HIGEN MOTORS

SQUIRREL CAGE
AC INDUCTION MOTORS

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

Dripproof Enclosure

TEFC Enclosure

HIGEN Motor Co., Ltd.

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General Information

This manual contains general procedures that apply to our Motor products. Be sure to read and understand the Safety Notice statements in this manual. For your protection, do not install, operate or attempt to perform maintenance procedures until you understand the Warning and Caution statements. A Warning statement indicates a possible unsafe condition that can cause harm to personnel. A Caution statement indicates a condition that can cause damage to equipment.

This instruction manual is not intended to include a comprehensive listing of all details for all procedures required for installation, operation and maintenance. This manual describes general guidelines that apply to most of the motor products shipped by us. If you have a question about a procedure or are uncertain about any detail, do not proceed. Please contact us for more information or clarification.

Before you install, operate or perform maintenance, become familiar with the following: NEMA Publication MG-2, Safety Standard for Construction and guide for Selection, Installation and Use of Electric Motors and Generators, The National Electrical Code, Local codes and Practices

Safety Notice

This equipment contains high voltage! Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt installation, operation and maintenance of electrical equipment. Be sure that you are completely familiar with NEMA publication MG-2, safety standards for construction and guide for selection, installation and use of electric motors and generators, the National Electrical Code and local codes and practices. Unsafe installation or use can cause conditions that lead to serious or fatal injury. Only qualified personnel should attempt the installation, operation and maintenance of this equipment.

Personnel should be instructed to:

1. Disconnect all power to motor and accessories prior to initiating any installation, maintenance or repairs.

   WARNING: Do not touch electrical connections before you first ensure that power has been disconnected. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the installation, operation and maintenance of this equipment.

2. Avoid contact with rotating parts.

   WARNING: This equipment may be connected to other machinery that has rotating parts or parts that are driven by this equipment. Improper use can cause serious or fatal injury. Only qualified personnel should attempt to install operate or maintain this equipment.

3. Be sure equipment is properly enclosed to prevent access by children or other unauthorized personnel in order to prevent possible accidents.

   WARNING: Do not by-pass or disable protective devices or safety guards. Safety features are designed to prevent damage to personnel or equipment. These devices can only provide protection if they remain operative.

4. Act with care in accordance with this manual's prescribed procedures in handling and installing this equipment.

5. Be sure frames and accessories of motors are electrically grounded and proper electrical installation wiring and controls are used in accordance with local and national electrical codes. Motors shall be grounded by connecting to grounding provisions in the conduit box.

   WARNING: Be sure the system is properly grounded before applying power. Do not apply AC power before you ensure that all grounding instructions have been followed. Electrical shock can cause serious or fatal injury.

6. Be sure shaft key is fully captive before unit is energized.

WARNING: Be sure the load is properly coupled to the motor shaft before applying power. The shaft key must be fully captive by the load device. Improper coupling can cause harm to personnel or equipment if the load decouples from the shaft during operation.
WARNING: Before performing any motor maintenance procedure, be sure that the equipment connected to the motor shaft cannot cause shaft rotation. If the load can cause shaft rotation, disconnect the load from the motor shaft before maintenance is performed. Unexpected mechanical rotation of the motor parts can cause injury or motor damage.

7. Always be sure grease lubricated units are filled with correct grease to Proper level before operating.

8. Provide proper safeguards for personnel against rotating parts and applications involving high inertia loads which can cause overspeed.

9. Avoid extended exposure to equipment with high noise levels. Be sure to wear ear protective devices to reduce harmful effects to your hearing.

10. Observe good safety habits at all times and use care to avoid injury to yourself or damage to your equipment.

11. Be familiar with the equipment and read all instructions thoroughly before installing or working on equipment.

WARNING: Avoid the use of automatic reset devices if the automatic restarting of equipment can be hazardous to personnel or equipment.

WARNING: Use proper care and procedures that are safe during handling, lifting, installing, operating and maintaining operations. Improper methods may cause muscle strain or other harm.

WARNING: Do not use these motors in the presence of flammable or combustible vapors or dust. These motors are not designed for atmospheric conditions that require explosion proof operation.

Caution: To prevent premature equipment failure or damage, only qualified maintenance personnel should perform maintenance.

Caution: Do not lift the motor and its driven load by the motor lifting hardware. The motor lifting hardware is adequate for lifting only the motor. Disconnect the load from the motor shaft before moving the motor.

Caution: If eyebolts are used for lifting a motor, be sure they are securely tightened. The lifting direction should not exceed a 20° angle from the shank of the eyebolt or lifting lug. Excessive lifting angles can cause damage.

Caution: To prevent equipment damage, be sure that the electrical service is not capable of delivering more than the maximum motor rated amps listed on the rating plate.

Caution: If a HI POT test (High Potential Insulation test) must be performed, follow the precautions and procedure in NEMA MG-1 and MG-2 standards to avoid equipment damage.

If you have any questions or are uncertain about any statement or procedure, or if you require additional information please contact us.

Receiving

Each our Electric Motor is thoroughly tested at the factory and carefully packaged for shipment. When you receive your motor, there are several things you should do immediately.

1. Observe the condition of the shipping container and report any damage immediately to the commercial

carrier that delivered your motor.

2. Verify that the part number of the motor you received is the same as the part number listed on your purchase order.

Storage

If the motor is not put into service immediately, the motor must be stored in a clean, dry and warm location. Several precautionary steps must be performed to avoid motor damage during storage.

1. Use a “Megger” periodically to ensure that the integrity of the winding insulation has been maintained. Record the Megger readings. Immediately investigate any significant drop in insulation resistance.

2. Do not lubricate bearings during storage. Motor bearings are packed with grease at the factory. Excessive grease can damage insulation quality.

3. Rotate motor shaft at least 10 turns every two months during storage (more frequently if possible). This will prevent bearing damage due to storage.

4. If the storage location is damp or humid, the motor windings must be protected from moisture. This can be done by applying power to the motors’ space heater (if available) while the motor is in storage.

Unpacking

Each our motor is packaged for ease of handling and to prevent entry of contaminants.

