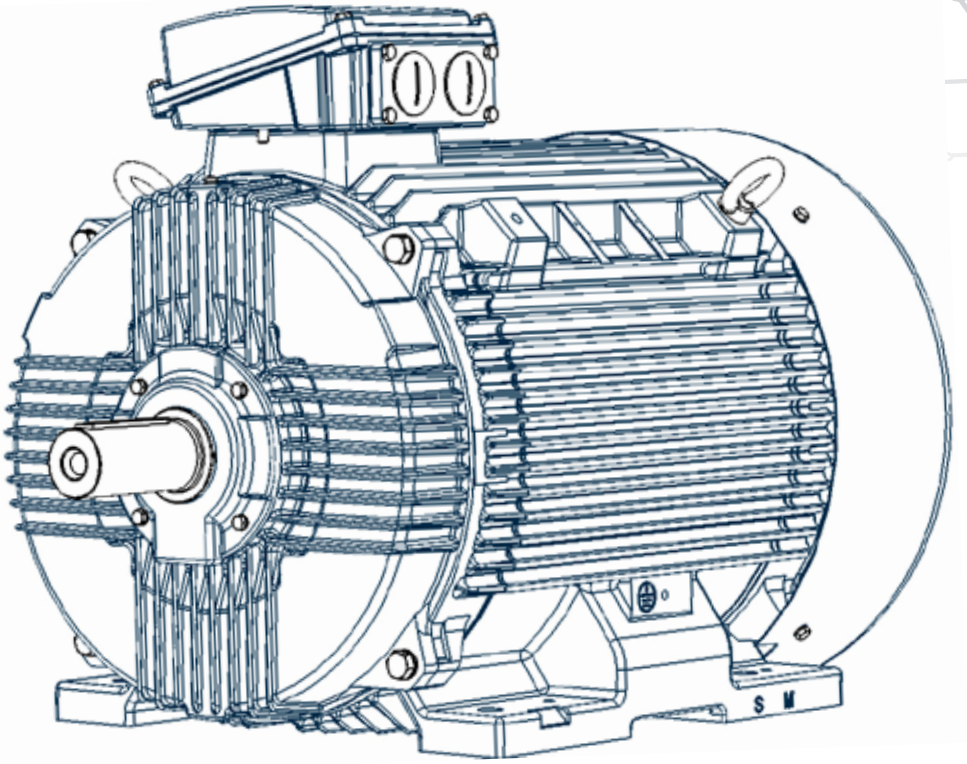
marathon® Motors



TerraMAX® LOW VOLTAGE INDUSTRIAL MOTORS

INSTALLATION, OPERATION, MAINTENANCE & SAFETY MANUAL

REGAL®

marathon® Motors

TerraMAX® Installation, Operation, Maintenance and Safety Instructions

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FORM
SB0250E
July 2020

⚠ WARNING

- Warning indicates a hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

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

NOTICE

- Notice indicates a situation not related to personal injury which, if not avoided, could result in motor or equipment damage.

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1.0 INTRODUCTION

These operating instructions describe the motor and explain best practices in motor handling, from initial delivery to final disposal of the motor. These instructions 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, STOP, and call the appropriate Regal motor company.

Read these operating instructions before you handle the motor to become familiar with its design and operating principles and thus assist with a problem-free machine operation and long service life.

Always follow the safety instructions and notices in these operating instructions.

WARNING! Failure to follow all instructions for proper motor installation, operation, and maintenance could result in serious personal injury, death, and/or property damage. Contact a Regal office with any questions or concerns. Contact information is on the last page of this document.

2.0 SAFETY INSTRUCTIONS

Before installing, using, or servicing this product, carefully read and fully understand the instructions including all warnings, cautions, & safety notice statements.

2.1 ELECTRICAL SAFETY

WARNING! ELECTRICAL SHOCK HAZARDS

Electrical connections shall be made by qualified electrical personnel in accordance with all applicable codes, ordinances and sound practices. Only qualified personnel who are familiar with the applicable national code and local codes should install or repair electrical motors and their accessories.

WARNING! ELECTRICAL LIVE CIRCUIT HAZARD

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! ELECTRICAL GROUNDING HAZARD

Properly ground motors as per local codes (e.g. NEC for USA - article 430 & 250). See grounding connection information from Electrical connection section 4.6.

WARNING! AUTOMATIC RESET PROTECTOR HAZARD

Do not use automatic reset protectors if automatically restarting the motor, doing so would place personnel or equipment at risk.

WARNING! MANUAL RESET PROTECTOR HAZARD

If a tripped manual reset thermal protector is exposed to a temperature less than –7°C (20°F) it may reset and restart the motor automatically. If an application requires a motor with a manual reset thermal protector that will be operated at temperatures less than –7°C (20°F) contact Regal to review the application/ motor requirements.

WARNING! DISASSEMBLY, MODIFICATION OR REPAIR

Motors nameplated for use in Zone-1 & Zone-21 or Division-1 hazardous locations can only be disassembled, modified or repaired by the plant facility that is listed under IECEx or ATEX category for motors and generators, rebuilt for use in hazardous locations.

2.2 MECHANICAL SAFETY

WARNING! LOOSE PARTS HAZARD

Before starting the motor, remove all unused shaft keys and loose rotating parts to prevent them from flying off.

WARNING! ROTATING PARTS HAZARD

Keep extremities, hair, jewelry and clothing away from moving parts.

2.3 ENVIRONMENTAL SAFETY

WARNING! HAZARDOUS LOCATIONS

The local authorities having jurisdiction (e. g. NEC for USA) must be consulted concerning the installation and suitability of motors for use in Hazardous Locations. The local authority having jurisdiction must make the final determination of what type of motor is required. The application and operation is beyond the control of the motor manufacturer.

Zone-1 & Zone-21 or Division-1 hazardous locations motors can only be modified or reworked by the manufacturer or facility that is listed under IECEx®* or ATEX®* category for motors and generators, rebuilt for use in hazardous locations.

Do not use a IECEx or ATEX category motor with a variable frequency drive (VFD) unless the motor nameplate specifically states that the motor is suitable for use on Pulse Width Modulated (PWM) type VFD power. In addition, the nameplate must be marked with the inverter rating; for example, "2:1 CT", "2 to 1 Constant Torque", etc.

