
M40X1.5	1.25" or 1.5"	23.0	32.2	M80X2	3" or 3.5"	62.2	72.0

### 6.3.1 Definitions of environmental conditions

- (a) Very dirty and wet :  
Locations include those that may be subjected to deluge systems or comprise open deck on offshore locations.
- (b) Coastal outdoor :  
Locations within three kilometer from average High-tide line (mark) to the land.
- (c) Other outdoor :  
Exception of "Very dirty and wet" and "Coastal outdoor", environment which easily dust accumulated, causing the lower efficiency of cooling system.
- (d) Clean outdoor :  
Exception of "Very dirty and wet" and "Coastal outdoor", environment which often cleaned up, causing no (or slight) influence of cooling system.
- (e) Clean and dry indoor :  
Indoor use and often cleaned up, causing no (or slight) influence of cooling system.

## 6.4 Special notes for operation

### 6.4.1 Operation

- 
- (a) The maximum ambient temperature must not exceed the given value that is indicated on the name plate and in the motor certificate.
  - (b) The maximum start numbers has been declared in technical documents.
  - (c) The starting sequence is allowed after the motor has cooled to the ambient temperature (cold starts) or to operating temperature (warm starts).( For more information, see 4.2.2 of this manual)

#### **6.4.2 Quality of Air Supply**

The system should be connected to a protective gas supply, which is suitable for purging and pressurization.

The supply pipe must be appropriate for the maximum input flow rate for the application.

The air supply must be regulated at a pressure less than the maximum stated inlet pressure.

The air supply must be: clean, non-flammable and from a non-hazardous location. The air should be of Instrument Air Quality. Although the purge control system will operate with lower air quality, its operational life will be adversely affected. The equipment that is being protected may also suffer because of poor air quality.

With reference to BS ISO 8573-1: 2010, Instrument Air is typically specified as:

##### **Particle Class 1**

In each cubic metre of compressed air, the particulate count should not exceed 20,000 particles in the 0.1 to 0.5 micron size range, 400 particles in the 0.5 to 1 micron size range and 10 particles in the 1 to 5 micron size range.

##### **Humidity or pressure dew point**

The dew point, at line pressure, shall be at least 10 °C below the minimum local recorded ambient temperature at the plant site. In no case, should the dew point at line pressure exceed +3 °C.

##### **Oil Class 2**

In each cubic metre of compressed air, not more than 0.1mg of oil is allowed. This is a total level for liquid oil, oil aerosol and oil vapour.

When an inert gas is being used to supply the purge system, risk of asphyxiation exists. Refer to Application Suitability section.

Before connection of the air supply to the purge system, the supply pipe work should be flushed through with instrument quality air to remove any debris that may remain in the pipes. This must be carried out for at least 10 seconds for every meter of supply pipe.

Please ensure that the fluid pressure and/or flow conditions are satisfied with outline drawing or equipment manual.

#### **6.4.3 Pre-purge Procedure**

- (a) Before motor starting, turn on air supply & the vent of cooler should be opened.
  - (b) Then pre-purge is started, it means:
    - (1) the purge air will enter the enclosure
    - (2) the air will then exit the vent of cooler
  - (c) Once enough purge air flow is measured the system will start the timed purge cycle.
-

- (d) After the purge has completed the set purge time without interruption, it means the pre-purge procedure complete.
- (e) Close the vent of cooler and turn off air supply.

Please following the manual steps to start pre-purge procedure if there have been installed a specific pre-purge auxiliary.

#### **6.4.4 Ex p device**

- (a) Read the Ex p device manual carefully before use.
- (b) Ex p motor and its device were appropriate adjust before sending to customer, all relative parameters about Ex p device is also recorded on the device and documents which TECO provided.
- (c) Parts of explosion proof device are mechanical controlled (including pressure controlling system and magnet valve), it may cause some error during transport and oscillation, please contact TECO for help if errors causing hard use.

TECO cannot be held responsible for damage due to self-maintenance or self-adjust without discussing with TECO or device provider.

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#### 6.4.3.1 Limitations

- (a) The requirements of the enclosure purge air are indicated on the name plate and in the motor certificate.
  - (b) Each and every machine is to be subjected to a leakage test (normal and over pressure). The leakage shall not exceed the given value that is indicated on the name plate and in the motor certificate.
  - (c) The pressurization and purging system attached to the enclosures must be:-
    - (1) Set to provide the above purge flow rate and time.
    - (2) Set to provide a low pressure monitoring system set to a minimum of 1.5mbar and a high pressure relief valve set to a maximum of 30mbar.
  - (d) The pressurization and purging system attached to the enclosures shall be subjected to a test to demonstrate effective operation under the following conditions:-
    - (1) Under pressure - The low pressure switch shall operate if the enclosure overpressure falls below the minimum specified above (e.g. if an inspection panel is opened).
    - (2) Purge flow failure - The purging system (including the timer) shall reset to the beginning of the purge cycle if the purging air flow rate (measured at the outlet) falls below the minimum specified above (e.g. the supply restricted during purge).
    - (3) Supply pressure failure - The low pressure switch shall operate when or before the enclosure overpressure falls below the minimum specified above (e.g. the supply restricted after purge).
  - (e) For correct operation the on-site pressurizing air supply must be capable of providing a minimum of 1000 l/min for leakage compensation.
  - (f) The connection of the external supply cables shall be made in such a way that the IP54 rating of the terminal boxes is maintained.
  - (g) The stator winding RTD shall either be disconnected in the event of a purge/pressurization failure or be separately protected by the use of an intrinsic safety supply in accordance with EN 60079-11.
  - (h) The heating element supply circuit shall be interlocked such that the heaters cannot be energized whilst the motor is running; the supply circuit is to include a suitable over-current protection device.
-

## 6.5 Additional maintenance of explosion proof motor

- (a) If appropriate, centering the fan to the center of fan cover or air guide after any maintenance. The clearance should be at least 1% of the maximum diameter of the fan and in accordance with standards.
- (b) Don't remove or adjust any parts in terminal boxes, which would change clearance or creepage distances between any parts.
- (c) Don't install any new parts to terminal boxes without asking advice from TECO.
- (d) All connections in main terminal boxes must be made with approved connector, which are delivered with the motor by manufacturer. In other case ask advice from TECO.
- (e) If possible, please check and renew the air filter during suitable period to ensure the pre-purge function.
- (f) Please make a periodic inspection (refer to nameplate for the period) to maintain the valid function of explosion proof.
- (g) Inspection:

### **Visual inspection**

(Inspection which identifies, without the use of access equipment or tools, those defects, such as missing bolts, which will be apparent to the eye)

### **Close inspection**

(Inspection which encompasses those aspects covered by a visual inspection and, in addition, identifies those defects, such as loose bolts, which will be apparent only the use of access equipment, for example steps, (where necessary), and tools)

### **Detailed inspection**

(Inspection which encompasses those aspects covered by a close inspection and, in addition, identifies those defects, such as loose terminations, which will only be apparent by opening the enclosure, and/or using, where necessary, tools and test equipment)

Please find List 6-1 and 6-2 for inspection schedule, ensure each inspect procedure is conformed to the explosion proof type and storage each result for check.

To ensure all the function of explosion proof, if having any overhaul or maintenance requirement, please contact TECO for advice. TECO cannot be held responsible for damage due to incorrect inspection and/or maintenance procedure.

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Table 6-1 Inspection schedule for Ex d, Ex e and Ex n motor

(D = Detailed, C = Close, V = Visual)

Date:	Staff:	Ex “d”			Ex “e”			Ex “n”		
Item		Grade of inspection								
		D	C	V	D	C	V	D	C	V
<b>A. Equipment</b>										
1. Equipment is appropriate to the EPL/Zone requirements of the location	*	*	*	*	*	*	*	*	*	*
2. Equipment group is correct	*	*		*	*		*	*		
3. Equipment temperature class is correct	*	*		*	*		*	*		
4. Equipment circuit identification is correct	*			*			*			
5. Equipment circuit identification is available	*	*	*	*	*	*	*	*	*	*
6. There are no unauthorized modifications	*			*			*			
7. There are no visible unauthorized modifications		*	*		*	*		*	*	
8. Bolts, cable entry devices (direct or indirect) and blanking elements are of the correct type and complete and tight.										
– Physical check	*	*		*	*		*	*		
– Visual check			*			*				*
9. Flange faces are clean and undamaged and gaskets, if any, are satisfactory	*									
10. Flange gap dimensions are within maximum value permitted	*	*								
11. Electrical connections are tight				*			*			
12. Condition of enclosure gaskets is satisfactory				*			*			
13. Motor fans have sufficient clearance to enclosure and/or covers	*			*			*			
<b>B. Installation</b>										
1. Type of cable is appropriate	*			*			*			
2. There is no obvious damage to cables	*	*	*	*	*	*	*	*	*	*
3. Sealing of trunking, ducts, pipes and/or conduits is satisfactory	*	*	*	*	*	*	*	*	*	*
4. Stopping boxes and cable boxes are correctly filled	*									
5. Earth connections, including any supplementary earthing bonding connections are satisfactory (for example connections are tight and conductors are of sufficient cross-section)										
– Physical check	*			*			*			
– Visual check		*	*		*	*		*	*	*
6. Insulation resistance is satisfactory	*			*			*			
7. Specific conditions (if applicable) are complied with	*			*			*			
8. Cables not in use are correctly terminated	*			*			*			
9. Obstructions adjacent to flameproof flanged joints are in accordance with IEC 60079-14	*	*	*							
<b>C. Environment</b>										
1. Equipment is adequately protected against corrosion, weather, vibration and other adverse factors	*	*	*	*	*	*	*	*	*	*
2. No undue accumulation of dust and dirt	*	*	*	*	*	*	*	*	*	*
3. Electrical insulation is clean and dry				*			*			

Table 6-2 Inspection schedule for Ex p motor  
(D = Detailed, C = Close, V = Visual)

Date:	Staff:	Ex “p”		
Item		Grade of inspection		
		D	C	V
<b>A. Equipment</b>				
1. Equipment is appropriate to the EPL/Zone requirements of the location		*	*	*
2. Equipment group is correct		*	*	
3. Equipment temperature class is correct		*	*	
4. Equipment circuit identification is correct		*		
5. Equipment circuit identification is available		*	*	*
6. There are no unauthorized modifications		*		
7. There are no visible unauthorized modifications			*	*
<b>B. Installation</b>				
1. Type of cable is appropriate		*		
2. There is no obvious damage to cables		*	*	*
	3. Earth connections, including any supplementary earthing bonding connections are satisfactory (for example connections are tight and conductors are of sufficient cross-section)			
— Physical check		*		
— Visual check			*	*
4. Protective gas inlet temperature is below maximum specified		*		
5. Ducts, pipes and enclosures are in good condition		*	*	*
6. Protective gas is substantially free from contaminants		*	*	*
7. Protective gas pressure and/or flow is adequate		*	*	*
8. Pressure and/or flow indicators, alarms and interlocks function correctly		*		
9. Time for pre-purge is satisfactory		*		
10. Condition of spark and barriers of ducts for exhausting the gas in hazardous area are satisfactory		*		
11. Specific conditions of use (if applicable) are complied with		*		
<b>C. Environment</b>				
1. Equipment is adequately protected against corrosion, weather, vibration and other adverse factors		*	*	*
2. No undue accumulation of dust and dirt		*	*	*

## 7. FAULT FINDING AND RECOGNITION

Kinds of Breakdown	Symptoms	Possible causes	Remedies	
Fail to start without load	Motionless and soundless	Power-off	Consult power company	
		Switch-off	Switch-on	
		No fuse	Install fuse	
		Broken wiring	Check wiring and repair	
		Broken lead	Check wiring and repair	
		Broken windings	Check windings and repair	
	Fuse blowing. (Automatic switch trips off, slow start with electromagnetic noise)		Short circuit of circuit switches	Check circuit switches and replace
			Incorrect wiring	Check wiring according to nameplate
			Poor contact at terminals	Lock tightly
			Windings grounded	Factory repair
			Broken windings	Factory repair
			Poor contact of circuit switches	Check and repair
			Broken wiring	Check and repair
			Poor contact of starting switches	Check and repair
			Short circuit of starting switches	Check and repair
			Incorrect connections of starting switches	Connect according to nameplate
Loading after start	Fuse blowing. Fail to restart due to trip-off of automatic switch	Insufficient capacity of fuse	Replace fuse if wiring permits	
		Overload	Lighten load	
		High load at low voltage	Check circuit capacity and reduce load	
	Overheating motor		Overload or intermittent overload	Lighten load
			Under-voltage	Check circuit capacity and power source
			Over-voltage	Check power source
			Ventilation duct clogged	Remove the foreign matter in the duct
			Ambient temperature exceeds 40°C	Correct insulation class F, or lower ambient temperature.
			Friction between rotor and stator	Factory repair
			Fuse blown (Single-phase rotating)	Install the specified fuse
			Poor contact of circuit switches	Check and repair
			Poor contact of circuit starting switches	Check and repair
			Unbalanced three-phase voltage	Check circuit or consult power company

Kinds of Breakdown	Symptoms	Possible causes	Remedies
Loading after start	Speed falls sharply	Voltage drop	Check circuit and power source
		Sudden overload	Check machine
		Single-phase rotating	Check circuit and repair
	Switch overheat	Insufficient capacity of switch	Replace switch
		High load	Lighten load
	Bearing overheating	Lack of oil	Add oil
		Lack of grease	Add grease
		Misalignment between motor and machine shafts	Re-align
Over speed of bearing outer-ring		Adjust bracket	
High bearing noise		Replace the damaged bearing	
Noise	Electromagnetic noise induced by electricity	Occurrence from its first operation	May be normal
		Sudden sharp noise and smoking	Short circuit of windings Should be repaired at factory
	Bearing noise	Churning sound	May be normal noise from grease circulating through the bearing
		Rattling noise as result of poor lubrication	Add Grease
		Larger noise	Inspect cause -replace the damaged bearing
	Mechanical noise caused by machinery	Loose belt sheave	Adjust key and lock the screw
		Loose coupling or skip	Adjust the position of couplings, lock key and screw
		Loose screw on fan cover	Lock fan cover screw tightly
		Fan rubbing	Adjust fan position
		Rubbing as a result of ingress of foreign matters	Clean motor interior and ventilation ducts
		Wind noise	Noise induced by air flowing through ventilation ducts
Vibration	Electromagnetic vibration	Short circuit of windings	Factory repair
		Open circuit of rotor	Factory repair
	Mechanical vibration	Unbalanced rotor	Factory repair
		Unbalanced fan	Factory repair
		Broken fan blade	Replace fan
		Unsymmetrical centers between belt sheaves	Align central points
		Central points of couplings not in alignment	Adjust the alignment between motor and driven equipment
		Improper mounting installation	Check mounting and alignment
		Motor mounting bed is not strong enough	Reinforce mounting bed
		Mounting bed vibration caused by near machines	Eliminate the vibration source near motor
<p>Remarks:</p> <p>(1) Circuit switches: These include knife switches, electromagnetic switches, fuse and other connection switch etc.</p> <p>(2) Starting switches: These include Delta-Star starters, compensate starters, reactance starters, resistor starters, starting controllers etc.</p>			

## 8. RECYCLE

### 8.1 Introduction

TECO obey its environmental and protection policies. TECO has always been committed through the use of recyclable and life cycle analysis of the results to improve environmental protection products. Products, production processes or flow designs are all reflected the concept of environmental protection. TECO's environmental management system through the ISO 14001 certification is used to implement an environmental policy tool.