1. To avoid condensation inside the motor, do not unpack until the motor has reached room temperature. (Room temperature is the temperature of the room in which it will be installed). The packing provides insulation from temperature changes during transportation.

2. When the motor has reached room temperature, remove all protective wrapping material from the motor.

Handling

The motor should be lifted using the lifting lugs or eyebolts provided.

1. Use the lugs or eyebolts provided to lift the motor. When a motor has two eyebolts, both eyebolts must be used. Never attempt to lift the motor and additional equipment connected to the motor by this method. The lugs or eyebolts provided are designed to lift only the motor. Never lift the motor by the motor shaft.

2. If the motor must be mounted to a plate with the driven equipment such as pump, compressor etc., it may not be possible to lift the motor alone. For this case, the assembly should be lifted by a sling around the mounting base. The entire assembly can be lifted as an assembly for installation. Do not lift using the motor lugs or eyebolts provided.

   If the load is unbalanced (as with couplings or additional attachments) additional slings or other means must be used to prevent tipping. In any event, the load must be secure before lifting.

Installation & Operation

Installation should conform to the National Electrical Code as well as local codes and practices. When other devices are coupled to the motor shaft, be sure to install protective devices to prevent future accidents. Some protective devices include coupling, belt guard, chain guard, shaft covers etc. These protect against accidental contact with moving parts. Machinery that is accessible to personnel should provide further protection in the form of guardrails, screening, warning signs etc.

Location

The motor should be installed in an area that is protected from direct sunlight, corrosives, harmful gases or liquids, dust, metallic particles, and vibration. Exposure to these can reduce the operating life and degrade performance. Be sure to allow clearance for ventilation and access for cleaning, repair, service and inspections. Ventilation is extremely important. Be sure the area for ventilation is not obstructed. Obstructions will limit the free passage of air. Motors get warm and the heat must be dissipated to prevent damage.

These motors are not designed for atmospheric conditions that require explosion proof operation. They must NOT be used in the presence of flammable or combustible vapors or dust.

1. ODP motors are suitable only for indoor applications.

2. TEFC motors are suitable for indoor or outdoor standard service applications.

Mounting

The motor must be securely installed to a rigid foundation or mounting surface to minimize vibration and maintain alignment between the motor and shaft load. Failure to provide a proper mounting surface may cause vibration, misalignment and bearing damage.

Motors should be set on the mounting plates(bed, base or slide rails) installed on the foundation. The foundation must be solid and rigid enough to sustain machine weights or shocks during operation. The foundation surface should be roughly leveled when grouting. The mounting plates(or motor) should be correctly leveled by using a spirit level and shims when coupling to the driven machine. It is recommended that a fabricated steel base (sole plate) be used between motor feet and foundation.

For V-belt drives, the motor will be mounted on a single or two slide rails. When two slide rails are used, leveling must be made as to each rail first, and then on two rails putting a straight-edge across the rails and setting the spirit level on it. It is important that the level check be made with all foundation bolts tightened securely. For level adjustment, use a few thick shims rather than a large number of thin shims.

After installation is complete and accurate alignment of the motor and load is accomplished, the base should be grouted to the foundation to maintain this alignment.

Grouting is the process of firmly securing equipment to a concrete base. This base is a continuation of the main foundation, designed to dampen any machine vibration present and prevent the equipment from shaking loose during operation. A serviceable and solid foundation can be laid only by careful attention to proper grouting procedure.
In practical terms, “grout” is plastic filler that is poured between the motor sole plate and the foundation upon which it is to operate. Being plastic, it is expected to fill all spaces and cavities before it sets or solidifies and becomes an integral part of the principal foundation. Wherever practical, the principal foundation is allowed to set through chemical reaction and dehydration for approximately four weeks before loading, to permit it to sustain its full static load without deformation.

Mounting couplings and sheaves

Mount the couplings and sheaves in the following procedure.

1. Remove the key from shaft extension and wash out anticorrosive paint on the key and shaft extension with solvent.

2. Make sure by hand that the key moves axially in the keyway of the boss of coupling or V-belt sheave and fit the key into the keyway of shaft extension by hitting it lightly.

3. Expand the boss of coupling by heating with a torch or heater.

4. After heating, locate the coupling or V-belt sheave in place on the shaft quickly.
   Note: Hammering or pounding with a mallet is not recommended to install couplings, pulleys or sprockets, as the motor bearings can be damaged.

5. If the shaft does not rotate freely or makes a clicking sound, mounting may not be proper. The motor must be disassembled and inspected.

6. Setscrew , if used, should be mounted after the temperature of boss becomes 40℃ or below.

Alignment

Accurate alignment of the motor with the driven equipment is extremely important.
Before grouting the base, the alignment should be checked as follows. Be sure that every level check is made with all hold-down bolts and foundation bolts tightened.

Align the motor and machine as follows.

1. **Direct Drive**

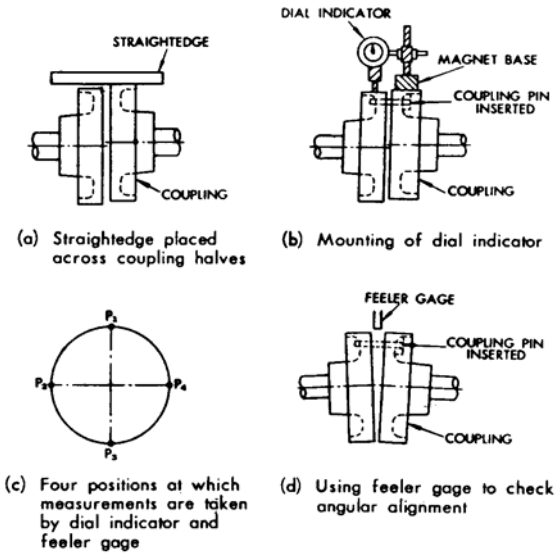
For direct drive, use flexible couplings if possible. Consult the drive or equipment manufacturer for more information. Mechanical vibration and roughness during operation may indicate poor alignment. Use dial indicators to check alignment. The space between coupling hubs should be maintained as recommended by the coupling manufacturer.