3.0 RECEIVING & INSPECTION

3.1 INITIAL INSPECTION

TerraMAX motors are delivered through safe and reliable transport in appropriate packing to avoid damage during transit. On receipt of the motor, thoroughly inspect the unit for any transit damage, if needed in the presence of an insurance agent. Any equipment damage or shortfall should be immediately reported to the Regal.

Check the following:

- Rating plate details and enclosure are as ordered ;
- Shaft turns freely (in absence of shaft locking clamp);
- Condensation drain holes are in the correct position for the motor mounting application (they should be located at the lowest point of the motor when it is in its operating position);
- If the winding is Insulation Resistance (IR) tested to earth, ensure that the thermal protectors are not inadvertently damaged. (The thermistor leads should be shorted together whilst IR testing takes place).

3.2 HANDLING

WARNING! FALLING OBJECT HAZARD

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).

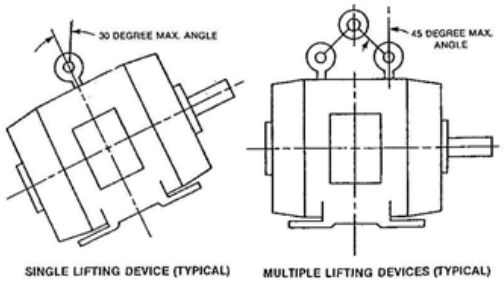
Utilizing the motor lifting provision to lift other components such as pumps and gear boxes could result in serious personal injury, death and/or property damage. Built-on parts (e.g. incremental encoders) are not to be used for lifting.

NOTICE: Screwed-in lifting eyebolts are to be tightened or removed after installation.

WARNING! FALLING OBJECT HAZARD

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 the motor must have adequate lifting capacity. While lifting the motor DO NOT stand under or in the vicinity of the motor.

3.2.1 LIFTING ANGLE LIMITATIONS



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3.3 STORAGE

When the motor is not for immediate use, store as follows:

- Clean and dry location.
- Avoid locations with large temperature swings that will result in condensation.
- Motors must be covered to eliminate airborne dust and dirt build up on the motor.
- If the storage location exhibits high vibration, place isolation pads under motor to minimize damage to motor bearings.

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 (see section 7.5) before start-up.

3.3.2 SHAFT ROTATION: Rotate the motor shaft 5 - 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.

3.3.3 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.

3.3.4 MOTOR WINDING: Stator winding should be insulation resistance tested once every 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.

4.0 INSTALLATION

The following items should be considered on installation to ensure reliable operation of the motor.

4.1 SURROUNDINGS

- Ensure that the motor is properly protected against ingress of oil, water or dust especially if construction work is in progress around the motor. 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.
- Ensure air intake is not obstructed. Refer to dimension BL in this document, free flow of air around the motor should not be obstructed. Provide accessible clearance for cleaning, repair, service, and inspections.
- When installing hazardous location motors, make sure that the zone, group or division and class along with temperature codes on nameplate are compiled with.
- Standard motor ambient temperature range: -20°C to +50°C. Extended ambient temperature range: -40°C to +60°C (if marked on nameplate). Fans, if utilized, for ambients below -20°C require aluminum construction.

***NOTICE:* INSULATION DEGRADATION**

Insulation at high temperatures ages at an accelerated rate. Each 10°C increase in temperature reduces the insulation life by half.

4.2 MOUNTING

4.2.1 RIGID BASE (FOOT MOUNTED): The motor must be securely installed to a rigid foundation or a mounting surface to minimize vibration and maintain alignment between the motor shaft and the load's shaft. The mounting surfaces of the four mounting pads must be flat within 0.25mm for IEC 132 frame and smaller; 0.38mm for IEC 160 frame and larger; 0.010 inches for NEMA 210 frame & smaller; 0.015 inches for NEMA 250 frame & larger. This may be accomplished by shims under the motor feet. The number of shims used should be kept as low as possible, i.e. stack as few as possible. For special isolation mounting, contact manufacturer for assistance.

4.2.2 VERTICAL MOUNTING: When motors are being mounted vertically, all the existing lifting eyes and hoisting straps, if any, and/or belts should be used to stabilize the position of the motor. Standard IEC®* 225 frame and above (NEMA®* 360 & above) foot mounted (rigid base) motors are not suitable for vertical shaft up/down application, special higher grade (FG250) frame casting needed for such applications.

WARNING! FALLING OBJECT HAZARD

The lifting provision on standard horizontal foot mounted (rigid base) motors are not designed for lifting the motor in a vertical shaft up or shaft down position. (see 3.2.1 lifting angles). Lifting method / provisions for mounting a foot mounted (rigid base) motor vertically is the responsibility of the installer.

Most standard horizontal motors IEC 80-315 frame and thru NEMA 140-449 frame (excludes IEC 355 & above frames and brake motors) can be mounted in a vertical shaft down orientation. IEC 355 & above frames use angular contact bearings. For vertical brake motors see section 4.7.1

When the motor is installed vertically with the shaft end facing downwards, a protective cover for the fan cover is recommended to prevent foreign objects from falling into the motor.

When the motor is installed with the shaft end facing upwards, the end user must prevent the ingress of fluid along the shaft or contact manufacturer for assistance.

***NOTICE:* BEARING FAILURE.** Unless approved by the motor manufacturer do NOT direct couple a vertical shaft up or roller bearing motor. Direct coupling a vertical shaft up motor or a motor with a roller bearing may result in bearing damage.

4.3 APPLICATION ASSEMBLY TO THE MOTOR

4.3.1 PULLEYS AND COUPLINGS

- Pulleys or couplings should be independently balanced with a half key as the motor rotor is balanced with a half key during manufacture.
- In fitting pulleys or couplings to the motor shaft, care must be taken to ensure that the roller/ball bearings are not damaged. Both shaft and coupling bore should be cleaned and lubricated. If the fit is still too tight, the pulley or coupling should be pre-heated in air or oil to enable easy assembly.
- Shock methods must not be used in fitting or removing pulleys or couplings. Proper wheel or pulley removers should be used to prevent shaft and bearing damage. Tapped holes are provided in shaft extensions to assist in the fitting of couplings and/or pulleys.

4.3.2 PULLEY AND BELTS

- If the motor is to be coupled to the load using pulleys and belts it is important to ensure that the belt tension does not exceed the safe working radial load of the motor.