The following guidelines only deal with the suggestions of environmental treatment on the equipments. Customer shall be responsible for compliance with local regulations. This manual may not include some of the customer's specific content. Project document provides additional documentation.

### 8.2 Materials Average Content

When producing electrical equipments, the average material content used are as follows:

Material	Die-casting frame Induction machinery	Steel plate frame Induction Machinery
Steel	45 – 56 %	79 - 83 %
Copper	8 – 10 %	12 – 14 %
Cast iron	32 – 43 %	1 – 3 %
Aluminum	0 – 5 %	0 - 1 %
Insulation materials	1 - 2 %	2 – 4 %
Stainless steel	Below 1 %	Below 1 %
Other	Below 1 %	Below 1 %

### 8.3 Packing Materials Recycling

When the equipments arrived to the place, the packing materials should be removed.

- All wood-made packing materials can be burned.
- The packing materials used with impregnated wood at sea shipping for some country must be recycled according to local regulations.
- The plastic materials around equipments can be recycled.
- The anticorrosive agent covered on the surface of equipments can be cleaned by gasoline-based cleaner or wipers. Treating the wipers must be complied with local regulations.

## 8.4 Equipment of disassembling

Disassembling equipment is a basic operation because equipment is assembled by bolts. However, due to the heavy weight of equipment, the operator must be required to have received training in handling the transportation of heavy loads to avoid any danger.

## 8.5 Classification of different materials

### 8.5.1 Frame, Bracket (bearing housing), Cover and Fan

These parts are made of structural steel and can be recycled according to local regulations. All of auxiliary equipment, cables and bearings must be removed before melting.

### 8.5.2 Parts with electrical insulation

The stator and rotor are the main part of machinery included electrical materials. Some auxiliary parts also included similar materials and should be used the same methods to dispose. These materials include each insulator in terminal box, exciter, transformer with adjustable voltage and current function, cables, wires, corona discharger and capacitor. Some parts are used for synchronous machineries and some used for few equipments.

All of these parts are in an inert state when equipments were completed. Some parts (especially the components into stator and rotor) including a large number of copper can be separated by appropriate heat treatment and the organic adhesive materials in insulation materials can be gasified. In order to ensure proper gas combustion, burner should provide an appropriate supplementary burner. In the combustion process of heat treatment, following conditions are recommended to minimize the material distributed processing:

Temperature of Heat treatment :

380 ~ 420 °C ( 716 ~ 788 °F )

Duration :

Processing object should be kept at that temperature for at least 5 hours when reaching to 90% of target temperature.

Supplementary gas combustion temperature for adhesives smoke :

850 ~ 920 °C ( 1562 ~ 1688 °F )

Flow rate :

Adhesives smoke in the combustion chamber should be kept at least three seconds.

Note :

The distribution of substances include O<sub>2</sub>, CO, CO<sub>2</sub>, NO<sub>x</sub>, C<sub>x</sub>H<sub>y</sub> gas and micro-particles. User shall be responsible to ensure that the process comply with local regulations.

Note :

You should pay particular attention to thermal processes and heat treatment equipment maintenance, so as not to bring fire or explosion hazard. Since this work will use a variety of devices, so TECO cannot provide a detailed maintenance guideline for treatment process or equipment, customers will be responsible for dealing with these issues.

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### 8.5.3 Permanent Magnet

If permanent magnet synchronous machineries will be totally melted, it's no need to deal with the permanent magnets.

In order to achieve a more complete recovery and removal of equipment or if the rotor will be sent out after recovery, we suggest doing permanent magnet demagnetization. Rotor can be heated in the furnace until the temperature of a permanent magnet reaches 300 °C (572 °F) to achieve degaussing purpose.



**Open or disassemble permanent magnet synchronous machinery or remove the rotor of such equipment will produce stray magnetic fields. It may interfere with or damage to other electrical or electromagnetic devices and components, such as cardiac pacemakers, credit cards and more.**

### 8.5.4 Hazardous Waste

The grease in oil lubrication system is hazardous waste and must be treated by local regulations.

### 8.5.5 Buried Waste

All insulation materials can be treated as landfill waste.

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## Appendix 1. Daily inspection

Checking point	Checking item	Description or inspection parts	Method	Criteria or notes
1. Bearing	Oil supply	Oil quantity	Check oil level from oil sight gauge.	In the middle of oil sight gauge.
		Oil pressure (forced oil lubrication only)	Check oil supply pressure gauge near inlet pipe or supply unit.	Within $\pm 20\%$ of specified pressure.
		Oil ring rotation (horizontal sleeve bearing only)	Check oil ring from window at 12 o'clock.	Rotating smoothly
	Oil leakage	Shaft · labyrinth seal · piping connection · parting line of housing	Inspect by eye and touch by hand.	Dampness around housing is normal. But oil accumulation on floor should be checked.
	Temperature	Bearing temperature detector	Check the value is the same as normal.	Recommendation : See 4.2.8
	End play	Axial fluctuation of shaft	Inspect by eye.	The shaft shoulder should not touch the liner.
		Magnetic center	Inspect the magnetic center pointer on drive end.	$\pm 3\text{mm}$
	Vibration	Ref to 4.2.9	If the vibration level is higher than normal, please measure the spectrum by instrument.	Analyze the spectrum.
	Noise	Ref to 4.2.9	Listen for unusual noise	Assess noise, stop and inspect if necessary
2. Stator	Temperature	Winding temperature detector	Check the value is the same as normal.	Recommendation : See 4.2.10
	Load	Voltage · current	Check the value from control panel	Voltage variation $< 10\%$ Current $<$ rated current
3. Cooler	Water supply	Water quantity	Check the water flow relay or indicator & temperature.	The water flow rate and temperature limitations are shown on outline drawing.
4. Filter	Dust or pollution	Clean filter	Clean by fresh water	Clean filter
5. Others	Odor	Windings & Bearings	Check winding and bearing temperature monitors	Check load / cooling air flow, oil condition.

## Appendix 2. Monthly inspection

Checking point	Checking item	Description or inspection parts	Method	Criteria or notes
1. Bearing	Oil supply	Oil quantity	Check oil level from oil gauge.	In the middle of oil gauge. If the oil quantity is low , please add oil and check for leaks
	Oil leakage	Shaft 、 labyrinth seal 、 piping connection 、 parting line of housing	Inspect by eye and touch by hand.	If oil is leaking, it is important to find the root cause.
2. Stator	Temperature	Winding temperature detector	Check the value if the same as normal.	Recommendation : See 4.2.10
	Appearance	Bolts/nuts for bracket or frame etc.	Inspect by eye and touch by hand.	Re-tighten all loose.
	Resistance	Winding	500VDC/1000VDC megger. Once every three months at least.	Ref to “Operation” 4.1.2 measurement of insulation resistance.
3. Cooler	Water supply	Water quantity	Check the water flow relay or indicator & temperature.	The water flow rate and temperature limitations are shown on outline drawing.
4. Coupling	Appearance	Bolts/nuts	Inspect by eye and touch by hand.	Re-tighten all loose bolts.
5. Space heater	Resistance	Heater wire	500VDC megger.	Ref to “Operation” 4.1.2 measurement of insulation resistance.

### Appendix 3. Regular Inspection

item	Checking point	Description	Regular inspection			
			In situ Exterior surface inspection	In situ Open inspection	Removed for Disassembly inspection	
1. Inspection before disassembly	(1)	Vibration	Measure and record the vibration levels for reference	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	(2)	Temperature	Record bearing, winding & ambient temperature for reference.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	(3)	Coupling	Measure the mounting and shaft end dimensions. Check if any bolts are loose. Check if there are any mounting hole, key & keyway deformation.			<input type="radio"/>
	(4)	Alignment	Check and record the alignment for reference			<input type="radio"/>
	(5)	Anchor bolt, mounting bolt & nut	Check if there are any parts loose. Check condition of all nuts , bolts, Replace if defective.		<input type="radio"/>	<input type="radio"/>
	(6)	Adjusting shims	Check if rusty, damaged and replace if damaged.			<input type="radio"/>
	(7)	Shaft vibration	Measure the shaft vibration value and record.			<input type="radio"/>
	(8)	Foundation level	Check for any deformation that may have occurred.			<input type="radio"/>
	(9)	Air gap	Measure this value and record in 3 places at least for each end.			<input type="radio"/>
2. Sleeve bearing inspection	Sleeve bearing	According to RENK “Instructions for Maintenance and Inspection”.		<input type="radio"/>	<input type="radio"/>	
3. Stator inspection	(1)	Winding resistance	Use 500VDC/1000VDC megger to measure and record results.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	(2)	Winding appearance	Check if any dust or oil contamination on winding coil			<input type="radio"/>
	(3)	Coil end	Check coils for loose blocking, lashings, end rings.			<input type="radio"/>
	(4)	Coil insulation	Check coil insulation material for wear, discolouration or damage			<input type="radio"/>
	(5)	Cable lead	Check if lead insulation broken, cracked or damaged.			<input type="radio"/>
	(6)	Terminal lug	Check for loose or damaged lugs or terminals.			<input type="radio"/>
	(7)	Coil wedge	Check for loose or damaged slot wedges.			<input type="radio"/>
	(8)	Air guide	Check each bolt & nut to see if any is loose.			<input type="radio"/>

### Appendix 3. Regular Inspection (continue)

item	Checking point	Description	Regular inspection		
			In situ Exterior surface inspection	In situ Open inspection	Removed for Disassembly inspection
4. Rotor inspection	(1) Rotor appearance	Check if any dust or oil contamination is on rotor.			○
	(2) Rotor bar	Check for loose or damaged bars Check rotor bar end ring welds.			○
	(3) Rotor core	Check for loose or damaged laminations.		○	○
5. Fan	Fan	Check welded portions for cracks, bolts & nuts, any built up dirt or rust.			○
6. Inspection before operation	(1) Winding resistance	Use 500VDC/1000VDC megger to measure, record results.	○	○	○
	(2) Supply lead connection	Check all incoming supply leads correctly connected.		○	○
	(3) Protection relay	Check protection relay in normal operation.	○	○	○
	(4) Lubrication oil	Oil level at the middle of oil gauge. Oil inlet pressure correct and oil drains smoothly.	○	○	○
	(5) Alignment	Check and record the alignment.			○
	(6) Anchor bolt & mounting bolt	Check all mounting bolts are securely tightened.		○	○
	(7) Driven equipment	Check if all driven equipment is ready for operation.	○	○	○
	(8) Cooling water	Check cooling water flow rate & quantity.	○	○	○
7. Inspection before starting	(1) Rotational direction	Check rotational direction.	○	○	○
	(2) Oil ring	Check if oil ring runs smoothly.	○	○	○
	(3) Noise	Check there is no abnormal noise.	○	○	○
	(4) Vibration	Check if vibration is normal.	○	○	○
	(5) Bearing temperature	For test run, please keep monitoring for 2hrs at least.	○	○	○
	(6) Oil level	Check oil level.	○	○	○
	(7) Current	Make sure current is below rated value shown on nameplate.	○	○	○

**Note :****(a) Disassembly inspection :**

Removing the rotor to inspect the stator & rotor.

Recommendation :

Every four (4) years, but depends on operation environment conditions & machine type.

**(b) Open inspection :**

Inspect the maximum possible portions without removing rotor.

Recommendation :

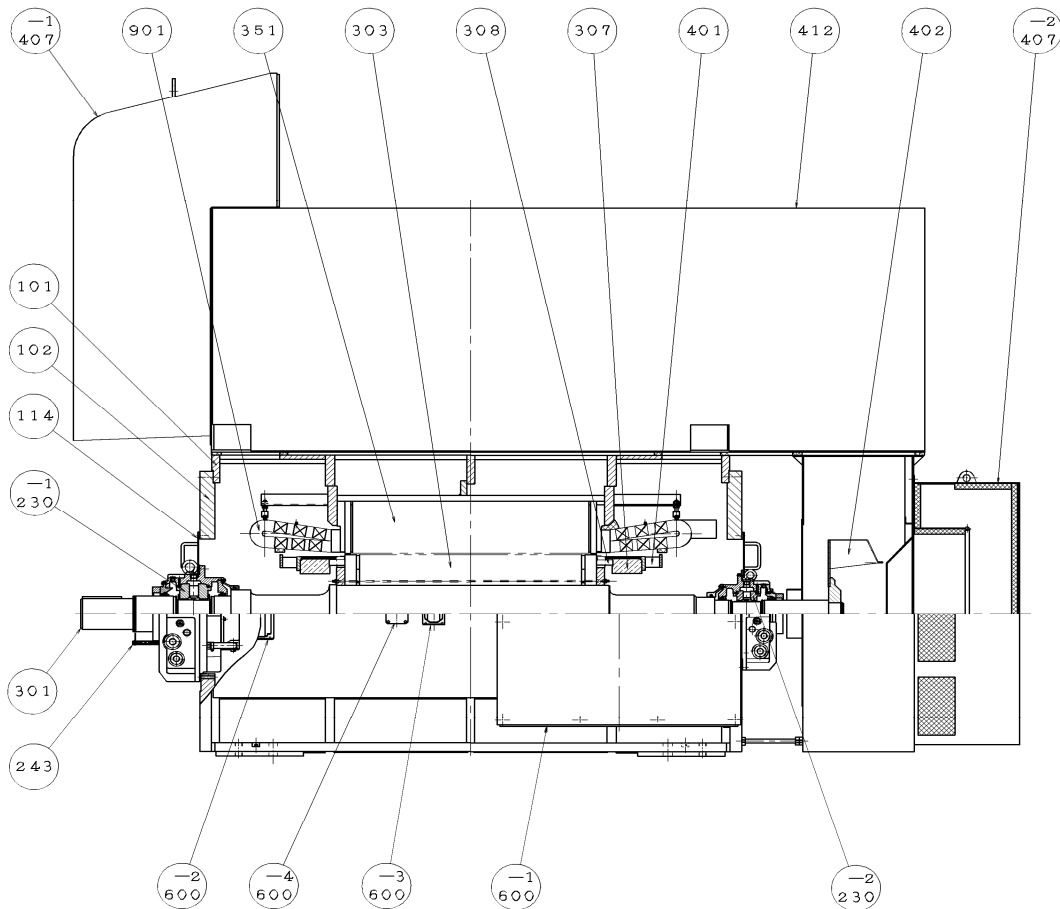
Every two (2) years, but depends on operation environment conditions & machine type.

**(c) Exterior surface inspection :**

Recommendation : Every year.