Rough alignment
Check roughly the radial alignment by using a straightedge. Place the straightedge across the coupling halves at top, bottom and both sides as indicated in fig. (a) and (c), and detect visually any gaps between the straightedge and coupling halves. Correct misalignment, if any, by shimming between the base and the machine or foundation, or move the motor until no gap is observed. This rough alignment facilitates the fine alignment described below.

Accurate alignment

- Offset misalignment
  Check for offset misalignment, fig. (b). Set a dial indicator to one coupling half and place the indicator finger tip against outside diameter of the other coupling half. Then rotate both coupling halves together keeping the finger tip on the coupling. Read the indicator at four points - top, bottom and both sides of the coupling as shown in fig. (c). Be sure that the dial indicator supports do not bend or sag, since this will give inaccurate readings. The value of distortion must be deducted from the value measured. If the reading difference between top and bottom exceeds values shown in below table, correct the alignment by shimming, and between right and left sides, by moving the base or the motor. Alignment is satisfactory when these differences do not exceed values in table.

- Angular misalignment
  Check for angular misalignment as illustrated in fig. (d). Insert a feeler gage between the coupling faces and rotate both coupling halves simultaneously. Note the feeler gage readings at four equidistant points, fig. (d). The maximum variation between any two readings should not exceed values in table. If difference is larger than those, correct the alignment by shimming under the base or the machine.
  After the motor has been aligned completely, make sure that the motor is bolted down solidly to the base and the base to the foundation. If any loose bolts are founded, set them tight and recheck the alignment repeating steps offset and angular misalignment described above.



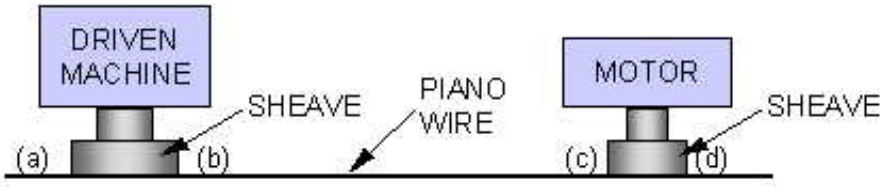
Coupling	Speed (r/min)	Offset Tolerance (mm)	Angular Tolerance (mm)	
			Coupling dia Up to 400	Coupling dia 400 to 600
Flexible Coupling	2500~4000 1300~2500 below 1300	0.010 0.025 0.040	0.02 0.05 0.08	0.03 0.07 0.10
Rigid coupling	2500~4000 below 2500	0.010 0.015	0.02 0.03	0.02 0.03

2. **Belt Drive**

Align sheaves carefully to minimize belt wear and axial bearing loads. Belt tension should be sufficient to prevent belt slippage at rated speed and load. However, belt slippage may occur during starting.

Setting the slide rails
For V-belt drive, the motor is mounted on the slide rails. Level the slide rails as described in foundation and mounting plates.

Parallelism of sheaves
Mount the motor on the leveled slide rails so that the shaft of the motor and driven machine are parallel to each other, and align the sheaves. To check alignment of two sheaves, apply a piano wire, stretching tautly as shown in figure and determine if points (a),(b),(c) and (d) are in line.

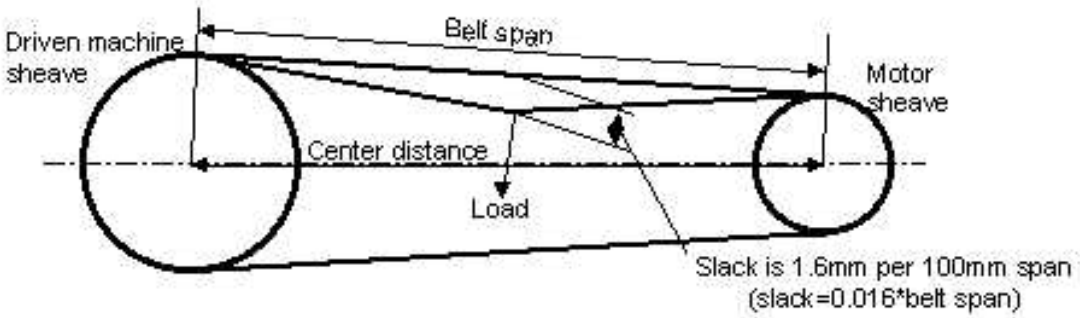


V-belt tension adjusting
Adjust the V-belt tension to just prevent slippage when the motor is running at full-load and accelerated. And too tight V-belt may cause not only rapid wear of the belt but also undue stress to the machine shafts, resulting in shorter below is a suggested way to obtain the proper belt tension.

Caution : Do not over tension belts.

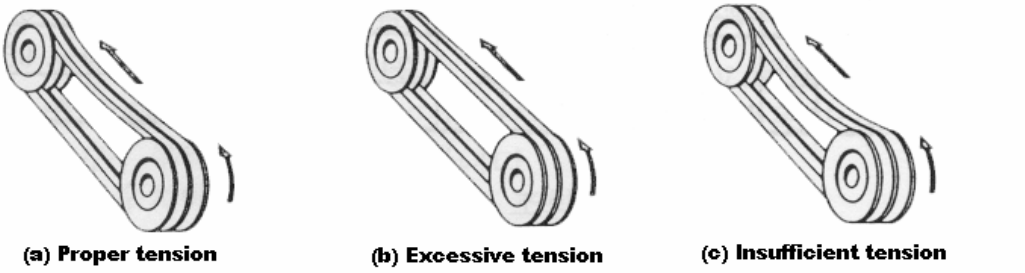
Caution : The pulley ratio should not exceed 8:1.

