MANUFACTURERS OF MIXED FLOW
AND AXIAL FLOW PUMPS

OPERATION AND MAINTENANCE MANUAL

MIXED FLOW PUMPS
#12MFCH MIXED FLOW

MANUFACTURED BY:

CASCADE PUMP COMPANY
10107 S. NORWALK BLVD.
SANTA FE SPRINGS, CA 90670

FOR:

DXP SUPERCENTER
11691 W. 85TH STREET
LENEXA, KS 66214

IN SUPPORT OF:

CITY OF WITCHITA, KS
WATER POLLUTION CONTROL
WASTEWATER TREATMENT PLANT #2
REPLACEMENT OF SO#13112/24

PURCHASE ORDER NO. 4793051

CASCADE PUMP CO. SERIAL NUMBER: 18659/60

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SECTION I

INSTALLATION AND IMPELLER ADJUSTMENT INSTRUCTIONS
OIL LUBRICATED MIXED FLOW PUMPS
VERTICAL HOLLOW SHAFT MOTOR

WARNING

If the user or installer of this pumping equipment is not experienced in this type of installation, start-up, and operation, or has any questions, please contact your equipment distributor, or the factory at (562) 946-1414, Fax (562) 941-3730, e mail: pumpinfo@cascadepump.com

Pump Installation

1. Lift and set pump with anchor bolts through holes in baseplate. Pump should sit on leveling nuts threaded on anchor bolts.

2. Level pump using machined surface of motor mounting base on pump head (bubble level on good quality mechanics level) using leveling nuts on anchor bolts.

3. Make up discharge pipe connection making sure that pump discharge nozzle is not placed in a bind. Pump discharge should be free standing without any loading from discharge pipe.

4. Grout under baseplate.

5. Install hold down nuts on anchor bolts to secure baseplate to foundation.

6. Verify that tension nut and lock ring are secure.

7. Install oil reservoir, solenoid valve (if furnished), needle valve dripper and copper tubing in accordance with instructions furnished separately (see Installation and Operation of Drip Feed Oil Lubrication System). Fill reservoir with ISO Viscosity grade 32, 135-165 SUS @ 100° F. oil.

Motor Installation

1. Review motor operating manual.

2. Make sure machined surfaces of motor mounting base on pump head and motor base are clean and alignment registers are free of burrs.

3. Mount and secure motor to pump head. Make sure male/female registers join properly.

4. Connect power leads to motor (see motor wiring diagrams).

5. Fill motor with recommended lubricant (see motor operating manual).

6. Remove hood from top of motor.

7. Optional recommendation is to remove non reverse ratchet assembly from top of motor.

8. Bump motor to check rotation. Rotation should be counter clockwise from top of motor.

9. Reinstall ratchet assembly if it was removed.

INSTALLATION AND IMPELLER ADJUSTMENT INSTRUCTIONS

Headshaft Installation

1. Take gib key from motor and hand fit to headshaft keyway. Some hand filing may be needed on key or keyway to allow a smooth fit.

2. Install headshaft (without gib key) through motor. Couple to lineshaft (threads are left hand). Tighten shaft into coupling so that shafts butt. Coupling should be centered at shaft joint.

3. From top of motor, align keyway on clutch to keyway on headshaft. Insert gib key.

Impeller Adjustment

1. From top of motor, make sure impeller is seated in bowl. Using a rubber mallet tap on top of shaft. Sound, or feel, should be "solid".

2. For ease of impeller adjustment mark the location of the 4 small tapped holes on the motor clutch outside the diameter of the adjusting nut.

3. Thread adjusting nut onto headshaft (right hand thread) until it seats on top of clutch.

4. Using a wrench or strap wrench, turn adjusting nut approximately 1/2 turn. Rotate nut forward until lock screw hole in nut aligns with a tapped hole in motor clutch. Insert and secure lock screw to motor clutch.

5. Attempt to rotate shaft/impeller assembly by hand. This can be done at top of motor by rotating the ratchet (clutch) assembly. If the shaft/impeller assembly appears to rotate free, then, as a second check, rotate the shaft by hand just above the packing box. Shaft should rotate freely without interference or binding. If there is difficulty in rotating the shaft, rotate adjusting nut forward an additional ¼ turn to next tapped hole in motor clutch and rotate shaft again. If difficulty persists contact the factory for further direction.

6. Reinstall motor hood.

Initial Start

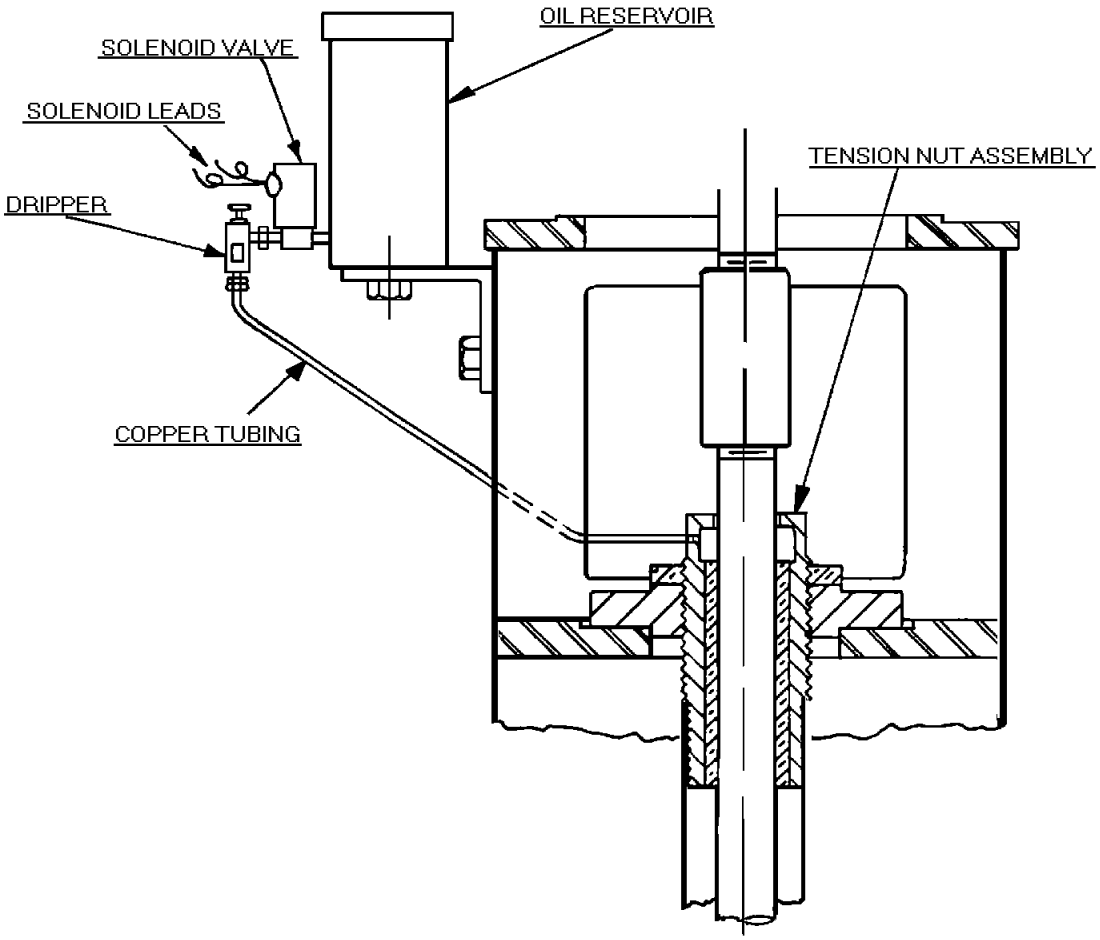
1. Make sure all bolting on pump, motor and discharge connection are secure.

2. If possible, energize solenoid valve and open needle valve to allow oil to flow into tension nut body. Allow oil to flow approximately 5 minutes prior to motor start.

3. Start motor.

4. Adjust oil drip rate on needle valve to 20 to 30 drops per minute. After a short run time then reduce to 6 to 8 drops per minute for normal operation.

5. Do a visual inspection of pump and motor to make sure equipment is operating properly without leaks, or excessive vibration or noise.



INSTALLATION AND OPERATION OF DRIP FEED OIL LUBRICATION SYSTEM

INSTALLATION

1. Mount oil reservoir on the bracket using cap screws furnished.
2. Connect the solenoid valve (when furnished) and the dripper, as shown.
3. Connect the copper tubing from the dripper to the nearest opening in the tension nut. The opening on the opposite side of the tension nut should be plugged. The tubing should slope downward with no kinks which might cause an air lock.

SOLENOID VALVE - OPTIONAL - FOR AUTOMATIC OPERATION

1. Be sure solenoid valve is mounted between reservoir and dripper. The opening labeled "in" should be nearest the reservoir.
2. The leads are usually wired across two of the motor leads at the junction box. Be sure the voltage stamped on the top of the valve agrees with the power supply. This can be within plus or minus 10%.

OIL LUBRICATION SYSTEM OPERATION

A one-quart oil reservoir was furnished with the pump. With a set drip rate of 8 to 10 drops of oil per minute, one-quart of oil will last approximately 24 hours of pump run time. The lube system is designed such that the oil gravity flows down the shaft. Excess will exit through the bypass port and mix with the pumpage.

Refer to the instruction plate mounted on the oil reservoir for the type and grade of oil to use. Typically any ISO 32 grade, 135-165 SUS, non-detergent, turbine oil can be used.

Cascade Pump Company
Santa Fe Springs, CA

GUIDE TO TROUBLESHOOTING

CONDITION	PROBABLE CAUSE	REMEDY
Pump Will Not Run	1. Motor overload protection contacts open. a. Incorrect control box. b. Incorrect connections. c. Faulty overloads. d. Low voltage. e. Ambient temperature of control box or starter too high. 2. Blown fuse, broken or loose electric connections. 3. Defective Motor. 4. Faulty control equipment. 5. Faulty switch. 6. Pump binding.	1. a. Check nameplate for HP and voltage. b. Check wiring diagram furnished with starter. c. Replace. d. Check voltage at pump side of control box. e. Use ambient compensated relays. 2. Check fuses, relays or heater elements for correct size and all electrical connections. 3. Repair or replace. 4. Check all circuits and repair. 5. Repair or replace. 6. Pull master switch, rotate pump by hand to check. Check impeller adjustment or disassemble unit to determine cause.
Pump Runs But No Water Delivered	1. Discharge pipe check valve backward. 2. Discharge pipe check valve stuck. 3. Unit running backward. 4. Operating head too high for pump. 5. Pump not submerged. 6. Excessive amounts of air or gas. 7. Intake strainer or impeller plugged or pump in mud or sand. 8. Impeller(s) loose on shaft.	1. Reverse check valve. 2. Free the valve. 3. Check rotation. Make sure it is counter clockwise From top of motor. If not, reverse motor leads or phasing problem. 4. Check with performance curve. 5. Lower pump if possible or add water to sump. 6. Vent pump discharge pipe. 7. Pull pump and clean. 8. Pull pump and repair.
Reduced Capacity	1. Bypass open. 2. Operating head too high for pump. 3. Motor not coming up to speed. 4. Strainer or impellers partly plugged. 5. Scaled or corroded discharge pipe or leaks anywhere in system. 6. Excessive amounts of air or gas. 7. Excess wear due to abrasives. 8. Impellers not properly adjusted. 9. Impeller(s) loose on shaft.	1.Check bypass valving. 2. Check performance curve. 3. Check voltage while unit is running. 4. Pull pump and clean. 5. Replace pipe or repair leaks. 6. Correct conditions. 7. Replace worn parts. 8. Check impeller running clearance and adjust if needed. 9. Pull unit and repair.
Motor Overloaded	1. Line voltage not correct. 2. Faulty equipment used to check 3. Specific gravity higher than design. 4. Operation at point on pump curve other than design. 5. Motor speed too high. 6. Impellers dragging. 7. Pump in bind.	1. Check and correct. 2. Check equipment. 3. Correct specific gravity or reevaluate system. 4. Check performance curve. 5. Line voltage too high or incorrect frequency. 6. Readjust impeller running clearance. 7. Pull master switch, rotate pump by hand to check. disassemble unit to determine cause.

GUIDE TO TROUBLESHOOTING

CONDITION	PROBABLE CAUSE	REMEDY
Pump Vibrating Excessive And Noisy	1. Unit running backwards. 2. Pump breaking suction and pumping air. 3. Loose fasteners. 4. Badly worn motor or pump bearings. 5. Impeller(s) loose on shaft. 6. Pump & motor shafts misaligned. 7. Stress due to piping misalignment.	1. Check rotation. Make sure it is counter clockwise from top of motor. If not, reverse motor leads or phasing problem. 2. Lower pump or reduce capacity. 3. Check all bolts, nuts, etc. 4. Pull unit and repair. 5. Pull unit and repair. 6. Pull unit and repair. 7. Adjust piping connection(s) to not have any stress on pump discharge or suction.
Excess Wear	1. Abrasives. 2. Pump in bind. 3. Vibration.	1. Clean system. 2. Pull master switch, rotate pump by hand to check. Disassemble unit to determine cause. 3. Determine cause and correct.
Corrosion	1. Impurities. 2. Corrosive liquid.	1. Analyze fluid. 2. Change to corrosion resistant materials.
Pumped Liquid in Enclosing Tube	1.Insufficient pressure and flow from lubricating system. 2. Worn bowl bearings. 3. Defective enclosing tube or connector bearing thread. 4. On oil lubricated design, bypass port in discharge bowl is probably plugged.	1. Adjust pressure/flow. Check for blockage. 2. Replace bearings. 3. Check and replace if necessary. 4. If plugged, clean out port.
Excessive Packing Box Leakage	1. Gland not properly tightened. 2. Ends of packing not staggered. 3. Worn packing or sleeve.	1. Adjust as necessary. 2. Repack. 3. Replace worn parts.
Overheating	A. Bearings 1. Shaft bent. 2. Rotating elements bind. 3. Pipe strain. 4. Insufficient bearing lubrication. 5. Incorrect type grease or oil. 6. Flushing water not circulating through enclosing tube. B. Packing Box 1. Packing gland too tight. 2. Water flush line plugged.	A. 1. Remove and straighten or replace. 2. Check for bent shaft. 3. Adjust piping connection(s) to not have any stress on pump discharge or suction. 4. Increase lubrication. 5. Correct. 6. Check for blockage or insufficient pressure. B. 1. Loosen gland until temperature drops. 2. Correct.

DISASSEMBLY INSTRUCTIONS
OIL LUBRICATED MIXED FLOW PUMPS
VERTICAL HOLLOW SHAFT

I. DRIVER.

1. Shut-off power.
2. Disconnect electrical leads to driver.

II. DRIVER COUPLING.

1. Vertical hollow shaft driver.
   (a) Remove lock screw in driver headshaft adjusting nut.
   (b) Loosen adjusting nut until propeller/impeller bottoms.
   (c) Unscrew sleeve motor coupling below driver (LH threads).
   (d) Remove headshaft up through driver.
   (e) Remove driver.

III. PUMP REMOVAL.

1. Disconnect elbow connection.
2. Remove baseplate mount nuts.
3. Drain oil reservoir if applicable, disconnect oil lines.
4. Lift pump off mounting floor.
5. Lay pump horizontally on supports.
6. Remove lubrication lines/guards.

IV. PUMP DRIVE COUPLING.

1. Remove pump half coupling (2-3 piece unit).

V. COLUMN/ELBOW DISASSEMBLY.

1. (a) Oil Lube - one (1) piece bronze tubing tension nut, remove tubing tension nut (RH thread).
   (b) Oil Lube - three (3) tubing tension nut assembly, remove tension nut lock ring (bronze) and tension nut (cast iron) (RH thread).
2. Remove bolts at column flange below motor base.
3. Remove elbow or baseplate column section.
   (a) Oil/Grease Lube - remove exposed enclosing tube sections (5’-0” or less), lineshaft bearing and shaft coupling.

DISASSEMBLY INSTRUCTIONS CONT.

VI. BOWL DISASSEMBLY.

1. Remove suction bowl bolts, remove suction bowl.
2. Remove impeller locking device.
   (a) Mixed Flow sizes #6, #8 & #6 two-stage, set screw in hub between blades.
   (b) Mixed Flow sizes #10 through #20 (one-stage) utilizes a TRU-ARC ring to support the thrust collars. Use TRU-ARC pliers to remove ring.
   (c) Mixed Flow sizes #24 through #42 (one-stage) utilize a bolted thrust collar retainer, remove bolts.
   (d) Mixed Flow sizes #8 through #42 (two-stage) utilize bolted thrust collar retainers, remove bolts.
3. Remove impeller thrust collar halves.
   (a) Pump sizes #20 and smaller - raise the impeller relative to the shaft until the split thrust collars are exposed (about 1/2 inch) and remove collars.
   (b) Pump sizes #24 Mixed Flow and larger - the split thrust collars will be exposed after removal of thrust collar retainer. Raise impeller about 1/2" on shaft and remove collars.
   (c) Remove impeller from bowl shaft, units are keyed to the shaft.
4. Two-stage bowl assembly - intermediate bowl.
   (a) Repeat steps 2, 3 & 4.
5. Remove bowl shaft.

VII. PUMP ASSEMBLY.

1. Inspect all mating surfaces for burrs and foreign matter.
2. Inspect all threads for damage.
3. Inspect all shafting for damage and straightness (± .005")
4. Apply thread lubricant to all threads.
5. Reverse disassembly procedure to assemble.

START-UP & OPERATION

CAUTION: Prior to starting verify that the pump and motor turn freely. Thoroughly check the pumping system. Verify that all piping is in place and that valves and gauges are operating properly. Verify that bolts and nuts are tight. Be sure that no foreign matter is near any of the rotating parts. Verify that all electrical connections are correct and tight. Verify that driver unit has proper lubrication. Verify that there is an adequate source of fluid at the suction side of the pump and that the discharge valve is open.

1. Follow the manufacturer's start-up procedures for starting the driver unit and for proper lubrication requirements.

2. Observe pump during start-up. It should run smoothly and without excessive vibration.

3. While the pump is in operation, check it on a regular basis (hourly is suggested) to verify that the pump is operating correctly and no evidence of heat build up and that the driver is operating properly.

CASCADE PUMP COMPANY
MANUFACTURERS OF AXIAL AND MIXED FLOW PUMPING EQUIPMENT
10107 SOUTH NORWALK BOULEVARD, P.O. BOX 2767 • SANTA FE SPRINGS, CALIFORNIA 90670-0767
E-MAIL: PUMPINFO@CASCADEPUMP.COM • WWW.CASCADEPUMP.COM
TEL:562.946.1414 • FAX:562.941.3730

Emergency / Normal Operation Instructions

OPERATING INSTRUCTIONS:

1. **Normal Operation –** The pump should be run with all valves open.

2. **Emergency Conditions –** No special actions are required for operation under emergency conditions.

BOLT TORQUE VALUES

Column Flanges

There are no specific bolt torque value requirements for the bolts used to secure column flanges on the pump. If an impact wrench is used, spin the nut or cap screw to a snug condition. (Snug condition is the point when the socket ceases to turn freely and the wrench begins to impact.) Continue to tighten the bolts a minimum ½ turn to maximum ¾ turn.

Torque Values for Standard Fasteners

Max Torque (foot-pounds) for Clean, Dry Threads

Bolt Size-Thread Pitch	Grade 2	Grade 5	Grade 8
1/4 –20	6	10	12
1/4 –28	7	12	15
5/16-18	13	20	24
5/16-24	14	22	27
3/8-16	23	36	44
3/8-24	26	40	48
7/16-14	37	52	63
7/16-20	41	57	70
1/2-13	57	80	98
1/2-20	64	90	110
9/16-12	82	120	145
9/16-18	91	135	165
5/8-11	111	165	210
5/8-18	128	200	245
3/4-10	200	285	335
3/4-16	223	315	370
7/8-9	315	430	500
7/8-14	340	470	550
1-8	400	650	760
1-14	460	710	835

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Important Notice

Failure to follow instructions may cause serious personal injury or property damage.

CAUTION: The equipment supplied can cause serious personal injury or death if mishandled and extreme care is not exercised in the operation of the equipment. **NO ONE SHOULD EVER BE ALLOWED NEAR THE SUCTION OR OPEN DISCHARGE OF THE PUMP DURING OPERATION.** A double custody lock should be installed on circuit breaker before anyone should be allowed to do any checking, maintenance or other work on equipment. If the unit is supplied from the factory with OSHA approved coupling guards they must be installed at all times during operation to prevent injury to personnel.

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Pump / Driver

Preventive Maintenance Requirements

A periodic once a month inspection is suggested for all units. During this inspection the pump and driver should be checked for performance and change in noise or vibration level, loose bolts or piping, dirt or corrosion. Clean and repair all areas rusted or corroded. It is very helpful to develop a vibration trend analysis based upon periodic vibration reading recordings. This will determine optimum repair frequency.

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SAFETY PRECAUTIONS

Qualified personnel must perform installation, operation, and maintenance. It is important to observe safety precautions to protect personnel from possible injury. Familiarization with the installation and operation manuals of the pump drivers (electric motors or gear drives from engines) is recommended. Generally, the following precautions should be followed.

1. Disconnect and lock out all power to the motor or engine prior to commencing any installation, maintenance, or repairs.
2. Discharge pipe valve should be closed to prevent any back flow of water into the pump or sump.
3. Cranes with adequate lifting capacity should be used to install the equipment.
4. All rotating shafts and couplings must be adequately guarded before operating the gear drive or motor. The top cover supplied with gear drive or motor must be installed prior to equipment start-up.
5. Act with care in accordance with this manual's prescribed procedures in handling and installing the equipment.
6. Be sure equipment and accessories are electrically grounded and proper electrical installation wiring and controls are used in accordance with local national electrical codes.
7. Be sure equipment is properly enclosed or protected to prevent children or unauthorized personnel in order to prevent possible accidents.
8. Be sure the shaft gib key, applicable to hollow shaft drivers, is fully captive in the motor clutch before unit is energized or engaged.
9. Provide proper safeguard for personnel against rotating parts.
10. Avoid extended exposure to equipment with high noise levels. Use ear protection where necessary.
11. Observe good safety habits at all times and use care to avoid injury to yourself or damage to equipment.
12. Observe all special instructions attached to the equipment. Remove shipping fixtures if so equipped before energizing unit.
13. Check motor or gear drive for proper rotation and phase sequence prior to coupling to the pump shaft.
14. Electric motors can retain a lethal charge even after being shut off. Certain accessories (space heaters, etc.) are normally energized when the motor is turned off. Other accessories such as power factor correction capacitors, surge capacitors, surge capacitors, etc. can retain an electrical charge after being shut off and disconnected.

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CASCADE PUMP COMPANY

STANDARD LIMITED WARRANTY

All equipment of Cascade Pump Company manufacture is warranted against defects in material or workmanship under normal service for a period not to exceed one year from the date of start-up and acceptance, but not to exceed 18 months from shipment. The company's obligation under this warranty is limited, however, to replacing or repairing without charge, f.o.b. factory, any defective part or parts of its own manufacture. No allowances will be made for local repair bills or expenses without the written approval of this company. Cascade Pump Company can assume no obligation for damages or delay and no allowance for repairs or alterations unless officially authorized. Other equipment supplied by Cascade Pump Company such as drivers, lubrication systems, etc. are guaranteed only to the extent of the original manufacturer's guarantee, which is similar in warranty obligation and time period as Cascade Pump Company.