NOTICE: Excessive radial load will lead to reduced bearing life with the potential of breaking the motor shaft. Because of this, care must be taken to ensure the correct selection of pulley size and type (toothed, vee or flat) and this is best done in consultation with the power transmission supplier.

- The belt manufacturer's recommendations for installation, alignment and tensioning must be strictly adhered to when fitting belt drives.

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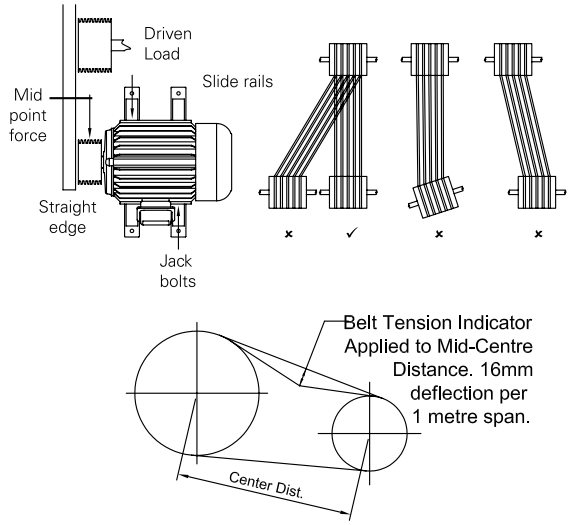
marathon® Motors

4.3.3 ALIGNMENT

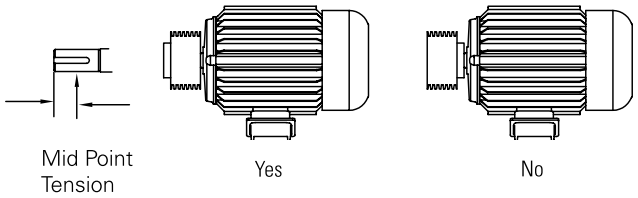
NOTICE: Great care must be taken in aligning the complete motor, since misalignment can cause rapid deterioration of bearings and lead to other mechanical failures due to the stress produced.

- After final tightening of foundation bolts, motor alignment should be rechecked as bed plates could move and/or distort during motor mounting,
- When slide rails are used in conjunction with pulley drives, the adjusting screw ends should be positioned between the motor and load at drive shaft end and the other screw positioned diagonally opposite. This assists with correct belt installation.
- Proper alignment of the motor and drive equipment minimizes vibration levels, maximizes bearing life and extends the overall life of the machinery. Consult the drive or equipment manufacturer for more information.
- The correct alignment of the motor pulley with the load pulley is imperative. Both these pulleys must have matched center distances between grooves and alignment must be carried out using a suitable metal straight edge or other recommended tools to ensure parallel offset or angular displacement of the pulleys with respect to each other is inside permissible limits as recommended by the power transmission supplier. Correct alignment will result in a uniform distribution of belt tension across the width of the pulley (and the motor shaft) and assist with the life of both the belts and bearings.

  NOTE*:* The pulley should always be mounted firmly against the shaft shoulder and should be a firm fit onto the shaft. Impact force must not be used.
- Right & wrong alignment to be identified clearly.



As a general rule the midpoint of the applied force should be at the midpoint of the shaft and it is good engineering practice to mount the motor pulley with hub and locking screw at the shaft end.

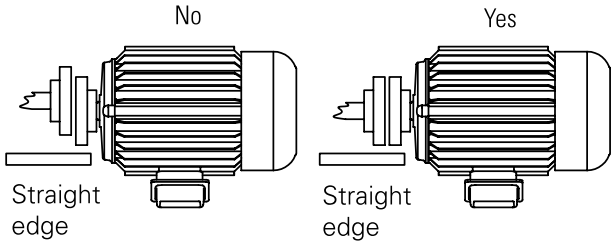


NOTICE: **BEARING FAILURE.** During assembly do NOT force components onto the shaft. Striking or hammering components may result in bearing damage.

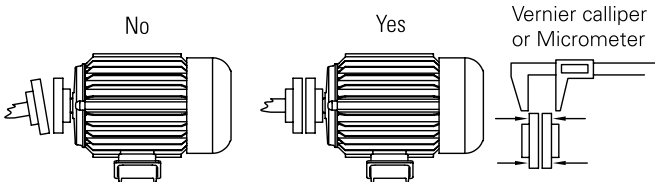
4.3.4 DIRECT COUPLED

Where direct coupling of the motor is required, proper alignment must be achieved to prevent bearing damage to both motor and load. Use flexible couplings if possible.

For parallel offset, use a straight edge or other recommended tools, as shown below.

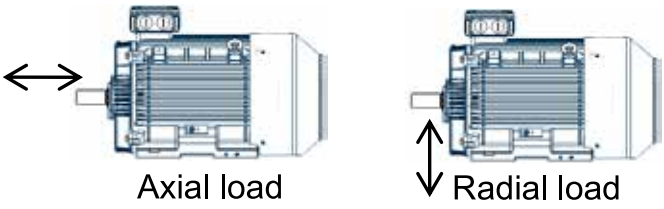


Excessive angular displacement must also be prevented. The recommended method to achieve correct angular alignment is shown below.



4.3.5 AXIAL LOAD

Where motors with standard bearings are required to be mounted in either vertical shaft up or vertical shaft down orientation, there are limits on the axial forces that must not be exceeded. This also applies to horizontal mounted motors with certain loads that produce axial thrust.



Axial loads exceeding those listed in the catalogue will reduce bearing life and may lead to internal motor damage. Different bearing types will be required where higher than recommended axial loads are necessary. (Contact customer service team).

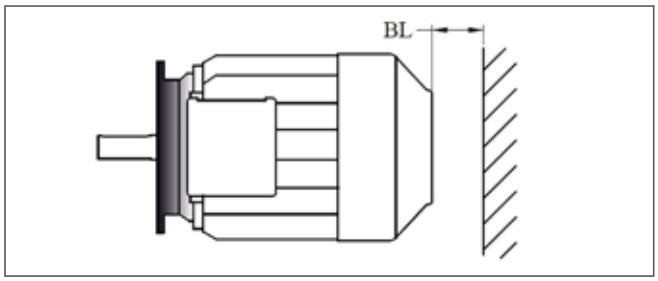
4.4 COOLING

There are various types of cooling methods. IC 411 (Totally Enclosed Fan Cooled) is the most common cooling method used for the TerraMAX® motors.

