marathon® Motors LEESON®

Installation Operation, and Maintenance Instructions for Vertical Hollow Shaft AC Induction Motors

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FORM
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⚠ WARNING

- Warning indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury and/or property damage.

⚠ CAUTION

- Caution indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

INSTALLER: PLEASE LEAVE THIS MANUAL FOR THE OWNER'S USE
OWNER: READ AND SAVE THESE INSTRUCTIONS

Safety Instructions

Before installing, using, or servicing this product, carefully read and fully understand the instructions including all warnings, cautions, & safety notice statements. To reduce risk of personal injury, death and/or property damage, follow all instructions for proper motor installation, operation and maintenance.

Although you should read and follow these instructions, they are not intended as a complete listing of all details for installation, operation, and maintenance. If you have any questions concerning any of the procedures, or if you have a safety concern not covered by the instructions, STOP, and contact the motor manufacturer.

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1.0 INSTALLER/OWNER/OPERATOR RESPONSIBILITY:

1.1 WARNINGS; ALL MOTORS

WARNING! SHOCK HAZARD

Only qualified personnel should install, connect or repair electrical motors and their accessories. Installation, connections, and repairs shall conform to the appropriate national and local codes, ordinances and sound practices (USA = NEC plus any state or local codes). Do not touch electrically live parts. Disconnect, lockout and tag input power supply before installing or servicing motor (includes accessory devices). Use a voltmeter to verify that power is off before contacting conductors.

WARNING! INSTALLATION

Check power supply to make certain that voltage, frequency and current carrying capacity are in accordance with the motor nameplate values. Motor and control wiring, fusing, overload protection, disconnects, accessories and grounding must always conform to the applicable electrical codes as well as local codes and sound practices. Motor lead connections must be secured and insulated. The conduit box cover must be fastened in place before electrical power is connected.

WARNING! GROUNDING HAZARD

Properly ground motors, per the appropriate national & local codes [USA = National Electrical Code (NEC) Article 430 plus any state or local codes]. For general information on grounding refer to NEC Article 250 and "Ground Connections" section 3.4.4 of this specification. VFD: Improper grounding of an inverter fed motor may result in frame voltages in excess of 500 Volts. In making the ground connection, the installer must make certain that a good electrical connection is obtained between motor and grounding lead. Power factor correction capacitors should never be installed between the VFD and the motor.

WARNING! LIFTING / LOOSE PARTS / PROTECTIVE DEVICES

LIFTING: Before using the lifting provision, check the eyebolts and/or other lifting means to assure they are not bent or damaged and are completely threaded, seated & secured to the motor. Equipment to lift motor must have adequate lifting capacity. While lifting the motor DO NOT stand under or in the vicinity of the motor. Eyebolts or lifting lugs, where provided, are intended for lifting only the motor and accessories mounted by the motor manufacturer (unless specifically stated otherwise on the motor). The lifting provision on standard horizontal footed motors is not designed for lifting the motor in a vertical shaft up or shaft down position. (see 2.2.1 lifting angles). Lifting method / provisions for mounting a rigid base (footed) motor vertically is the responsibility of the installer. LOOSE PARTS: Before starting the motor, remove all unused shaft keys and loose rotating parts to prevent them from flying off. PROTECTIVE DEVICES: When devices are assembled to the motor shaft, install protective devices such as belt guards, chain guards, and shaft covers. These protective devices must protect against accidental contact with extremities, hair, jewelry, and clothing.

WARNING! EXPLOSION HAZARD

A motor should never be placed in an area with a hazardous process or where flammable gases or combustible materials may be present unless it is specifically designed and nameplated for this type of service. Hazardous Locations motors are intended for installations in accordance with NEC Article 500. For all installations involving Hazardous Locations motors, consult the NEC, local codes, and the authority having jurisdiction.

2.0 RECEIVING AND INSPECTION

2.1 INITIAL INSPECTIONS

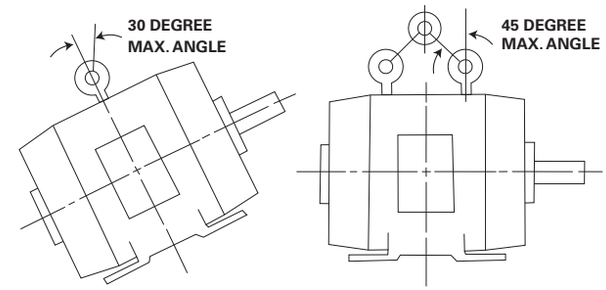
2.1.1 Check packing list and inspect to make certain no damage has occurred in shipment. If there is visible damage to the packaging, unpack and inspect the motor immediately. Purchaser claims for shipment damage to be issued by purchaser against the transportation company.

2.1.2 Check nameplate for conformance with purchase order requirements and compliance with power supply and control equipment requirements.

2.1.3 If motor has oil-lubricated bearings and will be placed into storage: drain any oil that had previously been added, by removing the drain plug located at the bottom of the oil sump in the bottom of the casting. Refill reservoir to the proper level (per lubrication plate) using new, clean oil.

2.2 HANDLING:

2.2.1 LIFTING ANGLE LIMITATIONS



SINGLE LIFTING DEVICE (TYPICAL) MULTIPLE LIFTING DEVICES (TYPICAL)

2.3 STORAGE: Motors must be stored indoors in a clean, dry location. Avoid locations with large temperature swings that will result in condensation. Motors must be covered to eliminate airborne dust and dirt. If the storage location exhibits high vibration, place isolation pad under motor to minimize damage to motor bearings. Maintenance requirements are divided into three main time periods: "3 to 12 months", "12 months to 24 months" and "24 months or greater"., not put into service immediately, must be stored indoors in a c.

2.3.1 STORAGE 3 months to 12 months

2.3.1.1 BEARING LUBRICATION: Bearings are grease packed at the factory; relubrication upon receipt of motor or while in storage is not necessary. If stored more than one year, add grease per lubrication instructions (Table 4-4) before start-up.

2.3.1.2 SHAFT ROTATION: It is recommended that the motor shaft be rotated 5 to 10 rotations every three months to distribute the grease in the bearings. This will reduce the chance for corrosion to form on the bearing rolling elements and raceways. Note: Shaft seals and bearing seals may add drag.

2.3.1.3 DAMP OR HUMID STORAGE LOCATIONS: Treat unpainted flanges, shafts, and fittings with a rust inhibitor. Apply appropriate power to the motor's space heaters (if so equipped) or utilize a trickle heating system to minimize condensation on motor windings.

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2.3.1.4 MOTOR WINDING: Stator winding should be megger tested once per two-month period to ensure that the integrity of the winding insulation has been maintained. If winding resistance to ground is less than 1.5 Meg-ohms, consult the local authorized service shop before energizing the motor.