THIS WARRANTY IS THE SOLE WARRANTY OF SELLER AND SELLER HEREBY EXPRESSLY DISCLAIMS AND BUYER WAIVES ALL OTHER WARRANTIES EXPRESSED, IMPLIED IN LAW OR IMPLIED IN FACT, INCLUDING ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Seller's sole obligation under this warranty shall be, at its option, to repair or replace any equipment (or its component parts) which has a defect covered by this warranty, or to refund the purchase price of such equipment or part. Under the terms of this warranty, seller shall not be liable for (a) consequential, collateral, special or liquidated losses or damages; (b) equipment conditions caused by normal wear and tear, abnormal conditions of use, accident, neglect, or misuse of said equipment; (c) the expense of, and loss or damage caused by, repairs or alterations made by anyone other than the seller; (d) damage caused by abrasive materials, chemicals, scale deposits, corrosion, lightning, improper voltage, mishandling, or other similar conditions; (e) any loss, damage, or expense relating to or resulting from installation, removal or reinstallation of equipment; (f) any labor costs or charges incurred in repairing or replacing defective equipment or parts, including the cost of reinstalling parts that are repaired or replaced by seller; (g) any expense of shipment of equipment or repaired or replacement parts; or (h) any other loss, damage or expense of any nature.

SECTION II

NIDEC MOTOR CORPORATION
8050 WEST FLORISSANT AVE.
ST. LOUIS, MO 63136

DATE: 1/18/2017

P.O. NO.: 603202
Order/Line NO.: 16705666 SO 100

TO: Cascade Pump Co
10107 S Norwalk Blvd
PO Box 2767
Santa Fe Springs, CA, 90670-0767
ATTN: DAN LINCOLN

Model Number: NA
Catalog Number:
VHS Weather Protected
CONF,MOTOR,VHS WPI

REVISIONS:
(NONE)

ALL DOCUMENTS HEREIN ARE CONSIDERED CERTIFIED BY NIDEC MOTOR CORPORATION.
THANK YOU FOR YOUR ORDER AND THE OPPORTUNITY TO SERVE YOU.

Features:

HOLD PRODUCTION
Horsepower ..... 00015.00~00000.00 ~ KW: 11.19
Enclosure ..... WPI
Poles ..... 08~00 ~ RPM: 900~0
Frame Size ..... 286~TPA
Phase/Frequency/Voltage.. 3~060~460 ~ Random Wound
Service Factor 1.15
Insulation Class ..... Class "F" ~ Insulife 1000
Altitude In Feet (Max) .. 3300 Ft.(1000 M) ~ +40 C
Efficiency Class ..... Premium Efficiency
Application ..... Unknown
Customer Part Number .... SO#18659/60
12" Base ~ Coupling Size: 1-3/16" Bore, 1/4" Key
Non-Reverse Ratchet ~ Steady Bushing Not Requested
Pricebook Thrust Value (lbs).. 4200
Customer Down Thrust (lbs) ... 4200
Customer Shutoff Thrust (lbs).
Up Thrust (lbs): ~
Temperature Rise (Sine Wave): "B" Rise @ 1.0 SF (Resist)
NEMA Design ..... B
Starting Method ..... Direct-On-Line Start
Duty Cycle ..... Continuous Duty
Efficiency Value ..... 90.2 % ~ Typical
Load Inertia (lb-ft2): NEMA ~ NEMA Inertia: 400.00 ~ 1.00
Number Of Starts Per Hour: NEMA
Motor Type Code ..... AUS
Rotor Inertia (LB-FT²) 4.73 LB-FT²
Qty. of Bearings PE (Shaft) 1
Qty. of Bearings SE (OPP) 1
Bearing Number PE (Shaft) 7310 BEP
Bearing Number SE (OPP) 6210-2Z-J/C3

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ATTN: DAN LINCOLN

Model Number: NA
Catalog Number:
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CONF,MOTOR,VHS WPI

REVISIONS:
(NONE)

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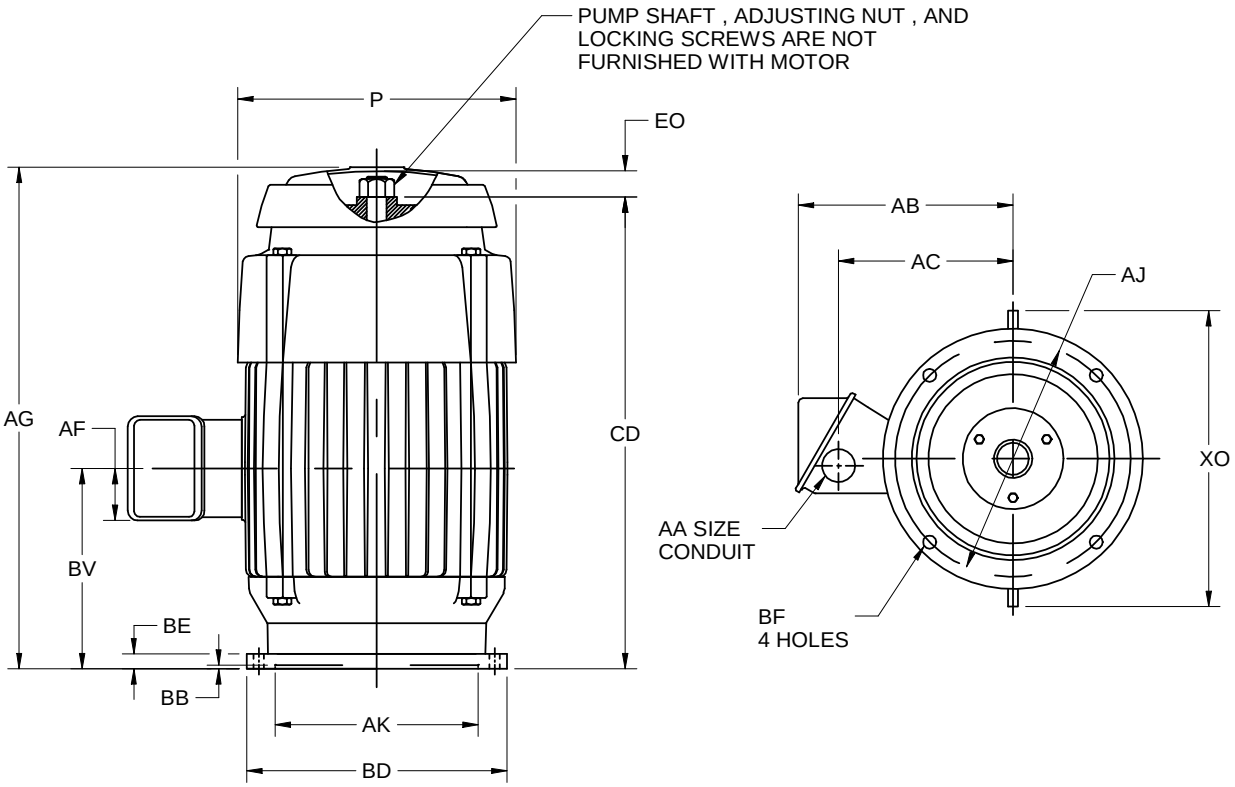
THANK YOU FOR YOUR ORDER AND THE OPPORTUNITY TO SERVE YOU.

Accessories:
Counter CW Rotation FODE

USE THE DATA PROVIDED BELOW TO SELECT THE APPROPRIATE DIMENSION PRINT

Horsepower	15
Pole(s)	08
Voltage(s)	460
Frame Size	286TPA
Outlet Box AF	2.59
Outlet Box AA	1.50

EFFECTIVE: 11-MAY-15	DIMENSION PRINT	PRINT: 09-2290
SUPERSEDES: 22-DEC-11	WEATHER PROTECTED TYPE I FRAME: 284,286TP, TPA, TPH BASIC TYPE: AU, AUE, AUI	SHEET: 1 OF 1



ALL DIMENSIONS ARE IN INCHES AND MILLIMETERS

	UNITS	P[2]	AA	AB	AC	AF	AG	BE	BV	CD	EO	XO
	IN	14.00	1.50	11.07	8.32	2.59	28.13	.94	12.25	24.75	3.22	16.88
	MM	356		281	211	66	715	24	311	629	82	429

	FRAME	UNITS	AJ	AK	BB MIN	BD MAX	BF
	284,286TP	IN	9.125	8.250	.25	10.00	.44
		MM	231.78	209.55	6	254	11
	284,286TPH	IN	14.750	13.500	.25	16.50	.69
		MM	374.65	342.90	6	419	18
	284,286TPA	IN	9.125	8.250	.25	12.00	.44
		MM	231.78	209.55	6	305	11

TOLERANCES	8.250 AK	13.500 AK
FACE RUNOUT	.004 T.I.R.	.007 T.I.R.
PERMISSIBLE ECCENTRICITY OF MOUNTING RABBET	.004 T.I.R.	.007 T.I.R.
TOLERANCE ON AK-DIMENSION	+.003	+.005

1. ALL ROUGH DIMENSIONS MAY VARY BY .25" DUE TO CASTING AND/OR FABRICATION VARIATIONS.
2. LARGEST MOTOR WIDTH.
3. TOLERANCES SHOWN ARE IN INCHES ONLY.
4. CONDUIT BOX MAY BE LOCATED IN STEPS OF 90° REGARDLESS OF LOCATION. STANDARD AS SHOWN WITH CONDUIT OPENING DOWN.

Nidec Motor Corporation
St. Louis, Missouri

ISSUED BY	F. CRUZ
APPROVED BY	F. LARA

IHP_DP_NMCA (MAR-2011) SOLIDEDGE

NAMEPLATE DATA

CATALOG NUMBER:				NAMEPLATE PART #:	422703-007		
MODEL		FR	286TPA	TYPE	AUS	ENCL	WPI
SHAFT END BRG	7310 BEP - QTY 1			OPP END BRG	6210-2Z-J/C3 - QTY 1		
PH	3	MAX AMB	40 C	ID#	(ref: Order#: 16705666, Type: SO, Line#: 100)		
INSUL CLASS	F	Asm. Pos.		DUTY	CONT		

HP	15		RPM	880		HP		RPM	
VOLTS	460					VOLTS			
FL AMPS	21.5					FL AMPS			
SF AMPS	24.1					SF AMPS			
SF	1.15	DESIGN	B	CODE	F	SF		DESIGN	CODE
NEMA NOM EFFICIENCY	90.2	NOM PF	73.0	KiloWatt	11.2	NEMA NOM EFFICIENCY		NOM PF	
GUARANTEED EFFICIENCY	88.5	MAX KVAR	7.5	HZ	60	GUARANTEED EFFICIENCY		MAX KVAR	HZ

HAZARDOUS LOCATION DATA (IF APPLICABLE):

DIVISION		CLASS I	GROUP I
TEMP CODE		CLASS II	GROUP II

VFD DATA (IF APPLICABLE):

VOLTS			
AMPS			
TORQUE 1		TORQUE 2	
VFD LOAD TYPE 1		VFD LOAD TYPE 2	
VFD HERTZ RANGE 1		VFD HERTZ RANGE 2	
VFD SPEED RANGE 1		VFD SPEED RANGE 2	
SERVICE FACTOR		FL SLIP	
NO. POLES	8	MAGNETIZING AMPS	11.1
VECTOR MAX RPM		Encoder PPR	
Radians / Seconds		Encoder Volts	

TEAO DATA (IF APPLICABLE):

HP (AIR OVER)		HP (AIR OVER M/S)		RPM (AIR OVER)		RPM (AIR OVER M/S)	
FPM AIR VELOCITY		FPM AIR VELOCITY M/S		FPM AIR VELOCITY SEC			

ADDITIONAL NAMEPLATE DATA:

Decal / Plate	WD=499495	Customer PN	SO#18659/60
Notes		Non Rev Ratchet	NRR
Max Temp Rise	80C RISE/RES@1.00SF	OPP/Upper Oil Cap	GREASE
Thermal (WDG)		SHAFT/Lower Oil Cap	GREASE
Altitude			
Regulatory Notes		Regulatory Compliance	
COS		Marine Duty	
Balance		Arctic Duty	
3/4 Load Eff.	90.9	Inrush Limit	
Motor Weight (LBS)	325	Direction of Rotation	
Sound Level		Special Note 1	
Vertical Thrust (LBS)	4200	Special Note 2	
Thrust Percentage		Special Note 3	
Bearing Life		Special Note 4	
Starting Method		Special Note 5	
Number of Starts		Special Note 6	
200/208V 60Hz Max Amps		SH Max. Temp.	
190V 50 hz Max Amps		SH Voltage	
380V 50 Hz Max Amps		SH Watts	
NEMA Inertia		Load Inertia	
Sumpheater Voltage		Sumpheater Wattage	
Special Accessory Note 1		Special Accessory Note 16	
Special Accessory Note 2		Special Accessory Note 17	
Special Accessory Note 3		Special Accessory Note 18	
Special Accessory Note 4		Special Accessory Note 19	
Special Accessory Note 5		Special Accessory Note 20	
Special Accessory Note 6		Special Accessory Note 21	
Special Accessory Note 7		Special Accessory Note 22	
Special Accessory Note 8		Special Accessory Note 23	
Special Accessory Note 9		Special Accessory Note 24	
Special Accessory Note 10		Special Accessory Note 25	
Special Accessory Note 11		Special Accessory Note 26	
Special Accessory Note 12		Special Accessory Note 27	
Special Accessory Note 13		Special Accessory Note 28	
Special Accessory Note 14		Special Accessory Note 29	
Special Accessory Note 15		Special Accessory Note 30	
Heater in C/B Voltage		Heater in C/B Watts	
Zone 2 Group		Division 2 Service Factor	

NIDEC MOTOR CORPORATION

ST. LOUIS, MO

TYPICAL NAMEPLATE DATA
ACTUAL MOTOR NAMEPLATE LAYOUT MAY VARY
SOME FIELDS MAY BE OMITTED

MOTOR PERFORMANCE

MODEL NO.	CATALOG NO.	PHASE	TYPE	FRAME
NA	NA	3	AUS	286TPA

ORDER NO.	16705666	LINE NO.	100

MPI:	225258
HP:	15
POLES:	8
VOLTS:	460
HZ:	60
SERVICE FACTOR:	1.15
EFFICIENCY (%):	
S.F.	89.4
FULL	89.5
3/4	90.9
1/2	90.4
1/4	85.8
POWER FACTOR (%):	
S.F.	75.1
FULL	73
3/4	66.8
1/2	55.6
1/4	35.1
NO LOAD	4.3
LOCKED ROTOR	40.3
AMPS:	
S.F.	24.1
FULL	21.5
3/4	17.3
1/2	14
1/4	11.7
NO LOAD	11.1
LOCKED ROTOR	95
NEMA CODE LETTER	F
NEMA DESIGN LETTER	B
FULL LOAD RPM	880
NEMA NOMINAL / EFFICIENCY (%)	90.2
GUARANTEED EFFICIENCY (%)	88.5
MAX KVAR	7.5
AMBIENT (°C)	40
ALTITUDE (FASL)	3300
SAFE STALL TIME-HOT (SEC)	0
SOUND PRESSURE (DBA @ 1M)	0
TORQUES:	
BREAKDOWN{% F.L.}	226
LOCKED ROTOR{% F.L.}	163
FULL LOAD{LB-FT}	89.4

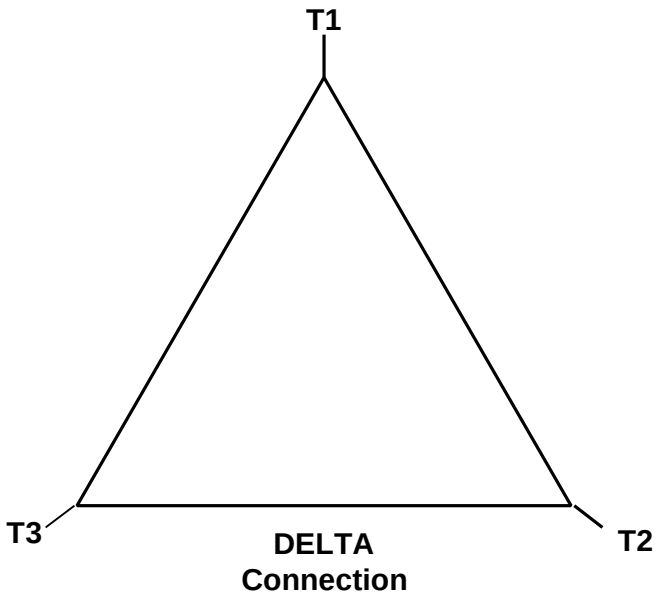
NEMA Nominal and Guaranteed Efficiencies are up to 3,300 feet above sea level and 25 ° C ambient

The Above Data Is Typical, Sinewave Power Unless Noted Otherwise

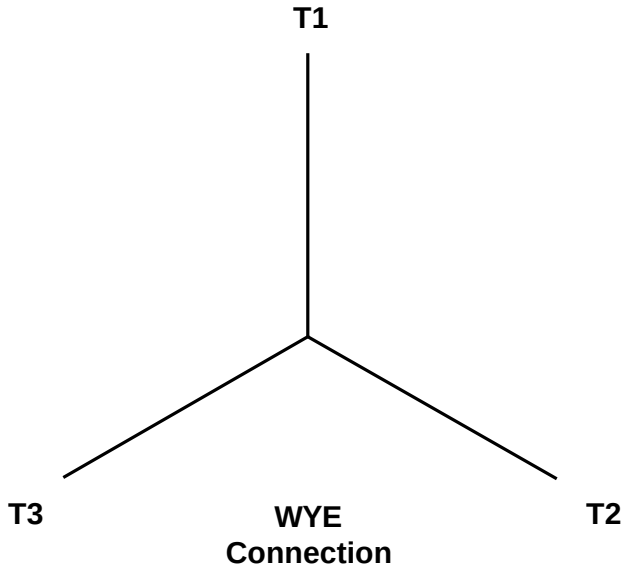
NIDEC MOTOR CORPORATION
ST. LOUIS, MO

499495

Motor Wiring Diagram



or



LEAD CONNECTION

1 2 3

Line

Each lead may consist of one or more cables having the same lead number.

499495

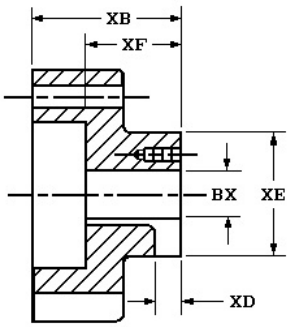
To reverse direction of rotation interchange connections L1 and L2.

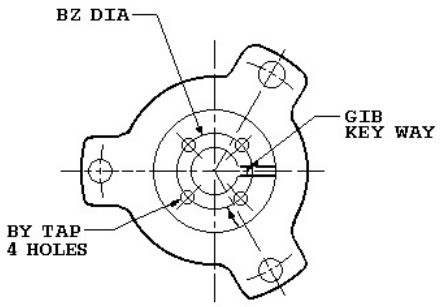
Each lead may be comprised of one or more cables.
Each cable will be marked with the appropriate lead number.

EFFECTIVE: 2/27/96
SUPERCEDES: X736618, 96441, 179879, 284138
Connection Plate: 499495
Connection Decal: 912113

Vertical HOLLOSHAFT Coupling Dimensions

Standard Coupling Dimensions





Coupling Part Number	104720
BX Nominal	1 3/16
Actual Bore	1.188
BY	1/4-20
BZ	1 3/4
XB	2 9/16
XD	13/32
XE	2 1/4
XF	1 5/8
SQ. KEY	1/4

Notes:

1. All Rough casting dimensions may vary by 0.25" due to casting variations.
2. All tapped holes are Unified National Course, Right Hand thread.
3. Coupling bore dimension "BX" is machined with a tolerance of - .000", +.001" up to 1.50" bore inclusive. Larger bores: -.000", +.002".

TYPICAL REED CRITICAL FREQUENCY DATA

Note: Motor RCF Test Data can be provided at time of motor shipment through special test.
Please contact your Nidec Motor Corporation representative for more information.

MODEL NO: NA
CATALOG NO: NA

Frame: 286TPA Type: AUS

REED CRITICAL FREQUENCY:	75	HZ
CENTER OF GRAVITY:	11.7	IN
DEFLECTION @ CENTER OF GRAVITY:	0.0017	IN
UNIT WEIGHT:	330	LBS
BASE DIAMETER:	ALL	IN
TOLERANCE ON RCF VALUE:	20%	
DATE:	1/18/2017	

General Information for Integral Horsepower (IHP) Motors on Variable Frequency Drives (VFDs)

Variable Frequency Drives (VFD)

A VFD is a type of controller used to vary the speed of an electric motor. The VFD takes a fixed AC voltage and frequency and allows it to be adjusted in order to get different speeds from the motor. Motor speed can be varied by changing the frequency of the input power waveform. The equation below shows how the frequency affects the speed of a three phase induction motor.

$$\text{Speed} = \frac{120^* \text{ Fundamental Input Frequency}}{\text{Number of Motor Poles}}$$

How does a VFD work?

A VFD takes the fixed frequency and voltage sine wave from the power grid or power station and puts it through a few steps in order to allow the VFD user to vary the frequency and in turn control the motor speed. First it rectifies the AC power into DC Power. Because of this step, a term commonly used instead of VFD is inverter. This only describes one step of what the VFD does to the power waveform. Once rectified into a DC voltage the drive sends the power through a set of transistors or switches. These switches can take the DC waveform and by opening and closing at certain speeds and durations can create an output waveform that mimics the sine wave that is required to drive a three phase electric motor. The output wave form is known as a Pulse Width Modulation (PWM) waveform because the waveform is created by multiple pulses of the switches at short intervals.

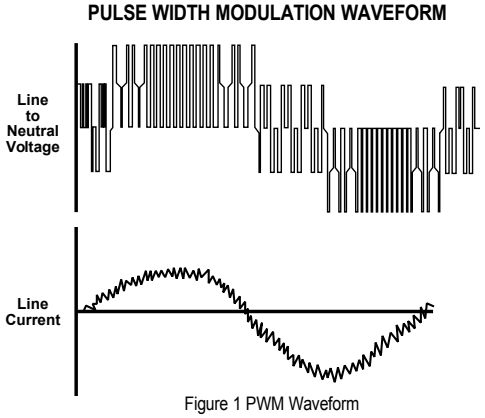


Figure 1 PWM Waveform

What variables should be considered when deciding whether to power a motor with a VFD?

VFD compatibility with motors is complex. As a result, many variables must be considered when determining the suitability of a particular motor for use with a VFD. These variables include:

- Torque requirements (Constant or Variable)
- Speed Range
- Line / System Voltage
- Cable length between the VFD and the motor
- Drive switching (carrier) frequency
- Motor construction
- VFD dv/dt
- High temperatures or high humidity
- Grouding system

Wider speed ranges, higher voltages, higher switching frequencies, insufficient grounding and increased cable lengths all add to the severity of the application and, therefore, the potential for premature motor failure.

How does a VFD affect the motor?

There are many things to consider when a motor is powered using a VFD or PWM power. When a motor is powered by a PWM waveform the motor windings very often see a large differential voltage, either from phase to phase or turn to turn. When the voltage differential becomes large enough it creates a reaction at the molecular level that converts available oxygen into O3. This phenomenon is called partial discharge or corona. This reaction creates energy in the form of light and heat. This energy has a corrosive effect on the varnish used to protect the motor windings. PWM waveforms can also magnify shaft voltages which lead to arcing across the bearing and causing premature bearing failure. Corrective action must be taken to mitigate these issues that arise when using an electric motor with a VFD.

How do I protect the motor?