The IC 411 cooling method uses a fan mounted on the non-drive end of the motor shaft, enclosed by a fan-cowl. Air is drawn through the grilled opening of the fan-cowl and guided over the fins of motor frame by the fan. The fan itself is designed for either direction of the rotation, standard direction being clock-wise from driving end or as specified on the fan-cowl.

It is important that the cooling fins remain clear of debris to allow the airflow to be fully effective in maintaining motor winding temperature within the design limits.

It is equally important to ensure the installation provides good unrestricted access to normal ambient air at the fan entry point at all times and that the inlet grill is clear of blockage. Ensure that discharged air of any adjacent equipment is not immediately part of the intake air for the motor. Refer to dimension BL below.



IEC®* (NEMA®*) frames	Dimensions BL [mm]
80 - 100	50
112 - 132	75
160 - 180	125
320 - 440	175
315 - 355	225

4.5 TERMINAL BOX

4.5.1 CABLE ENTRIES: Cable entries are via appropriate cable glands or conduits fitted to the threaded entries in the wall of the terminal box or the gland plate attached to the terminal box. IEC®* frames are provided with metric (straight) threads whereas NEMA®* frame sizes utilize an NPT threaded conduit opening.

Cable entries for various frame sizes are as per the following table:

Main Terminal box supply cable entries (IEC)

IEC Frames	No. of entries	Entry size x pitch
80 - 100	2	M20 X 1.5
112 - 132	2	M25 X 1.5
160 - 180	2	M32 X 1.5
200 - 225	2	M40 X 1.5
250 - 280	2	M50 X 1.5
315	2	M63 X 1.5
355	4	M63 X 1.5

Main Terminal box supply cable entries (NEMA)

NEMA frames	Min Thrade size - NPT
180	3/4
210	1
250	1.25
280	1.5
320	2
360	3
400	3
440	3

Cable glands used by installer on hazardous location motors must be of IECEx®* certified type as appropriate to the installation requirements. Unused cable entries must be blanked off by installer using IECEx certified conduit stops as appropriate.

Cable glands and conduit stops must be of an IP Rating equal to or better than that of main motor as marked on the nameplate. Vibration sensors and shaft encoders when fitted by the installer are to be appropriately certified by IECEx or ATEX®* for the same zone protection method(s) and temperature code.

4.5.2 SUPPLY TERMINALS

Supply terminals are located in the terminal box. They are suitable for receiving crimped lugs on the supply cables. In addition the terminal box also houses an earthing terminal.

Motor frame	Terminal Size	Tightening torque		*Max supply cable size (mm2)
		min	max	
80-100	M5	1.8	2.5	10
112-132	M5	1.8	2.5	16
160-180	M6	2.7	4	35
200-225	M8	5.5	8	50
250-280	M10	9	13	95
315	M12	14	20	240
355	M16	27	40	300

** Applicable for single run, 3 Core, XLPE insulated copper cables*

4.6 ELECTRICAL CONNECTION

WARNING! Before making any electrical connections, review the Electrical Connection Safety Instructions in Section 2.1.

TerraMAX® motors are provided with three earthing bolts, one inside the terminal box and other two are on the foot. IEC 315 & 355 frame have additional earthing bolt inside the terminal box, 2 bolts inside the TB & another 2 bolts on to the foot.

WARNING! 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. Ensure that proper earthing connections are made with all washers, as provided.

SECONDARY "EXTERNAL" GROUND

All 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 gronding connections where local codes permit or require such connection.

Depending on the cross-section of the line conductor, the earthing conductor cross-section must be:

Line conductor cross-section	Earth conductor cross-section
≤ to 25mm²	Same Section
Between 25mm² and 50mm²	25mm²
> 50mm²	≥ 50% of the section

CAUTION! Failure to follow the below instructions on electrical connections could result in minor or moderate injury.

- Ensure all electrical connections are solid and continuous.
- Check motor starter and overloads for correct rating and trip setting.
- All circuit breakers, HRC fuses or protective devices associated with the motor must be rated to suit motor running current and starting characteristics.
- Supply cables must be appropriately selected considering the voltage drop.
- When using long supply cables with VVVF drive, check with Regal for proper recommendations to avoid high voltage transients occurring at motor terminals.
- Check the connection diagram on the motor terminal box and make sure the supply leads are properly connected considering the supply phase sequence.
- Ensure that the supply cable termination on to the motor terminal board is firm, without loss of strands while using crimped lugs and all washers are used in the correct order as provided.
- Ensure enough clearances are provided between supply cable lugs and the earth, especially so in the case of hazardous location motors.
- If using conduit for the supply leads, ensure the conduit is completely threaded in and seal the threads appropriately.
- If RTDs of hazardous location motors are connected to monitor the winding temperature, the maximum voltage to the RTDs must be kept to 90V(peak) or below.
- The thermal protection devices shall be connected into the motor control circuit in such a manner as to disconnect the source of supply in order to prevent the nominated temperature class from being exceeded. The stator RTDs and thermistors can be connected via a standard industrial controller, provided that the controller is located in a safe area.

4.7 ACCESSORIES / PROVISIONS

CAUTION! Carefully read and understand the accessory manufacturer's instructions, supplied with motor. Contact Regal for additional information.

4.7.1 BRAKE MOTORS

CAUTION! VERTICAL MOTOR PREMATURE BRAKE FAILURE
Motors with brakes that are designed for vertical applications are equipped with springs to support the brake pressure plate. Mounting a horizontal brake motor vertically shaft up or down may require a pressure plate spring modification. Failure to modify the brake for the vertical application may result in premature brake failure that results in minor/moderate injury.

CAUTION! BRAKE SOLENOID WIRING: Do NOT connect the brake solenoid to the output of a VFD. The brake solenoids must be wired to 50/60 Hz line power.

4.7.2 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.

4.7.3 THERMAL PROTECTION

WARNING! Electrical Hazard, see section 2.1 of this manual.