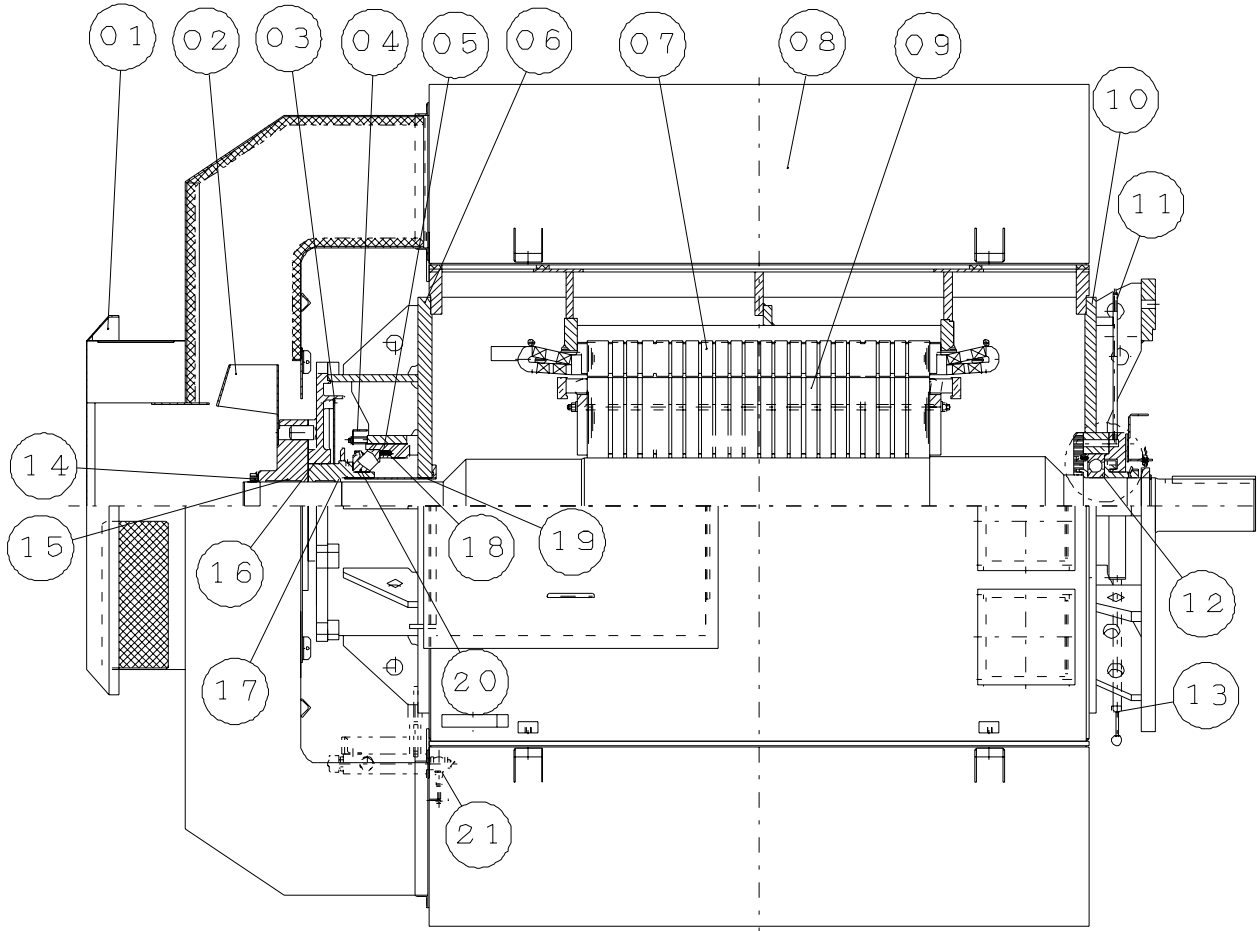
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## Appendix 4-1. Typical motor cross sectional drawings : SCIM, TEAAC



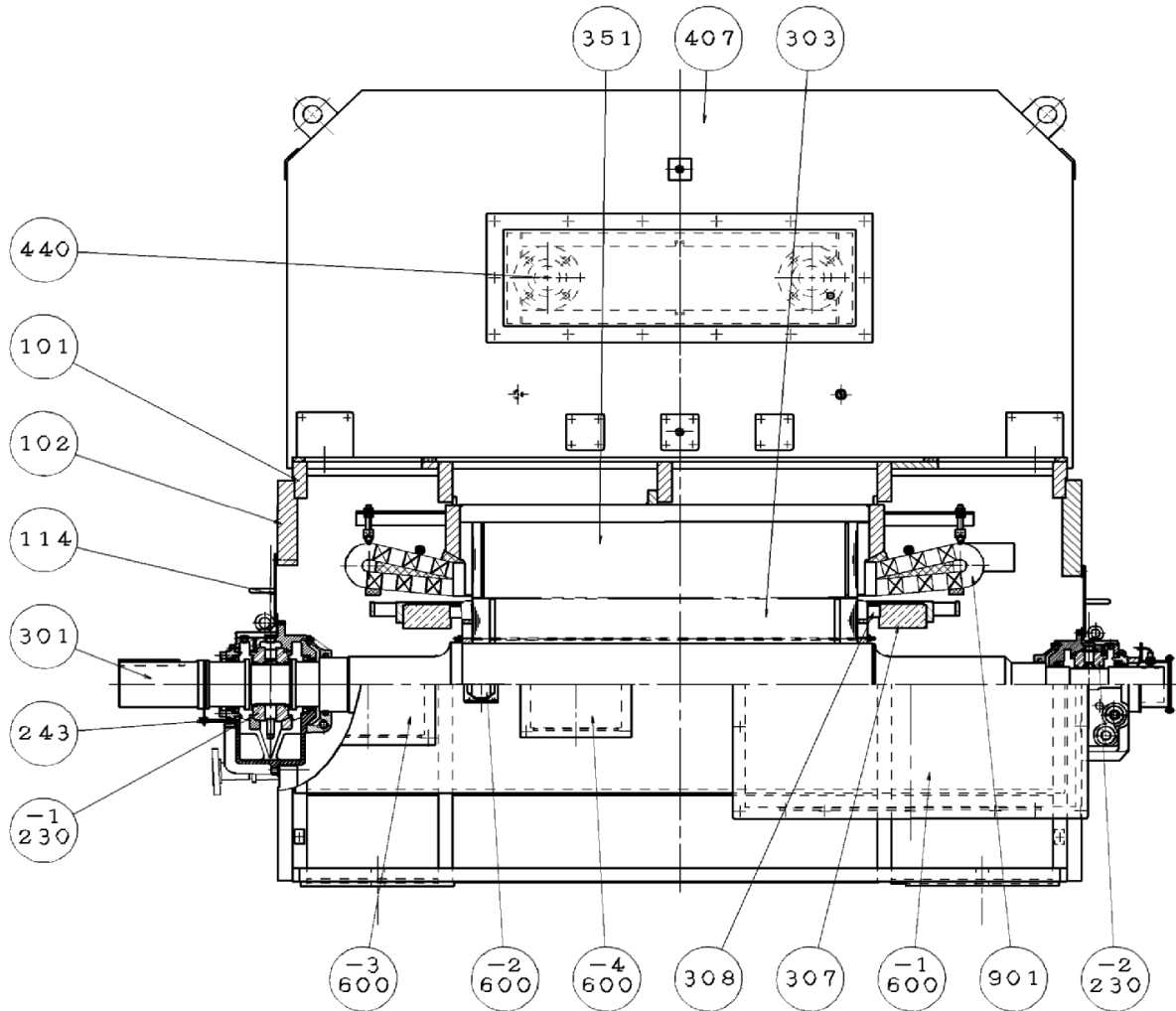
Item	Name	Item	Name
101	Frame	401	Inner Fan
102	Bracket	402	External Fan
114	Cover (Bracket)	407 <sup>-1</sup>	Fan Cover
230 <sup>-1</sup>	Sleeve Bearing Assembly (L)	407 <sup>-2</sup>	Fan Cover
230 <sup>-2</sup>	Sleeve Bearing Assembly (F)	412	Cooler
243	Magnetic Center Indicator	600 <sup>-1</sup>	Primary T-box
301	Shaft	600 <sup>-2</sup>	Winding R.T.D. T-box
303	Rotor Core	600 <sup>-3</sup>	Space Heater T-box
307	End Ring-R	600 <sup>-4</sup>	Bearing R.T.D. T-box
308	Rotor Bar	901	3 Phase Stator Winding
351	Stator Core		

## Appendix 4-2. Typical motor cross sectional drawings : SCIM, TEAAC



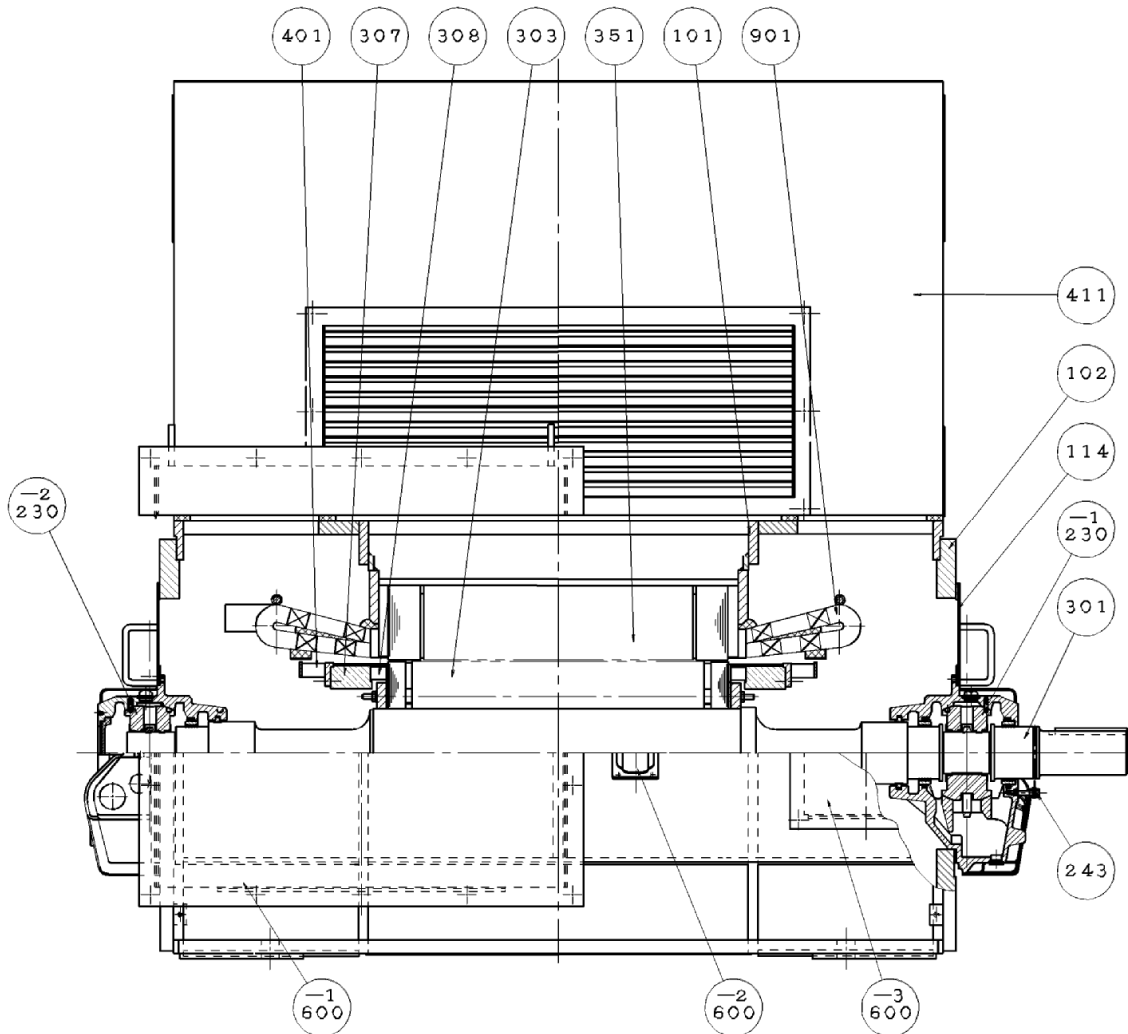
Item	Name	Item	Name
01	FAN COVER	12	LOWER BEARING
02	EXTERNAL FAN	13	OIL DRAIN COVER ASSY
03	OIL BAFFLE	14	LK NUT
04	COVER	15	RATCHET PIN CARRIER
05	BEARING HOUSING	16	RATCHET
06	BRACKET	17	BEARING SEAT
07	SCORE	18	SPRING
08	COOLER	19	OIL SEPARATOR
09	ROTOR	20	UPPER BEARING
10	FLANGE BRACKET	21	SCREWED GLOBE VALVE
11	GREASE PIPE		

## Appendix 5. Typical motor cross sectional drawings : SCIM, TEWAC



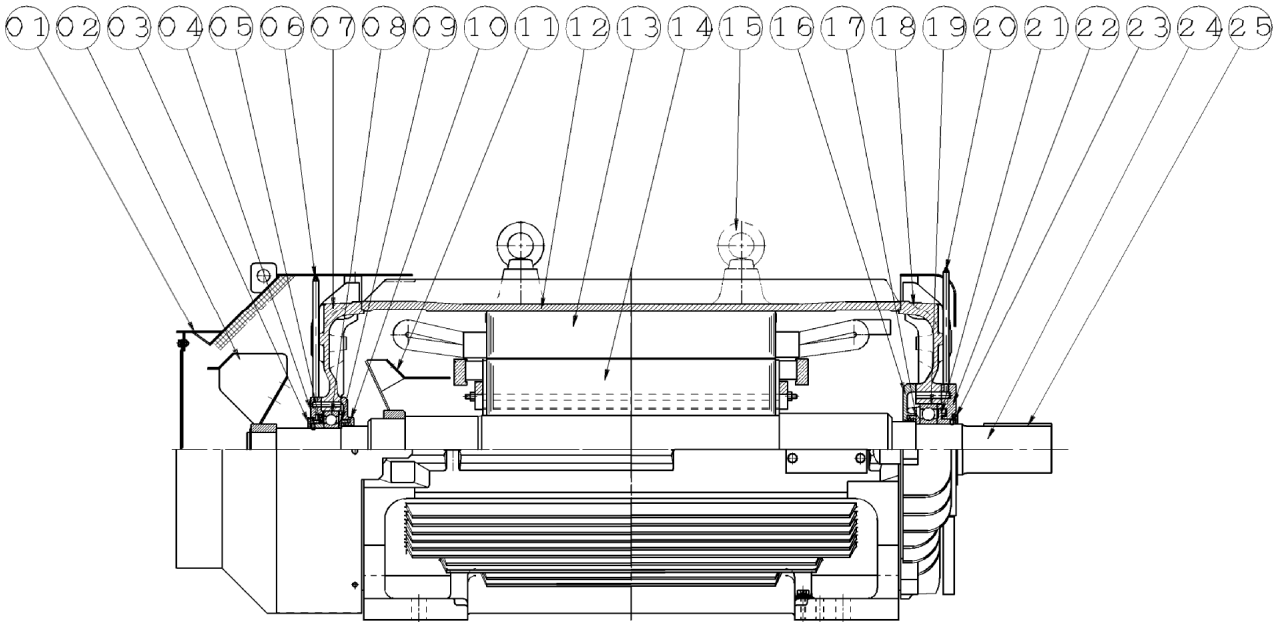
Item	Name	Item	Name
101	Frame	308	R Bar
102	Bracket	351	S Core
114	Cover	407	Air Cabinet
230 <sup>-1</sup>	Sleeve Bearing Assembly (L)	440	Heat Exchanger
230 <sup>-2</sup>	Sleeve Bearing Assembly (F)	600 <sup>-1</sup>	Primary T-box
243	Magnetic Center Indicator	600 <sup>-2</sup>	Space Heater T-box
301	Shaft	600 <sup>-3</sup>	Winding R.T.D. T-box
303	R Core	600 <sup>-4</sup>	Rotation Direction T-box
307	End Ring-R	901	3 Phase Stator Winding