Nidec Motor Corporation (NMC) has developed specific motor designs to decrease the harmful affects that a VFD can have on a motor. NMC's INVERTER GRADE® insulation system is the first line of defense against corona and phase to phase faults that can be common when a motor is powered using a PWM waveform. The INVERTER GRADE® insulation system is standard on all of NMC's Inverter Duty products. Along with the INVERTER GRADE® insulation, thermostats are installed as a minimum protection against over heating the motor. Special consideration must also be given to bearings in motors powered by VFD's. In order to create a low resistance path to ground for built up shaft voltages a shaft grounding device can be used. On larger horsepower motors an insulated bearing system should be used in conjunction with the shaft grounding device when installed, to force the stray shaft voltages to ground. The bearing failures are more prominent on motors with thrust handling bearings. NMC has created an Inverter Duty vertical motor line that not only uses the INVERTER GRADE® insulation system, but that also comes standard with a shaft grounding device. On motors that are 100 HP and greater the thrust bearing is also insulated for additional protection.

What does "Inverter Duty" mean?

An Inverter Duty motor should describe a motor that helps mitigate potential failure modes of a motor that is powered by a VFD. Inverter duty motor windings should be able to withstand the voltage spikes per NEMA MG1 Part 31.4.4.2 and protect against overheating when the motor is run at slow speeds. On thrust handling bearings it is apparent that the bearings require additional protection. Inverter Duty vertical motors should have a shaft grounding device to protect the motor bearings from fluting due to voltage discharge through the bearing. On larger motors (100HP and larger) the shaft should also be electrically isolated from the frame in order to aid the shaft grounding ring in discharging the shaft voltages to ground.

*This information applies only to Integral Horsepower (IHP) motors as defined on the Agency Approval page, under UL®† & CSA®† listings where indicated.

Motor / Inverter Compatibility

Thermal Overloads and Single Phase Motors

Motors with thermal overloads installed may not operate properly on a VFD. The current carrying thermal overload is designed for sine wave power. Operation on a VFD may cause nuisance tripping or potentially not protect the motor as would be expected on line power. Thermostats or thermistors installed in the motor and connected properly to the VFD may provide suitable thermal overload protection when operating on a VFD. (consult codes for installation requirements)

Single phase motors and other fractional horsepower ratings are not designed to be operated on a VFD. Within Nidec Motor Corporation standard products, all motors NEMA®† 48 frame (5.5" diameter) and smaller are not suitable for VFD applications. Three phase 56 and 143/145 frame applications should be noted on the catalog price page; or if in doubt ask an Nidec Motor Corporation technical representative for recommendations on compatibility with a VFD.

Slow Speed Motors

Motors with a base design of slower than six poles require special consideration regarding VFD sizing and minimizing harmonic distortion created at the motor terminals due to cable installation characteristics. Additional external PWM waveform filters and shielded motor cables designed for PWM power may be required to provide acceptable motor life. Harmonic distortion on the output waveform should be kept to a minimum level (less than 10%) mismatch impedence.

690V Applications

Motors that are rated for 690VAC and that will be powered by 690VAC PWM VFDs require the use of an external filter to limit peak voltage spikes and the use of an INVERTER GRADE® motor. Where available, an alternative to using an output filter is to upgrade to a 2300V insulation system.

Low Voltage TITAN® Motors

When using 449 frame and larger motors on PWM type VFDs consider the use of an external filter and shielded motor cables designed for PWM power to minimize harmonic distortion and peak voltages at the motor terminals. Harmonic distortion on the output waveform should be kept to a minimum level (less than 10%).

Bearing Currents Related to PWM Waveforms

Due to the uniqueness of this condition occurring in the field, protection of the motor bearings from shaft currents caused by common mode voltages is not a standard feature on sine wave or Inverter Duty motor products, unless explicitly noted. Some installations may be prone to a voltage discharge condition through the motor bearings called Electrical Discharge Machining (EDM) or fluting.

EDM damage is related to characteristics of the PWM waveform, and the VFD programming, and installation factors.

Bearing EDM as a result of VFD waveform characteristics may be prevented by the installation of a shaft grounding device such as a brush or ring and/or correction of the installation characteristics causing the shaft voltage condition. Insulated bearing(s) may be required. VFD filters may be used if bearing fluting is to be mitigated.

Bearing Protection on Inverter Duty Vertical Motors
All U.S. MOTORS® brand "Inverter Duty" vertical products have a shaft grounding system that allows damaging shaft currents a low resistance path to ground. **Bearings on vertical motors fed by VFD power without this bearing protection are not covered under any warranty.** All other bearing failure is covered per NMC's standard warranty. An electric motor repair shop approved to service U.S. MOTORS® brand motors must verify that the cause of the bearing failure was not due to EDM damage.

Multiple Motors on a Single VFD

Special considerations are required when multiple motors are powered from a single VFD unit. Most VFD manufacturers can provide guidelines for proper motor thermal considerations and starting/stopping of motors. Cable runs from the VFD and each motor can create conditions that will cause extra stress on the motor winding. Filters may be required at the motor to provide maximum motor life.

Grounding and Cable Installation Guidelines

Proper output winding and grounding practices can be instrumental in minimizing motor related failures caused by PWM waveform characteristics and installation factors. VFD manufacturers typically provide detailed guidelines on the proper grounding of the motor to the VFD and output cable routing. Cabling manufacturers provide recommended cable types for PWM installations and critical information concerning output wiring impedance and capacitance to ground.

Vertical Motors on VFDs

Vertical motors operated on VFD power present unique conditions that may require consideration by the user or installation engineer:

- • Locked rotor and drive tripping caused by non-reversing-ratchet operation at low motor speeds. It is not recommended to operate motors at less than 1/4 of synchronous speed. If slow speeds are required contact NMC engineering.
- • Unexpected / unacceptable system vibration and or noise levels caused by the torque pulsation characteristics of the PWM waveform, a system critical frequency falling inside the variable speed range of the process or the added harmonic content of the PWM waveform exciting a system component
- • Application related problems related to the controlled acceleration/ deceleration and torque of the motor on VFD power and the building of system pressure/ load.
- • The impact the reduction of pump speed has on the down thrust reflected to the pump motor and any minimum thrust requirements of the motor bearings
- Water hammer during shutdown damaging the non-reversing ratchet

Humidity and Non-operational Conditions

The possible build-up of condensation inside the motor due to storage in an uncontrolled environment or non-operational periods in an installation, can lead to an increased rate of premature winding or bearing failures when combined with the stresses associated with PWM waveform characteristics. Moisture and condensation in and on the motor winding over time can provide tracking paths to ground, lower the resistance of the motor winding to ground, and lower the Corona Inception Voltage (CIV) level of the winding.

Proper storage and maintenance guidelines are important to minimize the potential of premature failures. Space heaters or trickle voltage heating methods are the common methods for drying out a winding that has low resistance readings. **Damage caused by these factors are not covered by the limited warranty provided for the motor unless appropriate heating methods are properly utilized during non-operational periods and prior to motor start-up.**

NEMA®† Application Guide for AC Adjustable Speed Drive Systems: http://www.nema.org/stds/acadjustable.cfm#download

* This information applies only to Integral Horsepower (IHP) motors as defined on the Agency Approval page, under UL®† & CSA®† listings where indicated.

Warranty Guidelines for Integral Horsepower (IHP)* Motors on Variable Frequency Drives

Warranty Guidelines

The information in the following section refers to the motor and drive application guidelines and limitations for warranty.

Hazardous Location Motors

Use of a variable frequency drive with the motors in this catalog, intended for use in hazardous locations, is only approved for Division1, Class I, Group D hazardous location motors with a T2B temperature code, with a limitation of 2:1 constant torque or 10:1 variable torque output. **No other stock hazardous location motors are inherently suitable for operation with a variable frequency drive.** If other requirements are needed, including non-listed Division 2, please contact your Nidec Motor Corporation territory manager to conduct an engineering inquiry.

575 Volt Motors

575 volt motors can be applied on Inverters when output filters are used. Contact the drive manufacturer for filter selection and installation requirements.

Applying INVERTER GRADE® Insulated Motors on Variable Frequency Drives (2, 4, 6 pole)

The products within this catalog labeled "Inverter Duty" or "Vector Duty" are considered INVERTER GRADE® insulated motors. INVERTER GRADE® motors exceed the NEMA®† MG-1 Part 31 standard. Nidec Motor Corporation provides a three-year limited warranty on all NEMA®† frame INVERTER GRADE® insulated motors and allows long cable runs between the motor and the VFD (limited to 400 feet without output filters). Cable distance can be further limited by hot and humid environments and VFD manufacturers cable limits. These motors may be appropriate for certain severe inverter applications or when the factors relating to the end use application are undefined (such as spares).

Nidec Motor Corporation's U.S. Motors® brand is available in the following INVERTER GRADE® insulated motors:

- Inverter Duty NEMA®† frame motors good for 10:1 Variable Torque & 5:1 Constant Torque, including Vertical Type RUSI
- Inverter Duty motors rated for 10:1 Constant Torque
- ACCU-Torq® and Vector Duty Motors with full torque to 0 Speed
- 841 Plus® NEMA®† Frame Motors

Applying Premium Efficient motors (that do not have INVERTER GRADE® insulation) on Variable Frequency Drives (2, 4, 6 pole)

Premium efficient motors without INVERTER GRADE insulation meet minimum NEMA®† MG-1, Section IV, Part 31.4.4.2. These motors can be used with Variable Frequency Drives (with a reduced warranty period) under the following parameters:

- On NEMA®† frame motors, 10:1 speed rating on variable torque loads & 4:1 speed range on constant torque loads.
- On TITAN® frame motors, 10:1 speed rating on variable torque loads.
- On TITAN® frame motors, inquiry required for suitability on constant torque loads.

Cable distances are for reference only and can be further limited by hot and humid environments (refer to Table 1). Refer to specific VFD manufacturers cable limits. Refer to the Motor/ Inverter Compatibility page for special consideration of vertical motor bearings.

Table 1 - Cable Distances			
Maximum Cable Distance VFD to Motor			
Switching Frequency	460 Volt	230 Volt	380 Volt
3 Khz	127 ft	400 ft	218 ft
6 Khz	90 ft	307 ft	154 ft
9 Khz	73 ft	251 ft	126 ft
12 Khz	64 ft	217 ft	109 ft
15 Khz	57 ft	194 ft	98 ft
20 Khz	49 ft	168 ft	85 ft

Warranty Period Clarifications and Exceptions

Standard Energy Efficient Exclusion

Applying Standard & Energy Efficient Motors on Variable Frequency Drives is not recommended. VFD related failures on standard and energy efficient motors will not be covered under warranty.

Vertical Motor Windings

Premium efficient vertical motors without INVERTER GRADE® insulation that are installed using the criteria described in this document and applied in the correct applications shall have a warranty while powered by a VFD for 12 months from date of installation or 18 months from date of manufacturing whichever comes first. See limited warranty page for horizontal motor warranty periods.

Bearing Exclusion for Thrust Handling Bearings

Bearings used in premium efficienct vertical motors, and all thrust handling bearings, that are powered by VFDs without shaft grounding devices or insulated bearings (when required) will not be covered under any warranty for damages caused from being powered by a VFD. All other bearing failure is covered per NMC's standard warranty. An electric motor repair shop approved to service U.S. MOTORS® brand motors must verify that the cause of the bearing failure was not due to Electrical Discharge Machining.

Medium Voltage and Slow Speed Considerations

Motors that are rated above 700 VAC or that are eight pole and slower require special consideration and installation and are not covered under the warranty guidelines in this document. Motors that are rated above 700VAC have special cable length and voltage differential issues that are specific to the VFD type and manufacture. The motor construction and cost may vary dramatically depending on the VFD topology and construction. Contact your NMC representative with VFD manufacturer name and model type for application and motor construction considerations. Motors that are designed eight pole and slower also require special installation and filters per the drive manufacturer.

* This information applies only to Integral Horsepower (IHP) motors as defined on the Agency Approval page, under UL®† & CSA®† listings where indicated.

Vertical High Thrust Motors

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

Save this instruction manual for future reference.

SAFETY FIRST

High voltage and rotating parts can cause serious injury or loss of life. Installation, operation, and maintenance must be performed by qualified personnel. Familiarization with and adherence to NEMA MG2®†, the National Electrical Code, and local codes is recommended. It is important to observe safety precautions to protect personnel from possible injury. Personnel should be instructed to:

1. Disconnect all power to motor and accessories prior to initiating any installation, maintenance, or repairs. Also ensure that driven equipment connected to the motor shaft will not cause the motor to rotate (windmilling of fans, water flowing back through pump, etc.).

2. Avoid contact with rotating parts.

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

4. Be sure unit and accessories are electrically grounded and proper electrical installation wiring and controls are used in accordance with local and national electrical codes. Refer to "National Electrical Code Handbook" - NFPA No. 70. Employ qualified electricians.

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

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

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

8. Avoid extended exposure to equipment with high noise levels.

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

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

11. Observe all special instructions attached to the equipment. Remove shipping fixtures if so equipped before energizing unit.

12. Check motor and driven equipment for proper rotation and phase sequence prior to coupling. Also check if a unidirectional motor is supplied and note proper rotation.

13. Electric motors can retain a lethal charge even after being shut off. Certain accessories (space heaters, etc.) are normally energized when the motor is turned off. Other accessories such as power factor correction capacitors, surge capacitors, etc. can retain an electrical charge after being shut off and disconnected.

14. Do not apply power correction capacitors to motors rated for operation with variable frequency drives. Serious damage to the drive will result if capacitors are placed between the motor and drive. Consult drive supplier for further information.

Table of Contents

Shipment, Handling & Storage

I. SHIPMENT

Prior to shipment, all motors undergo extensive mechanical and electrical testing, and are thoroughly inspected. Upon receipt of the motor, carefully inspect the unit for any signs of damage that may have occurred during shipment. Should such damage be evident, unpack the motor at once in the presence of a claims adjuster and immediately report all damage and breakage to the transportation company.

When contacting Nidec Motor Corporation (NMC)concerning the motor, be sure to include the complete motor identication number, frame, and type which appear on the nameplate.

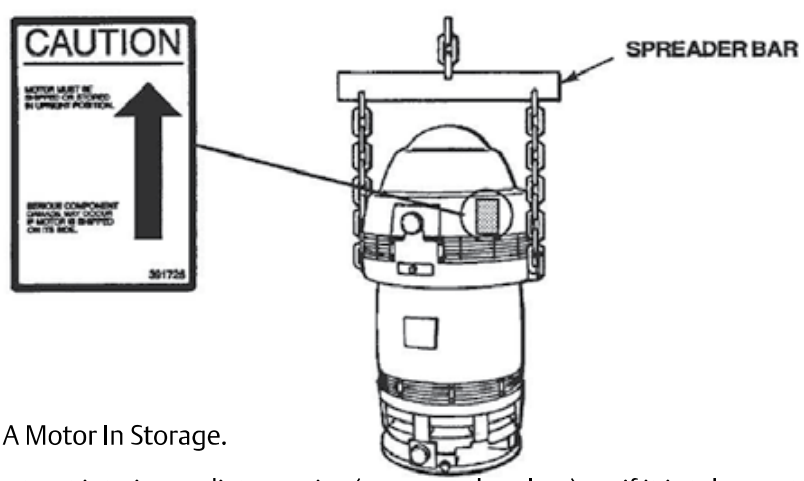
II. HANDLING

The equipment needed to handle the motor includes a hoist and spreader bar arrangement (see Figure 1) of sufficient strength to lift the motor safely. The spreader bar should have the lifting rings or hooks positioned to equal the span of the lifting lugs or eyebolts. The lifting lugs or eyebolts are intended to lift the motor weight only.

⚠ WARNING
Lifting the motor by other means may result In damage to the motor or injury to personnel.

⚠ CAUTION
Do not move motor with oil sumps filled. Sloshing action of oil in sumps can result in oil leaks and motor damage.

FIGURE 1



III. STORAGE

1. When To Put A Motor In Storage.

If a motor is not put into immediate service (one month or less), or if it is taken out of service for a prolonged period, special storage precautions should be taken to prevent damage. The following schedule is recommended as a guide to determine storage needs.

A. Out of service or in storage less than one month - no special precautions except that space heaters, if supplied, must be energized at any time the motor is not running.

B. Out of service or in storage for more than one month but less than six months - store per items 2A, B, C, D, E, F(2), and G, items 3A, B, and C, and item 4.

C. Out of service or in storage for six months or more - all recommendations.

2. Storage Preparation.

A. Where possible, motors should be stored indoors in a clean, dry area.

B. When indoor storage is not possible, the motors must be covered with a tarpaulin. This cover should extend to the ground; however, it should not tightly wrap the motor. This will allow the captive air space to breathe, minimizing formation of condensation. Care must also be taken to protect the motor from flooding or from harmful chemical vapors.

NOTICE

Immediately remove any shrink wrap used during shipping. Never wrap any motor in plastic for storage. This can turn the motor into a moisture trap causing severe damage not cover by Nidec Motor Corporation's limited warranty.

C. Whether indoors or out, the area of storage should be free from excessive ambient vibration which can cause bearing damage.

D. Precautions should be taken to prevent rodents, snakes, birds, or other small animals from nesting inside the motors. In areas where they are prevalent, precautions must be taken to prevent insects, such as dauber wasps, from gaining access to the interior of the motor.

E. Inspect the rust preventative coating on all external machined surfaces, including shaft extensions. If necessary, re-coat the surfaces with a rust preventative material, such as Rust Veto®† No. 342 (manufactured by E.F. Houghton Co.) or an equivalent. The condition of the coating should be checked periodically and surfaces re-coated as needed.

F. Bearings:

(1) When storage time is 6 months or more, grease lubricated cavities must be completely filled with lubricant. Remove the drain plug and fill cavity with grease until grease begins to purge from drainopening. Refer to section **IX. "LUBRICATION"** and/or review motor's lubrication nameplate for correct lubricant.

⚠ CAUTION

Do not re-grease bearings with drain closed or with unit running.

(2) Oil lubricated motors are shipped without oil. When storage time exceeds one (1) month, the oil sumps must be filled to the maximum capacity as indicated on the oil chamber sight gauge window. Refer to motor lubrication nameplate or Section IX "Lubrication" for proper oil.

NOTE: Motor must not be moved with oil in reservoir. Drain oil before moving to prevent sloshing and possible damage. With a clean cloth, wipe any excess oil from the threads of the drain plug and the inside of the drain hole. Apply Gasoila®† P/N SS08 or equivalent thread sealant to the threads of the drain plug and replace the plug in the oil drain hole. Refill oil when motor has been moved to the new location.

G. To prevent moisture accumulation, some form of heating must be utilized. This heating should maintain the winding temperature at a minimum of 5° above ambient. If space heaters are supplied, they should be energized. If none are available, single phase or "trickle" heating may be utilized by energizing one phase of the motor's winding with a low voltage. Request the required voltage and transformer capacity from Nidec Motor Corporation A third option is to use an auxiliary heat source and keep the winding warm by either convection or blowing filtered warm air into the motor.

3. Periodic Maintenance.

A. Oil should be inspected monthly for evidence of moisture or oxidation. The oil must be replaced whenever contamination is noted or every twelve months, which ever occurs first. It is important to wipe excess oil from the threads of the drain plug and the drain hole and to coat the plug threads with Gasoila®† P/N SS08 or equivalent thread sealant before replacing the drain plug.

B. Grease lubricated bearings must be inspected once a month for moisture and oxidation by purging a small quantity of grease through the drain. If any contamination is present, the grease must be completely removed and replaced.

C. All motors must have the shaft rotated once a month to maintain a lubricant film on the bearing races and journals.

D. Insulation Testing:

Two tests are used to evaluate the condition of the winding insulation.The first of these is the one minute insulation resistance test (IR_1) and the second is the polarization index test (PI), which can also be referred to as a dielectric absorption test. The results of either of these tests can be skewed by factors such as the winding temperature and its relation to the dew point temperature at the time the test was conducted . The PI test is less sensitive to these factors than the IR_1 test, but its results can still be affected significantly. Due to these factors, the most reliable method for evaluating the condition of the winding insulation is to maintain a record of periodic measurements, accumulated over months or years of service, for one or both of these tests. It is important that these tests be conducted under similar conditions of winding temperature, dew point temperature, voltage magnitude and duration, and relative humidity. If a downward trend develops in the historical data for either test, or if the readings from both tests drop below a minimum acceptable value, have an authorized electrical apparatus service shop thoroughly clean and dry the winding, and retreat, if necessary.

1. The recommended procedure for the IR_1 test is as follows:

(1) Disconnect all external accessories or equipment that have leads connected to the winding and connect them to a common ground. Connect all other accessories that are in contact with the winding to a common ground.

> ⚠ ***WARNING***
> ***Failure to have accessories grounded during this test can lead to the accumulation of a hazardous charge on the accessories.***

(2) Using a megohmmeter, apply DC voltage at the level noted below for 1 minute and take a reading of the insulation resistance between the motor leads and ground.

Rated Motor Voltage	**Recommended DC Test Voltage**
UP to 1000 (inclusvie)	500 VDC
1001 to 2500 (inclusive)	500 to 1000 VDC
2501 to 5000 (inclusive)	500 to 2500 VDC
5001 and up	500 to 5000 VDC

> ⚠ ***WARNING***
> ***Follow appropriate safety procedures during and after high voltage testing. Refer to the instruction manual for the test equipment. Make sure the winding insulation is discharged before beginning the test. The winding insulation will retain a potentially dangerous charge after the DC voltage source is removed, so use proper procedures to discharge the winding insulation at the end of the test. Refer to IEEE 43 Standard for additional safety information.***

(3) The reading should be corrected to a 40^0C base temperature by utilizing the formula:

$$R_{40C} = K_T R_T$$

Where:
R_{40C} = insulation resistance (in megohms) corrected to 40^0C
K_T = insulation resistance temperature coefficient at temperature T^0C
R_T = measured insulation resistance (in megohms) at temperature T^0C

The value of K_T can be approximated by using the formula:

$$K_T = (0.5)^{(40-T)/10}$$

Where:
T = the winding temperature in ^{O}C that the insulation resistance was measured at

The recommended procedure for the PI test is as follows:

(1) Perform steps 1 and 2 from the IR_1 test procedure. Heed the safety warnings given in the IR_1 test procedure.

(2) With DC voltage still being applied by the megohmmeter, taken an additional reading of insulation resistance between the motor leads and ground 10 minutes after the DC voltage was initially applied. To minimize measurement errors, the variation in winding temperature between the 1 minute and 10 minute readings should be kept to a minimum.

(3) Obtain the polarization index by taking the ratio of the 10 minute resistance reading to the 1 minute resistance reading.

If historical data from previous IR_1 and / or PI tests is available, then a comparison of the present test result to previous tests can be used to evaluate the condition of the insulation. To minimize error, all readings that are compared should be taken at test voltages, winding temperatures, dew point temperatures, and relative humidities that are similar as possible. If a downward trend in the readings develops over time, have an authorized electrical apparatus service shop thoroughly clean and dry the winding and, if necessary, retreat the winding. Then, repeat the test and re-check results before returning the motor service.

If historical data from previous IR_1 or PI tests is not available, then compare readings from the present test to the recommended minimum values listed below. If the readings from both tests fall below the minimum, have an authorized electrical apparatus service shop thoroughly clean and dry the winding and, if necessary, retreat the winding. Then. repeat the tests and re-check results before returning the motor to service.

The recommended minimum value for the 1minute insulation resistance reading corrected to 40^0C is:

Rated Motor Voltage	Minimum Insulation Resistance
Up to 999 (inclusive)	5 Megohms
1000 and up	100 Megohms

The recommended minimum value for the polarization index is 2.0. if the 1 minute insulation resistance reading corrected to 40^0 C is above 5000 megohms, however, the polarization index may not be meaningful. In such cases, the polarization index may be disregarded as a measure of insulation condition.