General Information: When thermal protection is provided, one of the following will be stamped on the nameplate:

"Thermally protected" This motor has built in thermal protection. Thermal protectors open the motor circuit electrically when the motor overheats or is overloaded. The protector cannot be reset until the motor cools. If the protector is automatic, it will reset itself. If the protector is manual, disconnect motor from power supply. After protector cools (five minutes or more) press the reset button and reapply power to the motor. In some cases a motor is marked "Auto" and the connection diagram on the motor will identify thermostat leads.

"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. 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.

"ATEX®* Zone 2 thermostats" Thermostats are an optional feature not required for ATEX, Zone 2 operation. Thermostats, when utilized, are hermetically sealed.

"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.)

"RTD Alarm & Trip Settings" Below tables are suggested initial RTD alarm and trip settings. For motors found to operate significantly below these values the settings may be reduced accordingly.

Winding RTD – Temperature Limit (°C) - 40°C Ambient

Class B Temp Rise [80°C]		Class F Temp Rise [105°C]	
Alarm	**Trip**	**Alarm**	**Trip**
120	130	145	155

Bearing RTD – Temperature Limit (°C) - 40°C Ambient

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

*ATEX is a trademark or tradename of European Union and is not owned or under the control of Regal Beloit Corporation

4.8 INITIAL START UP

WARNING! During the measurement, and immediately afterwards, some of the terminals are at hazardous voltage levels and must not be touched. Carry out a check with the power cables connected that no voltage can be applied.

CAUTION! Prior to initial start-up check the following:

- Insulation resistance of motor winding to earth to be over 1 MΩ for motors up to 600V and over 10 MΩ for over 600V.
- Thermistors or RTDs if fitted, should be checked for continuity with a multimeter.
- Ensure thermistors are wired up to the motor protection relay as to trip the supply to the motor in the event of an over temperature.
- Do not insulation resistance test thermal protective devices across their terminals. Short the entire protector leads together and apply the test voltage between the shorted leads and earth and/or phases.
- Hazardous location motors supplied by a Variable Voltage Variable Frequency (VVVF) drive must have the thermal protection devices connected into the motor control circuit in such a manner as to disconnect the source of supply in the event of an over temperature, thus preventing the nominated temperature class from being exceeded.
- Anti-condensation heaters, if provided, must be so connected as to switch on when the motor supply is disconnected and switch off when the motor supply gets connected.
- Ensure that the supply voltage and frequency correspond to the motor nameplate ratings.
- Ensure shaft turns freely before initial start.
- Measure winding resistance between supply terminals and record in the log book.

5.0 OPERATION

WARNING! Prior to initial start up check the following:

- Before energizing the motor make sure that the terminal box lid is closed and secured with appropriate clearance to live parts. Make sure that appropriate earthing is done.
- If an earthing ring and earth brush are provided, make sure that the earthing ring is clean and the earth brush makes a good contact with the earthing ring. This applies for the Safe Area motors.
- Make sure of no loose objects around that may be sucked by the cooling fan on the motor.

CAUTION! Prior to initial start up check the following:

- Make sure that the coupling and/or transmission is adequately guarded for safety.
- Check the mounting bolts and/or flanges are firmly secured.
- Make sure that the load applied is within the nameplate specification.
- Make sure that the ambient temperature is inside 40°C or as per nameplate specification.
- If an Adjustable Speed Drive is used on Ex nA motor, follow the instructions on additional nameplate for converter supply in respect to applied load and frequency.
- Check that the running current on no load and full load are reasonably balanced within 10% of the average and record the figures in the log book for future reference. Note that the current imbalance can be higher, typically 10 times the voltage imbalance if there is an imbalance in supply voltage.
- Brake motors used in hazardous locations must have a limited number of repeat stops to 20 per hour.

6.0 MAINTENANCE

A motor needs regular maintenance. Exact maintenance needs vary based on the site conditions. To obtain reliable service from the motor, the following maintenance schedule may be used as a guide.

WARNING! An authorised service agent must carry out maintenance of hazardous location motors. Clean the surface of the motor with a damp cloth to minimise the risk of electrostatic discharge.

A. Ensure air intake space is unobstructed.

B. On a weekly basis use an air hose to ensure all air ways are clear and free of dust.

C. Once every month, check motor for condensation. Replace drain plugs before starting if they are blocked or found missing.

D. Do not wash the motor down unless it is IP66 rated.

E. On a quarterly basis-

i. Check the motor terminals for tightness and proper contact.

ii. If terminal lug/s are discoloured, re-terminate with fresh lugs.

iii. Check operation of starting equipment, ensuring all terminations are tight.

iv. Check mechanical operation of thermal overload relays, if any.

v. Check mechanical operation of thermistor relays, if fitted.

vi. Check operation of anti-condensation heaters, if fitted.

vii. Check the earth ring and earth brush length, if fitted (For Safe Area Motors).

F. On a biannual basis, in addition to the items in 'E'

i. Check winding resistance between supply terminals and compare to original value and enter in log book.

ii. Check supply voltage at motor terminals and record in log book.

iii. Check bearings for abnormal noise/overheating.

G. On an annual basis, in addition to the items in 'E' and 'F' above

i. Re-grease the bearings as recommended under Lubrication & Bearings.

ii. Completely disassemble stator and rotor and clean thoroughly.

iii. Check bearings for wear/damage – replace as necessary.

iv. Check all bolts and nuts for cracks or damage – replace as necessary.

v. Check all holding down bolts for signs of fatigue or damage – replace as necessary.

vi. After re-assembly, check and record in the log book –
Insulation resistance;
No load current and voltages;
Full load current and voltages;
Compare these figures with the original records in the log book.

vii. Check and ensure that the cooling fan is operational.

7.0 LUBRICATION & BEARINGS

7.1 GROUND BRUSH LUBRICATION

For motors provided with a phosphor bronze bristle ground brush grease lubrication will significantly increase the life of the brush with no reduction in performance of the brush. Greasing the brush contact surface while lubricating the bearings is recommended.

7.2 SEALED BEARINGS

The required replacement interval for sealed bearings is generally determined by the grease life which is dependent on operating temperature, operating speed, the limiting speed of the bearing and the type of grease. Under normal operating conditions the following relationship applies for sealed bearings:

$$\log t = 6.54 - 2.6\frac{n}{N} - (0.025 - 0.012\frac{n}{N})T$$

Where:

t = Average grease life (hours)

n = Speed (RPM)

N = Bearing limiting speed with grease lubrication (RPM)

T = Operating temperature (°C)

For further information, please contact Regal for more information.