- Determine the belt span on the slack side of drive. The span is the length of the belt between the points at which the belt leaves the sheaves, and not the center distance of two shafts. If two sheaves are the same in diameter, the span is equal to the shaft center distance.



$$\text{Belt span} = \sqrt{\text{Center distance}^2 - \left(\frac{\text{Drive machine sheave dia.} - \text{Motor sheave dia.}}{2}\right)^2}$$

- Obtain the midpoint of the span. One suggested way is to take the span on a string and fold the string in two.
  Apply a spring balancer to midpoint of the belt. Then pull the belt inward at right angle to the belt until the slack becomes 1.6 millimeters per 100 millimeters, and register the balancer reading.
- Adjust the belt tension so that the spring balancer reading is between the maximum and minimum value in table of load to obtain proper V-belt tension. To shift the motor on the rails for tension adjustment, turn the adjusting screw on slide rails. Set firmly the mounting bolt of the motor upon completion of adjustment.
- After adjustment of belt tension, operate the drive a couple of minutes to see if belt tension has been set properly. An optimum belt tension gives a slight bow on the top (slack side) whole the drive is started and operating at full speed and full load as shown in fig. (a). too tight belt gives no bow as illustrated in fig.(b), and too slack belt produces a large bow, fig.(c).



(a) Proper tension **(b) Excessive tension** **(c) Insufficient tension**

Readjustment
The V-belt requires several days of operation to cozily adjust them. Be sure to check the belt tension after several days of operation and once a month after the drive has been put into operation. If the belt is loose, adjust the belt tension

3. **End-Play Adjustment**
   The axial position of the motor frame with respect to its load is also extremely important. The motor bearings are not designed for excessive external axial thrust loads. Improper adjustment will cause failure.

Bolting

Mounting bolts must be carefully tightened to prevent changes in alignment. Use a flat washer and lock washer under each nut or bolt head to hold the motor feet secure. Flanged nuts or bolts may be used as an alternative to washers.

Power Connection

Motor and control wiring, overload protection, disconnects, accessories and grounding should conform to the National Electrical Code and local codes and practices.

Conduit Box

For ease of making connections, an oversize conduit box is provided. The box can be rotated 360° in 90° increments. Auxiliary conduit boxes are provided on some motors for accessories such as space heaters, RTD's etc.

AC Power

Connect the motor leads as shown on the connection diagram located on the nameplate or inside the cover on the conduit box. Be sure the following guidelines are met:

1. AC power is within ±10% of rated voltage with rated frequency. (See motor nameplate for ratings). or

2. AC power is within ±5% of rated frequency with rated voltage. or

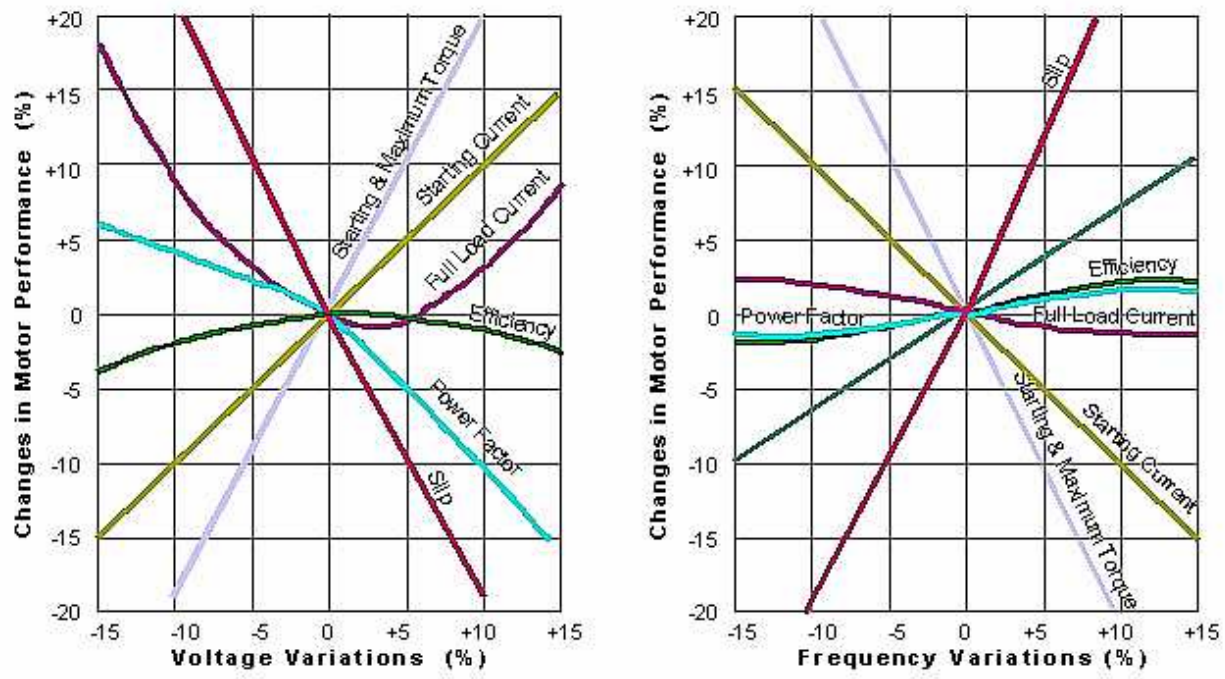
3. A combined variation in voltage and frequency of ±10% (sum of absolute values) of rated values, provided the
   frequency variation does not exceed ±5% of rated frequency.

Effects of Unbalanced Line Voltage

A system condition and potential cause of premature motor failure is unbalanced line (supply) voltage. Three phase motors produce useful work when they efficiently convert electrical energy into mechanical energy. This is accomplished when each phase of the supply voltage is of equal strength and works in harmony to produce a rotating magnetic field within the motor.

When the value of supply voltage leg to leg is not equal (460-460-460), the risk of unbalanced line voltage is present. If this voltage imbalance exceeds about 1%, excessive temperature rise will result. Unless the motor HP capacity is derated to compensate, the motor will run hot resulting in excessive aging of the insulation system
and the lubrication medium. Refer to NEMA MG-1, 14.35: Derating factors due to unbalanced line voltage.

Performance within these voltage and frequency variations are shown in Figure.