## Appendix 6. Typical motor cross sectional drawings : SCIM, WP II



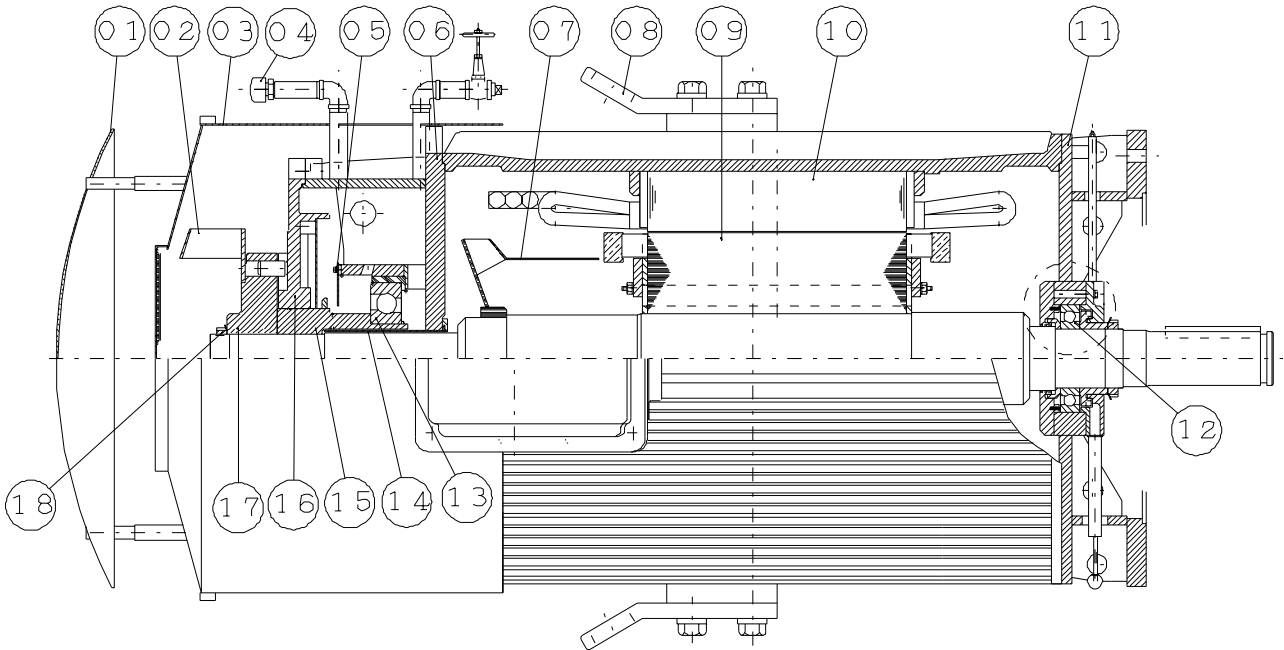
Item	Name	Item	Name
101	Frame	308	R Bar
102	Bracket	351	S Core
114	Cover (Bracket)	401	Inner Fan
230 <sup>-1</sup>	Sleeve Bearing Assembly (L)	411	(WP II) Silencer
230 <sup>-2</sup>	Sleeve Bearing Assembly (F)	600 <sup>-1</sup>	Primary T-box
243	Magnetic Center Indicator	600 <sup>-2</sup>	Space Heater T-box
301	Shaft	600 <sup>-3</sup>	Winding R.T.D. T-box
303	Rotor Core	901	3 Phase Stator Winding
307	End Ring-R		

## Appendix 7-1. Typical motor cross sectional drawings : SCIM, TEFC



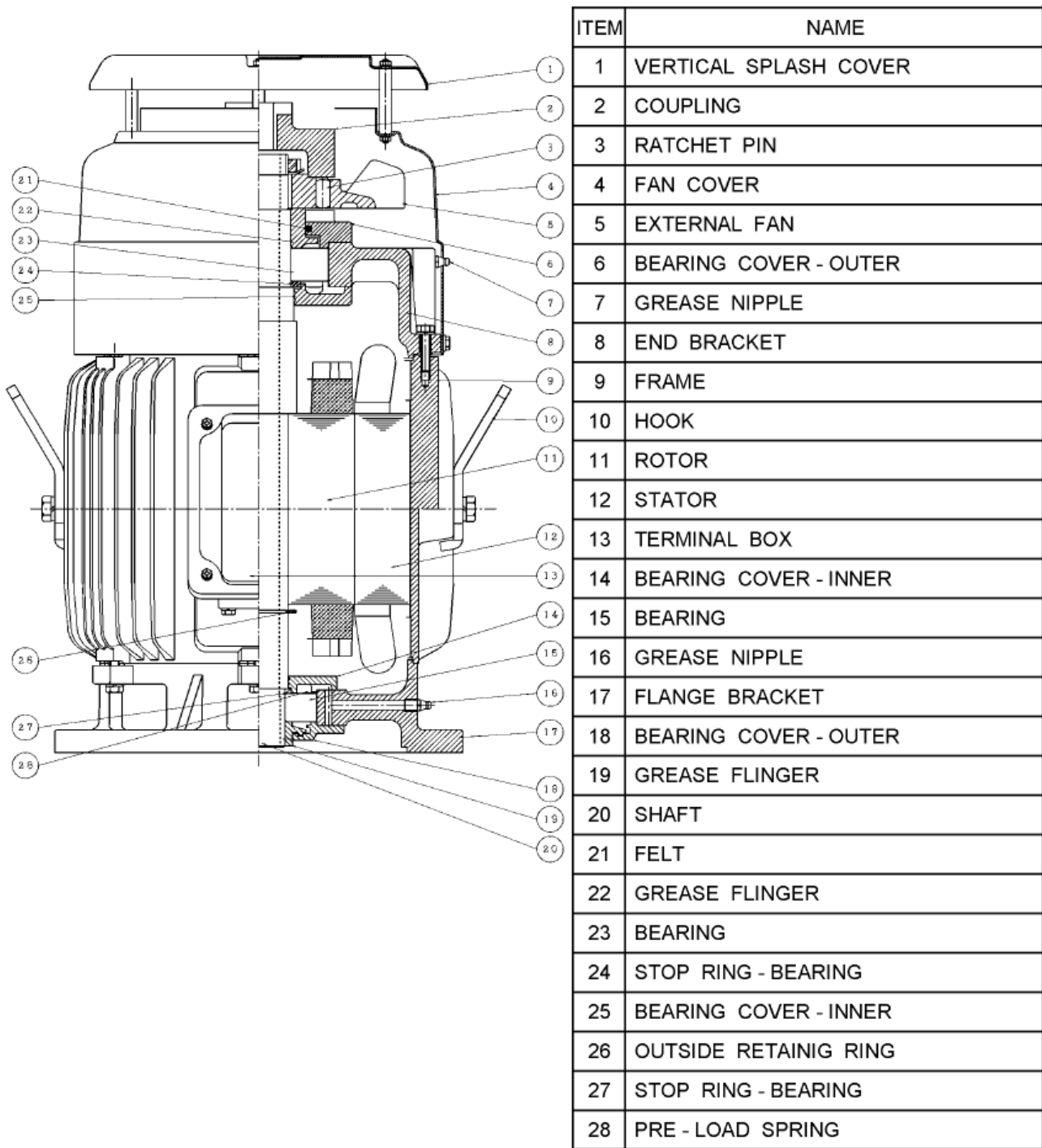
Item	Name	Item	Name
01	FAN COVER(N.D.E)	14	ROTOR
02	EXTERRAL FAN	15	EYE BOLT
03	DUST FLINGER	16	BEARING COVER-INNER
04	BEARING COVER-OUTER	17	GREASE FLINGER
05	GREASE FLINGER	18	END BRACKET
06	GREASE NIPPLE	19	BEARING
07	END BRACKET	20	GREASE NIPPLE
08	BEARING	21	GREASE FLINGER
09	GREASE FLINGER	22	BEARING COVER-OUTER
10	BEARING COVER-INNER	23	DUST FLINGER
11	INNER FAN	24	SHAFT
12	FRAME	25	SHIFT END KEY
13	STATOR		

## Appendix 7-2. Typical motor cross sectional drawings : SCIM, TEFC

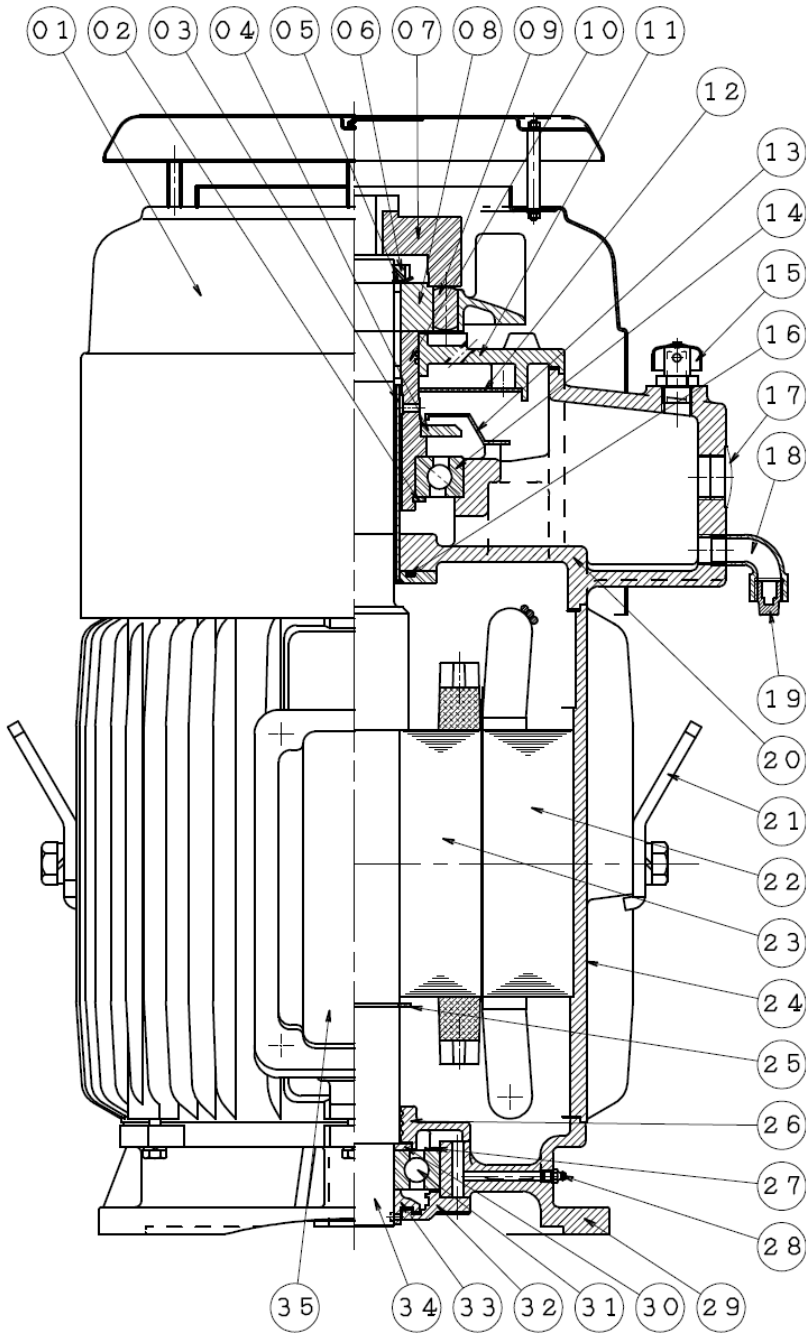


Item	Name	Item	Name
01	FAN COVER(N.D.E)	11	FLANGE BRACKET
02	EXTERNAL FAN	12	LOWER BEARING
03	VERTICAL PLASH COVER	13	UPPER BEARING
04	PLUG	14	OIL SEPARATOR
05	COVER	15	BEARING SEAT
06	INSULATION BRACKET	16	RATCHET
07	INNER FAN	17	RATCHET PIN CARRIER
08	HOOK	18	LK NUT
09	ROTOR		
10	S CORE		