2.3.2 STORAGE 12 months to 24 months

2.3.2.1 BEARING LUBRICATION: Bearings are grease packed at the factory; relubrication upon receipt of motor or while in storage is not necessary. If stored more than one year, add grease per lubrication instructions (Table 4-4) before start-up.

2.3.2.2 SHAFT ROTATION: It is recommended that the motor shaft be rotated 5 to 10 rotations every three months to distribute the grease in the bearings. This will reduce the chance for corrosion to form on the bearing rolling elements and raceways. Note: Shaft seals and bearing seals may add drag.

2.3.2.3 DAMP OR HUMID STORAGE LOCATIONS: Treat unpainted flanges, shafts, and fittings with a rust inhibitor. Check coatings after 12 months; recoat if necessary. Apply appropriate power to the motor's space heaters (if so equipped) or utilize a trickle heating system to minimize condensation on motor windings.

2.3.2.4 MOTOR WINDING: Stator winding should be megger tested once per two-month period to ensure that the integrity of the winding insulation has been maintained. If winding resistance to ground is less than 1.5 Meg-ohms, consult the local authorized service shop before energizing the motor.

2.3.3 STORAGE 24 months or greater

2.3.3.1 BEARING LUBRICATION: Bearings are grease packed at the factory; relubrication upon receipt of motor or while in storage is not necessary. If stored more than one year, add grease per lubrication instructions (Table 4-4) before start-up.

2.3.3.2 SHAFT ROTATION: It is recommended that the motor shaft be rotated 5 to 10 rotations every three months to distribute the grease in the bearings. This will reduce the chance for corrosion to form on the bearing rolling elements and raceways. Note: Shaft seals and bearing seals may add drag.

2.3.3.3 DAMP OR HUMID STORAGE LOCATIONS: Treat unpainted flanges, shafts, and fittings with a rust inhibitor. Check coatings after 12 months; recoat if necessary. Apply appropriate power to the motor's space heaters (if so equipped) or utilize a trickle heating system to minimize condensation on motor windings.

2.3.3.4 MOTOR WINDING: Stator winding should be megger tested once per two-month period to ensure that the integrity of the winding insulation has been maintained. If winding resistance to ground is less than 1.5 Meg-ohms, consult the local authorized service shop before energizing the motor.

3.0 INSTALLATION AND OPERATION

3.1 LOCATION

3.1.1 SELECTING A LOCATION: Consideration should be given to environment and ventilation. Motors should be installed in an area that is protected from direct sunlight, corrosives, harmful gases or liquids, dust, metallic particles, and vibration. A motor with the proper enclosure for the expected operating condition should be selected. Provide accessible clearance for cleaning, repair, service, and inspections. The location should be considered for possible future motor removal / handling. The free flow of air around the motor should not be obstructed.

Weather Protected I (WPI) motors can withstand dripping water but space heaters are recommended as protection from moisture on windings.

3.1.3 AMBIENT TEMPERATURE LIMITS: The ambient temperatures of the air inlet to the motor should not exceed 40°C (104°F) or be less than -25°C (-13°F) unless the motor nameplate specifically states an ambient temperature outside of these limits. The ambient inside an enclosure built around the motor shall not exceed the nameplate ambient. For ambient temperatures outside of these limits consult the motor manufacturer.

CAUTION: INSULATION DEGRADATION

When exposed to high temperatures, winding insulation ages at an accelerated rate. Each 10°C increase in temperature reduces the insulation life by ½.

3.2 APPLICATION ASSEMBLY TO MOTOR (MOUNTING):

CAUTION: EQUIPMENT DAMAGE DUE TO REVERSE ROTATION:

Do not connect or couple motor to load until correct rotational direction is established.

When the driven machine is likely to be damaged by the wrong direction of rotation, it is imperative to uncouple the motor from its load during the initial start and make certain it rotates in the correct direction. If it is necessary to change rotation, interchange any two line leads. On VHS motors do this before installing the pump head-shaft and upper half-coupling.

To run a VHS motor uncoupled, it is recommended the pump head-shaft be removed. If this cannot be done, remove the upper half-coupling and be sure the pump shaft is well centered in the motor shaft so it will not rub. IF THIS IS DONE, ROTATE THE MOTOR BY HAND TO BE SURE THERE IS NO INTERFERENCE BETWEEN SHAFTS. Do not try to run the motor uncoupled by just removing the gib key.

3.2.1 GENERAL: PROPER ALIGNMENT of the motor and driven equipment minimizes vibration levels, maximizes bearing life, and extends the overall life of the machinery. Consult the drive or equipment manufacturer for more information.

3.2.2 MOUNTING

a) Remove the hood (top hat) and coupling.

b) Lower the motor onto the pump head with the pump shaft extending through the hollow shaft.

c) The motor bracket should bolt down square with the pump head and at right angles with the pump head shaft.

d) The pump head shaft should be centered within the motor hollow shaft. Fit the coupling onto the motor and key it to the pump shaft using the gib key.

e) Install "adjusting nut" supplied with the pump and draw up on the impellers.

f) Lock the adjusting nut in place with a screw through the nut into a tapped hole in the coupling.

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3.2.3 THRUST

The axial thrust load imposed upon the motor by the pump shaft and impellers, plus the hydraulic load, should not exceed the value for which the motor was designed.

3.2.4 NON-REVERSE COUPLING (NRC)

A non-reverse coupling (NRC) permits rotation in the CCW direction when viewed from the coupling end of the motor. The NRC system consists of a stationary ratchet plate with slotted ramps and a rotating ball carrier that retains the steel balls. When the motor starts in the forward (CCW) direction, the slotted ramps in the ratchet plate lift the balls, where they are held in place by centrifugal force as the motor speed increases. When the motor speed decreases, the balls move down due to the decreasing centrifugal force and prevent CW (reverse) rotation by locking against the vertical edge of the slots in the ratchet plate.

3.3.5 Variable Frequency Drives: (also called VFD, inverter, Adjustable Speed Drive, ASD, adjustable frequency control, Variable Frequency Drives) OPERATION: [Read VFD Warnings Sections 1.1 & 1.2]

CAUTION: VFD/MOTOR SETUP:

It is the responsibility of the startup personnel during set up of the VFD / motor system to properly tune the drive to the motor for the specific application per the VFD user manual. The correct voltage boost and volts per hertz settings are application dependent and unique to each motor design. Failure to connect over temperature devices (when provided) will void the warranty.

3.3.5.1 Over-speed Capability: Do not exceed 125% of 60 Hz operating RPM.

3.3.5.2 Cable Lengths: For optimum insulation life, limit VFD to motor cable lengths to Table 3-5 values. Definite purpose VFD motors may accommodate longer cable lengths. For additional information contact motor manufacturer.

Table 3-5 Maximum Cable Lengths for General Purpose VHS Motors

These values are based on 3 kHz carrier frequency. Add suitable VFD output-side filters when exceeding the listed values.