7.3 OPEN (REGREASABLE) BEARINGS

It should be noted that for motors fitted with ball and roller bearings, the lubrication intervals for both bearings should be based on the roller bearing data.

The re-lubrication intervals recommended are calculated on the basis of normal working conditions.

Replenishment of grease media should be by means of a hand held grease gun while motor is running with relief plate removed.

The 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:

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: Texaco Polystar®* RB, Rykon®* Premium #2, Pennzoil®* Pen 2 Lube, Chevron®* SRI, SHELL GADUS®* S5 V100 - 2 & 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. When re-greasing bearings ensure that the correct type of grease is used. If in doubt about the existing grease type, clean out the old grease thoroughly from bearings and bearing housing, prior to re-greasing.

NOTE: Under hazardous conditions please contact the nearest Regal. Air operated grease guns should not be used.

NOTE: If lubrication instructions are provided on the motor nameplate, the nameplate instructions will superseded these instructions. Motors marked "Permanently Lubricated" do not require additional service.

***NOTICE:* BEARING/MOTOR DAMAGE WARNING**

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

***NOTICE:* NEVER MIX GREASE OF DIFFERENT TYPES.**

7.4 LUBRICATION PROCEDURE:

NOTE: IEC®* Frames 80 through 180 (NEMA®* 180-280) use shielded bearings and are not re-greaseable. IEC Frames 200 through 355 (NEMA 320 & above) use open re-greaseable bearings.

***NOTICE:* BEARING DAMAGE WARNING**

Added grease must be compatible with the original equipment's grease. If a grease other than those stated herein is to be used, contact the motor manufacturer. Nameplate information supersedes grease type referenced in this section. New grease must be free of dirt. Failure to follow these instructions and procedures may result in bearing and/or motor damage. For an extremely dirty environment, contact the motor manufacturer for additional information.

Step 1: Clean the grease inlet and drain plugs prior to re-greasing.
Step 2: Remove grease inlet and drain plugs
Step 3: Add grease per table on next page.
Step 4: Re-install grease inlet and drain plugs and ensure plugs have at least 5 full threads of engagement with motor

***NOTICE:* GREASE DRAIN PLUGGED**

Old grease may completely block the drain opening and must be mechanically removed prior to re- greasing. 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.

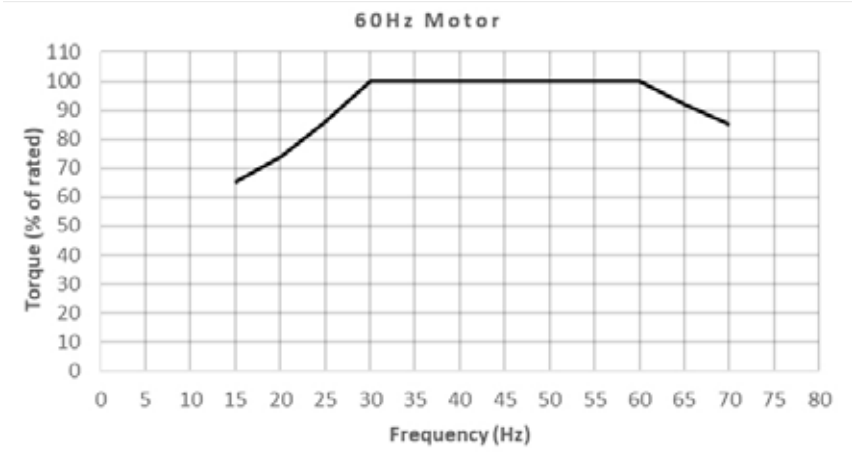
7.5 RECOMMENDED GREASE REPLENISHMENT INTERVALS (HOURS)[1]

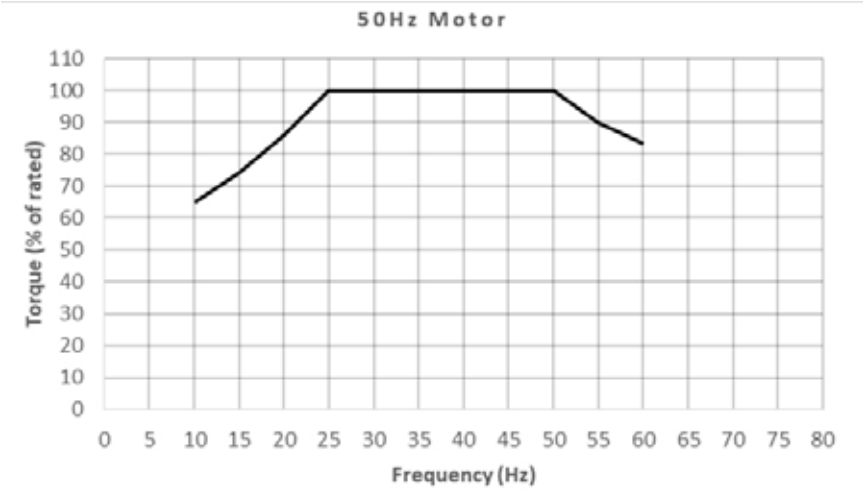
Bearing no. [2]	Bearing bore [mm]	Greae Qty [g]	3000 r/min		1500 r/min		1000 r/min		750 r/min	
			Ball	Roller	Ball	Roller	Ball	Roller	Ball	Roller
6312/NU312	60	22	3000	1500	9000	4500	12000	6000	12000	6000
6313/NU313	65	24	3000	1500	9000	4500	12000	6000	12000	6000
6314/NU314	70	26	2000	1000	8000	4000	10000	5000	10000	5000
6316/NU316	80	38	1500	750	4000	2000	7000	3500	7000	3500
6317/NU317	85	38	1500	750	4000	2000	7000	3500	7000	3500
6318/NU318	90	45	1000	500	3000	1500	5000	2500	5000	2500
6319/NU319	95	45	1000	500	3000	1500	5000	2500	5000	2500
6322/NU322	110	60	-		3000	1500	5000	2500	5000	2500
6324/NU324	120	72	-	-	2500	1250	4000	2000	4000	2000
6326/NU326	130	81	-	-	2500	1250	4000	2000	4000	2000
6328/NU328	140	93	-	-	2500	1250	4000	2000	4000	2000

(1) Based on maximum grease service life of 20,000 hours
(2) Refer to Nameplate / Motor to confirm bearing size.