Refer any question to the Nidec Motor Corporation Product Service Department.

For more information, refer to the IEEE ®† 43 Standard.

4. Start-up Preparations After Storage.

A. Motor should be thoroughly inspected and cleaned to restore to an "As Shipped" condition.

B. Motor which has been subjected to vibration must be disassembled and each bearing inspected for damage.

C. When storage time has been six (6) months or more, oil and/or grease must be completely changed using lubricants and methods recommended on the motor's lubrication plate, or in **Section IX - "Lubrication."**

D. The winding must be tested to obtain insulation resistance and dielectric absorption ratio as described in **Section III., item 3.**

E. Contact Nidec Motor Corporation Product Service Department prior to start-up if storage time has exceeded one year.

IV. INSTALLATION LOCATION

When selecting a location for the motor and driven unit, keep the following items in mind:

1. The location should be clean, dry, well ventilated, properly drained, and provide accessibility for inspection, lubrication, and maintenance. Ambient vibration should be kept to a minimum. Outdoor installations on open driproof motors require protection from the elements.

2. The location should provide adequate space for motor removal without shifting the driven unit.

3. Temperature rise of a standard motor is based upon operation at an altitude not exceeding 3300 feet (1000 meters) above sea level, and a maximum ambient temperature of 40^0C unless specified otherwise on nameplate. See NEMA® MG-1 20.28 for usual service conditions.

4. To avoid condensation inside the motor, it should not be stored or operated in areas subject to rapid temperature changes unless it is energized or protected by space heaters.

5. The motor should not be installed in close proximity to any combustible material or where flammable gases may be present, unless it is specifically built for that environment and is U.L. labeled accordingly.

6. Oil lubricated motors must be mounted within one degree of true vertical. Failure to do so will result in oil leakage and possibly bearing failure.

7. Recommended Minimum Installation Clearances

This is a general guide and cannot cover all circumstances. Unusual arrangments should have inquiries to Nidec Motor Corporation Product Service Department. Unusual arrangements might include high ambient, limited ventilation, or a large number of motors in a conned space. The distance to the wall is at the side or end of the motor. The distance to another motor is considered as surface to surface and for side-by-side arrangements. This recommendation considers all motors to be mounted in the same orientation (e.g. all main conduit boxes facing east).

Speed	Distance to Wall	Distance to Another Motor
3600 RPM	2 x Motor Width	2 x Motor Width
1800 RPM or Less	1 x Motor Width	

V. INITIAL INSTALLATION

1. General

Reliable, trouble free operation of a motor and driven unit depends on a properly designed foundation and base plus good alignment. If the motor and driven unit are not installed properly, the following may result:

* Noisy operation
* Bearing damage or failure
* Excessive vibration
* Motor failure

2. Shaft Alignment

On HOLLOSHAFT® motors, the pump shaft and motor coupling must be aligned within .003" TIR. On solid shaft motors, the motor and pump shafts must be aligned within .002" TIR.

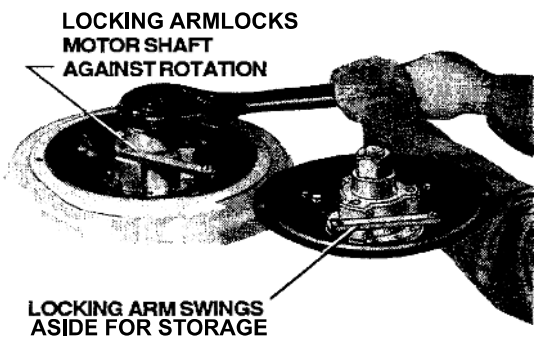
3. Pump Shaft Adjustment (HOLLOSHAFT® motors only)

To facilitate axial pump shaft adjustment, a locking feature is provided to lock the motor shaft against rotation. The two types of locking features are as follows:

A. Locking arm (Figure 2) -The locking arm is bolted to a stationary part and is pinned (for best results use arm in tension) or interferes with a rotating part (when locking arm is not in use it should be moved out of the way and bolted in place). A non-reverse ratchet functions as a locking device. Motors supplied with a non-reverse ratchet are not equipped with a locking arm.

B. Pinning through mating holes-Holes are provided in both a stationary and rotating part which line up allowing insertion of a pin.

FIGURE 2



⚠ WARNING
Locking device must be disengaged prior to starting motor or motor damage and/or injury to personnel may result.

⚠ CAUTION
Care should be exercised when lowering the motor over the pump shaft so that the oil retaining tube in the lower bracket is not damaged (applies only to motors with oil lubricated lower bearing).

4. Drive Coupling (HOLLOSHAFT® units only).

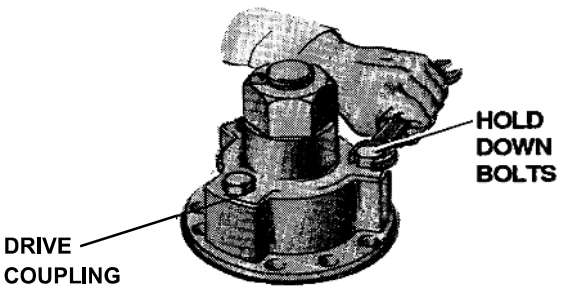
   The drive coupling may be utilized in one of two ways:

   A. Bolted type (Figure 3) - Hold down bolts are installed (some motors require removal of driving pins to allow installation of hold down bolts) in the drive coupling to prevent upward movement of the pump shaft. This will allow momentary upthrust from the pump to be taken by the motor's guide bearing.

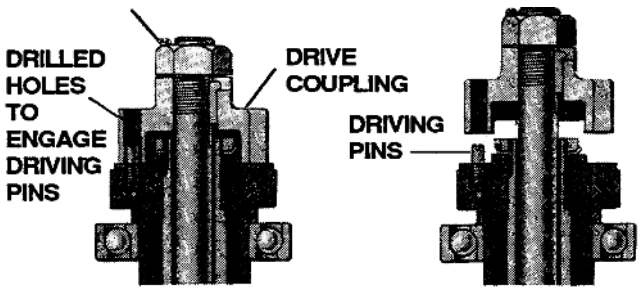
⚠ WARNING
Failure to tighten coupling and non-reverse ratchet bolts to required torque values may cause bolts to break, resulting in equipment damage or injury to personnel.

> ⚠ ***WARNING***
> ***Failure to tighten coupling and non-reverse ratchet bolts to required torque values may cause bolts to break, resulting in equipment damage or injury to personnel.***

BOLTED COUPLING
FIGURE 3



SELF RELEASE COUPLING
FIGURE 4



B. Self-release type (Figure 4) - Driving pins are used to engage the drive coupling with the rotor. A power reversal may unscrew the joints of the pump shafting, causing the shafting to lengthen and buckle or break if the shafting is restrained. The self-release coupling will lift out of engagement with partial unscrewing of the shafting, thus stopping further rota tion of the pump. The following items must be followed for proper functioning of the self-release coupling:

- The pump shaft adjusting nut must be properly secured to the drive coupling with a locking screw.
- The drive coupling should not bind on the driving pins.
- The drive coupling must not be bolted down.
- The pump shaft must be concentric to the motor shaft to prevent rubbing of the pump shaft inside the motor shaft.
- There must be no potential for upthrust in the application.
- Do not use the self-release feature in conjunction with a lower steady bushing, as friction between the parts can damage the line shafting and/or bushing.
- Due to the possibility of sparking as the parts separate, the self-release feature must not be used in an environment where explosive gases or dust may be present.

> ⚠ ***WARNING***
> ***Should a motor supplied with a self-release coupling become uncoupled, the motor and pump must be stationary and all power locked out before manually re-coupling.***

5. Water Cooling For Bearing Oil Reservoir.

If the motor is equipped with cooling coils in the oil reservoir, a minimum water supply of 4 GPM must be maintained at a maximum of 125 PSI with a 32°C (90°F) maximum inlet temperature. External water connections must be self draining to prevent cooling coil rupture at freezing temperatures. Use clean, noncorrosive water only. If corrosive conditions exist and are specified at time of motor order, special corrosion resistant fittings can be supplied.

6. Electrical Connection.

Refer to the motor nameplate for power supply requirements and to the connection diagram on the motor. Be sure connections are tight. Check carefully and assure that they agree with the connection diagram, then insulate all connections to be sure that they will not short against each other to ground. Be sure the motor is grounded to guard against possible electrical shock. Refer to the National Electrical Code Handbook (NFPA No. 70) and to local electrical codes for proper wiring, protection, and wire sizing. Be sure proper starting equipment and protective devices are used for every motor. For assistance, contact the motor starter manufacturer.

Part Winding Starters: Part winding starters used with part winding start motors should have the timer set at a minimum time consistent with the power company requirements. The recommended maximum time on part winding is two seconds. Setting the timer for longer periods can cause permanent damage to the motor and may void the warranty. Note that motor may or may not start on part winding start connection.

7. Direction Of Rotation.

As a standard, motors that are equipped with a non-reverse ratchet are designed to operate in a counterclockwise direction as viewed from the top of the motor. Also, some high speed motors have unidirectional ventilating fans. When the motor has a unidirectional ventilating fan, the direction of rotation is indicated by an arrow mounted on the motor and by a warning plate mounted near the main nameplate.

⚠ *CAUTION*

Apply power momentarily to observe the direction of rotation for which the leads are connected. Motor damage may occur if power is applied for more than ten seconds while rotation is locked against the non-reverse ratchet. The motor should be uncoupled from the driven equipment during this procedure to assure driven equipment is not damaged by reverse rotation. Couplings (if installed) should be properly secured.

For a 3 phase motor, to reverse the direction of rotation (if the motor is not operating in the correct direction), interchange any two of the three power leads on the motor. For a 1 phase motor, if the motor is not operating in the correct direction, follow the instructions on the connection plate attached to the motor in order to reverse the direction of rotation. For both 1 and 3 phase motors, be sure that the power is off and steps are taken to prevent accidental starting of the motor before attempting to change electrical connection.

8. Spring-Preloaded Thrust Bearings.

Motors built with spherical roller thrust bearings (bearing number 29xxx) at any speed or tandem angular contact thrust bearings (bearing number 7xxx) on large 3600 or 3000 RPM (2-pole) motors have preload springs which maintain a minimum thrust load at all times to prevent bearing skidding. These motors require a minimum external thrust load sufficient to compress the springs to properly seat the thrust bearing and to relieve the lower guide bearing of axial spring thrust. Refer to motor's minimum thrust nameplate for required thrust.

⚠ CAUTION
Do not run a motor which has bearing preload springs without thrust load for more than fifteen (15) minutes as bearing damage may result.

9. Initial Start.
After installation is completed, but before motor is put into regular service, make an initial start as follows:

A. Ensure that motor and control device connections agree with wiring diagrams.

B. Ensure that voltage, phase, and frequency of line circuit (power supply) agree with motor nameplate.

C. Check insulation resistance according to **Section III "STORAGE" item 3.**

D. Check all foundation, base, non-reverse ratchet (if applicable), and coupling bolts (if applicable) to ensure they are tight.

E. If motor has been in storage, either before or after installation, refer to **Section III "STORAGE" item 4** for preparations.

F. Motors are tested with oil at our manufacturing facility then drained prior to shipment. Note: A small amount of residual oil and rust inhibitor will remain in the oil sump. This residual oil and rust inhibitor is compatible with Turbine Type Mineral Oils and Synthetic, PAO (Poly Alpha Olefin) based oils listed in this manual. It is not necessary to drain this residual oil when adding new oil for operation. Check oil lubricated units to be certain that bearing housings have been filled to between the "MAX" and "MIN" levels on the sight gauge windows with the correct lubricant. Refer to **Section IX "LUBRICATION"** for proper oils.

G. Check for proper or desired rotation. See item 7 of this section for details.

H. Ensure that all protective devices are connected and operating properly, and that all outlet accessory, and access covers have been returned to their original intended position.

I. Start motor at lowest possible load and monitor to be sure that no unusual condition develops.

⚠ WARNING
All loosened or removed parts must be reassembled and tightened to original specifications. Keep all tools, chains, equipment, etc. clear of unit before energizing motor.

J. When checks are satisfactory to this point, increase load slowly up to rated load and monitor unit for satisfactory operation.

VI. NORMAL OPERATION

Start the motor in accordance with standard instructions for the starting equipment used.

1. General Maintenance.

Regular, routine maintenance is the best assurance of trouble-free, long-life motor operation. It prevents costly shutdown and repairs. Major elements of a controlled maintenance program are:

A. Trained personnel who have a working knowledge of rotational equipment and have read this manual.

B. Systematic records which contain at least the following:

1. Complete nameplate data.
2. Prints (wiring diagrams, certified outline dimensions).
3. Alignment data.
4. Results of regular inspection, including vibration and bearing temperature data, as applicable.
5. Documentation of any repairs.
6. Lubrication data:
   - Method of application
   - Types of lubricants for wet, dry, hot, or adverse locations
   - Maintenance cycle by location (some require more frequent lubrication)

2. Inspection and Cleaning

Stop the motor before cleaning. ***CAUTION: Assure against accidental starting of the motor.*** Clean the motor inside and out regularly. The frequency of cleaning depends upon actual conditions existing around the motor. Use the following procedures as they apply:

A. Wipe off dirt, dust, oil, water, or other liquids from external surfaces of motor. These materials can work into or be carried into the motor windings and may cause overheating or insulation breakdown.

B. Remove dirt, dust, or debris from ventilating air inlets. Never allow dirt to accumulate near air inlets. Never operate motor with air passages blocked.

C. Clean motors internally by blowing with clean, dry, compressed air at 40 to 60 PSI. If conditions warrant, use a vacuum cleaner.

⚠ CAUTION
When using compressed air, always use proper eye protection to prevent accidental eye injury.

D. When dirt and dust are solidly packed, or windings are coated with oil or greasy grime, disassemble the motor and clean with solvent. Use only high-flash naphtha, mineral spirits, or Stoddard solvent. Wipe with solvent dampened cloth, or use suitable soft bristled brush. ***DO NOT SOAK.*** Oven dry (150 – 175°F) solvent cleaned windings thoroughly before reassembly.

E. After cleaning and drying the windings, check the insulation resistance per **Section III, Item 3.**

VII. NON-REVERSE RATCHET

Units featuring non-reverse ratchets are refine-balanced by attaching weights to the rotating ratchet. If the ratchet is removed it should be marked and reassembled in the same position to retain proper balance.

VIII. ENDPLAY ADJUSTMENT

The term endplay is defined as the total axial float of the rotor. Should the motor be disassembled for any reason, the rotor endplay must be adjusted. Care must be taken to ensure that end play is within the proper range. Use one of the following procedures, depending upon the type of thrust bearing to set end play:

> ⚠ ***CAUTION***
>
> ***Excessive endplay can allow the thrust bearing to separate when units are run with zero thrust or momentary up thrust, resulting in thrust bearing failure. Insufficient endplay may cause the bearings to load against each other, resulting in extreme heat and rapid failure of both the guide and thrust bearings.***

1. Spherical Roller Thrust Bearings and Angular Contact Bearings (With Springs).

   Setting the correct end play on units with spring-preloaded spherical roller or angular contact thrust bearings requires a controlled assembly method, due to various deflections internal to the motor and friction of locknut threads from spring force. An end play setting of .005 to .008 inches is required to allow the lower guide bearing to return to an unloaded position when external thrust is applied to the motor (see Figure 5). End play can be properly adjusted by the following recommended procedure:

   A. Place spring retainer (without springs) and lower thrust washer of bearing into upper bearing bore.

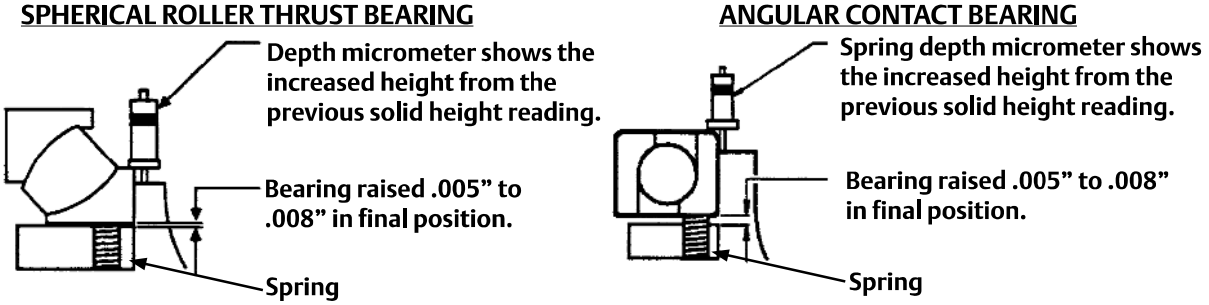
   B. Using a depth micrometer, measure the distance between the top of the lower thrust washer and the faced surface on top of the bearing housing (see Figure 5). Record dimension to three decimals.

   C. Add .005 to .008 inches to the recorded dimension to obtain the correct endplay range for the unit.

   D. Reassemble bearing with springs. Motor is now ready to set end play. Several acceptable methods for setting endplay are following.

   NOTE: Certain motor builds require removal of the fabricated steel or cast aluminum oil baffle to provide access for depth micrometer measurements.

FIGURE 5



2. Angular Contact Ball Bearings (Without Springs)

A. No preliminary measurements are required to set end play. End play may be set by any of the following methods described in this section.

B. To correctly adjust the endplay setting, a dial indicator should be positioned to read the shaft axial movement. (See figure 7 for location of dial indicator). The rotor adjusting lock nut should be turned until no further upward movement of the shaft is indicated. The locknut is then loosened until .005 to .008" endplay is obtained. Lock the locknut with lock washer.

⚠ *CAUTION*

Care should be taken to ensure that the locknut is not over-tightened, as this can lead to an erroneous end play setting (due to deflection of parts) and bearing damage may result.

C. Motors that have two opposed angular contact bearings that are locked for up and downthrust do not require endplay adjustment. The shaft, however, must be set to the original 'AH' (shaft extension length) to prevent the guide bearing from taking thrust.

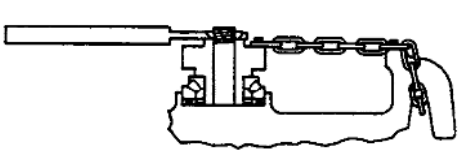
ENDPLAY ADJUSTMENT METHODS

1. Method 1 (refer to Figures 6 & 7)
This method requires the user to install a bolted chain from the bearing mount back to a lifting lug. Rotate the locknut with a spanner wrench (and bar extension) until dial indicator shows no movement on end of shaft. The locknut should then be loosened until proper endplay is obtained, lock the locknut with lock washer. (See figure 7 for location of dial indicator.)

NOTE: This is the lowest cost of the three methods and requires the least amount of equipment. This method, however, may be less desirable than Method 2 as considerable locknut torque may be encountered on units with bearing preload springs.

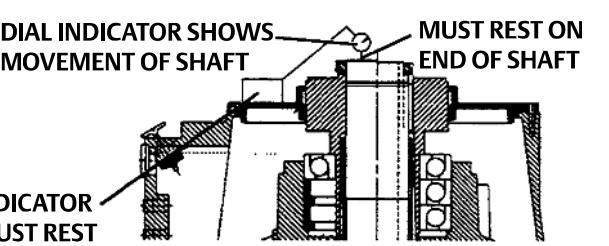
Special equipment required:
- Locking bolts
- 3/4" chain
- Spanner wrench with extension
- Dial indicator
- Depth micrometer

FIGURE 6 (METHOD 1)



MOUNTING SPRINGS ARE COMPRESSED AND ROTOR IS LIFTED BY LOCKNUT

FIGURE 7 (METHOD 1 & 3)



2. Method 2 (refer to Figure 8 - Utilized on Spring Loaded Bearings Only)

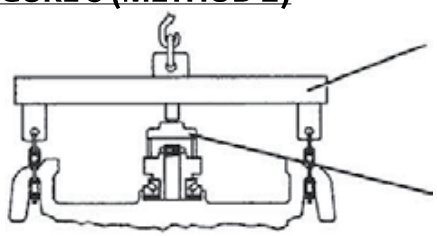
This method utilizes a spreader bar and chains to wrap around lifting lugs, a hydraulic jack (five ton), and crane to lift the spreader bar. The hydraulic jack is supported by two steel blocks of equal thickness on top of the bearing mounting with the jack pushing against the spreader bar. On large motors, the rotor can be lifted by placing a second jack below the motor shaft to allow the locknut to be turned easily.

NOTE: This method utilizes typical shop equipment and tools. Endplay settings can be checked quickly on larger vertical motor products. The locknut lifts rotor weight only.

Equipment required:
- Large spreader bar with chains and locking bolts
- Overhead crane
- Depth micrometer
- Spanner wrench
- Metal blocks
- 5-ton hydraulic jack
- Dial indicator

FIGURE 8 (METHOD 2)

MOUNTING SPRINGS ARE COMPRESSED – ONLY THE ROTOR IS LIFTED BY THE LOCKNUT.



3. Method 3 (refer to Figure 9)

This method uses a one inch thick steel disc with a center hole for the shaft end bolt and two threaded hydraulic jacks connected to a single pump. Apply load to hydraulic jacks until dial indicator shows no movement on end of shaft. (See figure 7 for location of dial indicator). The shaft locknut should be positioned and the pressure from hydraulic jack relieved until proper endplay is obtained .

⚠ CAUTION

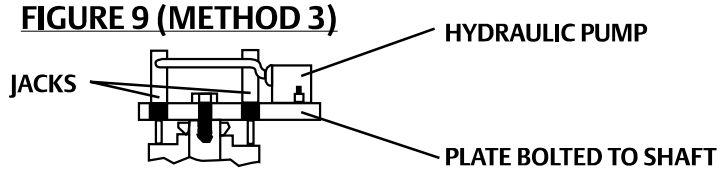
Use of excessive hydraulic pressure can damage bearings.

NOTE: This method is directly usable on solid shaft motors and can be used on most HOLLOSHAFT® motors with the use of a long threaded rod and plate. It is easy to apply and settings can be checked quickly, especially in field service. The locknut does not see any force and can be turned easily.

Equipment required: • Fixture with hydraulic jacks • Dial indicator • Spanner wrench

MOUNTING SPRINGS ARE COMPRESSED AND ROTOR IS LIFTED BY THE FIXTURE. THE LOCKNUT IS TURNED FOR ADJUSTMENT.

FIGURE 9 (METHOD 3)



⚠ CAUTION

After setting endplay, run unit for three to five minutes, then stop and verify the endplay setting. Readjust as necessary. All loosened or removed parts must be reassembled and tightened to original specifications. Keep all tools, chains, equipment, etc. clear of unit before energizing motor.

IX. LUBRICATION

Motor must be at rest and electrical controls should be locked open to prevent energizing while being serviced. If motor is being taken out of storage refer to **Section III "STORAGE", item 4** for instructions.

1. Oil Lubricated Bearings.

Motors are tested with oil at our manufacturing facility then drained prior to shipment. A small amount of residual oil and rust inhibitor will remain in the oil sump. This residual oil and rust inhibitor is compatible with Turbine Type Mineral Oils and Synthetic, PAO (Poly Alpha Olefin) based oils listed in this manual. It is not necessary to drain this residual oil when adding new oil for operation.

Change oil once per year with normal service conditions. Frequent starting and stopping, damp or dusty environment, extreme temperature, or any other severe service conditions will warrant more frequent oil changes. If there is any question, consult Emerson Motor Co. Product Service Department for recommended oil change intervals regarding your particular situation.