### Appendix 7-3. Typical motor cross sectional drawings : SCIM, TEFC

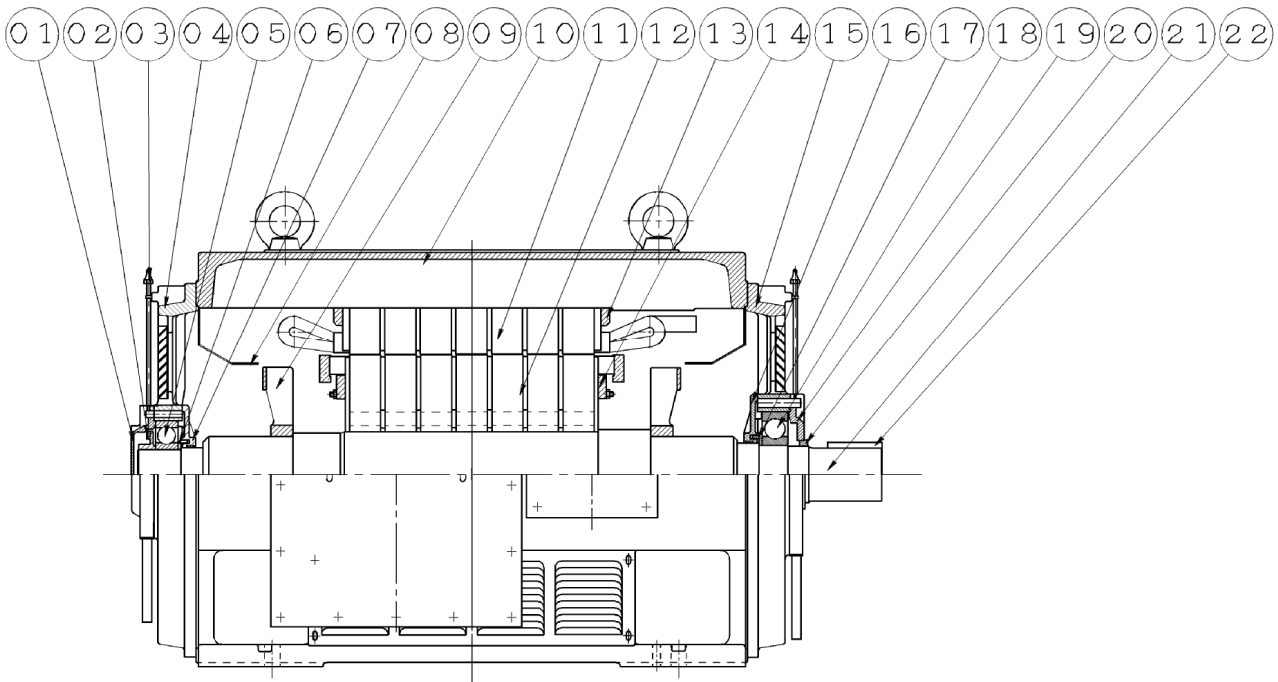


Appendix 7-4. Typical motor cross sectional drawings : SCIM, TEFC



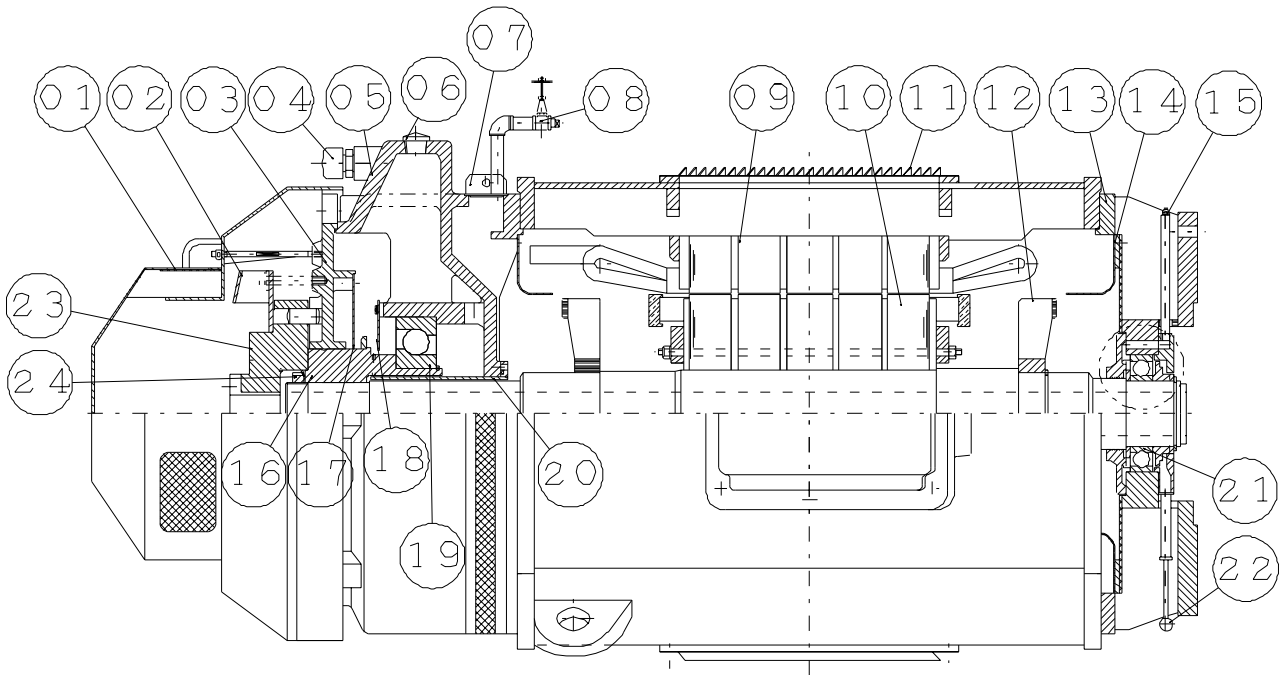
35	TERMINAL BOX
34	SHAFT
33	GREASE FLINGER
32	BEARING COVER-OUTER
31	BEARING
30	STOP RING-BEARING
29	FLANGE BRACKET
28	GREASE NIPPLE
27	PRE-LOAD SPRING
26	BEARING COVER-INNER
25	OUTSIDE RETAINING RING
24	FRAME
23	ROTOR ASSY
22	STATOR
21	HOOK
20	BRACKET
19	PLUG BOLT
18	SERRET ELBOW
17	OIL GAUGE
16	O RING
15	PLUG
14	BEARING
13	OIL BAFFLE
12	OIL BAFFLE
11	RATCHET
10	BEARING SEAT
09	RATCHET PIN
08	EXTERNAL FAN
07	COUPLING
06	LK NUT
05	LK WASHER
04	OIL BAFFLE
03	OIL SEPARATOR
02	OUTSIDE RETAINING RING
01	WEATHER COVER
ITEM	NAME

### Appendix 8-1. Typical motor cross sectional drawings : ODP



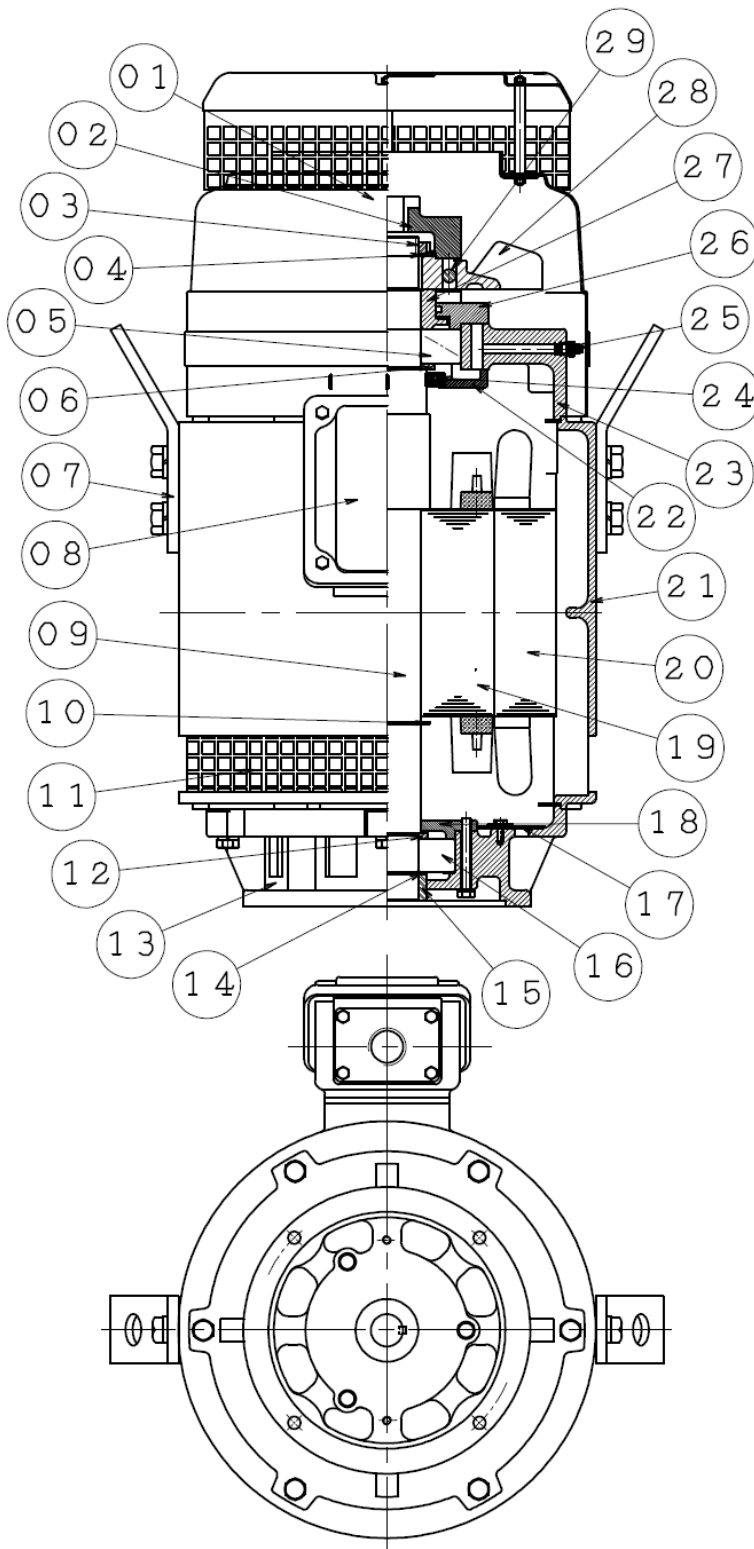
Item	Name	Item	Name
01	BEARING COVER-OUTER	12	R CORE
02	GREASE FLINGER	13	RETAINER RING-S
03	GREASE NIPPLE	14	RETAINER RING-R
04	BRACKET	15	BRACKET
05	BEARING	16	BEARING COVER-INNER
06	STOP RING-BEARING	17	STOP RING-BEARING
07	BEARING COVER-INNER	18	BEARING
08	AIR GUIDE	19	BEARING COVER-OUTER
09	INNER FAN	20	INPRO SEAL
10	FRAME	21	SHAFT
11	S CORE	22	KEY

## Appendix 8-2. Typical motor cross sectional drawings : ODP



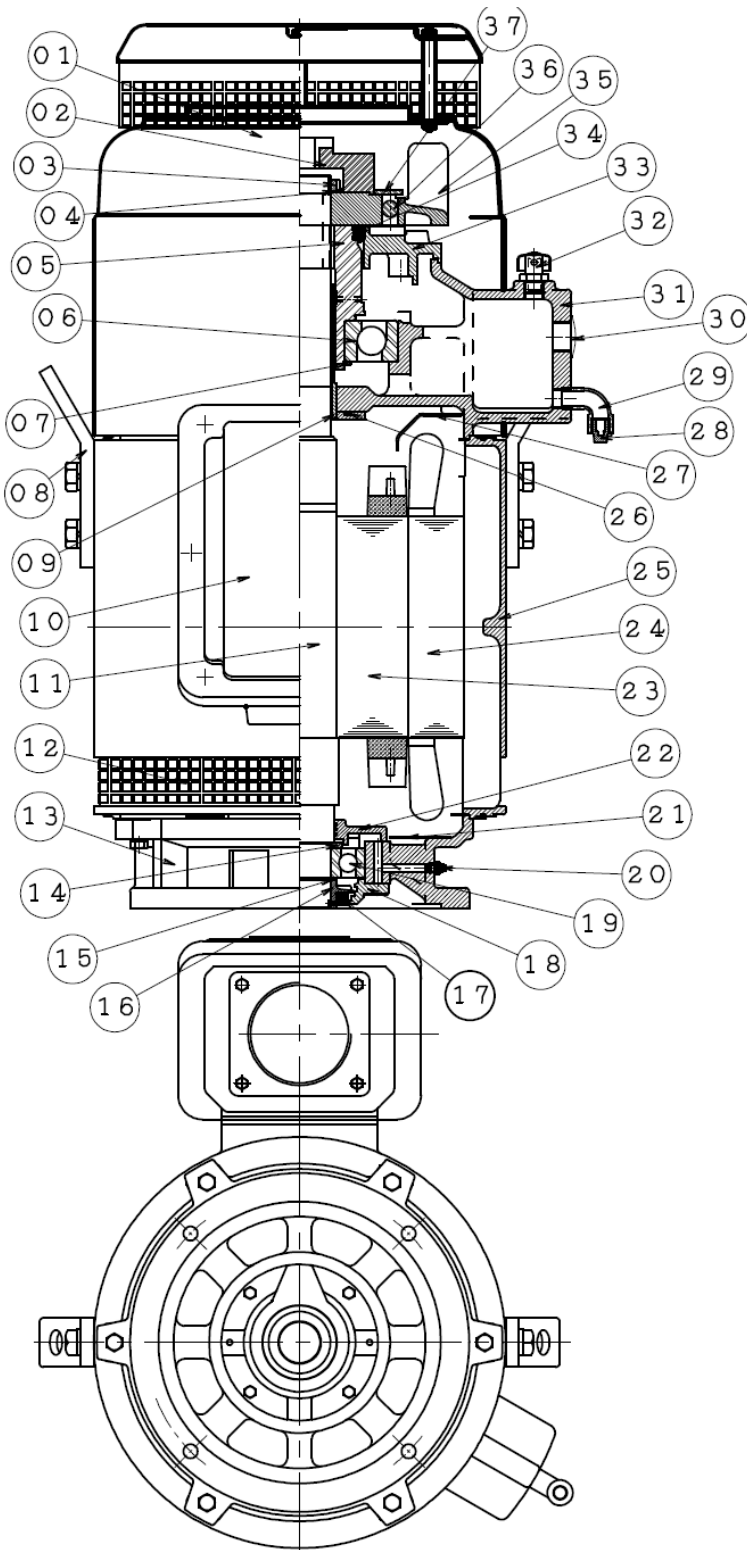
Item	Name	Item	Name
01	FAN COVER	13	FLANGE BRACKET
02	EXTERNAL FAN	14	AIR GUIDE
03	RATCHET	15	GREASE NIPPLE
04	PLUG	16	BEARING SEAT
05	BRACKET	17	OIL BAFFLE
06	OIL GAUGE	18	COVER
07	WINDOW COVER	19	UPPER BEARING
08	SCREWED GLOBE VALVE	20	OIL SEPARATOR
09	S CORE	21	LOWER BEARING
10	ROTOR	22	OIL DRAIN COVER ASSY
11	WINDOW	23	COUPLING
12	INNER FAN	24	LK NUT

### Appendix 8-3. Typical motor cross sectional drawings : ODP



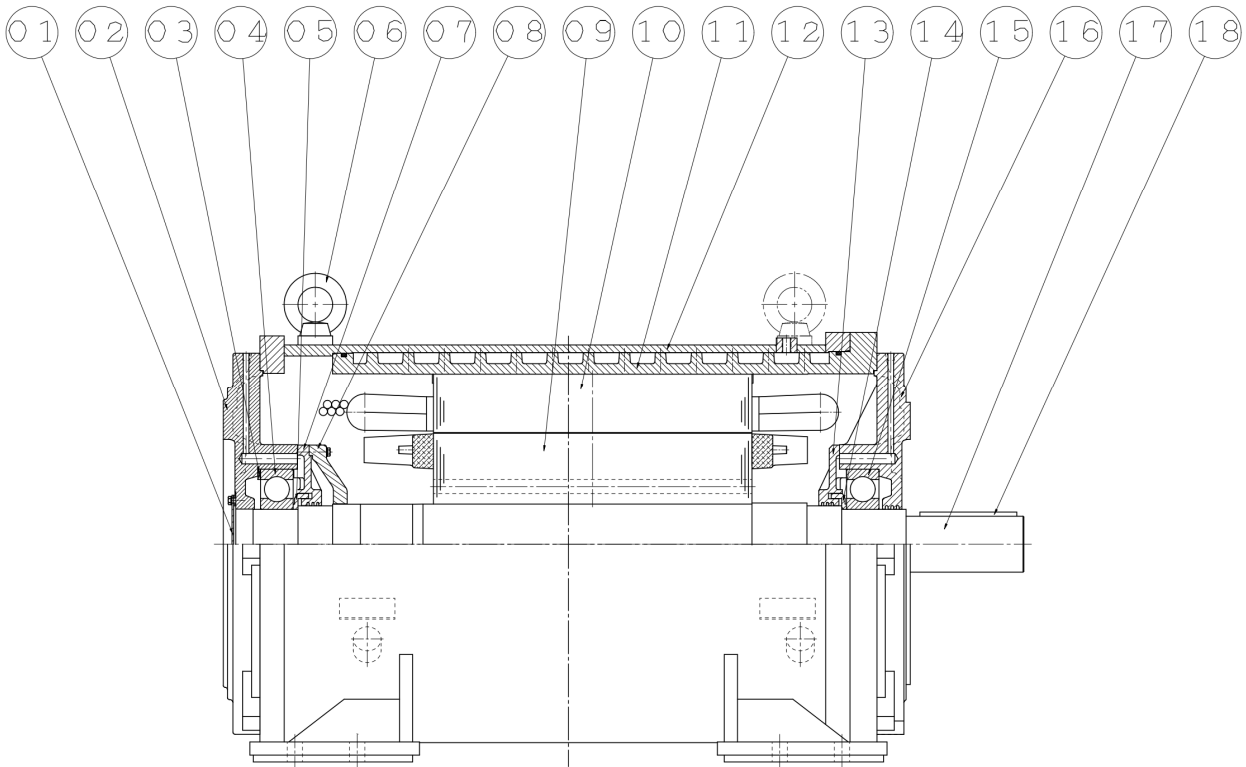
ITEM	NAME
01	WEATHER COVER
02	COUPLING
03	LK NUT
04	LK WASHER
05	BEARING
06	STOP RING-BEARING
07	HOOK
08	TERMINAL BOX
09	SHAFT
10	OUTSIDE RETAINING RING
11	SCREEN
12	STOP RING-BEARING
13	FLANGE BRACKET
14	OUTSIDE RETAINING RING
15	SHAFT SLEEVE
16	BEARING
17	SCREEN
18	BEARING COVER-INNER
19	ROTOR
20	STATOR
21	FRAME
22	BEARING COVER-INNER
23	BRACKET
24	OIL SEAL
25	GREASE NIPPLE
26	BEARING COVER-OUTER
27	GREASE FLINGER
28	EXTERNAL FAN
29	RATCHET PIN(BALL TYPE)