230V	460 V	575 V
600 ft.	125 ft.	40 ft.

3.3.5.4 VFD Grounding: Equipment grounding conductors may be run in the same conduit as the AC motor power leads. This wire must be used as the equipment ground for the motor and not as the fourth current carrying wire of a "WYE" motor circuit. The grounded metal conduit carrying the output power conductors can provide EMI shielding, but the conduit does not provide an adequate ground for the motor; a separate grounding conductor must be used. Grounding the motor neutral (WYE) of a VFD powered motor may result in a VFD ground fault trip. Improper grounding of an inverter fed motor may result in frame voltages in excess of 500 Volts. Refer to Grounding section.

3.3.5.5 Stray Voltage on Accessory Leads: VFD's will couple stray (common-mode) voltage to motor-mounted RTDs, thermistors, thermostats and space heaters. The leads of these elements must be properly insulated and control input circuits must be designed to withstand this common-mode voltage.

3.3.6 ACCESSORIES / PROVISIONS:

3.3.6.1 General: Carefully read and understand the accessory manufacturer's instructions, supplied with motor. Contact the manufacturer for additional information.

3.3.6.3 Space Heaters:

Motors provided with space heaters have two leads that are brought into the conduit box or into an auxiliary box. These leads are marked "H1," "H2" ("H3," "H4" if a second space heater is supplied). See the space heater nameplate on motor for heater rating.

3.3.6.4 Thermal Protection:

General Information: When thermal protection is provided, "With overheat protective device" will be stamped on the nameplate:

3.3.6.4.1 "WITH OVERHEAT PROTECTIVE DEVICE": This motor is provided with an overheat protective device that does not directly open the motor circuit. Motors nameplated with this phrase have thermostats (marked "P1", "P2"), thermistors or RTD's (marked "R1","R2"). The leads to these devices are routed into the motor conduit box or into an auxiliary box. The lead markings are defined on the nameplate or decal. The circuit controlled by the overheat protection device must be limited to a maximum of 600 volts and 360 volt-amps. See connection decal provided inside the terminal box cover. Failure to connect these over temperature devices (when provided) will void the warranty.

Resistance Temperature Detectors (RTD): When winding and/or bearing RTDs are provided the RTD lead markings are defined on the nameplate. (Normally "R1", "R2", "R3" etc.)

3.3.6.5 RTD Alarm & Trip Settings:

Tables 3-6A & 3-6B are suggested initial RTD alarm and trip settings. For motors found to operate significantly below these values the settings may be reduced accordingly.

Table 3-6A Winding RTD – Temperature Limit (ºC) 40ºC Max Ambient

Motor Load	Class B Temp Rise 80˚C		Class F Temp Rise 150˚C	
	Alarm	Trip	Alarm	Trip
Up to 1.0 SF	130	140	155	165
>1.0 to 1.15 SF	140	150	160	165

Table 3-6B Bearing RTD – Temperature Limit (ºC) 40ºC Max Ambient

Ambient	Alarm	Trip
Up to 40ºC	95	100
> 40ºC	110	115
Bearings that are Heat Stabilized to 150ºC	130	135

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3.3.7 GUARDS: [Read Protection Warnings Section 1.1]

3.4 ELECTRICAL CONNECTIONS:

[Read Electrical Warnings Sections 1.1 & 1.2]

3.4.1 POWER SUPPLY / BRANCH CIRCUIT

3.4.1.1 Branch Circuit Supply to a motor should include a disconnect switch, short circuit current fuse or breaker protection, motor starter (controller) and correctly sized thermal elements or overload relay protection.

3.4.1.2 Fuses, Breakers, Overload Relays

Short Circuit Current Fuses or Breakers are for the protection of the branch circuit. Starter or motor controller overload relays are for the protection of the motor. Each of these should be properly sized and installed per the applicable electrical codes as well as local codes and practices.

3.4.1.3 AC Power Supply Limits

Motors are designed to operate within the following limits at the motor terminals:

1.) AC power is within +/- 10 % of rated voltage with rated frequency applied. (Verify with nameplate 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.

4.) For 3 phase motors the line to line full load voltage must be balanced within 1%.

5.) If the motor is rated 208-230V, the voltage deviations must be calculated from 230V.

CAUTION: Reduced Motor Performance

Operation outside of these limits will degrade motor performance and increase operating temperature.

3.4.2 TERMINAL BOX:

3.4.2.1 Conduit Opening: For ease of connections, motors are typically provided with large terminal boxes. Most motors have conduit access in 90 degree increments. The terminal box conduit opening is typically provided via knockouts, holes with covers, or the terminal box is rotate-able to allow entry from multiple planes. Fabricated conduit boxes may have a removable plate for the installer to provide correctly sized hole(s).

3.4.3 LEAD CONNECTIONS

Electrical connections to be made per nameplate connection diagram or separate connection plate. In making connections follow the applicable electrical code as well as local codes and practices.

3.4.4 GROUND (EARTHING) CONNECTION(S):

[Read Grounding Warnings Section 1.1]

Primary "Internal" Ground: A grounding conductor must be connected to the grounding terminal provided in the terminal housing. This grounding terminal is either a ground screw, ground lug, or a tapped hole to be used with a separately provided ground screw. The internal grounding feature is accessible inside the terminal housing and must be used as the primary grounding connection.

Secondary "External" Ground: Some motors are provided with a supplemental grounding terminal located on the external surface of the motor frame or feet. This external terminal is for supplemental bonding connections where local codes permit or require such connection.

4.0 START UP: Read Warnings Sections Before Proceeding

CAUTION: HOT SURFACE

Normal motor surface temperatures may exceed 90°C (194°F). Touching the motor frame may cause discomfort or injury. Surface temperatures should only be measured with suitable instruments and not estimated by hand touch.

CAUTION: Do not energize the motor unless the Top Hat is properly installed and bolted to the motor frame.

4.1 Start Up - No Load Procedure

1. Check Instructions: Before startup carefully read and fully understand these instructions including all warnings, cautions, and safety notice statements.

2. Motors stored for more than three months: Check winding insulation integrity with a Megger. If winding resistance to ground is less than 1.5 Meg-ohms consult the local authorized service shop before energizing the motor.

3. Check Installation: Mechanical - Check tightness of all bolts and nuts. Manually rotate the motor shaft to ensure motor shaft rotates freely.

Motors with oil-lubricated bearings: If oil was added prior to storage, drain oil from reservoir by removing the drain plug located at the bottom of the oil sump (at the bottom of the frame casting).

4.2 ASSEMBLY INSTRUCTIONS FOR NON REVERSE COUPLING (NRC)

Section 4.2 contains assembly instructions for four coupling configurations – note the section heading carefully.