Determine required oil ISO Viscosity Grade (VG) and base oil type from Table 3, then see Table 4 for approved oils. Add oil into oil fill hole at each bearing housing until the oil level reaches between minimum and maximum marks located on the sight gauge window. It is important to wipe excess oil from the threads of the drain hole and to coat the plug threads with Gasoila®† P/N SS08, manufactured by Federal Process Corporation or equivalent thread sealant before replacing the drain plug. Plug should be tightened to a minimum of 20 lb.-ft. using a torque wrench. See the motor nameplate or Table 5 for the approximate quantity of oil required.

2. Grease Lubricated Bearings.

A. Relubrication of Units in Service

Grease lubricated bearings are pre-lubricated at the factory and normally do not require initial lubrication. Relubricating interval depends upon speed, type of bearing and service. Refer to Table 1 or suggested regreasing intervals and quantities. Note that operating environment and application may dictate more frequent lubrication. To relubricate bearings, remove the drain plug. Inspect grease drain and remove any blockage (caked grease or foreign particles) with a mechanical probe, taking care not to damage bearing.

⚠ WARNING

Under NO circumstances should a mechanical probe be used while the motor is in operation.

Add new grease at the grease inlet. New grease must be compatible with the grease already in the motor (refer to table 2 for compatible greases).

⚠ CAUTION

Greases of different bases (lithium, polyurea, clay, etc.) may not be compatible when mixed. Mixing such greases can result in reduced lubricant life and premature bearing failure. Prevent such intermixing by disassembling motor, removing all old grease and repacking with new grease per item B of this section. Refer to Table 2 for recommended greases.

Run the motor for 15 to 30 minutes with the drain plug removed to allow purging of any excess grease. Shut off unit and replace the drain plug. Return motor to service.

⚠ CAUTION

Overgreasing can cause excessive bearing temperatures, premature lubricant breakdown and bearing failure. Care should be exercised against overgreasing.

B. Change of Lubricant

Motor must be disassembled as necessary to gain full access to bearing housing(s).

Remove all old grease from bearings and housings (including all grease fill and drain holes). Inspect and replace damaged bearings. Fill bearing housings both inboard and outboard of bearing approximately 30 percent full of new grease. Grease fill ports must be completely charged with new grease. Inject new grease into bearing between rolling elements to fill bearing. Remove excess grease extending beyond the edges of the bearing races and retainers.

Table 1
Recommended Grease Replenishment Quantities & Lubrication Intervals

Bearing Number		Grease Replenishment Quantity (Fl.Oz.)	Lubrication Interval		
62xx, 72xx	63xx, 73xx		1801 thru 3600 RPM	1201 thru 1800 RPM	1200 RPM and slower
03 thru 07	03 thru 06	0.2	1 Year	2 Years	2 Years
08 thru 12	07 thru 09	0.4	6 Months	1 Year	1 Year
13 thru 15	10 thru 11	0.6	6 Months	1 Year	1 Year
16 thru 20	12 thru 15	1.0	3 Months	6 Months	6 Months
21 thru 28	16 thru 20	1.8	3 Months	6 Months	6 Months

Refer to motor nameplate for bearings provided on a specific motor. For bearings not listed in Table 1, the amount of grease required may be calculated by the formula:

$G = 0.11 \times D \times B$

Where: G = Quantity of grease in fluid ounces.
D = Outside diameter of bearing in inches.
B = Width of bearing in inches.

Table 2
Recommended Greases

Motor Frame Size	Motor Enclosure	Grease Manufacturer	Grease (NLGI Grade 2)
All Thru 447	All	Exxon Mobil	Polyrex-EM
449 and Up	Open Dripproof		
449 and Up	TEFC and Explosionproof	Exxon Mobil	Mobilith SHC-100

The above greases are interchangeable with the grease provided in units supplied from the factory (unless stated otherwise on motor lubrication nameplate).

Table 3
Nidec Motor Corporation Recommended Oil Viscosities

Angular Contact Thrust Bearing (7XXX Series) (ABMA BT-Series)					
Motor Enclosure	**Frame Size**	**Speed (RPM)**	**Ambient Temperature**	**ISO VG**	**Base Oil Type**
Open Dripproof or Weather Protected	324 and Larger	All	-15C thru 40C (5-104F)	32	Mineral or Synthetic
			41C thru 50C (105-122F)	68	Synthetic Only
Totally Enclosed or Explosion proof	404 thru 447		-15C thru 40C (5-104F)	32	Mineral or Synthetic
			41C thru 50C (105-122F)	68	Synthetic Only
	449 thru 5811	1801 - 3600	-15C thru 40C (104F)	32	Synthetic Only
		1800 & Below		68	Synthetic Only
		All	41C thru 50C (105-122F)	Refer to Office	
Spherical Roller Thrust Bearing (29XXX Series) (ABMA TS-Series)					
Motor Enclosure	**Frame Size**	**Speed (RPM)**	**Ambient Temperature**	**ISO VG**	**Base Oil Type**
Open Dripproof or Weather Protected	444 and Larger	1800 and Below	-15C thru 25C (5-77F)	68	Mineral or Synthetic
			6C thru 40C (42-104F)	150	
			41C thru 50C (105-122F)		Synthetic Only
Totally Enclosed or Explosion proof	449 and Larger		-15C thru 25C (5-77F)	68	Mineral or Synthetic
			6C thru 40C (42-104F)	150	Synthetic Only
			41C thru 50C (105-122F)	Refer to Office	

Notes:
1. If lower guide bearing is oil lubricated, it should use the same oil as the thrust bearing.
2. If lower guide bearing is grease-lubricated, refer to TABLE 2 for recommended greases.
3. Refer to Nidec Motor Corporation for ambient temperatures other than those listed.

Table 4
Nidec Motor Corporation Approved Oil Specifications For Use With Anti-Friction Bearings

Oil Manufacturer	**ISO VG 32**		**ISO VG 68**		**ISO VG 150**	
	Viscocity: 130-165 SSU @ 100F		**Viscocity: 284-347 SSU @ 100F**		**Viscocity: 620-765 SSU @ 100F**	
	Mineral Base Oil	**Synthetic Base Oil**	**Mineral Base Oil**	**Synthetic Base Oil**	**Mineral Base Oil**	**Synthetic Base Oil**
Chevron USA, Inc	GST Turbine Oil 32	Tegra 32	GST Turbine Oil 68	Tegra 68	R & O Machine Oil 150	Tegra 150
Conoco Oil Co.	Hydroclear Turbine Oil 32	Syncon 32	Hydroclear Turbine Oil 68	Syncon 68	Hydroclear AW Hyd. Fluid 150	N/A
ExxonMobil	Teresstic 32	Synnestic 32	Teresstic 68	Synnestic 68	Teresstic 150	Synnestic 150
ExxonMobil	DTE Oil Light	SHC 624	DTE Oil Heavy Medium	SHC 626	DTE Oil Extra Heavy	SHC 629
Pennzoil Co., Inc	Pennzbell TO 32	Pennzbell SHD 32	Pennzbell TO 68	Pennzbell SHD 68	Pennzbell TO 150	Pennzbell SHD 150
Phillips Petroleum Co.	Magnus 32	Syndustrial “E” 32	Magnus 68	Syndustrial “E” 68	Magnus 150	N/A
Shell Oil Co.	Tellus 32	Tellus HD Oil AW SHF 32	Tellus 68	Tellus HD Oil AW SHF 68	Tellus 150	N/A
Texaco Lubricants Co.	Regal 32	Cetus PAO 32	Regal 68	Cetus PAO 68	Regal 150	N/A

Table 5
Approximate Oil Sump Capacities

Frame Size	Motor Type Designation (See Motor Nameplate)	Oil Capacity (Quarts)	
		Upper Bearing	Lower Bearing
180 - 280	AU, AV-4	Grease	Grease
180 - 280	AV		
320 - 440	RV		
320 - 360	RV-4, RU	3	
400	RV-4, RU	5	
440	RV-4 (2 pole)	17	
	RV-4, RU (4 pole & slower)	6	
180 - 440	TV-9, TV, LV-9, LV	Grease	
180 - 360	TV-4, TU, LV-4, LU		
400	TV-4, TU, LV-4, LU	6	
440	TV-4, TU, LV-4, LU	5	
449	JU, JV-4	22	
	HU, HV-4	12	
	JV-3, JV, HV	Grease	
5000	HV, EV, JV, RV	Grease	
	RU, RV-4	30	
	HU, HV-4 (4 pole & slower)	12	
	HV-4 (2 pole only)	20	
	EU, JU, EV-4, JV-4	22	5
5800	RU, RV-4	48	4
	HU, HV-4	24	3
	EU, JU, EV-4, JV-4	37	4
6800	HU, HV-4	70	3
	HV (Bow Thruster)	Grease	Grease
	HV (Other Than Bow Thruster)	70	3
8000	RU, RV-4	70	6
	RV	Grease	Grease
9600	RU, RV-4	95	13
	RV	Grease	Grease

X. FUNDAMENTAL TROUBLESHOOTING - PROBLEM ANALYSIS

This chart can reduce work and time spent on motor analysis. Always check the chart first before starting motor disassembly, as what appears to be a motor problem may often be located elsewhere. For additional information, consult our website at www.usmotors.com.

SYMPTOM	POSSIBLE CAUSE	ANALYSIS
Motor fails to start	Defective power supply	Check voltage across all phases above disconnection switch.
	Blown or defective primary fuses	
	Blown or defective secondary fuses	Check voltage below fuses (all phases) with disconnect closed.
	Open control circuit	Push reset button
	Overload trips are open	
	Defective holding coil in magnetic switch	Push start button and allow sufficient time for operation of time delay, if used, the check voltage across magnetic holding coil. If correct voltage is measured, coil is defective. If no voltage is measured, control circuit is open
	Loose or poor connections in control circuits	Make visual inspection of all connections in control switch.
	Magnetic switch closes	Open manual disconnect switch, close magnetic by hand, and examine contractors and springs
	Poor switch closes	
	Opens circuit in control panel	Check voltage at TI, T2, & T3
	Open circuit leads to motor	Check voltage at leads in outlet box
	Leads improperly connected	Check lead numbers and connections
Motor fails to come up to speed	Low or incorrect voltage	Check voltage at TI, T2, & T3 in control panel and at motor leads in outlet box.
	Incorrect connection at motor	Check for proper lead connections at motor and compare with connection diagram on motor.
	Overload - mechanical	Check impeller setting. Check for a tight or locked shaft.
	Overlaoad - hydraulic	Check impeller setting. Check GPM against pump capacity and head.
Motor Vibrates	Headshaft misaligned	Remove top drive coupling and check alignment of motor to pump.
	Worn line shaft bearings or bent line shaft	Disconnect motor from pump and run motor only to determine source of vibration.
	Hyrdaulic disturbance in discharge piping	Check isolation joint in discharge piping near pump head.
	Ambient Vibration	Check base vibration level with motor stopped.
	System Natural Frequency (Resonance)	Revise rigidity of support structure.
Motor noisy	Worn thrust bearing	Remove dust cover, rotate rotor by hand, and make visual examination of balls and races. Bearing noise is commonly accompanied by a high frequency vibration and /or increased temp.
	Electrical noise	Most motors are electrically noisy during the starting period. This noise should diminish as motor reaches full speed.

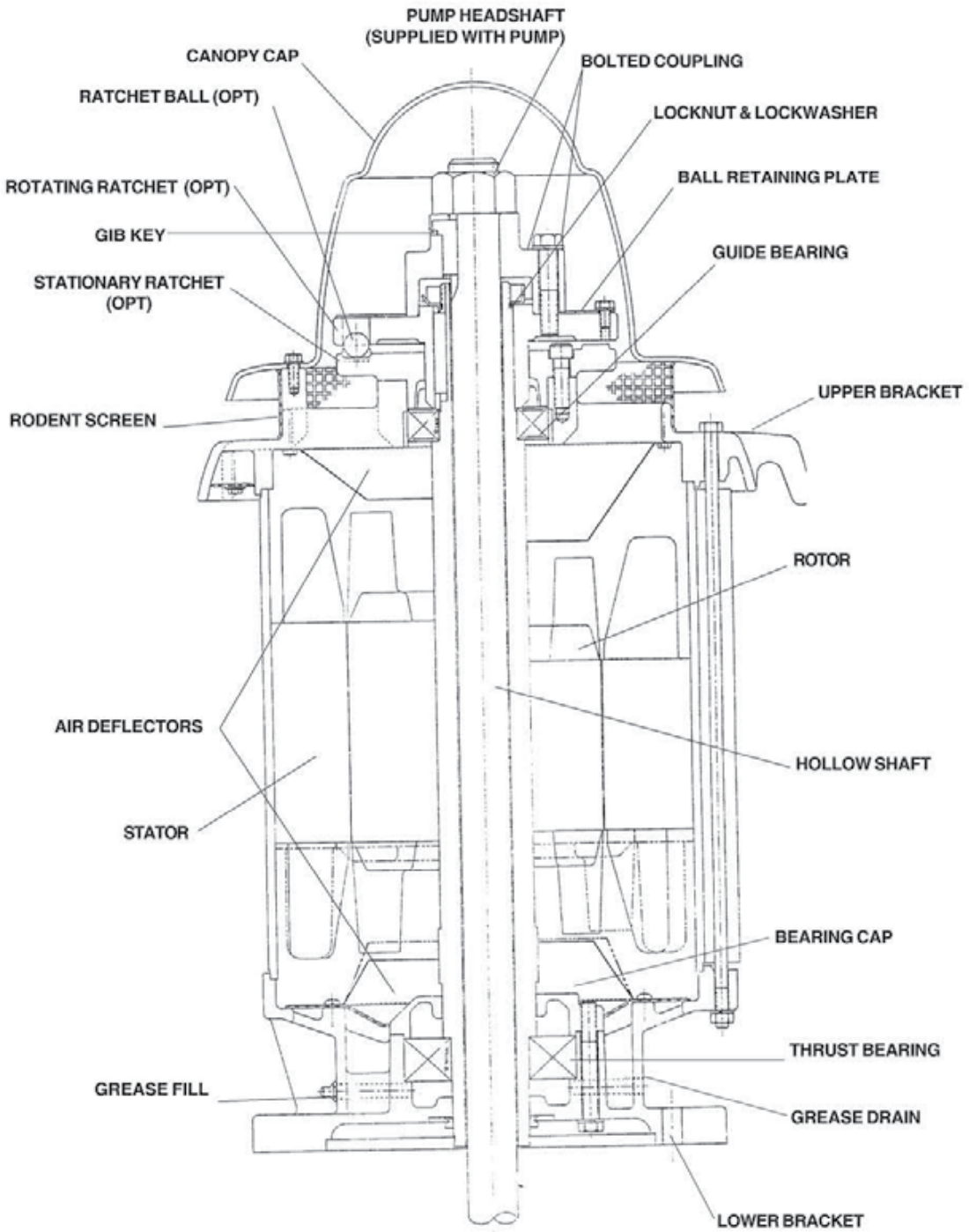
SYMPTOM	POSSIBLE CAUSE	ANALYSIS
Motor overheating (Check with thermo-couple or by resistance methods. Do not depend on hand.)	Overload	Measure load and compare to nameplate rating. Check for excessive friction in motor or in complete drive. Reduce load or replace motor with greater capacity motor. Refer to Appendix C.
	Motor intake or exhaust blocked or clogged.	Clean motor intake and exhaust areas. Clean filters or screens if motor is so equipped.
	Unbalanced voltage	Check voltage to all phases. Refer to Appendix A.
	Open stator windings	Disconnect motor from load. Check idle amps for balance in all three phases. Check stator resistance in all three phases.
	Over / Under Voltage	Check voltage and compare to nameplate voltage.
	Ground	Locate with test lamp or insulation tester and repair.
	Improper Connections	Recheck connections.
Bearing Overheating Generally, bearing temperatures (as measured by a tipsensitive RTD or thermocouple touching the bearing outer race) should not exceed 90^0C when using mineral-based lubricants or 120^0C when using synthetic-based lubricants.	Misalignment	Check alignment.
	Incorrect oil, or oil level too high or too low.	Refill with proper oil. Verify oil level is correct.
	Excessive thrust.	Reduce thrust from driven machine.
	Bearing over-greased.	Relieve bearing cavity of grease to level specified in lubrication section.
	Motor overloaded	Measure load and compare to nameplate rating. Check for excessive friction in motor or in complete drive. Reduce load or replace motor with greater capacity motor. Refer to Appendix C.
	Motor intake or exhaust blocked or clogged	Clean motor intake and exhaust areas. Clean filters or screens if motor is so equipped.
Bearing oil leeking around the drain plug.	Insufficient sealant applied to drain plug threads.	Remove drain plug and drain existing oil from sump. With a clean cloth, wipe excess oil from the plug threads and the threads in the drain hole. Apply Gasolia Thread Sealant P/N SS08 to the threads of the plug and replace. Fill sump with new oil to the proper level.

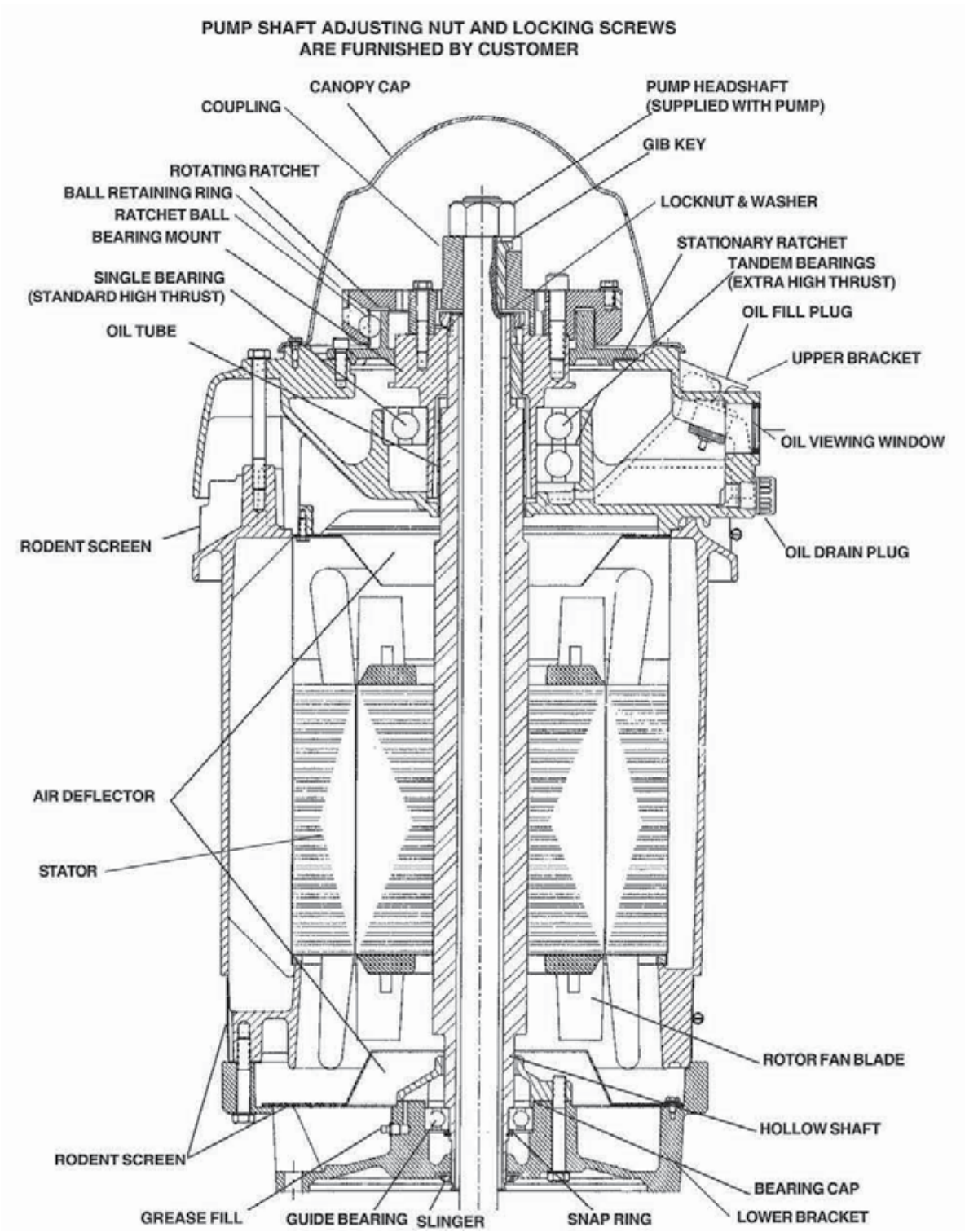
XI. SPARE PARTS

A parts list is available for your unit and will be furnished upon request. Parts may be obtained from local Nidec Motor Corporation distributors and authorized service shops, or through Nidec Motor Corporation distribution center.

Nidec Motor Corporation
710 Venture Drive
Suite 100
Southaven, MS 38672
Phone (662) 342-6910
Fax (662) 342-7350

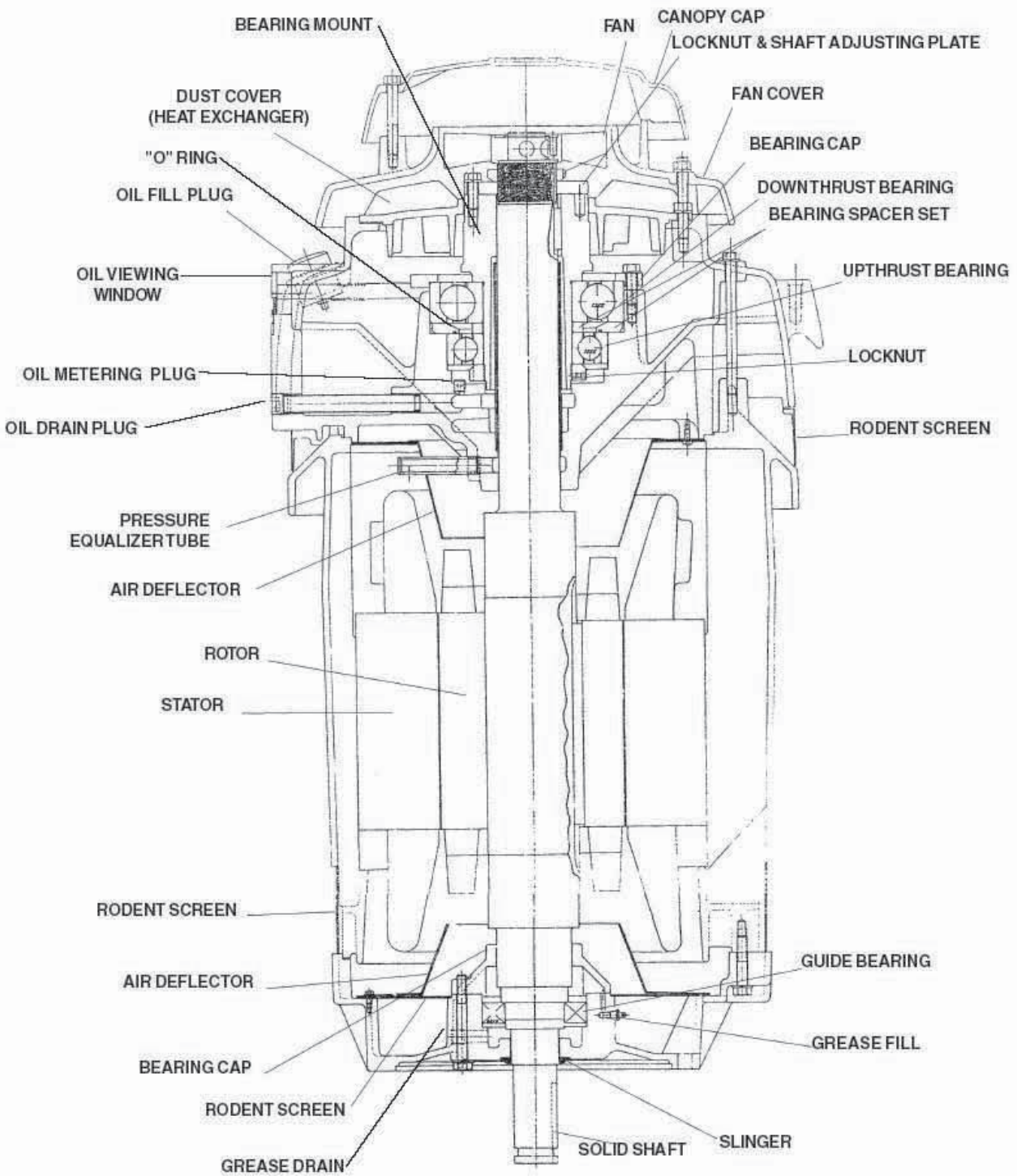
Drawings for many standard designs are supplied on the following pages. Most of the parts should be easy to identify. If however, there is some deviation from your machine, consult the factory for assistance.