8.0 MOTORS – PWM DRIVES

The TerraMAX® motor performs excellently without cogging at the low speed when operating in conjunction with a PWM (Pulse-Width Modulated) drive. The graph below shows the TerraMAX motor's load ability with a frequency converter.





9.0 HAZARDOUS LOCATION MOTORS TCN/TCT/TCE

Standard motors in the range of frame sizes 80 to 355 with appropriate modifications are certified for use in hazardous areas as below.

9.1 NON-SPARKING MOTORS / DUST IGNITION-PROOF MOTORS / INCREASED SAFETY MOTORS

Ex nA, Zone 2, Group II, Temperature class T3, (T_{amb} -20°C to +50°C) CE			
Ex tc, Zone 22, Group II, Temperature class T135, (T_{amb} -20°C to +50°C) CE			
Ex ec, Zone 2, Group II, Temperature class T3, (T_{amb} -20°C to +50°C) CE			
Brand	**Marking code:**	**Certification #:**	**Manufacturer Address:**
marathon® Motors	Ex II 3 G Ex nA IIC T3 Gc IP55 Ex II 3 D Ex tc IIIC T135 Dc IP66 Ex II 3 G Ex ec IIC T3 Gc IP55	IECEx®* UL®* 17.0014X DEMKO 17 ATEX®* 1836X	Regal Beloit America Inc. 100 E. Randolph St. Wausau, WI 54401, USA
cemp® Flameproof Motors	Ex II 3 G Ex nA IIC T3 Gc IP55 Ex II 3 D Ex tc IIIC T135 Dc IP66 Ex II 3 G Ex ec IIC T3 Gc IP55	IECEx UL 17.0104X DEMKO 17 ATEX 1952X	CEMP S.r.l® Via Piemonte 16-20030 SENAGO (Milan), ITALY
marathon® Motors	Ex II 3 G Ex nA IIC T3 Gc IP55 Ex II 3 D Ex tc IIIC T135 Dc IP66 Ex II 3 G Ex ec IIC T3 Gc IP55	IECEx UL 17.0111X DEMKO 17 ATEX 1963X	Regal Beloit Wuxi Co. Ltd 6 Xiangge Road, Hudai Town, Wuxi City, Jiangsu, CHINA
marathon® Motors	Ex II 3 G Ex nA IIC T3 Gc IP55 Ex II 3 D Ex tc IIIC T135 Dc IP66 Ex II 3 G Ex ec IIC T3 Gc IP55	IECEx UL 17.0112X DEMKO 17 ATEX 1964X	Regal Beloit Australia Pty Ltd 19 Corporate Avenue, Rowville VIC 3178 7 Mahogany Crt Willawong, QLD 4110, AUSTRALIA
marathon® Motors	Ex II 3 G Ex nA IIC T3 Gc IP55 Ex II 3 D Ex tc IIIC T135 Dc IP66 Ex II 3 G Ex ec IIC T3 Gc IP55	IECEx UL 17.0113X DEMKO 17 ATEX 1965X	Regal Beloit Australia Pty Ltd 19 Corporate Avenue, Rowville VIC 3178 7 Mahogany Crt Willawong, QLD 4110, AUSTRALIA
marathon® Motors	Ex II 3 G Ex nA IIC T3 Gc IP55 Ex II 3 D Ex tc IIIC T135 Dc IP66 Ex II 3 G Ex ec IIC T3 Gc IP55	IECEx UL 17.0114X DEMKO 17 ATEX 1966X	Regal Beloit New Zealand Ltd 18 Jomac Place, Avondale, Auckland, NEW ZEALAND
marathon® Motors	Ex II 3 G Ex nA IIC T3 Gc IP55 Ex II 3 D Ex tc IIIC T135 Dc IP66 Ex II 3 G Ex ec IIC T3 Gc IP55	IECEx UL 17.0115X DEMKO 17 ATEX 1967X	Regal Beloit Asia Pte. Ltd 12 Tuas Loop, SINGAPORE
rotor nl®	Ex II 3 G Ex nA IIC T3 Gc IP55 Ex II 3 D Ex tc IIIC T135 Dc IP66 Ex II 3 G Ex ec IIC T3 Gc IP55	IECEx UL 17.0129X DEMKO 17 ATEX 1968X	Rotor BV® Mors 1-5. 7151 MX, Eibergen, NETHERLANDS