210-280 Frame Motors with NRC for Unidirectional Pumps

210-280 Frame Motors with NRC for Bidirectional Pumps

320-449 Frame Motors with Rigid coupling for Unidirectional Pumps

320-449 Frame Motors with Rigid coupling Bidirectional Pumps

4.2.1 ASSEMBLY OPERATION FOR UNIDIRECTIONAL PUMP ROTATION 210-280 Frame

Table 1: Coupling Kit Packing List

Item	Quantity
Upper Half Coupling	1
Coupling Bolts	3
Coupling Lock Washers	3
Gib Key	1
Instructions	1

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Table 2: Bolt Torque Chart for Non Reverse Coupling Fasteners

Part Name	Frame Size	Qty	Item	Torque (Ft-Lbs)	Torque (N-M)
Top Hat Cover Bolts	210	3	1/4 - 20 UNC x 1/2 Bolt	8	11
Top Hat Cover Bolts	250-280	4	1/4 - 20 UNC x 1/2 Bolt	8	11
Coupling Bolts	210	3	5/16 - 18 UNC x 1-3/4 Bolt	17	23
Coupling Bolts	250/280	3	3/8 - 16 UNC x 2-1/4 Bolt	30	41

CAUTION: Do not energize the motor unless the Top Hat Cover is properly installed and bolted to the motor frame.

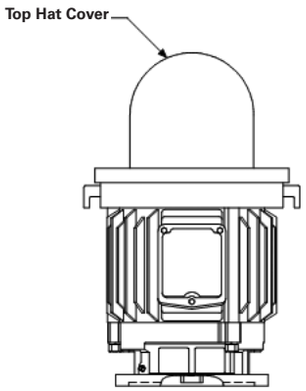

Figure 1: Motor Top Hat Cover Location

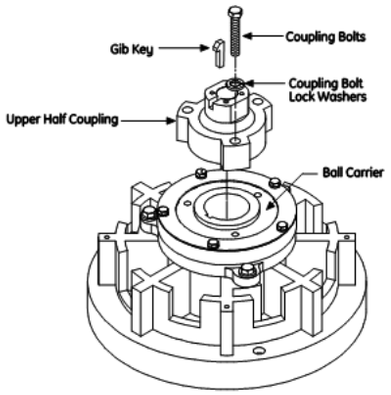

Figure 2: Non Reverse Coupling Exploded View

Non Reverse Coupling (NRC) Assembly Instructions for Unidirectional Pump Rotation

1. Disassemble the top hat cover from the motor by removing the top hat cover bolts. Refer to Figure 1. Carefully lift the cover from the motor.

2. Thoroughly clean the coupling and all related components prior to assembly.

3. Mount the upper half coupling so that it fits flush to the ball carrier. Refer to Figure 2.

4. Install the (3) coupling bolts and lock washers as shown in Figure 2. Initially tighten one bolt "hand tight" and in a circular fashion, tighten the remaining bolts "hand tight" as well. Afterwards, tighten each bolt to the required torque value shown in Table 2.

5. Connect the pump shaft to the upper half coupling.

6. Install the top hat and torque the top hat cover bolts to the torque value shown in Table 2.

4.2.2 ASSEMBLY OPERATION FOR BIDIRECTIONAL PUMP ROTATION 210-280 Frame

Table 3: Coupling Kit Packing List

Item	Quantity
Upper Half Coupling	1
Coupling Bolts	3
Coupling Lock Washers	3
Gib Key	1
Instructions	1

Table 4: Bolt Torque Chart for Bolted Coupling Fasteners

Part Name	Frame Size	Qty	Item	Torque (Ft-Lbs)	Torque (N-M)
Top Hat Cover Bolts	210	3	1/4 - 20 UNC x 1/2 Bolt	8	11
Top Hat Cover Bolts	250-280	4	1/4 - 20 UNC x 1/2 Bolt	8	11
Cover Plate Bolts	210-280	5	1/4 - 20 UNC x 1/2 Bolt	8	11
Coupling Bolts	210	3	5/16 - 18 UNC x 1-3/4 Bolt	17	23
Coupling Bolts	250/280	3	3/8 - 16 UNC x 2-1/4 Bolt	30	41

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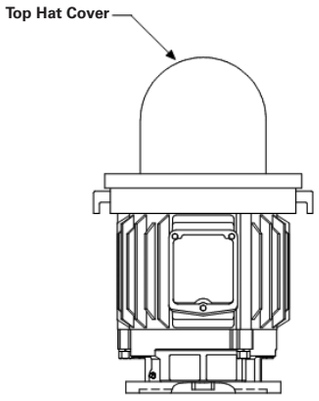
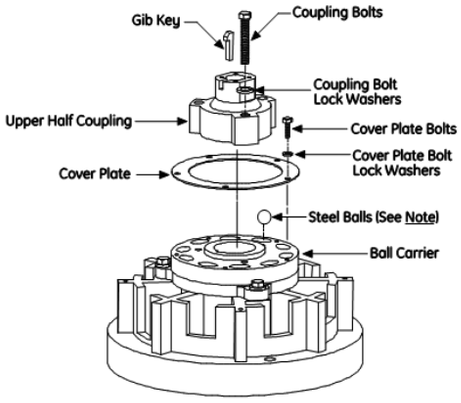


Figure 3: Motor Top Hat Cover Location



Note: Remove for Bolted Operation

Figure 4: Bolted Operation Exploded View

CAUTION: Do not energize the motor unless the Top Hat is properly installed and bolted to the motor frame.

Bolted Coupling Disassembly/Assembly Instructions for Bidirectional Pump Rotation

1. Disassemble the top hat cover from the motor by removing the top hat cover bolts. Refer to Figure 3. Carefully lift the cover from the motor.

2. Remove the (5) cover plate bolts and lock washers securing the cover plate to the ball carrier. Refer to Figure **4.** Carefully lift the cover plate from the motor. Note: Do not remove the ball carrier from the motor.

3. Using a magnet, remove the steel balls (10) from the angular drilled holes located on the ball carrier.

4. Reassemble the cover plate to the ball carrier. Install the (5) cover plate bolts with lock washers. Initially tighten one bolt "hand tight" and in a circular fashion, tighten the remaining bolts "hand tight" as well. Afterwards, tighten each bolt to the torque value shown in Table 4.

5. In preparation for mounting the upper half coupling, thoroughly clean the coupling and all related components prior to assembly.

6. Mount the upper half coupling so that it fits flush to the ball carrier. Refer to Figure 4 .

7. Install the (3) coupling bolts and lock washers as shown in Figure 4. Initially tighten one bolt "hand tight" and in a circular fashion, tighten the remaining bolts "hand tight" as well. Afterwards, tighten each bolt to the required torque value shown in the Table 4.