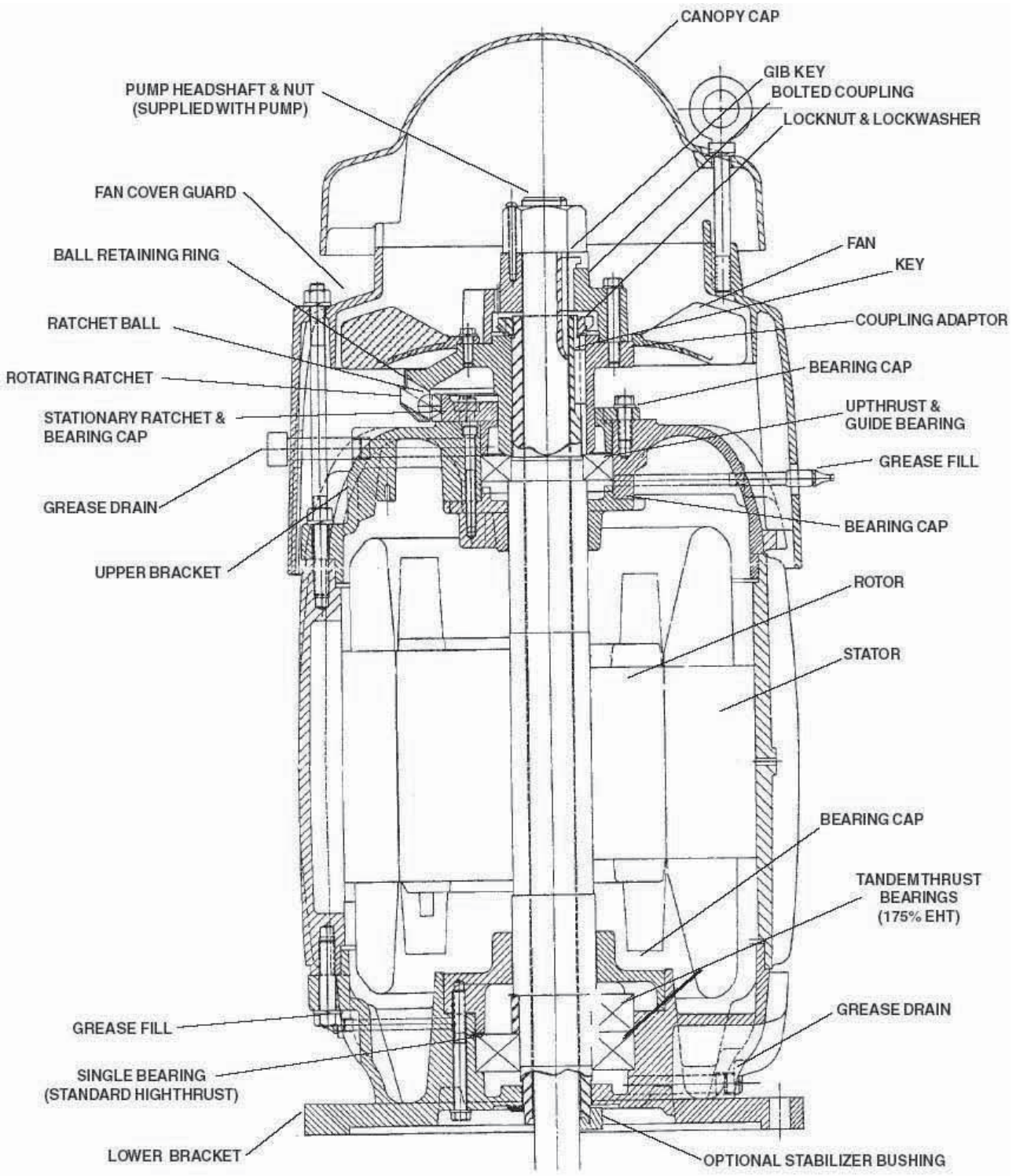

PUMP HEADSHAFT
(SUPPLIED WITH PUMP)
CANOPY CAP
BOLTED COUPLING
RATCHET BALL (OPT)
LOCKNUT & LOCKWASHER
ROTATING RATCHET (OPT)
BALL RETAINING PLATE
GIB KEY
GUIDE BEARING
STATIONARY RATCHET
(OPT)
UPPER BRACKET
RODENT SCREEN
ROTOR
AIR DEFLECTORS
HOLLOW SHAFT
STATOR
BEARING CAP
THRUST BEARING
GREASE FILL
GREASE DRAIN
LOWER BRACKET

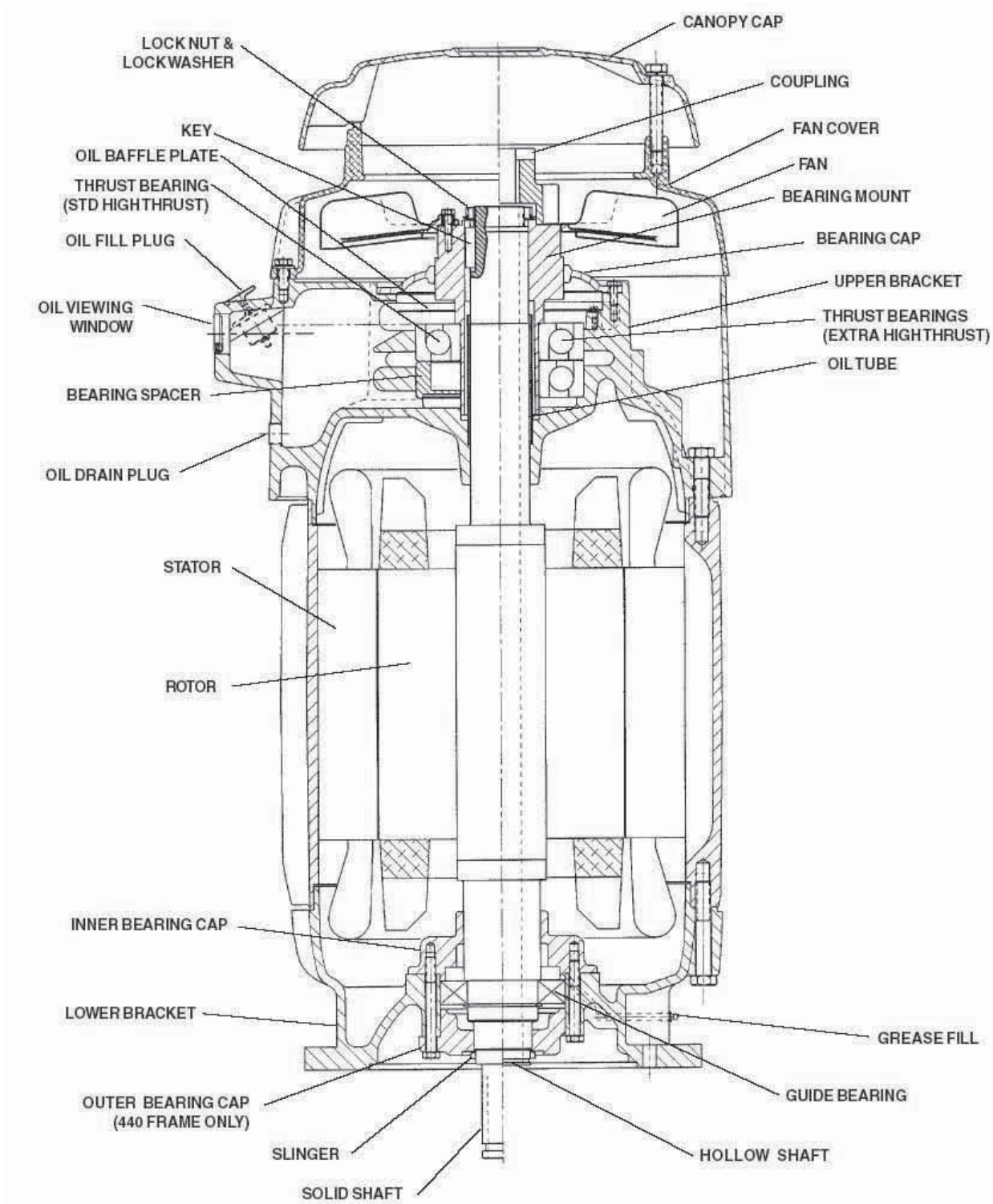

PUMP SHAFT ADJUSTING NUT AND LOCKING SCREWS
ARE FURNISHED BY CUSTOMER
CANOPY CAP
COUPLING
PUMP HEADSHAFT
(SUPPLIED WITH PUMP)
GIB KEY
ROTATING RATCHET
BALL RETAINING RING
RATCHET BALL
BEARING MOUNT
LOCKNUT & WASHER
STATIONARY RATCHET
TANDEM BEARINGS
(EXTRA HIGH THRUST)
SINGLE BEARING
(STANDARD HIGH THRUST)
OIL FILL PLUG
OIL TUBE
UPPER BRACKET
OIL VIEWING WINDOW
RODENT SCREEN
OIL DRAIN PLUG
AIR DEFLECTOR
STATOR
ROTOR FAN BLADE
HOLLOW SHAFT
RODENT SCREEN
BEARING CAP
GREASE FILL
GUIDE BEARING
SLINGER
SNAP RING
LOWER BRACKET

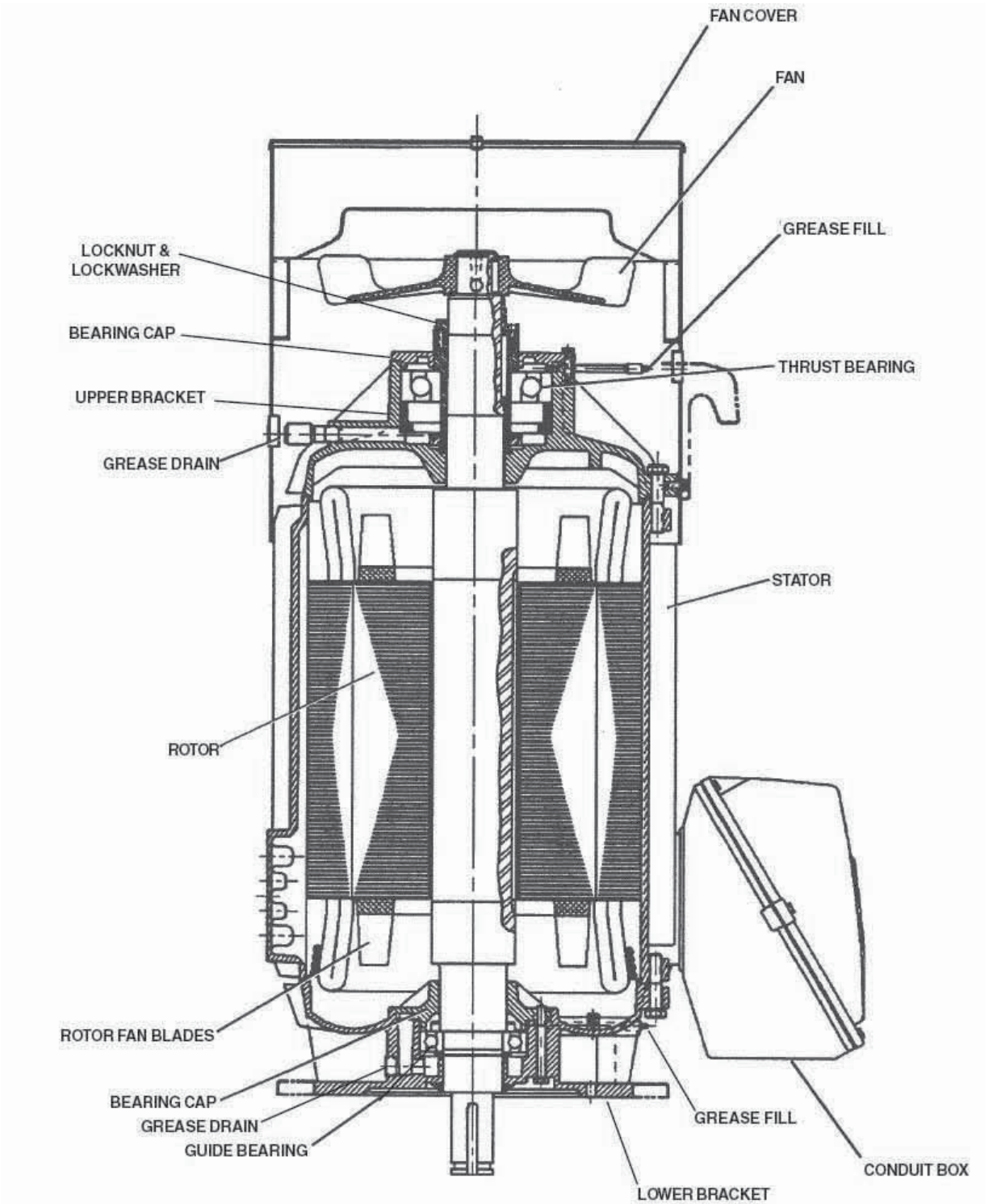
Spare Parts

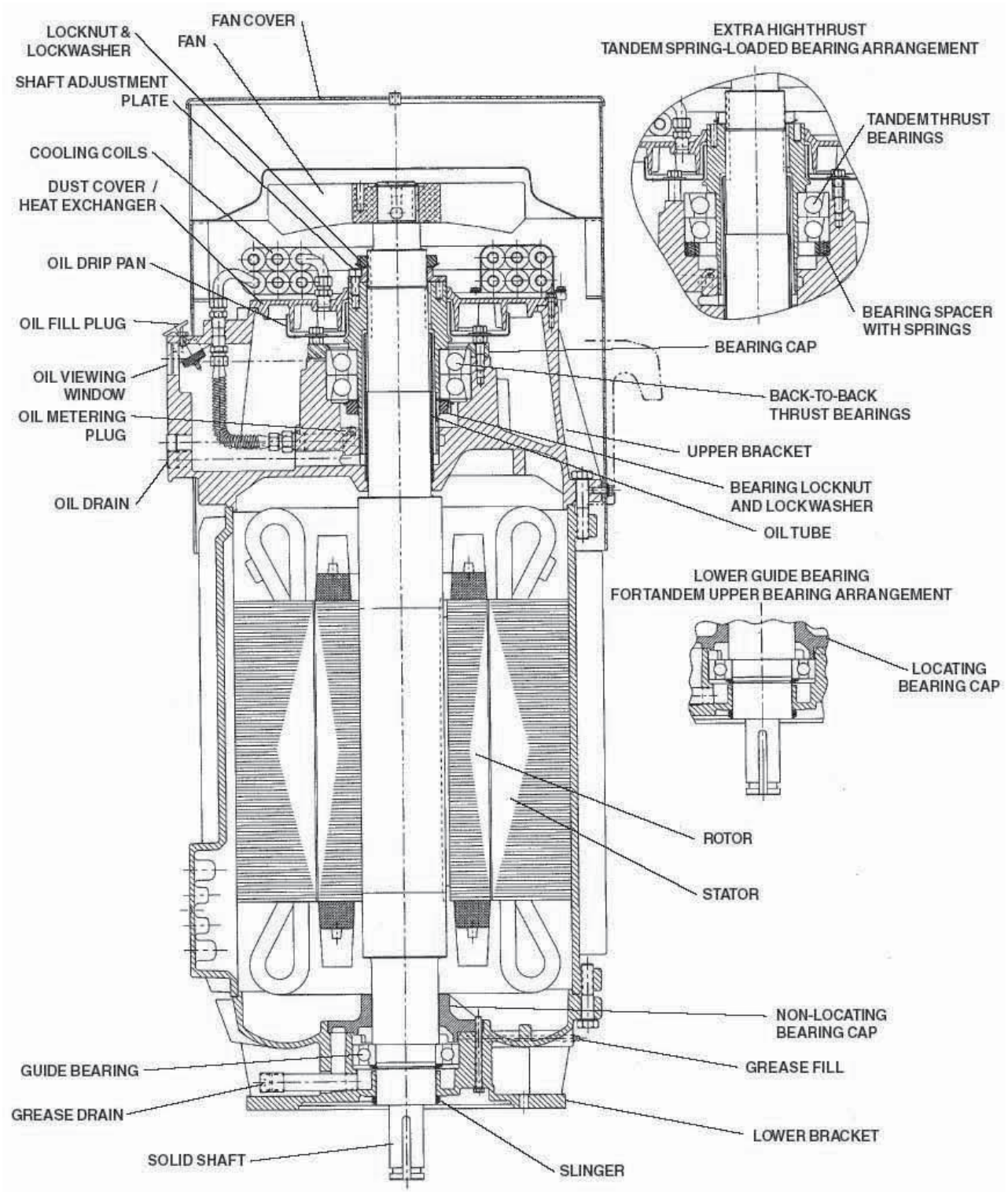
440 Frame, Type RV-4 (2 Pole)

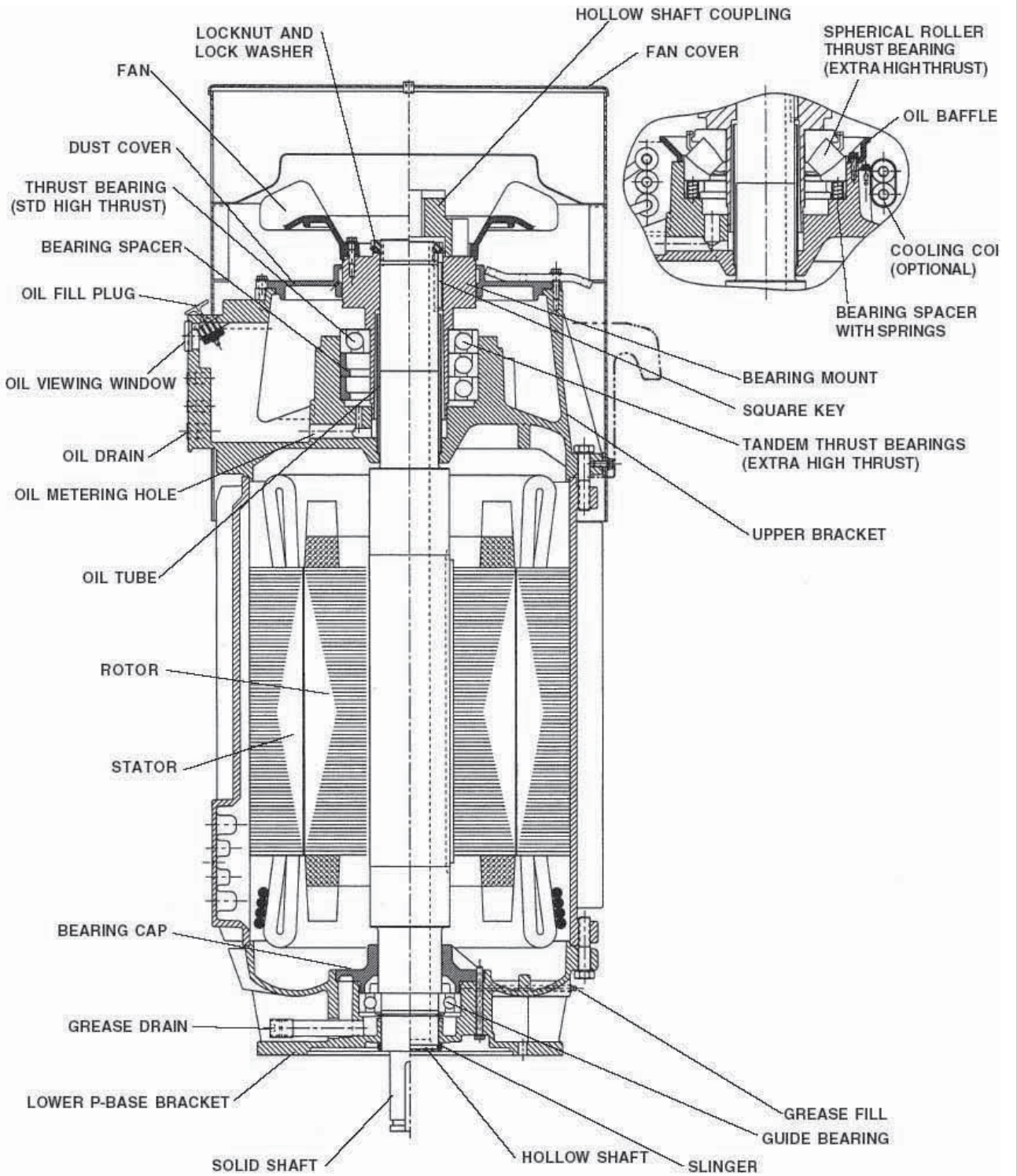


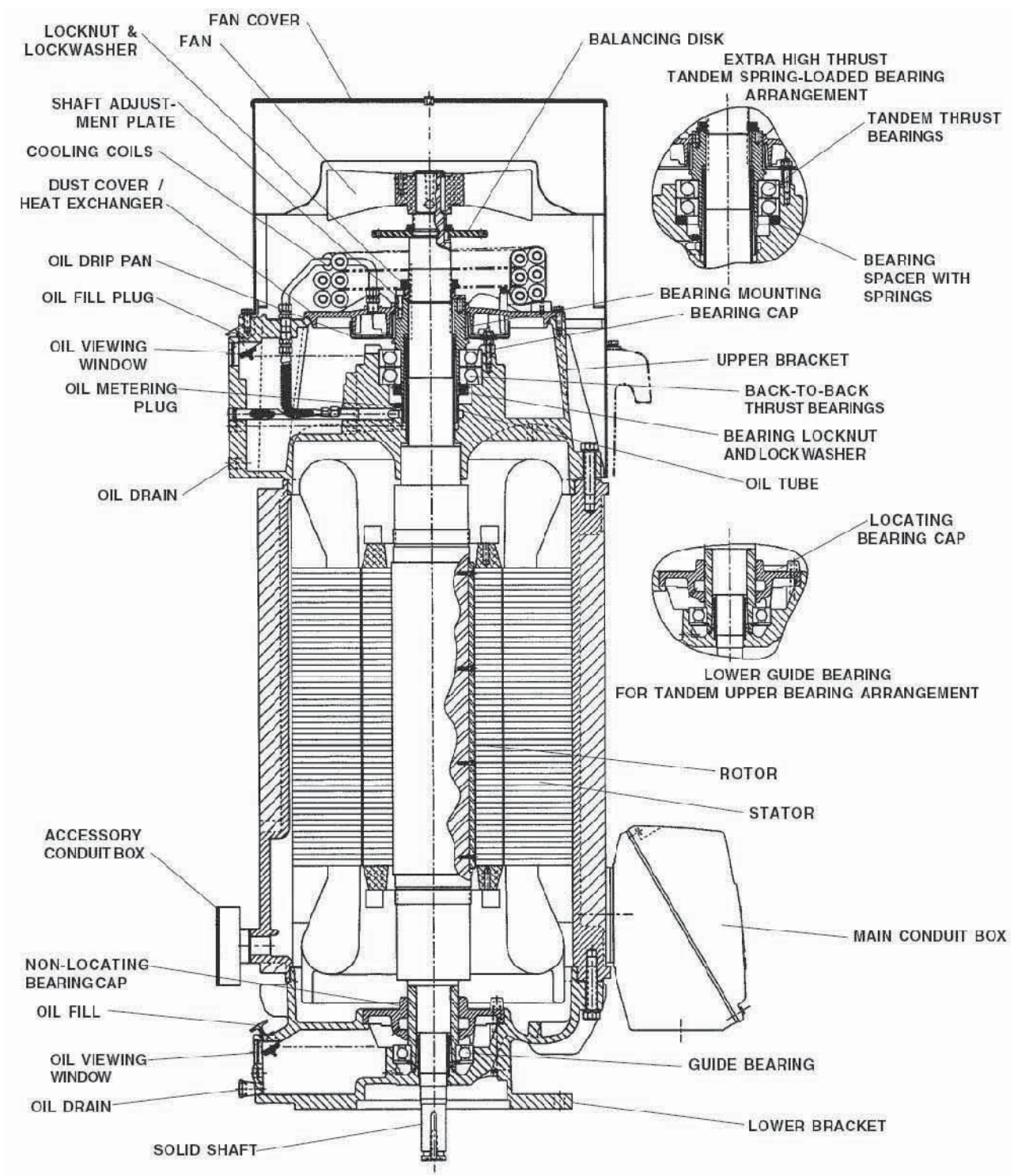

CANOPY CAP
GIB KEY
BOLTED COUPLING
LOCKNUT & LOCKWASHER
PUMP HEADSHAFT & NUT
(SUPPLIED WITH PUMP)
FAN COVER GUARD
BALL RETAINING RING
FAN
KEY
RATCHET BALL
COUPLING ADAPTOR
ROTATING RATCHET
BEARING CAP
STATIONARY RATCHET &
BEARING CAP
UPTHRUST &
GUIDE BEARING
GREASE FILL
GREASE DRAIN
BEARING CAP
UPPER BRACKET
ROTOR
STATOR
BEARING CAP
TANDEM THRUST
BEARINGS
(175% EHT)
GREASE DRAIN
GREASE FILL
SINGLE BEARING
(STANDARD HIGH THRUST)
LOWER BRACKET
OPTIONAL STABILIZER BUSHING