Electrical Connection & Grounding

Refer to the motor nameplate for power supply requirements and to the connection diagram on the motor. Be sure connections are tight. Check carefully and assure that they agree with the connection diagram, then carefully tape all connections with electrical tape, to be sure that they will not short against each other or to ground. Be sure the motor is grounded to guard against possible electrical shock. Frames and accessories of motors should be grounded in accordance with the National Electrical Code and to local electrical codes for proper wiring, protection and wire size. Motors shall be grounded by connecting to grounding provisions in the conduit box. Be sure proper starting equipment and protective devices are used for every motor. For assistance contact the local sales office of the motor starter manufacturer for the particular brand of equipment you are using.

Reversing Rotation
The direction of the rotation may be reversed by interchanging any two of the three power leads to the motor leads. Be sure that the power is off and steps are taken to prevent accidental restarting of the motor before attempting to change any electrical connections.

Initial Start

Be sure that all power to motor and accessories is off. Be sure the motor shaft is disconnected from the load and will not cause mechanical rotation of the motor shaft.

1. Make sure that the mechanical installation is secure. All bolts and nuts are tightened etc.

2. If motor has been in storage or idle for some time, check winding insulation integrity with a Megger.

3. Inspect all electrical connections for proper termination, clearance, mechanical strength and electrical continuity.

4. Be sure all shipping materials and braces (if used) are removed from motor shaft.

5. Manually rotate the motor shaft to ensure that it rotates freely.

6. Replace all panels and covers that were removed during installation.

7. Momentarily apply power and check the direction of rotation of the motor shaft.

8. If motor rotation is wrong, be sure power is off and change the motor lead connections. Verify rotation direction
before you continue.

9. Start the motor and ensure operation is smooth without excessive vibration or noise. If so, run the motor for 1 hour with no load connected.

10. After 1 hour of operation, disconnect power and connect the to load to the motor shaft. Verify all coupling guards and protective devices are installed. Ensure motor is properly ventilated.

Caution : Repeated trial starts can overheat the motor (particularly for across-the-line starting) or the external starting equipment.

Normal Operation

This procedure assumes a coupled start up. Also, that the first time start up procedure was successful.

1. Check the coupling and ensure that all guards and protective devices are installed.

2. Check that the coupling is properly aligned and not binding.

3. The first coupled start up should be with no load. Apply power and verify that the load is not transmitting excessive vibration back to the motor though the coupling or the foundation. Vibration should be at an acceptable level.

4. Run for approximately 1 hour with the driven equipment in an unloaded condition.

The equipment can now be loaded and operated within specified limits. Do not exceed the name plate ratings for amperes for steady continuous loads.

When checks are satisfactory to this point, operate at the minimum possible load and look for any unusual condition. Increase the load slowly and check unit for satisfactory operation. After alignment has been completed, run motor at minimum possible load (uncoupled from driven equipment if possible) and check for vibration. If vibration is excessive loosen one Motor Mounting Bolt. If vibration decreases add shims and retighten bolt. Repeat as necessary for all bolts until vibration is reduced to acceptable limits. Recheck coupling alignment after any change in shims. Recheck vibration after unit has run under full load and has reached operating temperature.

Caution : Jogging and Repeated Starts

Repeated starts and/or jogs of induction motors generally reduce the life of the motor winding insulation. A much greater amount of heat is produced by each acceleration or jog than by the same motor under full load. If it is necessary to repeatedly start or jog the motor, it is advisable to check the application with us.

Heating - Duty rating and maximum ambient temperature are stated on the motor nameplate. Do not exceed these values. If there is any question regarding safe operation, contact us.

Disassembly & Reassembly

Before disassembling, observe the following :

- Disassemble or reassemble the motor in a clean and dry place free from water drops.
- Keep small parts including screws so that it should not be missed for correct reassembly.
- During disassembling, protect colis or bearings from being damaged.
- Reset the disassembled parts on clean wooden board, paper or cloth.
- Care should be taken to avoid damage to the bearing. Do not blow bearing with a hammer or apply undue stress to the bearing.

Disassembly

The procedure, when the motor is disassembled from the drive end, is described below.

1. Disconnect power and assure against accidental starting of motor.

Drive end

2. Remove bearing cover by removing bolts.
3. Remove bracket by removing bolts.
4. Remove all thermostats, probes, thermocouples etc., from bearings and brackets.
5. Remove grease valve by loosening setscrews.
6. Pull off bearing. Refer to replacement of bearings.
7. Remove bearing cover together with bearing seal, using tapped holes on the bearing cover.

Opposite drive end

8. Remove grip of grease discharger.
9. Remove grease nipple by loosening its pipe.
10. Remove fan cover by removing bolts.

11. Take off external fan by loosening setscrews.
12. Remove bearing cover after removing bolts.
13. Remove bracket after loosening bolts.
14. Remove grease valve by loosening setscrews.
15. Pull off bearing. Refer to replacement of bearings.
16. Remove bearing seal and bearing cover.

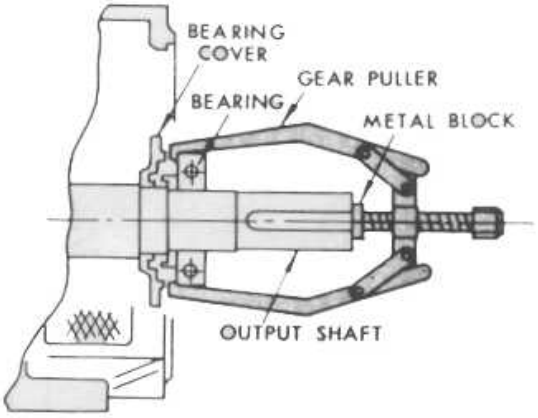
17. Pull off rotor from frame. Care should be taken not damage stator coils.