8. Connect the pump shaft to the upper half coupling.

9. Install the top hat cover and torque the top hat cover bolts to the torque value shown in Table 4.

4.2.3 ASSEMBLY OPERATION FOR UNIDIRECTIONAL PUMP ROTATION 320-449 Frame

Table 1: Coupling Kit Packing List

Item	Quantity
Upper Half Coupling	1
Coupling Bolts	3
Coupling Lock Washers	3
Gib Key	1
Instructions	1

Table 2: Bolt Torque Chart for Non Reverse Coupling Fasteners

Part Name	Frame Size	Qty	Item	Torque (Ft-Lbs)	Torque (N-M)
Top Hat Cover Bolts	210	3	1/4 - 20 UNC x 1/2 Bolt	8	11
Top Hat Cover Bolts	250-280	4	1/4 - 20 UNC x 1/2 Bolt	8	11
Coupling Bolts	210	3	5/16 - 18 UNC x 1-3/4 Bolt	17	23
Coupling Bolts	250/280	3	3/8 - 16 UNC x 2-1/4 Bolt	30	41

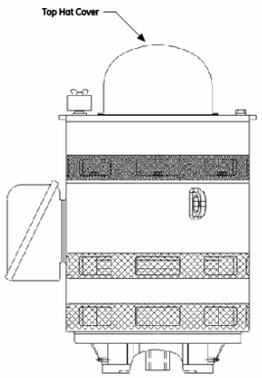


Figure 1: Motor Top Hat Cover Location

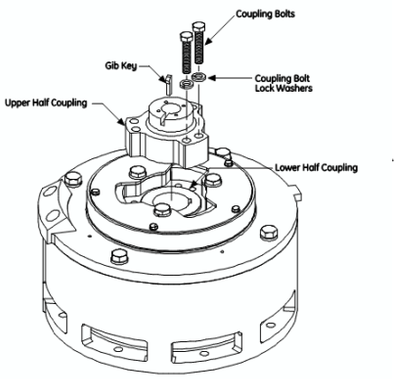


Figure 2: Non Reverse Coupling Exploded View

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Non Reverse Coupling (NRC) Assembly Instructions for Unidirectional Pump Rotation

1. Disassemble the top hat cover from the motor by removing the top hat cover bolts. Refer to Figure 1. Carefully lift the cover from the motor.

2. Thoroughly clean the coupling and all related components prior to assembly.

3. Mount the upper half coupling so that it fits flush to the ball carrier. Refer to Figure 2.

4. Install the (3) coupling bolts and lock washers as shown in Figure 2. Initially tighten one bolt "hand tight" and in a circular fashion, tighten the remaining bolts "hand tight" as well. Afterwards, tighten each bolt to the required torque value shown in Table 2.

5. Connect the pump shaft to the upper half coupling.

6. Install the top hat cover and torque the top hat cover bolts to the torque value shown in Table 2.

4.2.4 ASSEMBLY OPERATION FOR BIDIRECTIONAL PUMP ROTATION 320-449 Frame

Table 3: Coupling Kit Packing List

Item	Quantity
Upper Half Coupling	1
Coupling Bolts	3
Coupling Lock Washers	3
Gib Key	1
Instructions	1

Table 4: Bolt Torque Chart for Bolted Coupling Fasteners

Part Name	Frame Size	Qty	Item	Torque (Ft-Lbs)	Torque (N-M)
Top Hat Cover Bolts	210	3	1/4 - 20 UNC x 1/2 Bolt	8	11
Top Hat Cover Bolts	250-280	4	1/4 - 20 UNC x 1/2 Bolt	8	11
Cover Plate Bolts	210-280	5	1/4 - 20 UNC x 1/2 Bolt	8	11
Coupling Bolts	210	3	5/16 - 18 UNC x 1-3/4 Bolt	17	23
Coupling Bolts	250/280	3	3/8 - 16 UNC x 2-1/4 Bolt	30	41

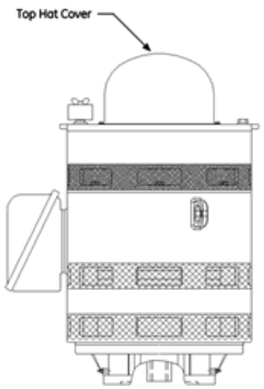

Figure 3: Motor Top Hat Cover Location

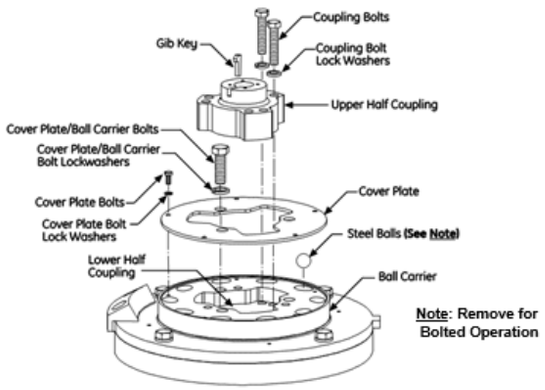

Figure 4: Bolted Operation Exploded View

Bolted Coupling Disassembly/Assembly Instructions for Bidirectional Pump Rotation

1. Disassemble the top hat cover from the motor by removing the top hat cover bolts. Refer to Figure 3. Carefully lift the cover from the motor.

2. Remove the (5) cover plate bolts and lock washers securing the cover plate to the ball carrier. Refer to Figure **4.** Carefully lift the cover plate from the motor. Note: Do not remove the ball carrier from the motor.

3. Using a magnet, remove the steel balls (10) from the angular drilled holes located on the ball carrier.

4. Reassemble the cover plate to the ball carrier. Install the (5) cover plate bolts with lock washers. Initially tighten one bolt "hand tight" and in a circular fashion, tighten the remaining bolts "hand tight" as well. Afterwards, tighten each bolt to the torque value shown in Table 4.

5. In preparation for mounting the upper half coupling, thoroughly clean the coupling and all related components prior to assembly.

6. Mount the upper half coupling so that it fits flush to the ball carrier. Refer to Figure 4 .

7. Install the (3) coupling bolts and lock washers as shown in Figure 4. Initially tighten one bolt "hand tight" and in a circular fashion, tighten the remaining bolts "hand tight" as well. Afterwards, tighten each bolt to the required torque value shown in the Table 4.

8. Connect the pump shaft to the upper half coupling.

9. Install the top hat and torque the top hat cover bolts to the torque value shown in Table 4.

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4.3 ADJUST END PLAY:

On standard VHS motors, the lower guide ring is restrained to take momentary up thrust. On spherical bearing motors, the restrained lower bearing also maintains spring tension on the thrust bearing during any periods the motor is running without external load.

CAUTION: When reassembling the motor, it is important a preload stress is not left on the guide and thrust bearing. The following assembly procedure must be used.