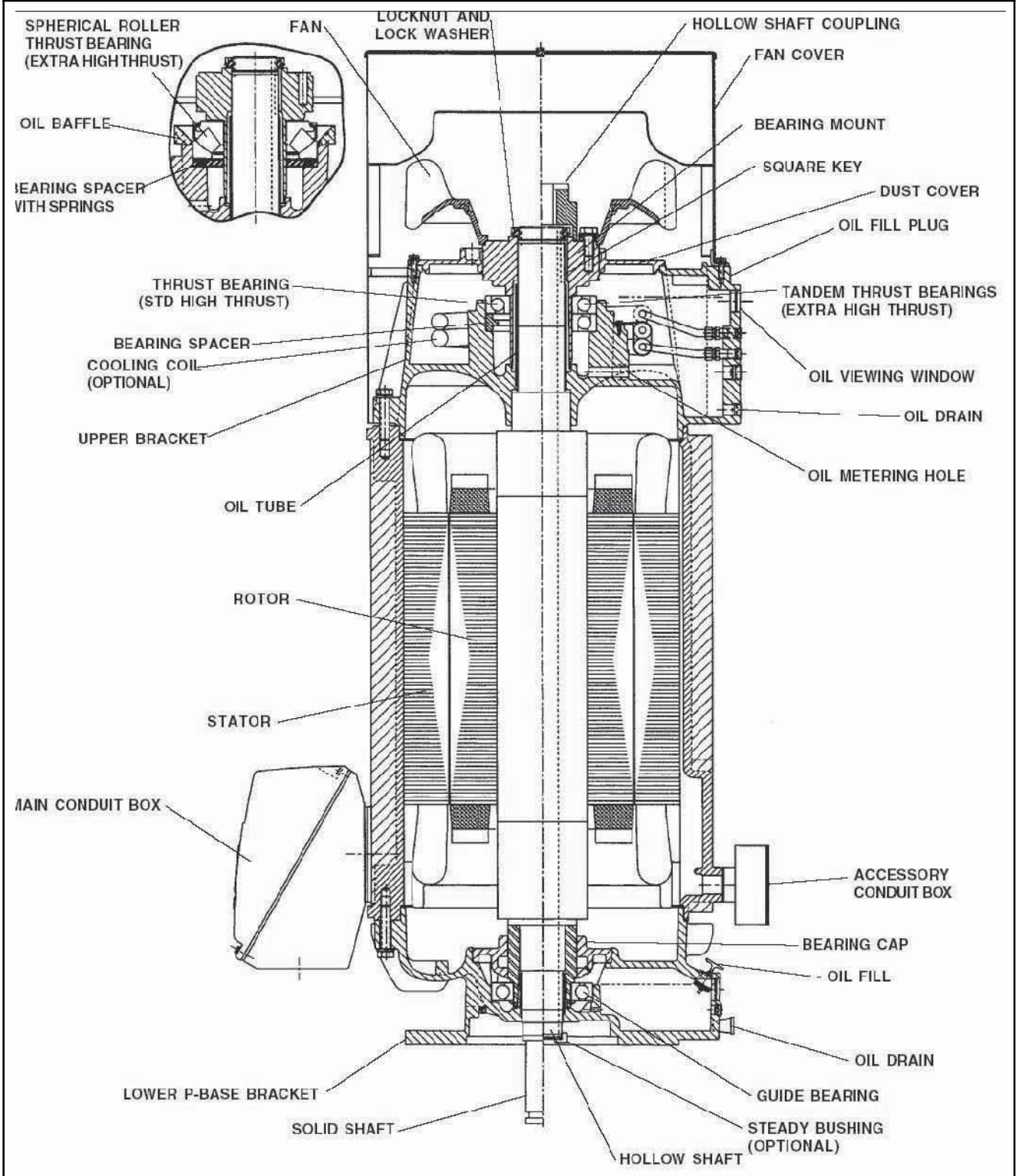

CANOPY CAP
LOCK NUT & LOCKWASHER
COUPLING
KEY
FAN COVER
OIL BAFFLE PLATE
FAN
THRUST BEARING (STD HIGH THRUST)
BEARING MOUNT
OIL FILL PLUG
BEARING CAP
UPPER BRACKET
OIL VIEWING WINDOW
THRUST BEARINGS (EXTRA HIGH THRUST)
OIL TUBE
BEARING SPACER
OIL DRAIN PLUG
STATOR
ROTOR
INNER BEARING CAP
LOWER BRACKET
GREASE FILL
GUIDE BEARING
OUTER BEARING CAP (440 FRAME ONLY)
SLINGER
HOLLOW SHAFT
SOLID SHAFT

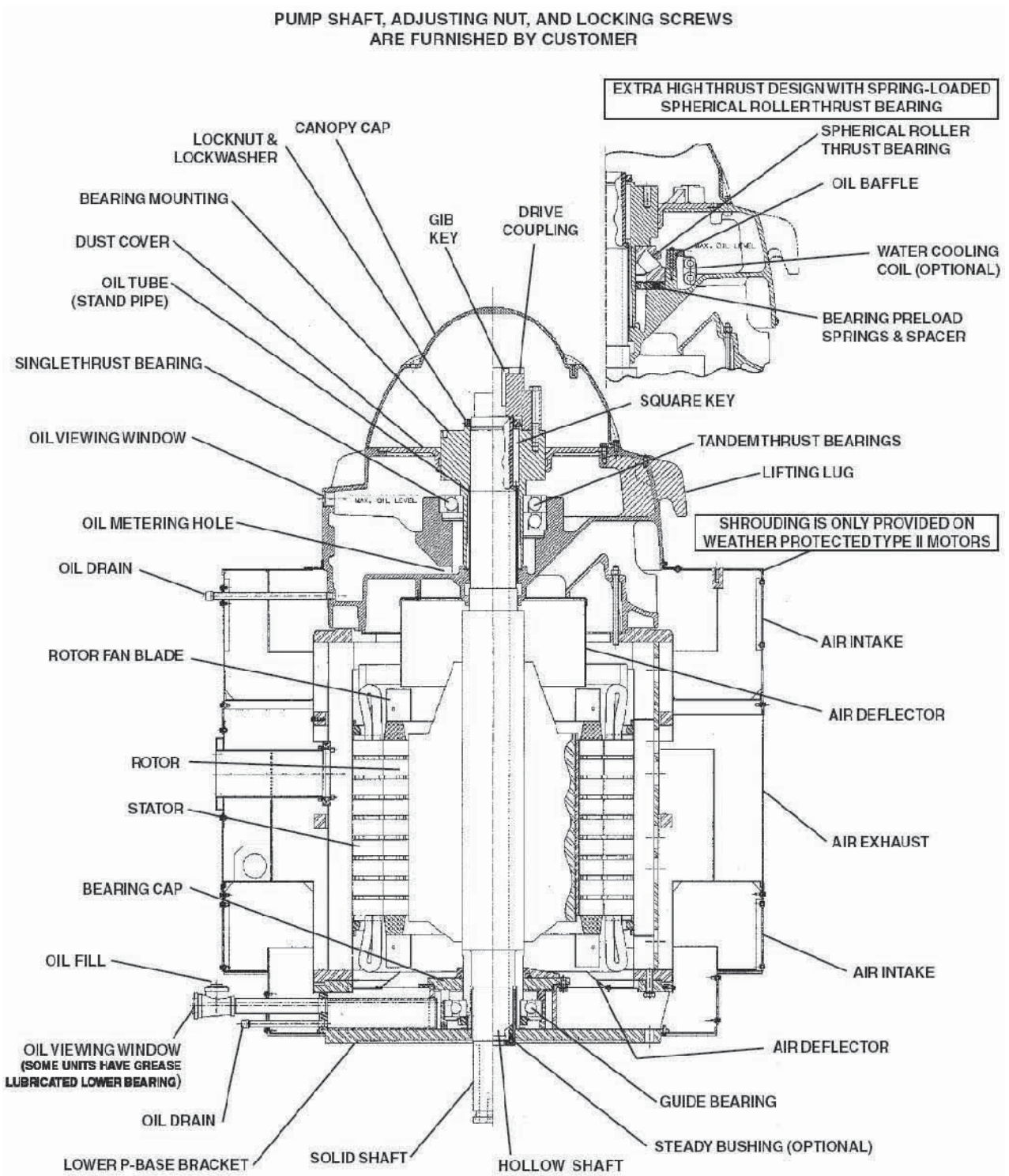

FAN COVER
FAN
GREASE FILL
LOCKNUT &
LOCKWASHER
BEARING CAP
THRUST BEARING
UPPER BRACKET
GREASE DRAIN
STATOR
ROTOR
ROTOR FAN BLADES
BEARING CAP
GREASE DRAIN
GUIDE BEARING
GREASE FILL
CONDUIT BOX
LOWER BRACKET

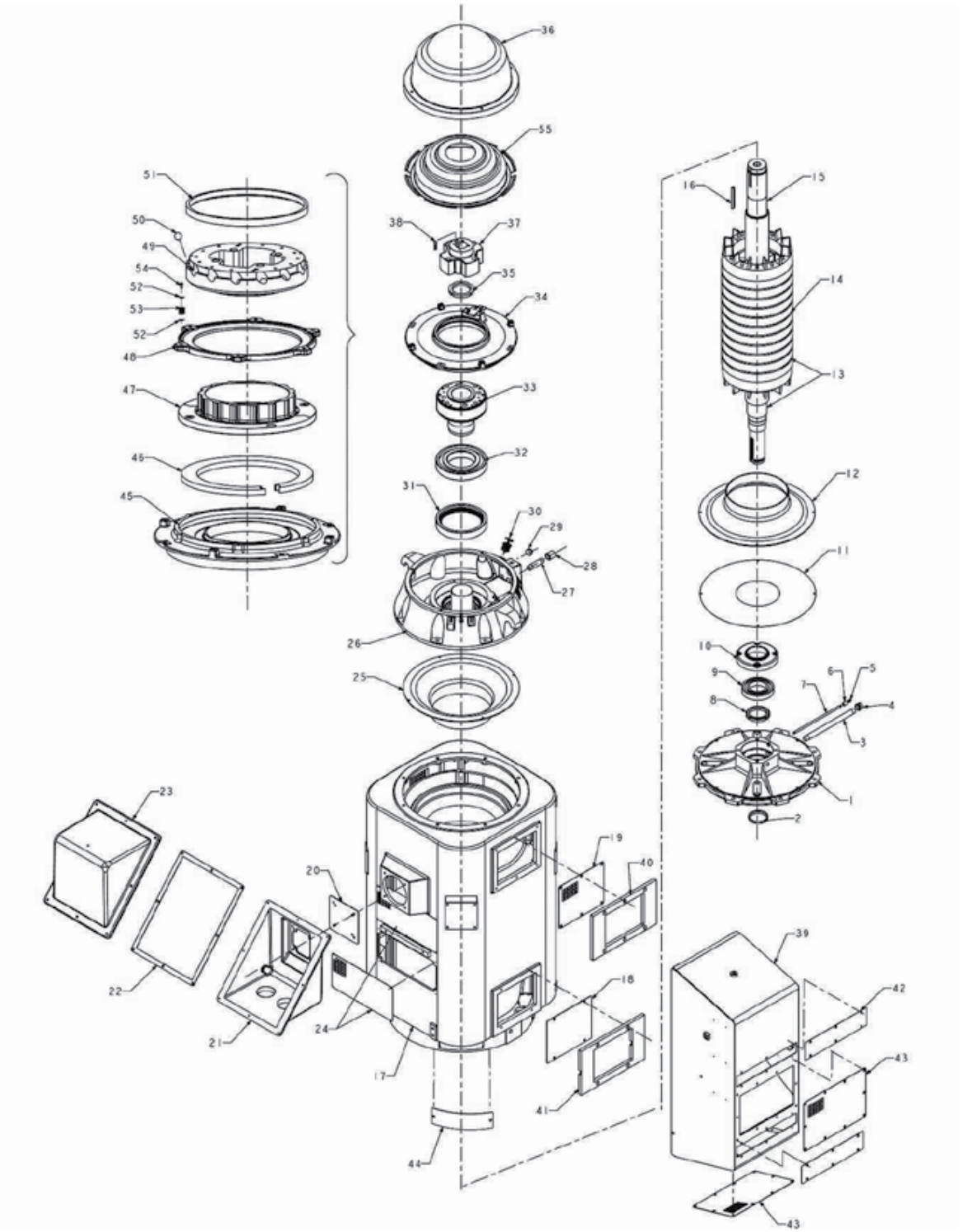

LOCKNUT & LOCKWASHER
FAN
FAN COVER
SHAFT ADJUSTMENT PLATE
COOLING COILS
DUST COVER / HEAT EXCHANGER
OIL DRIP PAN
OIL FILL PLUG
OIL VIEWING WINDOW
OIL METERING PLUG
OIL DRAIN
GUIDE BEARING
GREASE DRAIN
SOLID SHAFT
SLINGER
LOWER BRACKET
GREASE FILL
NON-LOCATING BEARING CAP
ROTOR
STATOR
LOCATING BEARING CAP
LOWER GUIDE BEARING FOR TANDEM UPPER BEARING ARRANGEMENT
OIL TUBE
BEARING LOCKNUT AND LOCKWASHER
UPPER BRACKET
BACK-TO-BACK THRUST BEARINGS
BEARING CAP
BEARING SPACER WITH SPRINGS
TANDEM THRUST BEARINGS
EXTRA HIGH THRUST TANDEM SPRING-LOADED BEARING ARRANGEMENT


HOLLOW SHAFT COUPLING
LOCKNUT AND LOCK WASHER
FAN COVER
SPHERICAL ROLLER THRUST BEARING (EXTRA HIGH THRUST)
FAN
OIL BAFFLE
DUST COVER
THRUST BEARING (STD HIGH THRUST)
COOLING COI (OPTIONAL)
BEARING SPACER
OIL FILL PLUG
BEARING SPACER WITH SPRINGS
OIL VIEWING WINDOW
BEARING MOUNT
SQUARE KEY
TANDEM THRUST BEARINGS (EXTRA HIGH THRUST)
OIL DRAIN
OIL METERING HOLE
UPPER BRACKET
OIL TUBE
ROTOR
STATOR
BEARING CAP
GREASE DRAIN
LOWER P-BASE BRACKET
GREASE FILL
GUIDE BEARING
SOLID SHAFT
HOLLOW SHAFT
SLINGER


LOCKNUT & LOCKWASHER
FAN
FAN COVER
BALANCING DISK
EXTRA HIGH THRUST TANDEM SPRING-LOADED BEARING ARRANGEMENT
TANDEM THRUST BEARINGS
SHAFT ADJUST-MENT PLATE
COOLING COILS
DUST COVER / HEAT EXCHANGER
OIL DRIP PAN
OIL FILL PLUG
OIL VIEWING WINDOW
OIL METERING PLUG
OIL DRAIN
BEARING SPACER WITH SPRINGS
BEARING MOUNTING
BEARING CAP
UPPER BRACKET
BACK-TO-BACK THRUST BEARINGS
BEARING LOCKNUT AND LOCK WASHER
OIL TUBE
LOCATING BEARING CAP
LOWER GUIDE BEARING FOR TANDEM UPPER BEARING ARRANGEMENT
ROTOR
STATOR
ACCESSORY CONDUIT BOX
MAIN CONDUIT BOX
NON-LOCATING BEARING CAP
OIL FILL
OIL VIEWING WINDOW
OIL DRAIN
GUIDE BEARING
LOWER BRACKET
SOLID SHAFT


SPHERICAL ROLLER THRUST BEARING (EXTRA HIGH THRUST)
FAN
LOCKNUT AND LOCK WASHER
HOLLOW SHAFT COUPLING
FAN COVER
OIL BAFFLE
BEARING MOUNT
SQUARE KEY
BEARING SPACER WITH SPRINGS
DUST COVER
OIL FILL PLUG
THRUST BEARING (STD HIGH THRUST)
TANDEM THRUST BEARINGS (EXTRA HIGH THRUST)
BEARING SPACER
COOLING COIL (OPTIONAL)
OIL VIEWING WINDOW
OIL DRAIN
UPPER BRACKET
OIL METERING HOLE
OIL TUBE
ROTOR
STATOR
MAIN CONDUIT BOX
ACCESSORY CONDUIT BOX
BEARING CAP
OIL FILL
OIL DRAIN
LOWER P-BASE BRACKET
GUIDE BEARING
SOLID SHAFT
STEADY BUSHING (OPTIONAL)
HOLLOW SHAFT


PUMP SHAFT, ADJUSTING NUT, AND LOCKING SCREWS
ARE FURNISHED BY CUSTOMER
EXTRA HIGH THRUST DESIGN WITH SPRING-LOADED
SPHERICAL ROLLER THRUST BEARING
SPHERICAL ROLLER
THRUST BEARING
OIL BAFFLE
WATER COOLING
COIL (OPTIONAL)
BEARING PRELOAD
SPRINGS & SPACER
LOCKNUT &
LOCKWASHER
CANOPY CAP
BEARING MOUNTING
DUST COVER
OIL TUBE
(STAND PIPE)
GIB
KEY
DRIVE
COUPLING
SINGLE THRUST BEARING
SQUARE KEY
OIL VIEWING WINDOW
TANDEM THRUST BEARINGS
LIFTING LUG
OIL METERING HOLE
SHROUDING IS ONLY PROVIDED ON
WEATHER PROTECTED TYPE II MOTORS
OIL DRAIN
AIR INTAKE
ROTOR FAN BLADE
AIR DEFLECTOR
ROTOR
STATOR
AIR EXHAUST
BEARING CAP
OIL FILL
AIR INTAKE
OIL VIEWING WINDOW
(SOME UNITS HAVE GREASE
LUBRICATED LOWER BEARING)
AIR DEFLECTOR
GUIDE BEARING
OIL DRAIN
STEADY BUSHING (OPTIONAL)
LOWER P-BASE BRACKET
SOLID SHAFT
HOLLOW SHAFT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3
2
1
23
22
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24
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18
41
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42
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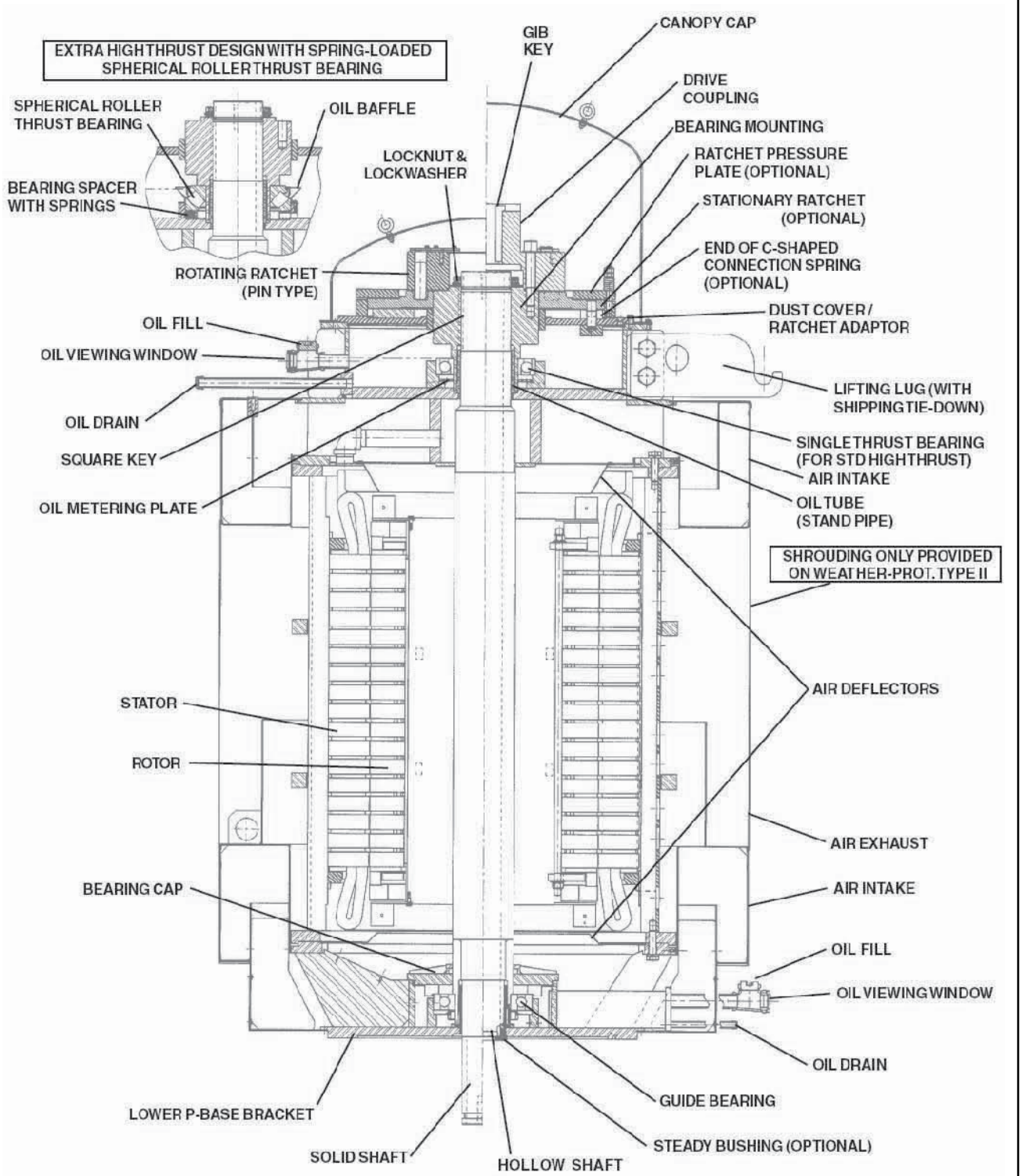
43