9.2 DUST IGNITION PROOF MOTORS / INCREASED SAFETY

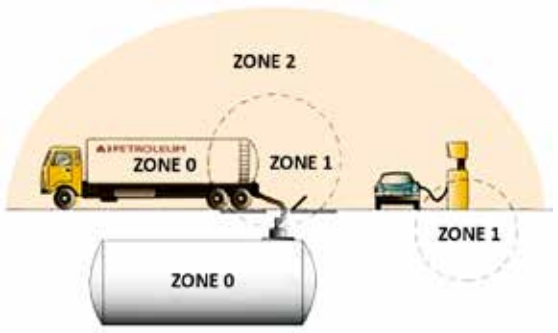
Ex tb, Zone 21, Group II, Temperature class T135, (T_{amb} -20°C to +50°C) CE 0539			
Ex eb, Zone 1, Group II, Temperature class T3, (T_{amb} -20°C to +50°C) CE 0539			
Brand	**Marking code:**	**Certification #:**	**Manufacturer Address:**
marathon® Motors	Ex II 2 D Ex tb IIIC T135 Db IP66 Ex II 2 G Ex eb IIC T3 Gb IP55	ECEx UL 17.0014X DEMKO 18 ATEX 1982X	Regal Beloit America Inc. 100 E. Randolph St. Wausau, WI 54401, USA
cemp® Flameproof Motors	Ex II 2 D Ex tb IIIC T135 Db IP66 Ex II 2 G Ex eb IIC T3 Gb IP55	IECEx UL 17.0104X DEMKO 18 ATEX 2068X	CEMP S.r.l Via Piemonte 16-20030 SENAGO (Milan), ITALY
marathon® Motors	Ex II 2 D Ex tb IIIC T135 Db IP66 Ex II 2 G Ex eb IIC T3 Gb IP55	IECEx UL 17.0111X DEMKO 18 ATEX 2073X	Regal Beloit Wuxi Co. Ltd 6 Xiangge Road, Hudai Town, Wuxi City, Jiangsu, CHINA
marathon® Motors	Ex II 2 D Ex tb IIIC T135 Db IP66 Ex II 2 G Ex eb IIC T3 Gb IP55	IECEx UL 17.0112X DEMKO 18 ATEX 2069X	Regal Beloit Australia Pty Ltd 19 Corporate Avenue, Rowville VIC 3178 7 Mahogany Crt Willawong, QLD 4110, AUSTRALIA
marathon® Motors	Ex II 2 D Ex tb IIIC T135 Db IP66 Ex II 2 G Ex eb IIC T3 Gb IP55	IECEx UL 17.0113X DEMKO 18 ATEX 2070X	Regal Beloit Australia Pty Ltd 19 Corporate Avenue, Rowville VIC 3178 7 Mahogany Crt Willawong, QLD 4110 ,AUSTRALIA
marathon® Motors	Ex II 2 D Ex tb IIIC T135 Db IP66 Ex II 2 G Ex eb IIC T3 Gb IP55	IECEx UL 17.0114X DEMKO 18 ATEX 2071X	Regal Beloit New Zealand Ltd 18 Jomac Place, Avondale, Auckland, NEW ZEALAND
marathon® Motors	Ex II 2 D Ex tb IIIC T135 Db IP66 Ex II 2 G Ex eb IIC T3 Gb IP55	IECEx UL 17.0115X DEMKO 18 ATEX 2072X	Regal Beloit Asia Pte. Ltd 12 Tuas Loop ,SINGAPORE
rotor nl®	Ex II 2 D Ex tb IIIC T135 Db IP66 Ex II 2 G Ex eb IIC T3 Gb IP55	IECEx UL 17.0129X DEMKO 18 ATEX 2074X	Rotor BV Mors 1-5. 7151 MX, Eibergen, NETHERLANDS

Classification of zone, group and temperature category are in accordance with the standards applied in the certificates.

The hazardous location motor nameplates also carry the certification number in addition to the marking codes for the specific protection levels. Details of the standards to which these are certified are available on the actual certificates, copies of which can be accessed from the Regal website **www.regalbeloit.com** or obtained from Regal.

WARNING! Only motors that carry nameplates indicating Ex e or Ex nA or Ex t or combination of them can be used in hazardous locations. Check nameplate before installing motors in hazardous locations.

Zone Classification



10.0 MOTOR TROUBLE SHOOTING AND CORRECTIVE ACTIONS

	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. CAUTION!** Ensure that steady state supply voltage at motor terminals is within limits (*see section 4.6).* 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 section F and G listed above. 2. Verify that VFD current limit and starting boost are set correctly. 3. Double-check motor and feedback parameter settings and VFD permissives. 4. Repeat autotune (for vector drives) procedure. 5. Consult VFD supplier.
	Motor has been running, then slows down, stalls, or fails to restart:	
A.	Supply voltage has dropped or has become severely unbalanced.	6. Replace fuse or reset circuit breaker. Allow motor to cool down before resetting manual protector on motor. **WARNING!** Check automatic and manual reset protector warnings *(see section 2.1).* 7. Verify that rated and balanced supply voltage has been restored before restarting motor. Measure voltage during restart. **CAUTION!** Ensure that steady state supply voltage at motor terminals is within limits *(see section 4.6).*
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.

	Likely Cause	Corrective Action:
	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. CAUTION!** Ensure that steady state supply voltage at motor terminals is within limits *(see section 4.6).* 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.	For Single Phase, reconnect motor according to wiring schematic provided. **NOTE:** Some motors are non-reversible.
	Motor overheats or overload 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 7.3 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).
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.	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.
F.	Supply voltage too low, too high, or unbalanced.	**1. CAUTION!** Ensure that steady state supply voltage at motor terminals is within limits *(see section 4.6).* 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. It is recommended that a 50 micron runout for shaft extension lengths up to 76mm (2 thou for 3" extension length). Add 12.7 micron for every 25.4mm (0.5 thou for every 1") shaft length beyond 76mm.
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 at rated motor current. 2. Adjust VFD stability for smooth operation. Vector drives may be unstable at light load.

	Likely Cause	Corrective Action:
F.	Motor miswired at terminal box.	Match motor lead wiring to nameplate connection diagram.
G.	Uneven, weak or loose mounting support.	Shim, strengthen or tighten where required.
H.	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 7.5).* • If noise persists contact warranty service.
I.	Motor out of balance.	1. Disconnect from load. 2. Set motor on rubber pads on solid floor. 3. Secure a ½ height key in shaft keyway and energize from balanced power supply at rated voltage. 4. 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.	1. If belt drive check system per section 4.3.2. 2. Other than belting, check loading on motor shaft. An unbalanced load will also cause the bearings to fail. 3. Check runouts of mating components, such as a C-face and pump flange.
B.	Bearings contaminated.	Motor enclosure not suitable for environment. Replace with correct enclosure construction.
C.	Incorrect grease or bearings for ambient extremes.	See Section 7.3 (Grease types).
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. CAUTION!** Verify that supply voltage is within limits *(see section 4.6).* 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.
	Start capacitors repeatedly fail	
A.	The motor acceleration time is too long.	Motor may be too small for load. Record acceleration time. Start capacitors may fail if acceleration time exceeds 3 seconds.
B.	Motor is being started too frequently.	Excessive starting will damage motor capacitors. Contact motor manufacturer if motor is started more than 20 times/hour or if acceleration time exceeds 3 seconds.
C.	Motor voltage low.	**CAUTION!** Verify that voltage at the motor terminals is within limits *(see section 4.6).*
D.	Defective start switch inside motor.	Motor internal switch failure overheats start capacitor. Contact service shop or motor manufacturer.
	Run capacitor fails	
A.	High ambient temperature.	Verify that the ambient does not exceed motor's nameplate value.
B.	Input voltage exceeds limit.	**CAUTION!** Verify that voltage at the motor terminals is within limits *(see section 4.6).*
C.	Power surge to motor (caused by lightning strike or other high transient voltage).	If a common problem, install surge protector.

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