1. Leave the locknut holding the runner on the shaft loose.

2. Tighten the lower bearing cap bolts.

3. Tighten down on the shaft locknut until the bearings are just starting to preload.

4. When slight preloading is experienced, there is no endplay and the rotor will not turn as freely by hand.

5. After slightly preloading the bearings, back off the locknut approximately 1/4 turn.

6. Shaft endplay for angular contact bearing motors should be 0.005 in. to 0.020 in. (0.127 mm to 0.508 mm). Movement should be checked with a dial indicator

7. When endplay is established, lock the nut in place with the lock washer.

CAUTION: Do not operate the motor until the bearing housing has been filled to the proper level with oil (as indicated on the lubrication plate)

5.4 CHECK INSTALLATION: Electrical - Inspect all electrical connections for proper terminations, clearance, mechanical tightness and electrical continuity. Be sure to verify connections are made per the nameplate connection diagram or separate connection plate. Replace all panels and covers that were removed during installation before energizing the motor.

5.5 ENERGIZE MOTOR: Check Rotation

If practical check motor rotation before coupling to the load. Unlock the electrical system. Momentarily provide power to motor to verify direction of rotation. If opposite rotation is required, lock out power before reconnecting motor. If motor has a rotational arrow only operate the motor in the rotation identified. Reapply power to ensure proper operation.

To run a VHS motor uncoupled, it is recommended the pump head-shaft be removed. If this cannot be done, remove the upper half-coupling and be sure the pump shaft is well centered in the motor shaft so it will not rub. IF THIS IS DONE, ROTATE THE MOTOR BY HAND TO BE SURE THERE IS NO INTERFERENCE BETWEEN SHAFTS. Do not try to run the motor uncoupled by just removing the gib key.

5.6 RECORD NO LOAD AMPS, WATTS & VOLTAGE:

Recommendation - To establish a baseline value, check and record the no-load amps, watts, and voltage. Voltage should be balanced and be within 10% of motor rated voltage.

4.7 START UP – LOAD CONNECTED PROCEDURE

1. Check Instructions: Before startup carefully read and fully understand these instructions including all warnings, cautions, & safety notice statements.

2. Coupling Installation: Check that the connected equipment is properly aligned and not binding. Check that all guards and protective devices are properly installed.

3. Energize Motor: When all personnel are clear of the machine, apply power and verify that the load is not transmitting excessive vibration back to the motor though the shaft or the foundation. Verify that motor amps are within nameplate rating. For repeated starts see Section **4.** The equipment can now be fully loaded and operated within specified limits as stated on the nameplate.

In the event of excessive vibration or unusual noise, remove all power and disconnect the machine from the load and check the mounting and alignment.

Space heaters (if supplied) should be de-energized during motor operation.

Check the operating current against the nameplate value. Do not exceed the value of nameplate amperes X service factor (if any) under steady continuous load. Also verify the current in all three lines is balanced.

4.8 JOGGING AND/OR REPEATED STARTS

Do not start more than twice in succession under full load. Repeated starts and/or jogs of induction motors can cause overheating and immediate failure. Contact the motor manufacturer if it is necessary to repeatedly start or jog the motor.

5.0 MAINTENANCE: [Read Warnings Sections 1.1 & 1.2]

5.1 GENERAL INSPECTION

Inspect the motor approximately every 500 hours of operation or every three months, whichever occurs first. The following steps should be performed at each inspection:

5.1.1 VENTILATION: Keep the motor clean and the ventilation and fin openings free of dirt, oil, grease, water, etc, which can accumulate and block motor ventilation. If the motor is not properly ventilated, overheating can occur and cause early motor failure.

5.1.2 INSULATION: Use a "Megger" periodically to ensure that the integrity of the winding insulation has been maintained. Record the Megger readings. If winding resistance to ground is less than 1.5 Meg-ohms consult the local authorized service shop before re-energizing the motor.

5.1.3 ELECTRICAL CONNECTIONS: Check all electrical connectors to be sure that they are tight.

5.1.4 FASTENERS AND TOOLS: Ensure all fasteners are tight, including the coupling. Fasteners must be secured using the appropriate tool. Sockets or enclosed wrenches must be used on all hex fasteners. Removal of heavy rotors requires a tool which balances the rotor during assembly / disassembly to prevent damage to the winding.

5.1.5 NON-REVERSE COUPLING (NRC)

The condition of non-reverse couplings should be checked periodically by removing the top cap. If dirt has caused the action of the balls to become sluggish, the ball carrier should be removed, disassembled and thoroughly cleaned with a suitable solvent. The parts should then be dried and reassembled in accordance with the instructions given under Section 4.2. Bolts on both bolted couplings and non-reverse couplings should be checked periodically to be sure they are tight. See Section B for tightening torques.

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A long period of operation under frequent stops and starts may causes the surface of the holes in the ball carrier to become polished, so that friction force will no longer hold the balls clear of the ratchet teeth when the motor is running. If this condition is observed, roughen the surface of the holes in the ball carrier with a piece of emery paper.

NOTE: Whenever a coupling is disassembled, use witness marks to ensure a balanced condition when reassembly is complete.

5.2 DISASSEMBLY TO INSPECT UPPER THRUST BEARING:

To service or inspect the thrust bearing, the parts should be removed in the following order:

1. top hat cover
2. drive nut from pump shaft
3. upper half coupling
4. ball carrier
5. ratchet balls
6. locknut and washer
7. ratchet plate
8. lower half coupling
9. bearing

When the thrust bearing is removed, the upper bracket can be lifted off the frame after removing the bracket bolts. If required, the rotor and shaft can be lifted out with the upper bracket by removing the lower bearing cap bolts.

6.0 LUBRICATION & BEARINGS:

Lubricating ability of 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. Longer bearing life can be obtained if the listed recommendations are followed:

CAUTION: BEARING / MOTOR DAMAGE

Lubricant should be added at a steady, moderate pressure. If added under heavy pressure, bearing shield(s) or seals may collapse. Overgreasing bearings greatly increases bearing friction and can cause premature bearing and/or motor failure.

6.1 GREASE TYPE (unless nameplate states otherwise):

Nameplate Ambient Temperature between -30°C (-22°F) to 65°C (150°F) inclusive: Recommended grease for standard service conditions is Mobil® Polyrex® EM. Equivalent and compatible greases include: Chevron® BRB-2, Texaco® Polystar™ RB, Rykon® Premium #2, Pennzoil® Pen 2 Lube, Mobil SHC 100. Grease types other than those listed above require approval of the motor manufacturer. [A grease with an EP additive is not acceptable]

Nameplate Ambient Temperature below -30°C (-22°F): Special low temperature grease is recommended, such as Aeroshell® 7 or Beacon™ 325 for ball bearings and Mobil SHC 100 for roller bearings.

Nameplate Ambient Temperature above 65°C (150°F): Dow Corning® DC44 or equivalent, a special high temperature grease is required. Note that Dow Corning DC44 grease does not mix with other grease types.