Appendix 8-4. Typical motor cross sectional drawings : ODP



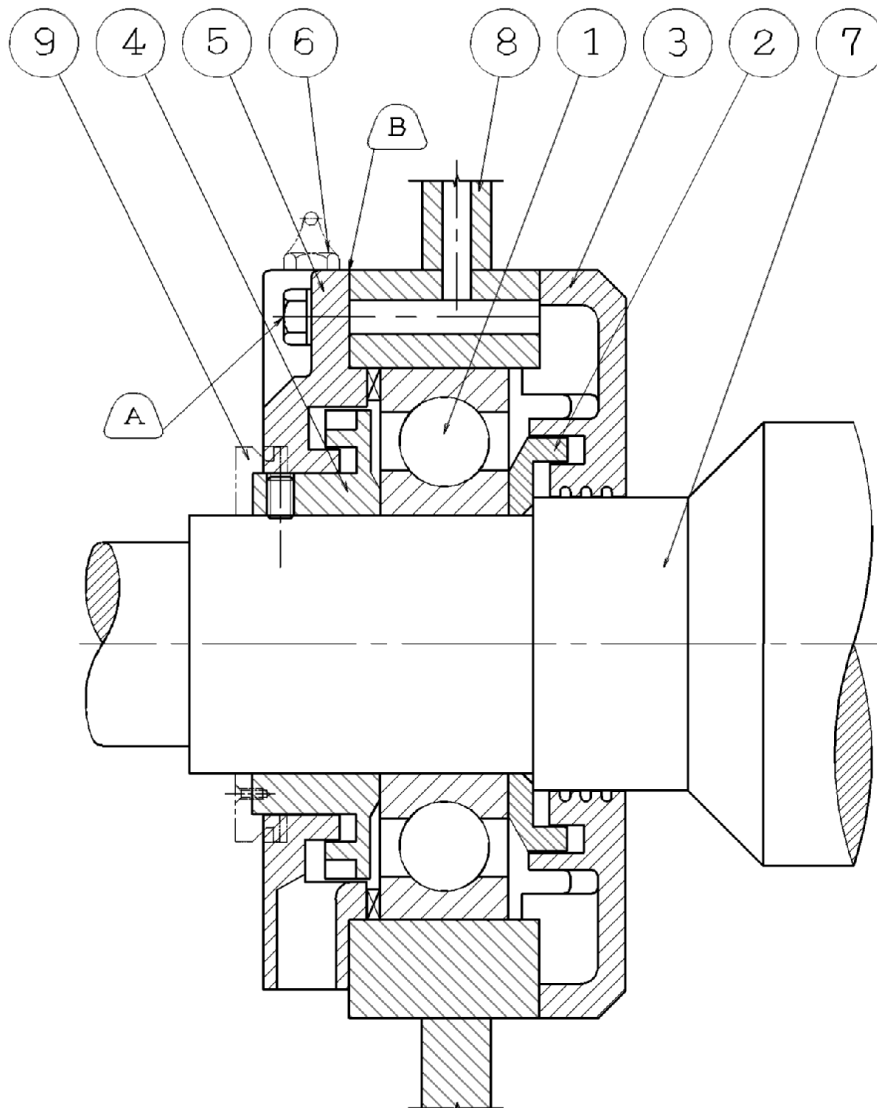
ITEM	NAME
01	WEATHER COVER
02	COUPLING
03	LK NUT
04	LK WASHER
05	BEARING SEAT
06	BEARING
07	OUTSIDE RETAINING RING
08	HOOK
09	OIL SEPARATOR
10	TERMINAL BOX
11	SHAFT
12	SCREEN
13	FLANGE BRACKET
14	STOP RING-BEARING
15	OUTSIDE RETAINING RING
16	GREASE FLINGER
17	OIL SEAL
18	BEARING COVER-OUTER
19	BEARING
20	GREASE NIPPLE
21	SCREEN
22	BEARING COVER-INNER
23	ROTOR
24	STATOR
25	FRAME
26	O-RING
27	AIR GUIDE
28	PLUG
29	SEREET ELBOW
30	OIL GAUGE
31	BRACKET
32	PLUG
33	RATCHET
34	OIL SEAL
35	EXTERNAL FAN
36	RATCHET PIN(BALL TYPE)
37	COVER

## Appendix 9. Typical motor cross sectional drawings : SCIM, TEWC



Item	Name	Item	Name
01	COVER	10	S CORE
02	FLANGE-BRACKET	11	FRAME-INNER
03	PRE-LOAD SPRING	12	FRAME-OUTER
04	BEARING	13	BEARING COVER-INNER
05	GREASE FLINGER	14	GREASE FLINGER
06	EYE BOLT	15	BEARING
07	BEARING COVER-INNER	16	FLANGE BRACKET
08	BEARING COVER-INNER	17	SHAFT
09	ROTOR	18	KEY

## Appendix 10. Typical ball bearing construction drawing

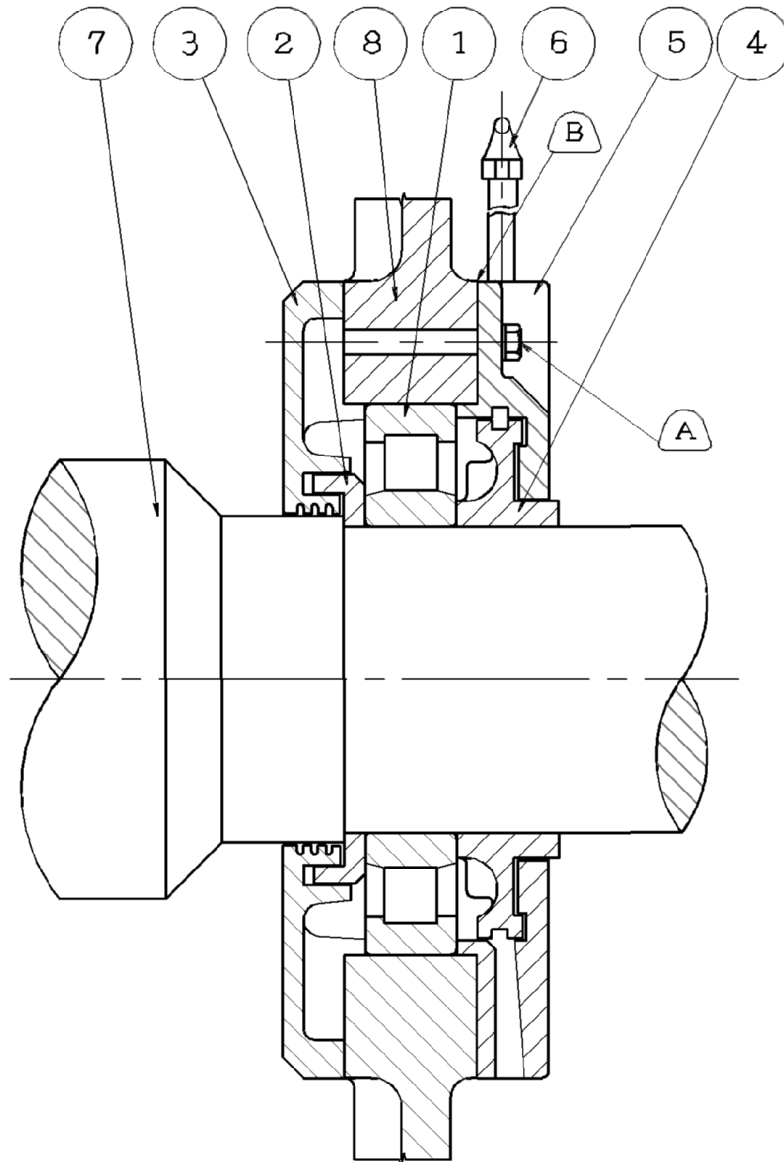


Item	Name	Item	Name
1	Ball Bearing	6	Grease Nipple & Pipe
2	Grease Flinger-Inner	7	Shaft
3	Bearing Cover-Inner	8	Bracket
4	Grease Flinger-Outer	9	Dust Flinger
5	Bearing Cover-Outer		

Please be noted :

1. Use sealing compound on screws (A) and the surface between parts (B).
2. In order to avoid abnormal bearing noise, please fill new grease as full as possible between races during the change process of bearing.

## Appendix 11. Typical roller bearing construction drawing

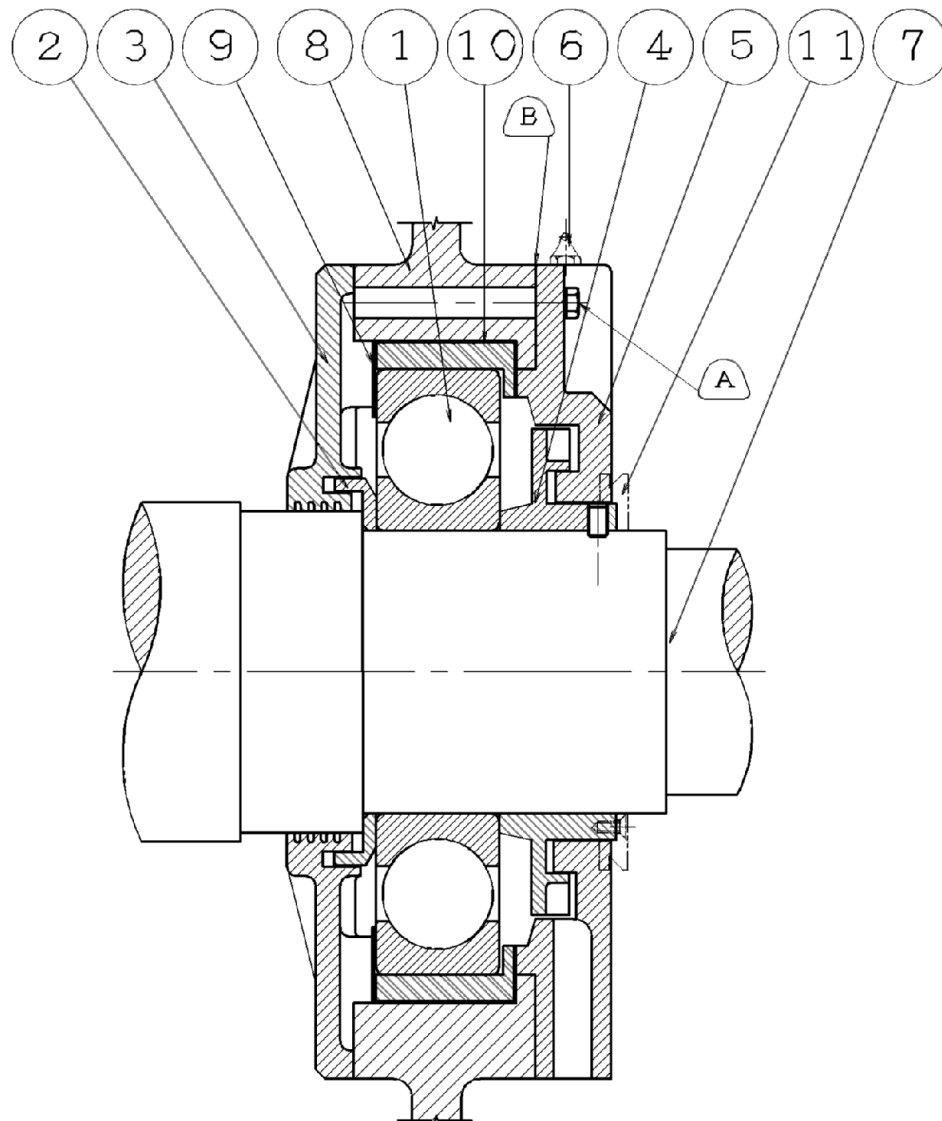


Item	Name	Item	Name
1	Roller Bearing	5	Bearing Cover-Outer
2	Grease Flinger-Inner	6	Grease Nipple & Pipe
3	Bearing Cover-Inner	7	Shaft
4	Grease Flinger-Outer	8	Bracket

Please be noted :

1. Use sealing compound on screws (A) and the surface between parts (B).
2. In order to avoid abnormal bearing noise, please fill new grease as full as possible between races during the change process of bearing.