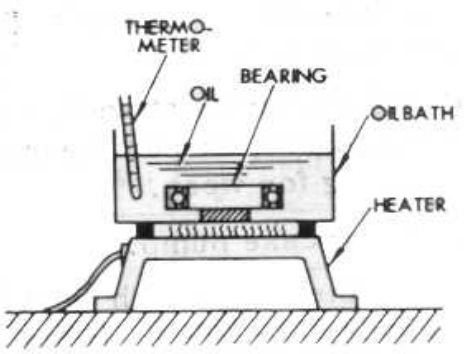
Reassembly

Reassembly of the parts is primarily a matter of reversing the disassembly operations after all parts are washed. When ball bearings are reassembled, inside of bearings are reassembled, inside of bearing covers and grease pipes should be packed 50% full with grease. Tighten each mounting bolt using washers. When reassembling use care that the bolts or screws must be secured in turn evenly and equally if a part, such as bracket and bearing cover, is fastened at more than one point. Touch up any scratched or chipped paint to protect motor surfaces.

Replacement of bearings

To remove the bearings, a gear puller may be used. Hook a puller between bearing and bearing cover or on bearing cover. Refer to figure.





Mounting of bearings

a. Apply grease to the labyrinth section of inside bearing cover.
b. Apply thin coat of grease to the shaft.
c. Heat the bearing to 90~100° C in an oil bath. Refer to figure.
d. Mount the bearing quickly and tightly against the shaft shoulder. Wrap the bearing with clean paper to protect it from dirt and contamination.
e. After the bearing has cooled, feed the grease specified. The bearing should be packed 50% full with grease.
f. Make sure that bearing outer race rotates smoothly by hand rotating.
g. Wrap the bearing with clean paper.

Caution: Do not handle the bearing with bare hands to prevent rust.
Caution: After shrinkage fitting of bearing, wrap the bearing with clean paper to protect it from dust.
Caution: Bearing should be cooled naturally. Do not use compressed air or fan for cooling.

Maintenance & Troubleshooting

General Inspection

Inspect the motor at regular intervals, approximately every 500 hours of operation or every 3 months, whichever occurs first. Keep the motor clean and the ventilation openings clear. The following steps should be performed at each inspection:

WARNING: Do not touch electrical connections before you first ensure that power has been disconnected. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the installation, operation and maintenance of this equipment.

1. Check that the motor is clean. Check that the interior and exterior of the motor is free of dirt, oil, grease, water, etc. Oily vapor, paper pulp, textile lint, etc. can accumulate and block motor ventilation. If the motor is not properly ventilated, overheating can occur and cause early motor failure.

2. Use a “Megger” periodically to ensure that the integrity of the winding insulation has been maintained. Record the Megger readings. Immediately investigate any significant drop in insulation resistance.

3. Check all electrical connectors to be sure that they are tight.

Lubrication & Bearings

Bearing grease will lose its lubricating ability over time, not suddenly. The lubricating ability of a grease (over time) depends primarily on the type of grease, the size of the bearing, the speed at which the bearing operates and the severity of the operating conditions. Good results can be obtained if the following recommendations are used in your maintenance program.

1. Motors with permanently greased bearings

Motors up to frame size 200 are normally provided with permanently greased bearings of 2Z type. Bearing types are specified in the name plate and the respective product catalogues. Motors provided with Z-bearings can be regreased by dismantling the motor, cleaning the bearings and bearing housings, and filling these with new grease to 50-70%.

Guidelines for regreasing intervals are:
1. 20,000 to 40,000 duty hours for 4 pole or greater motor.
2. 10,000 to 20,000 duty hours for 2 pole motors.

The shorter times are valid for larger frame sizes.

2. Motors with grease nipples

Type of Grease

A high grade ball or roller bearing grease should be used. Recommended greases are :

- Standard service conditions : Caltex Regal Starfak Premium 2 or Caltex Multifak AFB 2 (Factory Installed) or grease of Lithium base.
- High Ambient & Cold or Arctic Duty : Specified on Nameplate

For special high & low temperature environment, consult us. Greases with the correct properties are available from all the major lubricant manufacturers.

Caution: Greases of different soap bases (sodium, polyurea, clay, etc.) may not be compatible when mixed. Mixing such greases can result in reduced lubricant life and premature bearing failure. Prevent such intermixing by completely purging the bearing of old greases. When necessary, prevent such intermixing by disassembling the motor, removing all old grease from bearings and housings (including all grease fill and drain holes).

Lubrication Intervals

Recommended lubrication intervals are shown in Table 1. It is important to realize that the recommended intervals of Table 1 are based on average use. Refer to additional information contained in Tables 2,3 and 4.

Table 1. Lubrication Intervals (Ball bearings)

Frame Size (IEC)	Rated Speed - RPM			
	3600	1800	1200	900
Up to 132 incl.	7000 Hrs.	14000 Hrs.	18000 Hrs.	24000 Hrs.
Over 132 to 180 incl.	6000 Hrs.	12000 Hrs.	15000 Hrs.	18000 Hrs.
Over 180 to 250 incl.	3000 Hrs.	10000 Hrs.	12000 Hrs.	15000 Hrs.
Over 250 to 400 incl.	2000 Hrs.	6000 Hrs.	8500 Hrs.	11000 Hrs.

Above data are average values for reference only. Refer to motor nameplate for lubrication intervals. If roller bearings are used, the bearings must be lubricated more frequently, divide the listed lubrication interval by 2.

Table 2. Service Conditions

Severity of Service	Ambient Temperature Maximum	Atmospheric Contamination	Type of Bearing
Standard	40 ° C	Clean, Little Corrosion	Deep Groove Ball Bearing
Severe	50 ° C	Moderate dirt, Corrosion	Ball Thrust, Roller
Extreme	>50 ° C* or Class H Insulation	Severe dirt, Abrasive dust, Corrosion	All Bearings
Low Temperature	<–30 ° C *		

* For special high & low temperature environment, consult us.

Table 3. Lubrication Interval Multiplier

Severity of Service	Multiplier
Standard	1.0
Severe	0.5
Extreme	0.1

The table is prepared for horizontally mounted motors. Lubrication intervals for motors mounted vertically or in hostile environments are half of the above values.

Higher speed operation, i.e. inverter applications, or lower speed with heavy loading will require shortened lubrication intervals. Typically a doubling of speed will require a reduction of lubrication intervals to approx. 50% of values tabulated above. Suitability of bearings for high speed operation must also be checked.