6.2 BEARING OPERATING TEMPERATURE:

CAUTION: HOT SURFACE

The external surface temperature of the end shield (bracket) bearing hub may reach 100° C (212° F) during normal operation. Touching this surface may cause discomfort or injury. Surface temperatures should only be measured with suitable instruments and not estimated by hand touch. For RTD settings see Table 3-7.

6.3 LUBRICATION INSTRUCTIONS FOR GREASED BEARING

6.3.1 INTERVALS FOR GREASED BEARING

Table 6-1 Grease Lubrication Amounts and Intervals

NEMA® Frame Size	Upper Thrust Bearing	Amount		Lower Guide Bearing	Amount		Lubrication Interval (operating hours)		
		oz	mL		oz	mL	2 Pole	4 Pole	6 Pole
							3600/3000 rpm	1800/1500rpm	1200/1000rpm
213-215	7309	1.0	29	6209	1.0	29	2800	4300	4300
254-256	7311	1.0	29	6309	1.0	29	2800	4300	4300
284-286	7311	1.0	29	6311	1.0	29	2800	4300	4300
324-326	n/a	n/a	n/a	6312	1.0	29	2800	4300	4300
364-365	n/a	n/a	n/a	6313	1.0	29	2800	4300	4300
404-405	n/a	n/a	n/a	6314	1.8	52	1900	4300	4300
444-445	n/a	n/a	n/a	6314	1.8	52	n/a	4300	4300
447-449	n/a	n/a	n/a	6218	1.8	52	n/a	4300	4300

6.3.2 LUBRICATION PROCEDURE FOR GREASED BEARING

CAUTION: BEARING DAMAGE

Added grease must be compatible with the original equipment's grease. If a grease other than those stated in 4.2.1 is to be utilized contact the motor manufacturer. Nameplate information supersedes section 4.2.1 (GREASE TYPE). New grease must be free of dirt. Do not relubricate bearings with EP greases. EP greases can damage the motor winding. Failure to follow these instructions and procedure below may result in bearing and/or motor damage.

For an extremely dirty environment, contact the motor manufacturer for additional information.

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GREASE LUBRICATION PROCEDURE:

1. Clean the grease inlet plug or zerk fittings prior to regreasing.

2. (If present) Remove grease drain plug and clear outlet hole blockage.

CAUTION: IF GREASE DRAIN IS PLUGGED:

Old grease may completely block the drain opening and must be mechanically removed prior to regreasing. Forcing a blocked drain open by increased greasing pressure may collapse bearing shields and / or force excess grease through the bearings and into the motor.

1. Add grease per Table 6-1.

2. Re-install grease inlet and drain plugs (if removed).

6.4 LUBRICATION INSTRUCTIONS FOR OIL LUBRICATED BEARINGS

6.4.1 LUBRICATION INTERVAL FOR OIL LUBRICATED BEARING

For standard use, change oil every six months. For high ambient temperature or severe conditions, consult motor manufacturer.

CAUTION: BEARING DAMAGE

Using an oil that is too heavy (high viscosity) can cause increased temperature (leading to reduced bearing life) due to the following:

1. Increased fluid friction

2. Reduced heat transfer due to churning/foaming

3. Reduced heat transfer due to slower movement of oil around the balls

Using and oil that is too light (low viscosity) can cause reduced bearing life due to lack of sufficient oil film.

6.4.2 LUBRICATION PROCEDURE FOR OIL LUBRICATED BEARINGS

1. Do not run motor until the bearing housings have been filled to the proper level with oil as indicated on the oil lubrication plate and allowed to stand one (1) hour with oil in the bearings.

2. With the motor at standstill, fill the top bearing reservoir with a high quality grade of lubricating oil having a viscosity equivalent to S.A.E. #10W; 150 SUS (ISO 32) @ 100°F, 45 SUS @ 210°F

3. For oil lubricated ball bearing motors, drain oil from the reservoir that was put in at the time of receipt of the motor or during storage, by removing the drain plug located at the bottom of the oil sump in the bottom of the casting. Before starting the motor, replace the filler plug.

4. Maintain proper lubrication by checking the oil level periodically and adding oil when necessary. The normal level, with the motor stopped and the oil at ambient temperature, is marked as "STANDSTILL LEVEL" on the sight gage.

CAUTION: Do not permit the motor to operate with the oil level below the minimum shown on the gage. If it becomes necessary to add excessive amounts of make-up oil, investigate for all oil leaks.

Note: The oil level will be higher after the motor has been in operation for a few hours because of the clearing action of the bearing as the motor accelerates up to speed and because of the expansion of the oil as temperature increases.

Overfilling should be avoided not only because of the possibility that expansion may force the oil over the oil sleeve and into the motor, but also because operating with the oil level too high prevents the bearing from cleaning 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 gage, drain enough oil to bring the level back within the operating range. To drain the oil, remove the drain plug below the sight gage.

7.0 TROUBLESHOOTING

[Read Warnings Sections 1.1 & 1.2]

CAUTION: DISASSEMBLY APPROVAL REQUIRED:

Motor disassembly must be performed by a party approved by the motor manufacturer. To disassemble the motor without approval voids the warranty.

6.3.1 GENERAL TROUBLE-SHOOTING WARNINGS

1. DISCONNECT POWER TO THE MOTOR BEFORE PERFORMING SERVICE OR MAINTENANCE.

2. Discharge all capacitors before servicing motor.

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

4. Be sure required safety guards are in place before starting equipment.

5. If the problem persists contact the manufacturer.

INSTRUCTIONS FOR LANGUAGES OTHER THAN ENGLISH:

Contact importer or manufacturer for translation of these instructions for languages other than English.

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Table 7.1 Motor Trouble-shooting Cause / Corrective Action