## Appendix 12. Typical ball bearing with insulation bushing construction drawing

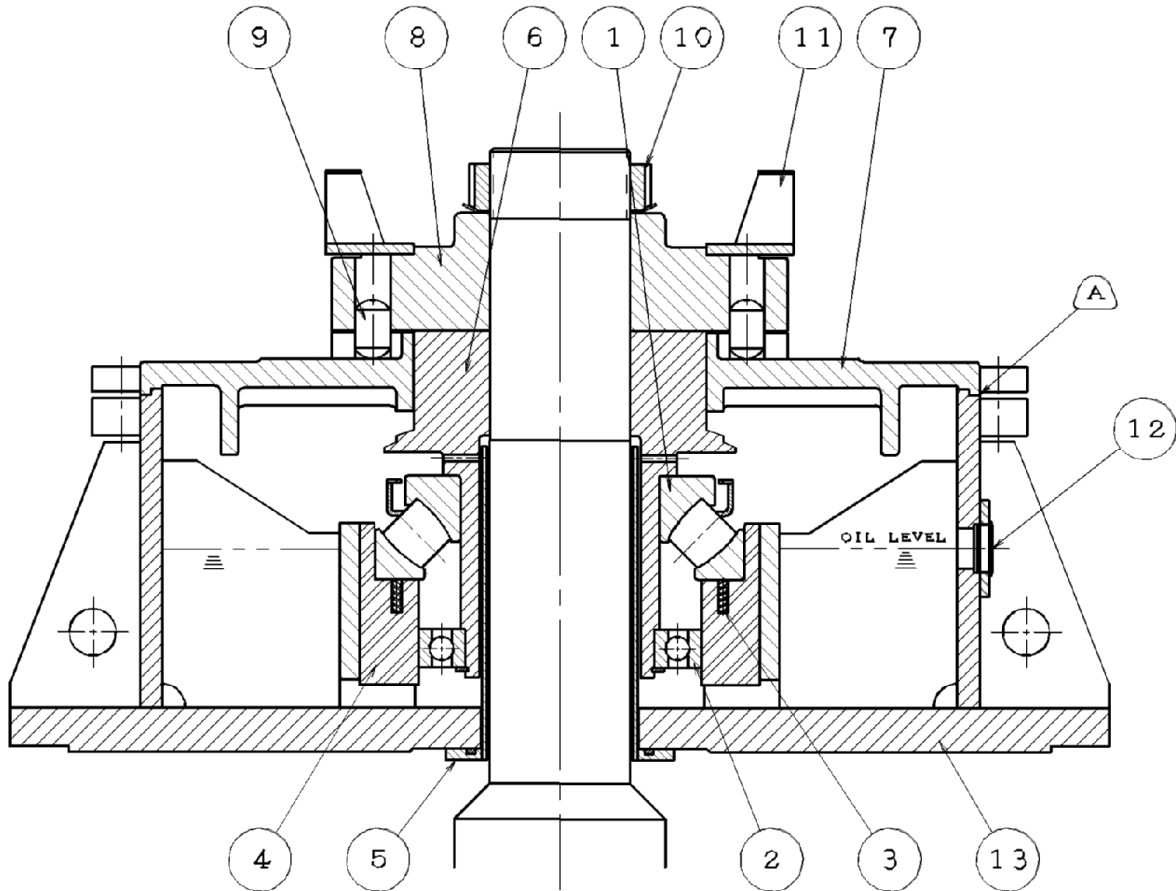


Item	Name	Item	Name
1	Ball Bearing	7	Shaft
2	Grease Flinger-Inner	8	Bracket
3	Bearing Cover-Inner	9	Insulation Plate
4	Grease Flinger-Outer	10	Insulation Bushing
5	Bearing Cover-Outer	11	Dust Flinger
6	Grease Nipple & Pipe		

Please be noted :

1. Use sealing compound on screws (A) and the surface between parts (B).
2. In order to avoid abnormal bearing noise, please fill new grease as full as possible between races during the change process of bearing.

### Appendix 13. Typical thrust bearing assembly drawing (vertical machine)

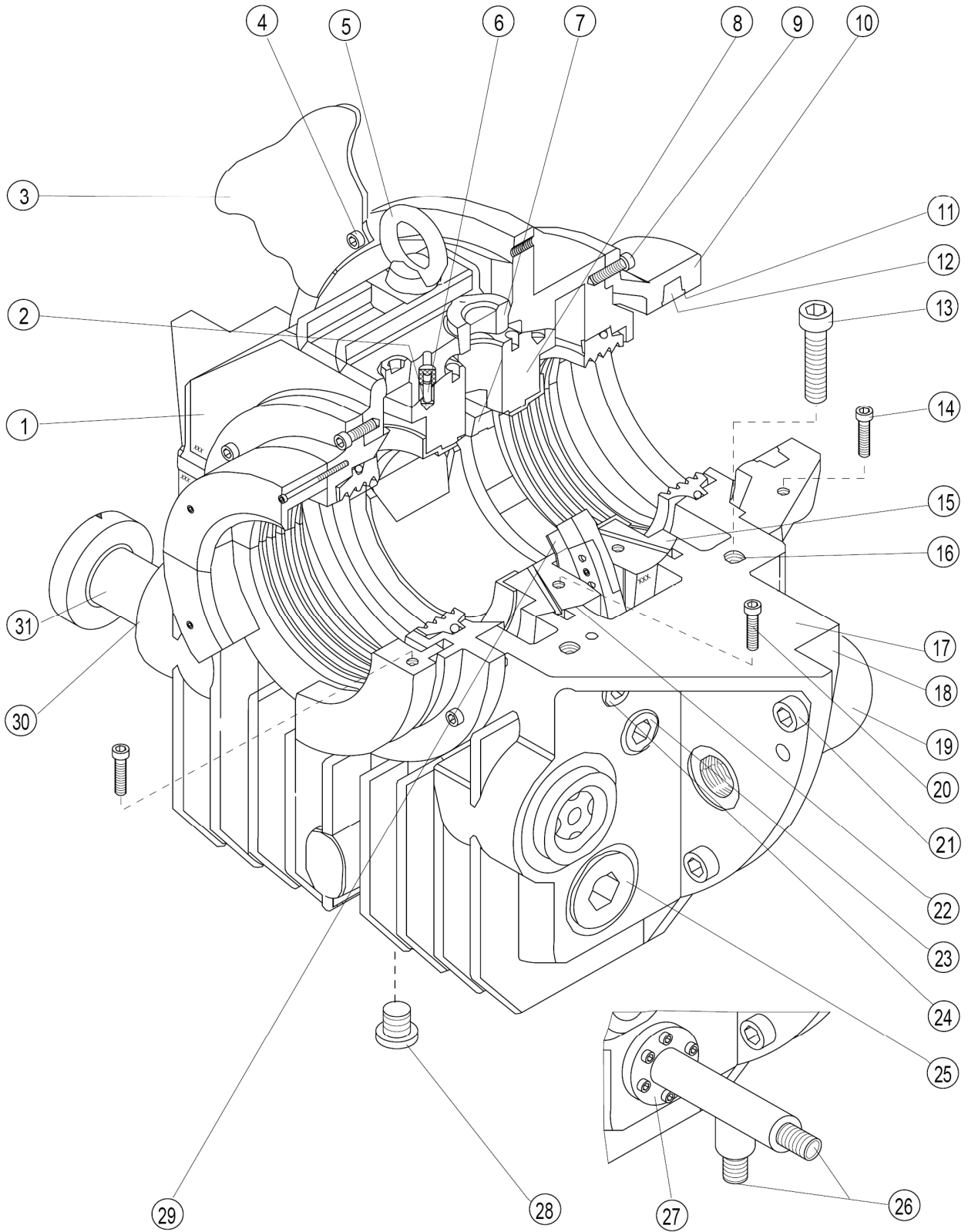


Item	Name	Item	Name
1	Thrust Bearing	8	Ratchet Pin Carrier
2	Ball Bearing	9	Ratchet Pin
3	Spring	10	Lock Nut
4	Insulation Bushing	11	External Fan
5	Oil Standpipe	12	Oil Lever Gauge
6	Upper Bearing Runner	13	Upper Bracket
7	Non-Reverse Ratchet		

Please be noted :

Use sealing compound on spigot of oil tank (A), between non-reverse ratchet (item 7) and upper bracket (item 13).

Appendix 14. Sleeve bearing construction



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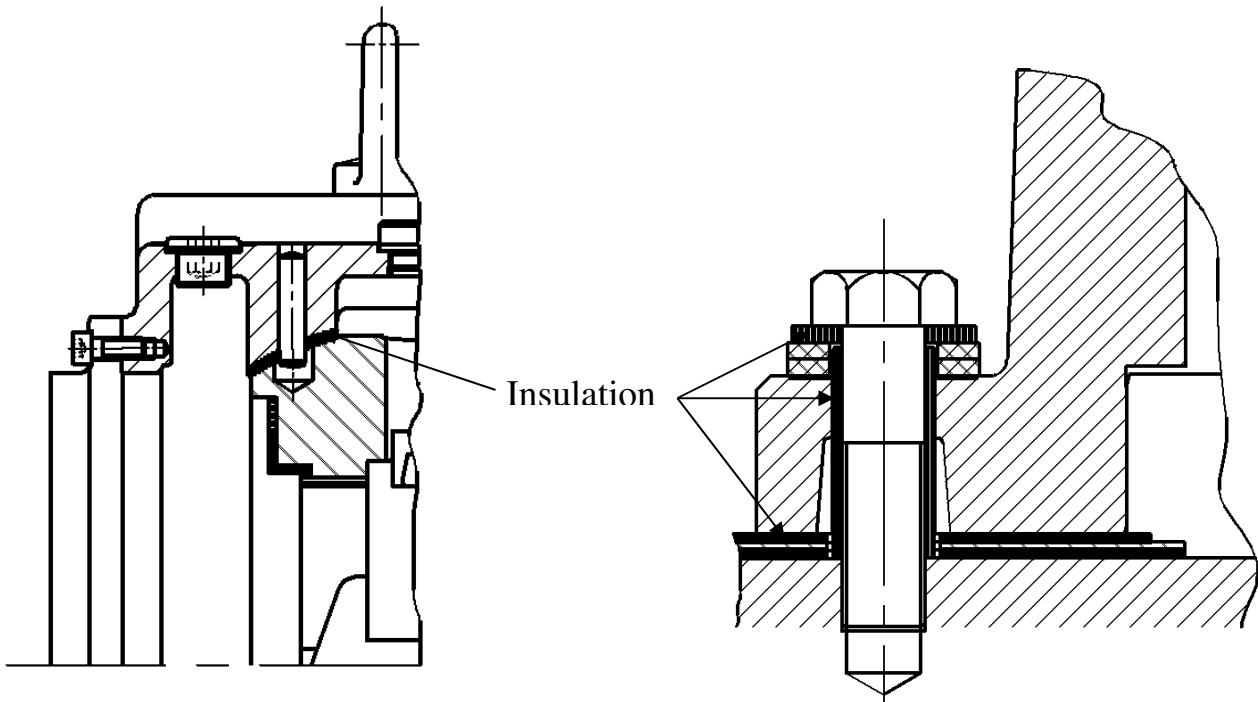
**Appendix 14. Sleeve bearing construction (continue)**

<b>Item</b>	<b>Name</b>	<b>Item</b>	<b>Name</b>
<b>1</b>	<b>Top half of the housing</b>	<b>2</b>	<b>Positioning pin nut</b>
<b>3</b>	<b>Plate ( Assembly opening )</b>	<b>4</b>	<b>Screw</b>
<b>5</b>	<b>Eye bolt</b>	<b>6</b>	<b>Positioning pin</b>
<b>7</b>	<b>Top sight glass</b>	<b>8</b>	<b>Top half of the shell</b>
<b>9</b>	<b>Screw</b>	<b>10</b>	<b>Machine seal</b>
<b>11</b>	<b>Hemp packing seal groove</b>	<b>12</b>	<b>Hemp packing</b>
<b>13</b>	<b>Screw(split line of the housing)</b>		
<b>14</b>	<b>Screw (split line of the machine seal)</b>		
<b>15</b>	<b>Bottom half of the shell</b>	<b>16</b>	<b>Tapped hole</b>
<b>17</b>	<b>Bottom half of the housing</b>	<b>18</b>	<b>Recess</b>
<b>19</b>	<b>Pressure equalizing hose</b>	<b>20</b>	<b>Screw (split line of the shell)</b>
<b>21</b>	<b>Screw</b>	<b>22</b>	<b>Spherical seating</b>
<b>23</b>	<b>Tapped hole for temperature measurement of the journal part</b>		
<b>24</b>	<b>Oil inlet connection hole</b>		
<b>25</b>	<b>Tapped hole for the oil sump temperature measurement</b>		
<b>26</b>	<b>Outlet/Inlet cooling water (optional)</b>		
<b>27</b>	<b>Cooler (optional)</b>		
<b>28</b>	<b>Hexagon head plug (Oil drain plug)</b>		
<b>29</b>	<b>Metal tabs ( optional for EMZL. )</b>		
<b>30</b>	<b>Oil outlet connection hole</b>		
<b>31</b>	<b>Oil outlet pipe</b>		

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## Appendix 15. Mounting of Insulated Sleeve Bearings

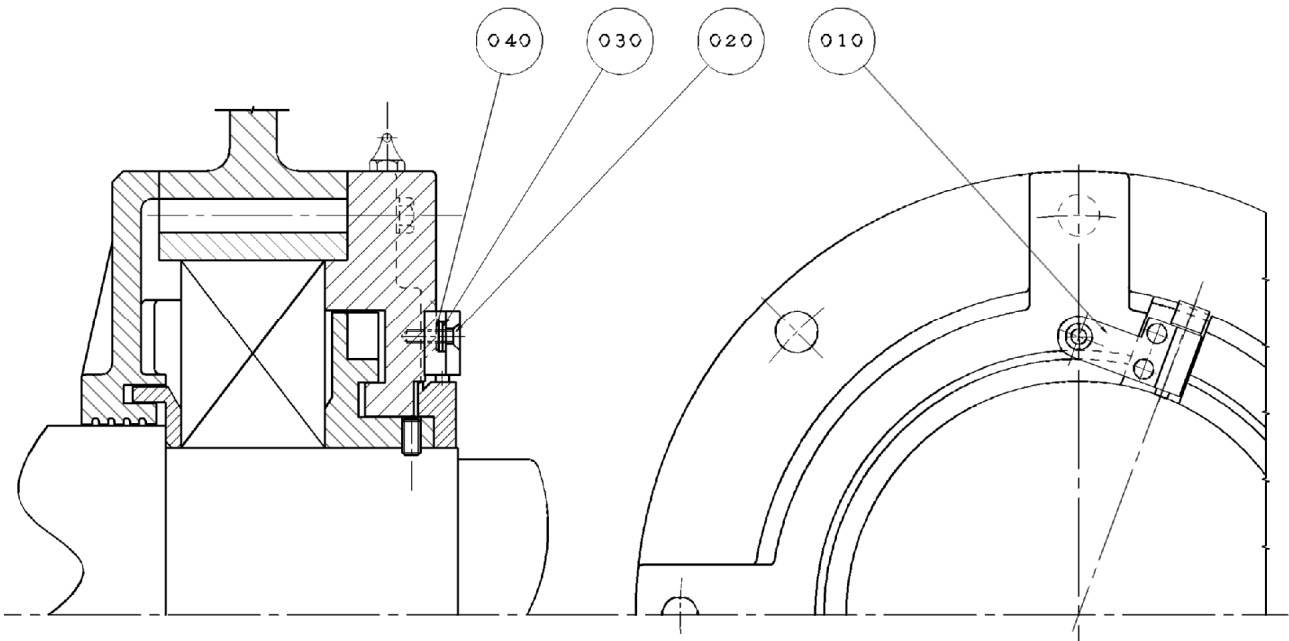


Please be noted :

Generally, a pedestal bearing is insulated by means of insulating washers or insulating bushes. (Right hand side of drawing)