ITEM NO.	QTY	NAME OF PART
1	1	Lower Bracket
2	1	Shaft Water Slinger
3	1	Pipe Nipple (Lower Grease Drain)
4	1	Pipe Cap (Lower Grease Drain)
5	1	Grease Zerk Fitting
6	1	Pipe Coupling (Lower Grease Fill)
7	1	Pipe Nipple (Lower Grease Fill)
8	1	Locknut and Lockwasher (Lower Bearing)
9	1	Lower Bearing
10	1	Lower Bearing Cap
11	1	Lower Intake Screen (Only on WP-1)
12	1	Lower Air Deflector
13	1	Rotor Assembly
14	1	Rotor Core
15	1	Rotor Shaft
16	1	Square Key (Bearing Mounting to Shaft)
17	1	Stator Assembly
18	2	Lower Air Intake Cover (Only on WP-1)
19	2	Upper Air Intake Screen (Only on WP-1)
20	1	Gasket (Outlet Box Base to Stator)
21	1	Outlet Box Base
22	1	Gasket (Outlet Box Cover to Base)
23	1	Outlet Box Cover
24	2-(5008) 4-(5012) 4-(5813)	Exhaust Screen
25	1	Upper Air Deflector
26	1	Upper Bracket
27	1	Pipe Nipple (Oil Drain)
28	1	Pipe Cap (Oil Drain)
29	1	Oil Sight Gauge Window

ITEM NO.	QTY	NAME OF PART
30	1	Oil Fill Plug (Expanding)
31	1	Bearing Spacer (or Tandem Thrust Bearing)
32	1	Upper Thrust Bearing
33	1	Bearing Mounting
34	1	Dust Cover (Only on Units Without Ratchet)
35	1	Locknut and Lockwasher (Brg Mtg to Shaft)
36	1	Canopy Cap
37	1	Thrust Coupling (Only on Hollowshaft)
38	1	Gib Key (Only on Hollowshaft)
39	2	WP2 Intake Box (Only on WP-2)
40	2	Upper Adapter Flange (Only on WP-2)
41	2	Lower Adapter Flange (Only on WP-2)
42	4	Filter Access Cover (Only on WP-2)
43	4	Intake Screen (Only on WP-2)
44	4	Cover (Flange Access) (Only on WP-2)
45	1	Ratchet Adaptor (Only on Units With Ratchet)
46	1	Connection Spring (Only on Units With Ratchet)
47	1	Stationary Ratchet (Only on Units With Ratchet)
48	1	Pressure Plate (Only on Units With Ratchet)
49	1	Rotating Ratchet (Only on Units With Ratchet)
50	12-(5008) 14-(5012) 16-(5813)	Ratchet Ball (Only on Units with Ratchet)
51	1	Ball Retaining Ring (Only on Units With Ratchet)
52	4-(5008) 12-(5012) 8-(5813)	Plain Washer (Only on Units With Ratchet)
53	4-(5008) 6-(5012) 8-(5813)	Die Spring (Only on Units With Ratchet)
54	4-(5008) 6-(5012) 8-(5813)	Screw (Only on Units With Ratchet)
55	1	Pressurization Baffle (5000 Frame Only)


EXTRA HIGH THRUST DESIGN WITH SPRING-LOADED SPHERICAL ROLLER THRUST BEARING
SPHERICAL ROLLER THRUST BEARING
OIL BAFFLE
BEARING SPACER WITH SPRINGS
LOCKNUT & LOCKWASHER
GIB KEY
CANOPY CAP
DRIVE COUPLING
BEARING MOUNTING
RATCHET PRESSURE PLATE (OPTIONAL)
STATIONARY RATCHET (OPTIONAL)
END OF C-SHAPED CONNECTION SPRING (OPTIONAL)
ROTATING RATCHET (PIN TYPE)
DUST COVER / RATCHET ADAPTOR
OIL FILL
OIL VIEWING WINDOW
OIL DRAIN
SQUARE KEY
OIL METERING PLATE
LIFTING LUG (WITH SHIPPING TIE-DOWN)
SINGLE THRUST BEARING (FOR STD HIGH THRUST)
AIR INTAKE
OIL TUBE (STAND PIPE)
SHROUDING ONLY PROVIDED ON WEATHER-PROT. TYPE II
AIR DEFLECTORS
STATOR
ROTOR
AIR EXHAUST
BEARING CAP
AIR INTAKE
OIL FILL
OIL VIEWING WINDOW
OIL DRAIN
GUIDE BEARING
LOWER P-BASE BRACKET
STEADY BUSHING (OPTIONAL)
SOLID SHAFT
HOLLOW SHAFT

Installation Record

NAMEPLATE AND INSTALLATION INFORMATION

SERIAL NUMBER OR MODEL NUMBER..... _____
HORSEPOWER ..... _____
MOTOR RPM..... _____
PHASE ..... _____
FREQUENCY ..... _____
AMPS ..... _____ **AT** _____ **VOLTS**
DESIGN ..... _____
FRAME ..... _____
DATE PURCHASED ..... _____ **P.C. NUMBER** _____
DATE INSTALLED ..... _____
LOCATION OF JOB SITE ..... _____
MACHINE OR INSTALLATION NUMBER ..... _____
PURCHASED FROM ..... _____
MOTOR RESISTANCE LINE TO LINE AT TIME OF INSTALLATION ..... _____

INSULATION TO GROUND READING AT TIME OF INSTALLATION .....

RECORD OF MAINTENANCE

GRADE AND TYPE OF LUBRICANT USED .....

DATE OF LAST RELUBRICATION	INSULATION RESISTANCE		OVERHAUL OR REPAIR	
	DATE	MEGOHMS	DATE	ACTION

Table 6
Threaded Fastener Torque Requirements

All threaded fasteners used for rigid joints (cast iron and low carbon steel) in products of Nidec Motor Corporation, are to be tightened to the torque values listed in the following tabulation. Values are based upon dry assembly.

Diameter of Fastener	Number of Threads Per Inch	Grade 5 Fasteners	Grade 2 Fasteners
#6	32	16 lb.-in.	10 lb.-in.
	40	18	12
#8	32	30	19
	36	31	20
#10	24	43	27
	32	49	31
#12	24	66	37
	28	72	40
1/4”	20	96	66
	28	120	76
5/16”	18	16 lb.-ft.	11 lb.-ft.
	24	18	12
3/8”	16	29	20
	24	34	23
7/16”	14	46	30
	20	52	35
1/2”	13	70	50
	20	71	55
9/16”	12	102	
	18	117	
5/8”	11	140	
	18	165	
3/4”	10	249	
	16	284	
7/8”	9	401	
	14	446	
1”	8	601	
	14	666	
1-1/8”	7	742	
	12	860	
1-1/4”	7	1046	
	12	1196	
1-3/8”	6	1371	
	12	1611	
1-1/2”	6	1820	
	12	2110	

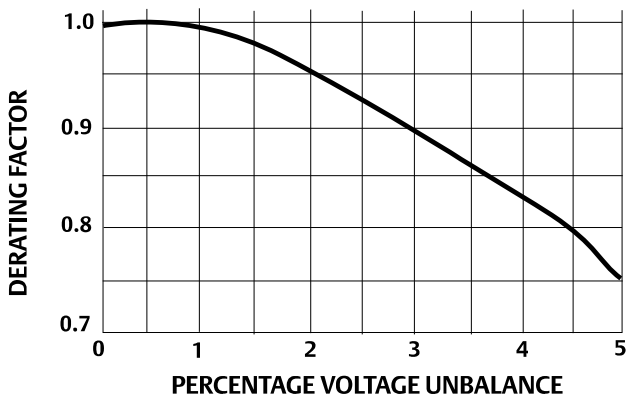
The above torque limits are not to be used when a drawing or specification lists a specific torque.

Effects of Unbalanced Line Voltage.

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

When the value of supply voltage leg to leg is not equal (e.g. 460-460-460), the risk of unbalanced line voltage is present. If this voltage unbalance exceeds about 1%, excessive temperature rise will result. Unless the motor HP capacity is derated to compensate, the motor will run hot resulting in degredation of the insulation system and bearing lubricant.

From NEMA MG-1, 14.36: Derating factors due to unbalanced line voltage



Example: Field ratings of Phase A - 480 v, Phase B = 460 v, Phase C = 450 v

As a rule of thumb, the percentage increase in temperature rise will be about two times the square of the percentage voltage unbalance. In this case the average voltage (480 + 460 + 450) is equal to 463 volts. The maximum deviation between legs is 17 volts (480 - 463 volts).

The Percentage voltage unbalance is determined as follows: 17 / 463 x 100 = 3.7%. The temperature rise will then increase $(3.7)^2$ x 2 = 27%. This condition will reduce the typical life of your motor to less than 25% of its design life. Should this condition be present, call your electric utility and resolve your unbalanced supply condition.

Other areas of motor performance will also be affected - e.g., loss of torque capacity, change in full load RPM, greatly unbalanced current draw at normal operating speed. Refer to NEMA MG-1 section 14.36 for details.

Motors Applied to Variable Frequency Drives (VFD's)

Electric motors can be detrimentally affected when applied with variable frequency drives (VFD's). The non-sinusoidal waveforms of VFD's have harmonic content which causes additional motor heating; and high voltage peaks and short rise times, which result in increased insulation stress, especially when long power cable lengths are used. Standard motors utilized with VFD's must be limited to those application consderations defined in **NEMA MG-1 Part 30.**

NEMA MG-1 Part 31 defines performance and application considerations for Definite-Purpose Inverter Fed motors. To insure satisfactory performance and reliability, Nidec Motor Corporation offers and recommends nameplated inverter duty motor products which meet the requirements of NEMA MG-1 Part 1. The use of non-inverter duty motors may result in unsatisfactory performance or premature failure, which may not be warrantable under the Terms and Conditions of Sale. Contact your Nidec Motor corporation Field Sales Engineer for technical assistance in motor selection, application and warranty details.

ELECTRIC MOTOR LOAD TEST USING THE WATT HOUR METER

In the analysis of electric motors it is sometimes desirable to conduct an accurate load check on a particular installation to determine whether the motor is operating within the rating and horsepower for which it was designed. Since most pumps installations have their own watt hour power meters, accurate readings will permit a load check via the following formula:

K = Disc constant (watts per revolution of disc per hour). This is typically found on the meter face.

R = Revolutions of disc in watt meter within the time of the test.

T = Time of test, in seconds.

Transformer ratio = Stated on meter face. Must be included where current transformers are used with watt meters.

To obtain input kilowatts:

$$\text{Input KW} = \frac{K \times R \times 3.6}{T}$$

To obtain input horsepower:

$$\text{Input HP} = \frac{K \times R \times 4.83 \times \text{Transformer Ratio}}{T}$$

The watt hour meter measures power consumed over a period of time. It is necessary to establish the rate at which power is being consumed by the work being done. We establish this rate by counting the revolutions of the disc in a given time. Here is a typical example of a load check:

GIVEN

- Pump motor to be load checked is rated 100 HP, 1800 RPM, 3-phase, 60 Hz, 1.15 service factor, 91.0 Percent Efficiency.
- Disc constant (K) found on face of meter = 40.
- Transformer ratio found on face of meter = 3.

DATA FOUND FROM TESTS
With stop watch, disc was observed to revolve 10 times in exactly 49 seconds. Therefore, R = 10; T = 49.

THUS

$$\text{Input HP} = \frac{40 \times 10 \times 4.83 \times 3}{49} = 118.29$$

Output HP = Input HP x Motor Efficiency
Output HP = 118.29 x 91% = 107.54

CONCLUSION
The output HP (107.54) is greater than output HP shown on nameplate (100 HP) but is well within the 1.15 service factor which applies to this motor.

Member of the following:

† All marks shown within this document are properties of their respective owners.

PN 835172 Rev. 08/11
IN509-1D

NIDEC MOTOR CORPORATION

8050 W. Florissant Avenue | St. Louis, MO 63136
Phone: 800-566-1418 | Fax: 314-595-8922
www.usmotors.com

SECTION III

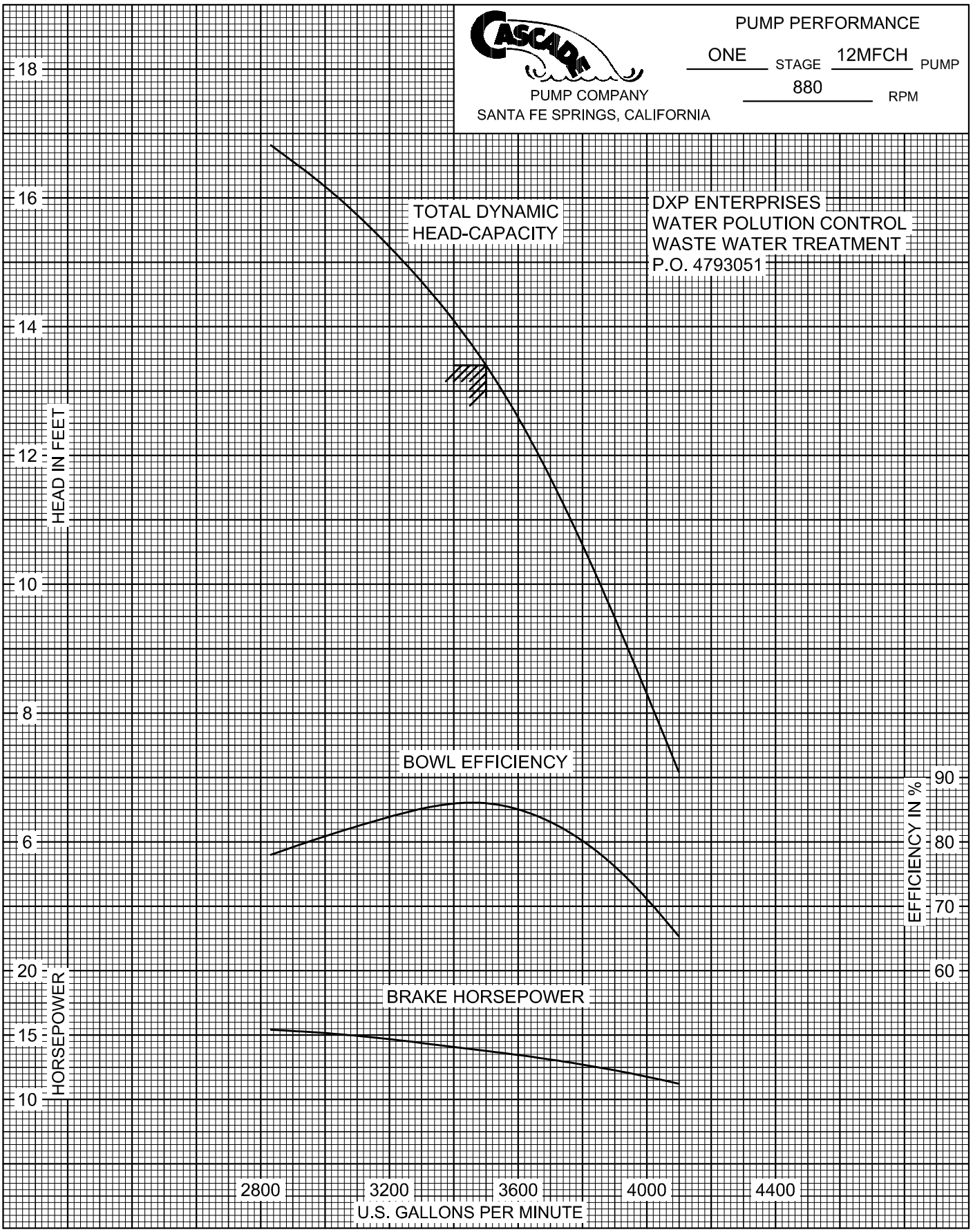
CURVE NO. 18659/60

CASCADE PUMP COMPANY
SANTA FE SPRINGS, CALIFORNIA

PUMP PERFORMANCE

ONE STAGE 12MFCH PUMP

880 RPM

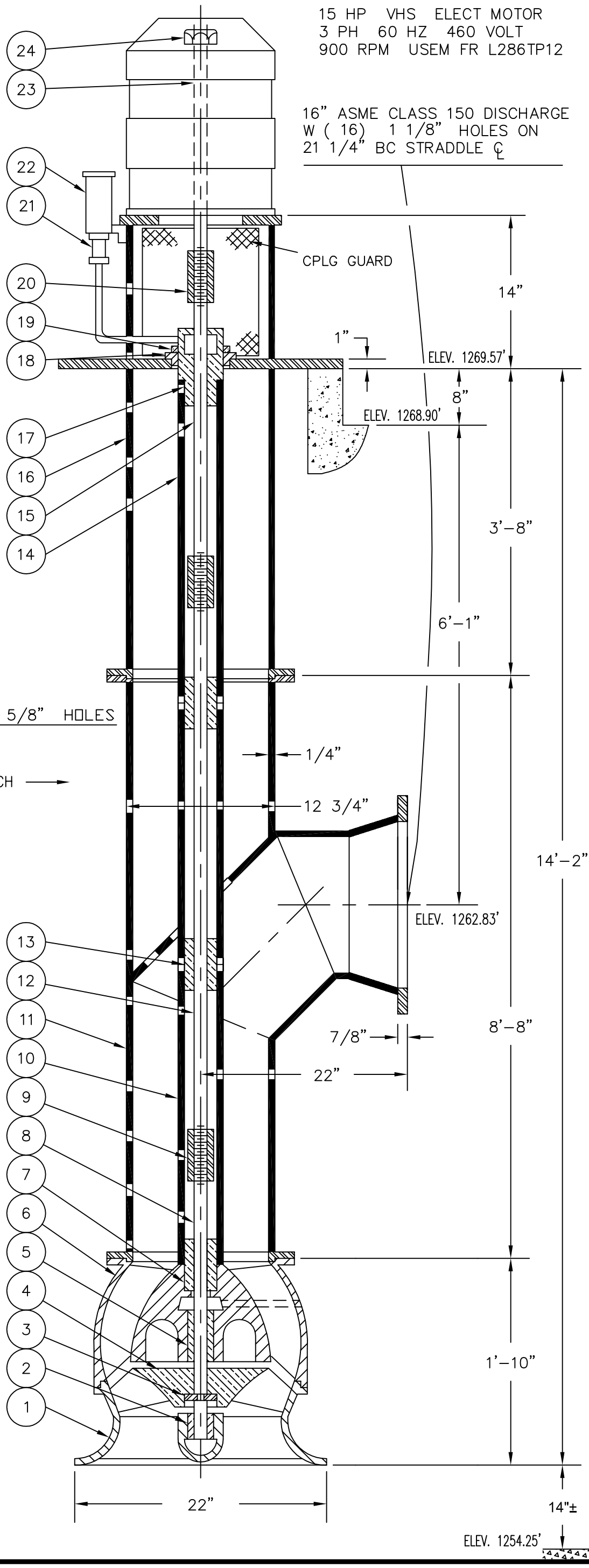


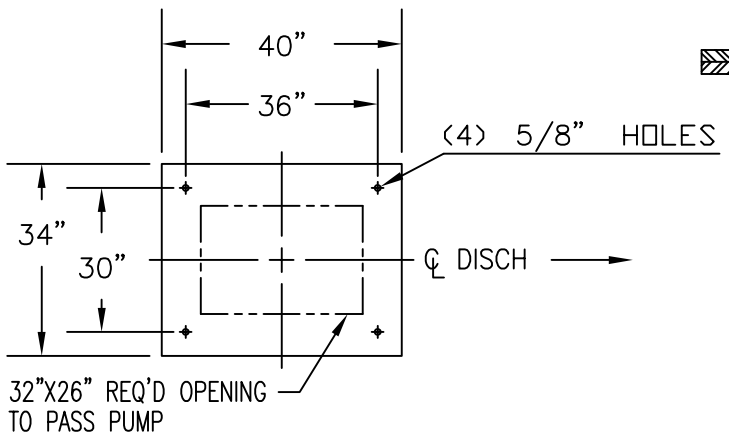
CURVES SHOW APPROXIMATELY THE CHARACTERISTICS WHEN PUMPING CLEAR NON-AERATED WATER. NO GUARANTEE IS MADE EXCEPT FOR THE RATED POINT.

REVISIONS

ITEM	REQ'D	DESCRIPTION	MATERIAL	PART NO.
1	1	SUCTION BOWL	C.I. CL–30	MFCH101
2	1	SUCT. BOWL BUSHING	BRONZE	E102
3	1	THRUST COLLAR & KEY	416 STN. STL.	M100D
4	1	IMPELLER	316 STN. STL.	MFCH103
5	1	DISCHARGE BOWL BUSHING	BRONZE	E102
6	1	DISCHARGE BOWL	C.I. CL–30	MFCH100
7	1	DISCH. BOWL BEARING	BRONZE	D106
8	1	BOWL SHAFT	416 STN. STL.	MFCH150
9	2	LINE SHAFT COUPLING	C–1020 STL.	SD950
10	1	BOTTOM ENCLOSING TUBE	EX–HVY PIPE	D108
11	1	DISCHARGE ELBOW	FAB. STEEL	18659–1
12	1	BOTTOM LINE SHAFT	C–1045 STL.	SD900
13	2	LINE SHAFT BEARING	BRONZE	D106A
14	2	TOP ENCLOSING TUBE	EX–HVY PIPE	D108
15	1	TOP LINE SHAFT	C–1045 STL.	18659–3
16	1	DISCHARGE COLUMN	FAB. STEEL	18659–2
17	1	TENSION NUT BODY	BRONZE	H36H
18	1	TENSION NUT	CAST IRON	H38
19	1	LOCK RING & WASHER	BRONZE	H39A
20	1	LINE SHAFT COUPLING	C–1020 STL.	SC950
21	1	LUBRICATOR – QUART	SOLENOID	STOCK
22	1	OIL RESERVOIR – 460 VOLT	ALUMINUM	STOCK
23	1	HEAD SHAFT	C–1045 STL.	C920
24	1	ADJUSTING NUT	STEEL	C921

ITEMS NO. ARE 2, 4, 5, 7, 8, 13 & 17 ARE RECOMMENDED SPARE PARTS





BASE PLATE DETAIL

BOWL SHAFT DIA.= 1 1/2"
LINE SHAFT DIA.= 1 1/2" X 1 3/16"
HEAD SHAFT DIA.= 1 3/16"
ENCL. TUBE DIA.= 2 1/2"

SHOP ORDER – 18659/60

WATER POLUTION CONTROL
WASTE WATER TREATMENT

CASCADE PUMP COMPANY
SANTA FE SPRINGS, CALIFORNIA

#12MFCH MIXED FLOW PUMP
16" ASME CLASS 150 DISCHARGE

DXP ENTERPRISE

ORDER	DATE	SCALE
4793051	1/10/17	N.T.S.
DRAWN	CHECKED	
CM		3MS7880