Table 4. Recommended Regreasing Intervals

Interval	Types of service
1-2 years	Infrequent operation or light duty in clean atmosphere
1 year	8-16 hrs/day in clean, relatively dry atmosphere
6 months	12-24 hrs/day, heavy duty, or if moisture is present
3 months	Heavy duty in dirty, dusty locations: High ambients: Moisture laden atmosphere: Vibration

WARNING: Many greases can cause skin irritation and eye inflammation. Follow any precautions specified by the manufacturer.

Recommended Grease Replenishment Quantities

Amount of grease to be added is dependent on the bearing type and size. Refer to motor nameplate for bearings on a specific motor. For bearings not marked on the nameplate, the amount of grease required may be calculated by the formula :

Ball bearing
Weight of grease in grams **= 0.008 x** Outside diameter of bearing(mm) **x** Width of bearing(mm)

Roller bearing
Weight of grease in grams **= 0.012 x** Outside diameter of bearing(mm) **x** Width of bearing(mm)

Lubrication Procedure

1. Clean all grease fittings.

2. Remove grease drain plug.

3. If motor is stopped, add the recommended amount of grease. If motor is to be greased while running, a slightly
greater quantity of grease will have to be added.
Add grease slowly until new grease appears drain hole. As new grease appears at the drain hole, the bearing grease cavity should be completely full. The grease cavity must be purged to approximately 60 to 70% full. Start the motor and run for approximately ten minutes, as mentioned before, with drain plug removed. This will allow the excess grease to purge itself from the grease cavity.

4. Replace grease drain plug.

Caution: To avoid damage to motor bearings, grease must be kept free of dirt.

Caution: Do not attempt to grease bearings with drain closed.

Caution: Excessively applied Lubrication.
We put a minimum amount of grease in the chambers before shipping your motor. Over greasing can cause excessive bearing temperatures, premature lubricant breakdown, and bearing failure. Care should be exercised to insure against over greasing.

Caution: If old grease cannot be readily purged from drain hole, immediately cease to add new grease. Investigate cause of grease exit blockage. A mechanical probe or scavenger may be required to dislodge blockage (caked grease or foreign particles) from grease drain (care should be exercised to prevent damage to bearing with probe or scavenger). Under no circumstances should a mechanical probe or scavenger be used while motor is in operation.

Accessories

The following is a partial list of accessories available from us. Contact us for availability and pricing information. When ordering spare parts, the full type designation and product code as stated on the nameplate must be specified. If the machine is marked with a serial manufacturing number, this should also be given.

Note: Space heaters and RTD's are standard on some motors.

Bearing RTD
RTD (Resistance Temperature Detector) devices are used to measure or monitor the temperature of the motor bearing during operation.

Bearing Thermocouples
Used to measure or monitor bearing temperatures.

Bearing Thermostat
Temperature device that activates when bearing temperatures is excessive. Used with an external circuit to warn of excessive bearing temperature or to shut down a motor.

Conduit Boxes
Optional conduit boxes are available in various sizes to accommodate accessory devices.

Space Heater
Added to prevent condensation of moisture within the motor enclosure during periods of shut down or storage.

Winding RTD

RTD (Resistance Temperature Detector) devices are used to measure or monitor the temperature of the motor winding during operation.

Winding Thermocouples
Used to measure or monitor winding temperatures.

Winding Thermostat
Temperature device that activates when winding temperatures are excessive. Used with an external circuit to warn of excessive winding temperature or to shut down a motor.
Note: On some motors, leads for accessory devices are brought out to a separate conduit box.

Troubleshooting

Your motor service and any trouble shooting must be handled by qualified persons who have proper tools and equipment.

If trouble is experienced in the operation of the motor, make sure that:

1. The bearings are in good condition and operating properly.

2. There is no mechanical obstruction to prevent rotation in the motor or in the driven load.

3. The air gap is uniform.

4. All bolts and nuts are tightened securely.

5. Proper connection to drive machine or load has been made.

In checking for electrical troubles, be sure that:

1. The line voltage and frequency correspond to the voltage and frequency stamped on the rating plate of the motor.

2. The voltage is actually available at motor terminals.

3. The fuses and other protective devices are in proper condition.

4. All connections and contacts are properly made in the circuits between the control apparatus and motor.

WARNING:

1. Disconnect power before working on motor or driven equipment. It is necessary to make sure that the rotor of the motor can neither be energized electrically nor start to rotate by any other means. Apply this also for the driven equipment.

2. Motors with automatic thermal protectors will automatically restart when the protector temperature drops sufficiently. Do not use motors with automatic thermal protectors in applications where automatic restart will be hazardous to personnel or equipment.

3. Motors with manual thermal protectors may start unexpectedly after protector trips. If manual protector trips, disconnect motor from power line. After protector cools (five minutes or more) it can be reset and power may be applied to motor.

4. Discharge all capacitors before servicing motor.

5. Always keep hands and clothing away from moving parts.

6. Never attempt to measure the temperature rise of a motor by touch. Temperature rise must be measured by thermometer, resistance, imbedded detector, or thermocouple. The temperature of the outlet of the motor may be hot to the touch during normal operation.