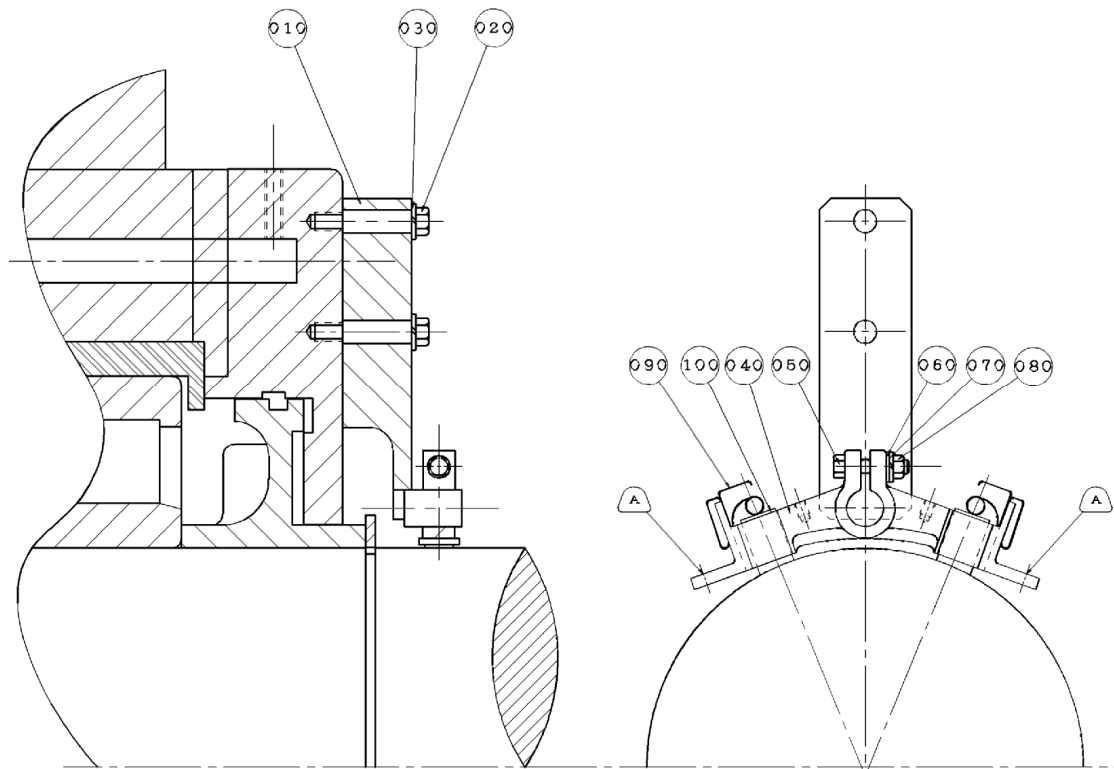
Upon request insulated E bearings can be supplied. In this case the spherical seating which accommodates the bearing shell is covered with a non-conductive plastic foil. (Left hand side of drawing)

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**Appendix 16. Shaft earth brush assembly drawing (Type I)**

<b>Item</b>	<b>Name</b>	<b>Item</b>	<b>Name</b>
<b>010</b>	<b>Brush</b>	<b>030</b>	<b>Plain Washer</b>
<b>020</b>	<b>CR C SCREW</b>	<b>040</b>	<b>T Lock Washer</b>

## Appendix 17. Shaft earth brush assembly drawing (Type II)



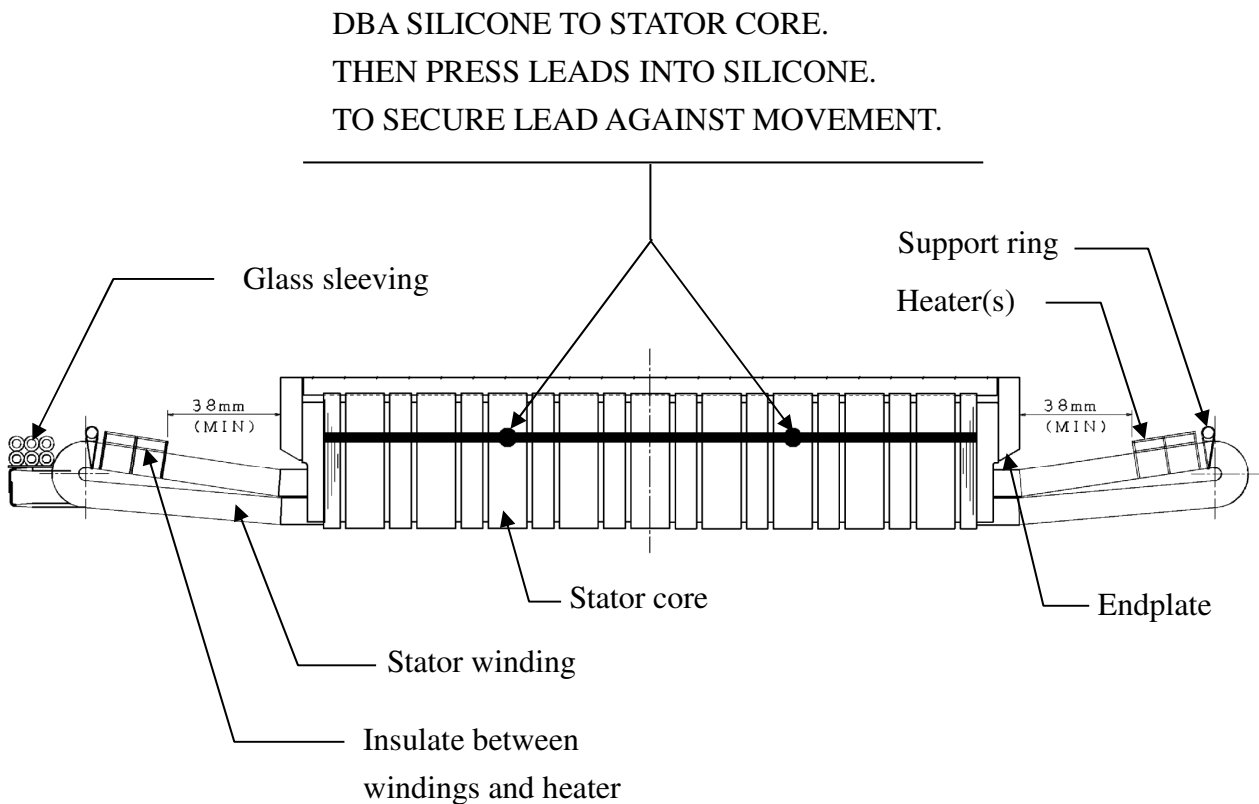
Item	Name	Item	Name
010	Support	060	Plain Washer
020	Hex Bolt	070	S Washer
030	S Washer	080	Hex Nut
040	Brush Holder	090	Brush Spring Assembly
050	Hex Bolt	100	Brush

Please be noted :

Directly connect grounding by a separate wire between one of M6 tap holes (A) on brush holder (item 040) and earth is highly recommended.

## Appendix 18. Space heater disassemble and reassemble

- (1) Cut all of original space heaters and carefully remove it from surface of winding taking care not to damage the winding insulation.
- (2) Place insulation material between the stator windings and heater. Then fit heaters to windings (one or more heaters each end as original).
- (3) Lash securely to winding with a maximum space of 200mm between tie points.
- (4) A heater must not overlap itself or an adjacent heater.
- (5) Tie heaters as shown in ref sketches.
- (6) Insulate all connections and bring out heater leads as needed.



### Appendix 19-1. Bolt Torque (kg-cm)

BOLT SIZE	THREAD PITCH	MILD STEEL (Property class 4.6 or 4.8)		TERMINAL
		WITHOUT SPRING WASHER	WITH SPRING WASHER	
M4	0.7	25~34	10~13	10~23
M5	0.8	38~52	20~25	20~25
M6	1.0	68~97	40~50	40~50
M8	1.25	161~230	90~110	90~110
M10	1.5	288~416	180~230	180~230
M12	1.75	462~660	320~400	320~400
M16	2.0	1,010~1,440	800~1,000	800~1,000
M20	2.5	2,100~3,000	1,600~2,000	1,600~2,000
M24	3.0	3,800~5,400	2,800~3,500	2,800~3,500
M30	3.5	8,000~11,500	5,800~7,250	5,800~7,250
M36	4.0	14,000~20,000	1,0000~12500	10,000~12,500

BOLT SIZE	THREAD PITCH	BRASS	Cr-Mo ALLOY STEEL (SCM3) (Property class 8.8)	
		WITHOUT SPRING WASHER	WITHOUT SPRING WASHER	WITH SPRING WASHER
M4	0.7	8.4~11.3	45~61	18~23
M5	0.8	16.2~22.0	68~94	36~45
M6	1.0	28~38	122~175	70~90
M8	1.25	68~91	290~414	160~200
M10	1.5	125~183	518~749	320~410
M12	1.75	230~310	832~1,190	580~720
M16	2.0	560~760	1,820~2,590	1,400~1,800
M20	2.5	1,090~1,470	3,800~5,400	2,900~3,600
M24	3.0	1,870~2,500	6,800~9,700	5,000~6,300
M30	3.5	3,800~5,100	14,400~20,700	10,400~13,000
M36	4.0	6,500~8,800	25,000~36,000	18,000~22,500

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**Appendix 19-2. Imperial Bolt Torque Specifications (continue) (Ft-Lb)**

Size	Threads	Grade5 (3 Radial Line)		Grade8 (5 Radial Line)	
		Dry	Lub.	Dry	Lub.
1/4	20UNC	8	8	12	9
1/4	28UNF	10	10	14	10
5/16	18UNC	17	17	25	19
5/16	24UNF	19	19	27	20
3/8	16UNC	31	31	43	32
3/8	24UNF	35	26	49	37
7/16	14UNC	49	37	70	52
7/16	20UNF	55	41	78	58
1/2	13UNC	75	56	107	80
1/2	20UNF	85	64	120	90
9/16	12UNC	109	82	154	115
9/16	18UNF	121	91	171	128
5/8	11UNC	150	112	212	159
5/8	18UNF	170	127	240	180
3/4	10UNC	266	199	376	282
3/4	16UNF	297	223	420	315
7/8	9UNC	394	295	608	456
7/8	14UNF	434	325	669	502
1	8UNC	591	443	911	683
1	14UNS	646	484	996	747
1-1/8	7UNC	794	595	1,290	967
1-1/8	12UNF	891	668	1,448	1,086
1-1/4	7UNC	1,120	840	1,821	1,386
1-1/4	12UNF	1,241	931	2,016	1,512
1-3/8	6UNC	1,469	1,102	2,387	1,790
1-3/8	12UNF	1,673	1,255	2,717	2,038
1-1/2	6UNC	1,949	1,462	3,168	2,376
1-1/2	12UNF	2,194	1,645	3,564	2,673

---

## Appendix 20. EU DECLARATION OF CONFORMITY



### TECO Electric & Machinery Co., Ltd.

10F, No.3-1, Yuan Cyu St., Nan-Kang,  
Taipei 115, Taiwan

TEL:886-2-6615-9111  
FAX:886-2-6615-2253

## EU DECLARATION OF CONFORMITY

We, **TECO ELECTRIC & MACHINERY CO., LTD.**  
10F, No.3-1, Yuan Cyu St., Nan-Kang,  
Taipei 115, Taiwan

Declare under our sole responsibility that the following three types of 3-phase squirrel cage induction motors:

To which this declaration relates, are in conformity with the following European Union Directives and standards identified in this declaration, if the motors are operated according to our "Operation & Maintenance Manual".

Series & Frame size	Ex Marking	Notified Body (ExNB)
AEZK_F#355~900	II 3G Ex ec IIC T3 Gc II 3G Ex ec pzc IIC T3 Gc	ExNB : SGS Fimko (Baseefa11ATEX0044X)
AEZW_F#355~900		
AFJH_F#315~560		
AFJK_F#355~560		
AFJG_F#315~560		
AFJP_F#315~450		

#### EU Directives

ATEX Directive 2014/34/EU

#### Standards

- EN 60079-0:2012+A11:2013  
Electrical apparatus for explosive gas atmospheres, General requirements
- EN 60079-7:2015  
Explosive atmosphere-Part 7: Equipment protection by increased safety "e"
- EN60034-1:2004 Rotating electrical machines, Rating and performance

The following person is authorised to compile the technical documentation:

Name: Kevin Meng

Address: Schiekade 830, 3032 AL Rotterdam, The Netherlands

If needed, the authorized person will transmit relevant information as paper copies or in electronic format to the national authorities.

This partly completed machinery must not put into service until the final machinery into which it is to be incorporated complies with the provisions of the Directive 2006/42/EC.

Benson Lin  
Acting Deputy Director  
R&D Center  
08 DECEMBER · 2020

*Benson Lin*  
*Dec. 08, 2020*

3A057M155E  
REV.04 1/1  
11W0-AA-C-5M-155

## Appendix 20. EU DECLARATION OF CONFORMITY (continue)

**TECO**  
**TECO Electric & Machinery Co., Ltd.**  
 10F, No.3-1, Yuan Cyu St., Nan-Kang, Taipei 115, Taiwan  
 TEL:886-2-6615-9111 FAX:886-2-6615-2253

### EU DECLARATION OF CONFORMITY

We, **TECO ELECTRIC & MACHINERY CO., LTD.**  
 10F, No.3-1, Yuan Cyu St., Nan-Kang,  
 Taipei 115, Taiwan

Declare under our sole responsibility that the following three types of 3-phase squirrel cage induction motors :

to which this declaration relates, are in conformity with the following European Union Directives and standards identified in this declaration, if the motors are operated according to our "Operation & Maintenance Manual".

Series	Ex Marking	Notified Body (ExNB)
AEZK/AECK	II 2G Ex eb pxb IIC T3 Gb	ExNB :TUV (TUV 17 ATEX 8153 X)
AEZW/AECW	Ex ec pzc IIC T3 Gc	

It includes the frame size 355,400,630,710,900.

EU Directives  
 ATEX Directive 2014/34/EU

#### Standards

- EN 60079-0:2012/A11:2013  
Electrical apparatus for explosive gas atmospheres, General requirements
- EN 60079-2:2014/AC:2015  
Explosive atmosphere-Part 2: Equipment protection by pressurized enclosure "p"
- EN 60079-7:2015  
Explosive atmosphere-Part 7: Equipment protection by increased safety "e"

The following person is authorised to compile the technical documentation:

Name: Kevin Meng

Address: Schiekade 830, 3032 AL Rotterdam, The Netherlands

If needed, the authorized person will transmit relevant information as paper copies or in electronic format to the national authorities.

This partly completed machinery must not put into service until the final machinery into which it is to be incorporated complies with the provisions of the Directive 2006/42/EC.

Benson Lin  
 Acting Deputy Director  
 R&D Center  
 20 MAR · 2019

*Benson Lin*  
*Mar. 20, 2019*

3A057M256E  
 REV.02 1/1  
 11W0-AA-C-5M-256

## Appendix 21. TECO Worldwide Operations

TECO has established a good reputation and track record on the global market. Following the establishment of the first overseas branch, TECO Singapore, in 1972, the company has successively set up marketing and service stations in the U.S., Australia, Malaysia, Hong Kong, Europe, and mainland China subsequently.



For more instant messages, please visit the website :  
<https://www.teco.com.tw/en/contact>



### Taiwan

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- ✓ Development
- ✓ Distributor

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For more information, please contact your local agent  
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