ISSUE:	LIKELY CAUSE:	CORRECTIVE ACTION:
Motor fails to start upon initial installation:		
A.)	Supply voltage is too low or is severely unbalanced (one phase is low or missing).	(1) Check power supply fuses (2) Match motor lead wiring to nameplate connection diagram and supply voltage (3) Ensure that steady state supply voltage at motor terminals is within limits (see section 3.4.1.3). Correct as needed (4) Obtain correct motor to match actual supply voltage.
B.)	Motor leads are miswired at conduit box.	
C.)	Driven load exceeds motor capacity .	(1) Verify that motor & load turn freely (2) Disconnect motor from load & ensure motor turns freely. Note: Roller bearings make noise when motor is uncoupled and shaft is rotated (3) Verify that motor starts when disconnected from load (4) Remove excessive / binding load if present.
D.)	Load is jammed.	
E.)	Fan guard is bent and making contact with fan.	Replace fan guard & fan (if blades are damaged).
F.)	VFD with power factor capacitors installed.	Remove power factor correction capacitors if equipped.
G.)	VFD with motor neutral lead grounded.	Ensure that motor neutral lead is ungrounded.
H.)	VFD programmed incorrectly.	(1) Repeat checks listed above (2) Verify that VFD current limit and starting boost are set correctly (5) Double-check motor and feedback parameter settings and VFD permissives (6) Repeat autotune (for vector drives) procedure (7) Consult VFD supplier.
Motor has been running, then slow down, stalls, or fails to restart:		
A.)	Supply voltage has dropped or has become severely unbalanced.	(1) Replace fuse or reset circuit breaker. Allow motor to cool down before resetting manual protector on motor. **WARNINGS:** - See section 1.1 for automatic and manual reset protector warnings (2) Verify that rated and balanced supply voltage has been restored before restarting motor. Measure voltage during restart. Ensure that steady state supply voltage at motor terminals is within limits (see section 3.4.1.3).
B.)	Motor is overloaded.	(1) Verify that motor & load turn freely. Repair binding components as needed (2) Reduce driven load to match motor capacity or increase motor size to match load requirements.
C.)	Motor bearings are seized.	
D.)	Load Is jammed.	
E.)	VFD will not restart motor after tripping.	(1) Check fault codes on VFD and follow VFD troubleshooting procedures (2) Verify that VFD input voltage is balanced and within limits (3) Remove excessive mechanical load if present.
F.)	Capacitor failure on single phase motor (if equipped).	**WARNING: Potential Shock Hazard:** Contact service shop to check capacitor.
Motor takes too long to accelerate:		
A.)	Motor leads are not connected correctly.	Match motor lead wiring to nameplate diagram.
B.)	Supply voltage has dropped or become severely unbalanced.	(1) Ensure that steady state supply voltage at motor terminals is within limits (see section 3.4.1.3). Correct as needed (2) Obtain correct motor to match actual supply voltage.
C.)	Load exceeds motor capability.	Determine correct motor size and contact motor representative to obtain replacement motor.
D.)	Faulty start capacitor (Single Phase).	Motor may be too small for load. Record acceleration time. Start capacitors may fail if acceleration time exceeds 3 seconds.
E.)	Mechanical Failure.	(1) Check to make sure motor & load turn freely (2) Disconnect motor from load & ensure motor turns freely.
Motor rotates in the wrong direction:		
A.)	Incorrect wiring connection at motor.	[Three Phase] Interchange any two power supply (phase) leads.
Motor overheats or thermal protector repeatedly trips		
A.)	Driven Load is excessive.	(1) If motor current exceeds nameplate value, ensure that driven load has not increased. Correct as needed. (2) If new motor is a replacement, verify that the rating is the same as the old motor. If previous motor was a special design, a general purpose motor may not have the correct performance.
B.)	Ambient temperature too high.	Most motors are designed to operate in an ambient up to 40 C. (See section 4.2.2 Hot Surface Caution).
C.)	Motor cooling fins and/or vent openings blocked.	Remove foreign materials – clear vent openings, fan guard air inlets and frame fins (TEFC motors) .

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Table 7.1 Motor Trouble-shooting Cause / Corrective Action (Continued)			
	D.)	Insufficient Air Flow.	TEAO (Totally Enclosed Air Over) motors: Measure airflow next to motor surface and obtain minimum requirements from motor manufacturer.
	E.)	Motor is started too frequently.	See section 3.4.5.3.
	F.)	Supply voltage too low, too high, or unbalanced.	(1) Ensure that steady state supply voltage at motor terminals is within limits (see section 3.4.1.3) Correct as needed (2) Reconnect motor per input voltage (3) Obtain correct motor to match power supply.
Motor Vibrates			
	A.)	Motor misaligned to load.	Realign load.
	B.)	Load out of balance (Direct drive application).	(1) Ensure that load is dynamically balanced: (2) Remove motor from load and inspect motor by itself. Verify that motor shaft is not bent. Rule of thumb is 0.002" runout for shafts extension lengths up to 3.00". Add 0.0005" per every additional inch of shaft length beyond 3.00".
	C.)	Uneven tension on multiple belts.	Mixing new with used belts. Replace multiple belt applications with a complete set of matched belts.
	D.)	Driven load operating at resonant point / natural frequency.	(1) De-energize motor and record vibration as load coasts from 100% speed to 0 RPM. If vibration drops immediately, vibration source is electrical. If levels do not drop immediately, source is mechanical (2) Redesign system to operate below the resonant point (3) On VFD-driven loads, program skip frequencies to bypass resonant points (4) Increase carrier frequency to obtain <3% THD current (5) On variable torque loads reduce volts/hertz below base speed.
	E.)	VFD torque pulsations.	(1) Adjust VFD to obtain <3% THD current @ rated motor current (2) Adjust VFD stability for smooth operation. Vector drives may be unstable at light load.
	F.)	Motor miswired at terminal box.	Match motor lead wiring to nameplate connection diagram.
		Uneven, weak or loose mounting support.	Shim, strengthen or tighten where required.
		Motor bearings defective.	Test motor by itself. If bearings are bad, you will hear noise or feel roughness. Roller bearings are normally noisy when operated without load, limit roller bearing no load run time to five minutes. If sleeve bearing, add oil per nameplate instructions. For motors with regreasing provisions, add grease per relubricating instructions (see section 4.2.3). If noise persists contact warranty service.
	I.)	Motor out of balance.	Disconnect from load. Set motor on rubber pads on solid floor. Secure a ½ height key in shaft keyway and energize from balanced power supply @ rated voltage. Record vibration levels and compare with appropriate standards. If excessive vibration persists contact motor manufacturer.
Bearings repeatedly fail.			
	A.)	Load to motor may be excessive or unbalanced.	Check thrust load versus bearing size and type.
	B.)	Bearings contaminated.	Replace bearing.
	C.)	Incorrect grease or oil for ambient extremes.	Replace grease or oil after cleaning cavity / reservoir.
	D.)	VFD bearing damage.	Ground brush, common mode filter, or insulated bearings must be added. Contact motor manufacturer.
Motor, at start up, makes a loud rubbing, grinding, or squealing noise.			
	A.)	Contact between rotating and stationary components.	Belt squeal during across the line starting is normal: (1) Verify that supply voltage is within limits (see section 3.4.1.3). (2) Ensure that motor lead wiring matches nameplate connection diagram: (3) Isolate motor from load. (4) To locate point of contact turn motor shaft by hand. (5) If point of contact is not located contact motor service shop.
Oil Leaks.			
	A.)	Incorrect oil or water in oil.	Replace oil.
	B.)	Loose fittings.	Tighten fittings using appropriate tool.
	C.)	Cracked casting .	Contact motor manufacturer or recommended service shop.
	D.)	Over filled oil reservoir.	Drain reservoir and refill with appropriate amount and type of oil.

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