7. Electrical repairs should be performed by trained and qualified personnel only.

8. Failure to follow instructions and safe electrical procedures could result in serious injury or death.

9. If safety guards are required, be sure the guards are in use.

TROUBLE	CAUSE	WHAT TO DO
Motor fails to start	Blown fuses	Replace fuses with proper type and rating.
	Overload trips	Check and reset overload in starter.
	Improper power supply	Check to see that power supplied agrees with motor name plate and load factor.
	Improper line connections	Check connections with diagram supplied with motor.
	Open circuit in winding or control switch	Indicated by humming sound when switch is closed. Check for loose wiring connections. Also see that all control contacts are closing.
	Mechanical failure	Check to see if motor and drive turn freely. Check bearings and lubrication.
	Short circuited stator	Indicated by blown fuses. Motor must be rewound.
	Poor stator coil connection	Remove end bells, locate with test lamp.
	Rotor detective	Look for broken bars or end rings.
	Motor may be overloaded	Reduce load.
Motor stalls	One phase may be open	Check lines for open phase.
	Wrong application	Change type or size. Consult manufacturer.
	Overload	Reduce load.
	Low voltage	See the name plate voltage is maintained. Check connection.
	Open circuit	Fuses blown, check overload relay, stator and push buttons.
Motor runs and then dies down	Power failure	Check for loose connections to line, to fuses and to control.
Excessive humming	High Voltage	Check input line connections.
	Eccentric air gap	Have motor serviced at our service center.
Motor does not come up to speed	Not applied properly	Consult supplier for proper type.
	Voltage too low at motor terminals because of line drop	Use higher voltage or transformer terminals or reduce load. Check connections. Check conductors for proper size.
	Starting load too high	Check load motor is supposes to carry at start.
	Broken rotor bars or loose rotor	Look for cracks near the rings. A new rotor may be required as repairs are usually temporary.
	Open primary circuit	Locate fault with testing device and repair.
Motor takes too long to accelerate and/or draws high amp	Excessive load	Reduce load.
	Low voltage during start	Check for high resistance. Adequate wire size.
	Defective squirrel cage rotor	Replace with new rotor.
	Applied voltage too low	Get power company to increase power tap.
Motor starts and then overcurrent relay opens	Improper setting of overcurrent relay	Correct the setting of relay.
	Starting time too long	When over 15 seconds, change the relay for long time limit.
	Overloaded motor	Reduce load or remove the cause of overload.
	Short circuit in phases	Check the resistance across the terminals. Repair the coils.
Wrong rotation	Wrong sequence of phases	Reverse connections at motor or at switchboard.
Motor overheats while running underload	Overload-Compare actual amps (measured) with nameplate rating	Locate and remove source of excessive friction in motor or load. Reduce load or replace with motor of greater capacity.
	High ambient temprature	Keep ambient temperature. Check ventilation conditions and air temperature at inlet. Remove obstacles.

	Frame or bracket vents may be clogged with dirt and prevent proper ventilation of motor		Open vent holes and check for a continuous stream of air from the motor. Check external cooling fan to be sure air is moving properly across cooling fins. Excessive dirt build-up on motor. Clean motor.
	Single Phasing		Check current at all phases (should be approximately equal) to isolate and correct the problem.
	Rotor rubbing on stator		Check air gap clearance and bearings.
	Over voltage or under voltage		Check input voltage at each phase to motor.
	Open stator winding		Check stator resistance at all three phases for balance.
	Grounded winding		Perform dielectric test and repair as required.
	Improper connections		Inspect all electrical connections for proper termination, clearance, mechanical strength and electrical continuity. Refer to motor lead connection diagram.
	Motor may have one phase open		Check to make sure that all leads are well connected.
	Unbalanced terminal voltage		Check for faulty leads, connections and transformers. Check voltage at all phases (should be approximately equal) to isolate and correct the problem.
Motor vibrates	Foundation not rigid		Check for adjacent vibration souce, settled foundation, crevice and rigidity of mount. Rebuild foundation. Reinforce mount.
	Low rigidity of bed		Reinforce bed or rebuild foundation
	Anchor bolts loosely tightened		Tighten nuts for anchor bolt. Rebuild foundation.
	Motor misaligned		Realign.
	Coupling or V-belt sheave	Eccentricity	Measure run-out tolerance and compare with yhat of shaft. If over 0.05mm, correct.
		Weight unbalanced	Correct.
		Damage	Repair or replace.
	Pin type flexible coupling	Worn of damaged coupling pin	Repair or replace.
		Poor position accuracy of holes for coupling pin	Check position of tram marks. Correct.
	Weak support		Strengthen base.
	Coupling out of balance		Balance coupling.
	Driven equipment unbalanced		Rebalance driven equipment.
	Defective bearings		Replace bearings.
	Bearings not in line		Line up properly.
	Balancing weights shifted		Rebalance motor.
	Contradiction between balancing of rotor and coupling (half key – full key)		Rebalance coupling or motor
	Polyphase motor running single phase		Check for open circuit.
	Rubbing between rotating parts and stationary parts		Isolate and eliminate cause of rubbing.
	Excessive end play		Adjust bearing or add shim.
Unbalanced line current on polyphase motors during normal operations	Unequal terminal volts		Check leads and connections.
	Single phase operation		Check for open contacts.
	Unbalanced voltage		Correct unbalanced power supply.
Scraping noise	Fan rubbing air shield		Remove interference.
	Fan striking insulation		Clear fan.
	Loose on bedplate		Tighten holding bolts.
Noisy operation	Airgap not uniform		Check and correct bracket fits or bearing.

	Foreign material in air gap or ventilation openings	Remove rotor and foreign material. Reinstall rotor. Check insulation integrity. Clean ventilation openings.
	Rotor unbalance	Rebalance.
Growling or whining	Bad bearing	Replace bearing. Clean all grease from cavity and new bearing. Repack with correct grease until cavity is approximately 1/2 filled.
Hot bearings general	Bent or sprung shaft	Straigthen or replace shaft.
	Excessive belt pull	Decrease belt tension.
	Excessive end thrust.	Reduce the end thrust from driven machine.
	Pulleys too far away	Move pulley closer to motor bearing.
	Pulley diameter too small	Use larger pulleys.
	Dirt in bearing.	Clean bearing cavity and bearing. Repack with correct grease until cavity is approximately 1/2 filled.
	Improper grease type	Change grease with proper one.
	Misalignment	Correct by realignment of drive.
Hot bearings ball	Insufficient grease in bearing	Maintain proper quality of grease in bearing.
	Deterioration of grease or lubricant contaminated	Remove old grease, wash bearings thoroughly in kerosene and replace with new grease.
	Excessive grease in bearing	Reduce quantity of grease, bearing should not be more than 1/2 filled.
	Overloaded bearing	Check alignment, side and end thrust.
	Broken ball or rough races	Replace bearing, first clean housing thoroughly.